

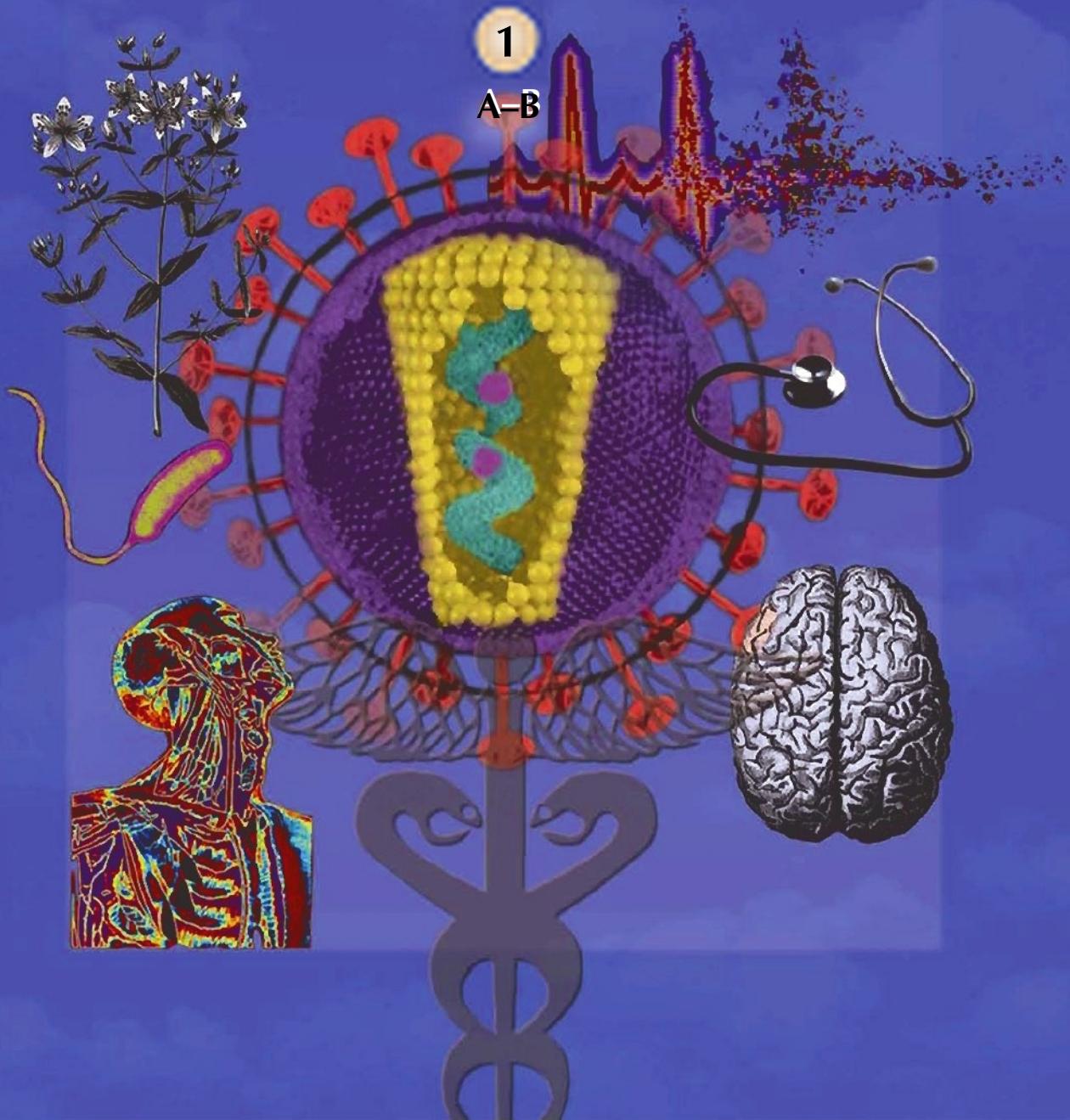
# The GALE ENCYCLOPEDIA *of Medicine*

FOURTH EDITION

VOLUME

1

A-B



*The GALE*  
ENCYCLOPEDIA *of*  
**MEDICINE**

**FOURTH EDITION**

# *The GALE* ENCYCLOPEDIA of MEDICINE

FOURTH EDITION

VOLUME

1

A-B

LAURIE J. FUNDUKIAN, EDITOR



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Barbiturates
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Bartonellosis
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Bedbug infestation
Bedsores
Bedwetting

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Beriberi	Bowel training	Carbon monoxide poisoning
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Beta blockers	Brain tumor	Cardiac blood pool scan
Bile duct cancer	Breast biopsy	Cardiac catheterization
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**C**

C-reactive protein  
Caffeine  
Calcium  
Calcium channel blockers  
Campylobacteriosis  
Cancer  
Cancer therapy, definitive

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Chorionic villus sampling	Congenital ureter anomalies	Cushing's syndrome
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Chronic granulomatous disease	Congestive heart failure	Cutaneous T-cell lymphoma
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Chronic obstructive pulmonary disease	Constipation	Cyanosis
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Cirrhosis	Contractures	Cyclosporiasis
Cleft lip and palate	Cooling treatments	Cystectomy
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Erythropoietin test	Fever	Gamma globulin
Escherichia coli	Fever evaluation tests	Gamma knife surgery
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Esophageal pouches	Fibrocystic condition of the breast	Gastric acid determination
Esophagogastroduodenoscopy	Fibromyalgia	Gastric bypass
Evoked potential studies	Fifth disease	Gastric emptying scan
Exercise	Filariasis	Gastrinoma
Exophthalmos	Finasteride	Gastritis
Expectorants	Fingertip injuries	Gastroenteritis
External sphincter electromyography	First aid	Gastroesophageal reflux disease
Extracorporeal membrane oxygenation	Fish and shellfish poisoning	Gastrostomy
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Eye glasses and contact lenses	Fluke infections	Gene therapy
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Female orgasmic disorder
Female sexual arousal disorder
Fetal alcohol syndrome

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Friedreich's ataxia
Frostbite and frostnip
Fugl-Meyer assessment
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Galactorrhea
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Gallbladder nuclear medicine scan
Gallbladder x rays
Gallium scan of the body
Gallstone removal

**G**

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Gastric acid determination
Gastric bypass
Gastric emptying scan
Gastrinoma
Gastritis
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Gastroesophageal reflux disease
Gastrostomy
Gaucher disease
Gay and lesbian health
Gender identity disorder
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Genetic counseling
Genetic testing
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Germ cell tumors
Gestalt therapy
Gestational diabetes
GI bleeding studies
Giardiasis
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Glaucoma
Glomerulonephritis
Glucose-6-phosphate dehydrogenase deficiency
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Glycogen storage diseases
Glycosylated hemoglobin test
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**H**

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Guillain-Barré syndrome	Hemoglobin test	Hospital-acquired infections
Guinea worm infection	Hemoglobinopathies	HPV vaccination
Gulf War syndrome	Hemolytic-uremic syndrome	Human-potential movement
Gynecomastia (male breast enlargement)	Hemolytic anemia	Human bite infections
	Hemophilia	Human chorionic gonadotropin pregnancy test
	Hemophilus infections	Human leukocyte antigen test
	Hemoptysis	Human papilloma virus
	Hemorrhagic fevers	Huntington's disease
	Hemorrhoids	Hydatidiform mole
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	Hepatitis, alcoholic	Hydrocephalus
	Hepatitis, autoimmune	Hydronephrosis
	Hepatitis B	Hydrotherapy
	Hepatitis C	Hyperaldosteronism
	Hepatitis D	Hyperbaric chamber
	Hepatitis, drug-induced	Hypercalcemia
	Hepatitis E	Hypercholesterolemia
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Inclusion conjunctivitis  
Incompetent cervix  
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Induction of labor

Infant massage  
Infection control  
Infectious arthritis  
Infectious disease  
Infectious mononucleosis  
Infertility  
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Infertility therapies  
Influenza  
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Insomnia  
Insulin resistance  
Intermittent claudication  
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Intersex states  
Interstitial microwave thermal therapy  
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Laser surgery  
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Legionnaires' disease	Lymph node biopsy	Medullary sponge kidney
Leishmaniasis	Lymphadenitis	Melioidosis
Leprosy	Lymphangiography	Memory loss
Leptospirosis	Lymphedema	Ménière's disease
Lesch-Nyhan syndrome	Lymphocyte typing	Meningitis
Leukemia stains	Lymphocytic choriomeningitis	Meningococcemia
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Leukemias, chronic	Lymphogranuloma venereum	Men's health
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Lichen simplex chronicus		Mesothelioma
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Lipoproteins test		Methemoglobinemia
Liposuction		Microphthalmia and anophthalmia
Listeriosis		Mifepristone
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Liver cancer		Mineral toxicity
Liver disease		Minerals
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Liver nuclear medicine scan		Minoxidil
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Lung abscess		Mood disorders
Lung biopsy		Motion sickness
Lung cancer, non-small cell		Movement disorders
Lung cancer, small cell		Movement therapy
Lung diseases due to gas or chemical exposure		MRSA infections
Lung perfusion and ventilation scan		Mucopolysaccharidoses
Lung surgery		Mucormycosis
Lung transplantation		Multiple chemical sensitivity

**M**

Macular degeneration
Magnesium imbalance
Magnetic field therapy
Magnetic resonance imaging
Malabsorption syndrome
Malaria
Malignant lymphomas
Malignant melanoma
Malingering
Mallet finger
Mallory-Weiss syndrome
Malnutrition
Malocclusion
MALT lymphoma
Mammography
Mania
Marfan syndrome
Marijuana
Marriage counseling
Marshall-Marchetti-Krantz procedure
Massage therapy
Mastectomy
Mastitis
Mastocytosis
Mastoidectomy
Mastoiditis
Maternal to fetal infections
Maxillofacial trauma
Measles
Meckel's diverticulum
Mediastinoscopy

Multiple-gated acquisition (MUGA) scan	Nasal trauma	Occupational therapy
Multiple endocrine neoplasia syndromes	Nasogastric suction	Oil spills: health effects
Multiple myeloma	Nasopharyngeal culture	Oligomenorrhea
Multiple personality disorder	Naturopathic medicine	Omega-3 fatty acids
Multiple pregnancy	Nausea and vomiting	Onychomycosis
Multiple sclerosis	Near-drowning	Oophorectomy
Mumps	Necrotizing enterocolitis	Ophthalmoplegia
Munchausen syndrome	Neonatal jaundice	Oppositional defiant disorder
Muscle relaxants	Nephrectomy	Optic atrophy
Muscle spasms and cramps	Nephritis	Optic neuritis
Muscular dystrophy	Nephrotic syndrome	Oral contraceptives
Mushroom poisoning	Nephrotoxic injury	Oral hygiene
Music therapy	Neuralgia	Orbital and periorbital cellulitis
Mutism	Neuroblastoma	Orchitis
Myasthenia gravis	Neuroendocrine tumors	Organ donation
Mycetoma	Neurofibromatosis	Organic food
Mycobacterial infections, atypical	Neurogenic bladder	Orthodontics
Mycoplasma infections	Neurolinguistic programming	Orthopedic surgery
Myelodysplastic syndrome	Neurological exam	Orthostatic hypotension
Myelofibrosis	Neurosurgery	Osteoarthritis
Myelography	Neutropenia	Osteochondroses
Myers-Briggs type indicator	Nicotine and related disorders	Osteogenesis imperfecta
Myocardial biopsy	Night terrors	Osteomyelitis
Myocardial resection	Nitrogen narcosis	Osteopathy
Myocarditis	Nocardiosis	Osteopetroses
Myoglobin test	Nongonococcal urethritis	Osteoporosis
Myomectomy	Non-nucleoside reverse transcriptase inhibitors	Ostomy
Myopathies	Nonsteroidal anti-inflammatory drugs	Otitis externa
Myopia	Noroviruses	Otitis media
Myositis	Nosebleed	Otosclerosis
Myotonic dystrophy	Numbness and tingling	Ototoxicity
Myringotomy and ear tubes	Nutrition	Ovarian cancer
Myxoma	Nutrition through an intravenous line	Ovarian cysts
	Nutritional supplements	Ovarian torsion
	Nystagmus	Overactive bladder
		Overhydration
		Oxygen/ozone therapy

**N**

Nail-patella syndrome  
Nail removal  
Narcolepsy  
Narcotics  
Nasal irrigation  
Nasal packing  
Nasal papillomas  
Nasal polyps

**O**

Obesity  
Obesity surgery  
Obsessive-compulsive disorder  
Obstetrical emergencies  
Occupational asthma

**P**

Pacemakers  
Paget's disease of bone  
Paget's disease of the breast  
Pain  
Pain management  
Palliative care

Palpitations	Peroxisomal disorders	Pneumonia
Pancreas transplantation	Personality disorders	Pneumothorax
Pancreatectomy	Pervasive developmental disorders	Poison ivy and poison oak
Pancreatic cancer, endocrine	Pet therapy	Poisoning
Pancreatic cancer, exocrine	Peyronie's disease	Polarity therapy
Pancreatitis	Pharmacogenetics	Polio
Panic disorder	Phenylketonuria	Polycystic kidney disease
Pap test	Pheochromocytoma	Polycystic ovary syndrome
Papilledema	Phimosis	Polycythemia vera
Paracentesis	Phlebotomy	Polydactyly and syndactyly
Paralysis	Phobias	Polyglandular deficiency syndromes
Paranoia	Phosphorus imbalance	Polyhydramnios and oligohydramnios
Parathyroid hormone test	Photodynamic therapy	Polymyalgia rheumatica
Parathyroid scan	Photorefractive keratectomy and laser-assisted in-situ keratomileusis	Polymyositis
Parathyroidectomy	Photosensitivity	Polysomnography
Paratyphoid fever	Phototherapy	Porphyrias
Parkinson's disease	Physical allergy	Portal vein bypass
Parotidectomy	Physical examination	Positron emission tomography (PET)
Paroxysmal atrial tachycardia	Physical therapy	Post-concussion syndrome
Parrot fever	Pica	Post-traumatic stress disorder
Partial thromboplastin time	Pickwickian syndrome	Postmenopausal bleeding
Paruresis	Piercing and tattoos	Postpartum depression
Patau syndrome	Pilates	Postpolio syndrome
Patent ductus arteriosus	Pinguecula and pterygium	Prader-Willi syndrome
Pellagra	Pinta	Precocious puberty
Pelvic exam	Pituitary dwarfism	Preeclampsia and eclampsia
Pelvic fracture	Pituitary tumors	Pregnancy
Pelvic inflammatory disease	Pityriasis rosea	Premature ejaculation
Pelvic relaxation	Placenta previa	Premature labor
Pelvic ultrasound	Placental abruption	Premature menopause
Penicillins	Plague	Premature rupture of membranes
Penile cancer	Plasma renin activity	Prematurity
Penile prostheses	Plasmapheresis	Premenstrual dysphoric disorder
Percutaneous transhepatic cholangiography	Plastic, reconstructive, and cosmetic surgery	Premenstrual syndrome
Perforated eardrum	Platelet aggregation test	Prenatal surgery
Perforated septum	Platelet count	Preparing for surgery
Pericardiocentesis	Platelet function disorders	Prepregnancy counseling
Pericarditis	Pleural biopsy	Presbyopia
Perinatal infection	Pleural effusion	Priapism
Periodic paralysis	Pleurisy	Prickly heat
Periodontal disease	Pneumococcal pneumonia	Primary biliary cirrhosis
Peripheral neuropathy	Pneumocystis pneumonia	Proctitis
Peripheral vascular disease	Pneumonectomy	Progressive multifocal leukoencephalopathy
Peritonitis		
Pernicious anemia		

Progressive supranuclear palsy  
 Prolactin test  
 Prolonged QT syndrome  
 Prophylaxis  
 Prostate biopsy  
 Prostate cancer  
 Prostate ultrasound  
 Prostatectomy  
 Prostate-specific antigen test  
 Prostatitis  
 Protease inhibitors  
 Protein components test  
 Protein electrophoresis  
 Protein-energy malnutrition  
 Prothrombin time  
 Proton pump inhibitors  
 Provence (sipuleucel-T)  
 Pseudogout  
 Pseudomonas infections  
 Pseudoxanthoma elasticum  
 Psoriasis  
 Psoriatic arthritis  
 Psychiatric confinement  
 Psychoanalysis  
 Psychological tests  
 Psychosis  
 Psychosocial disorders  
 Psychosurgery  
 Psychotherapy  
 Ptosis  
 Puberty  
 Puerperal infection  
 Pulmonary alveolar proteinosis  
 Pulmonary artery catheterization  
 Pulmonary edema  
 Pulmonary embolism  
 Pulmonary fibrosis  
 Pulmonary function tests  
 Pulmonary hypertension  
 Pulmonary valve insufficiency  
 Pulmonary valve stenosis  
 Pyelonephritis  
 Pyloric stenosis  
 Pyloroplasty  
 Pyruvate kinase deficiency

**Q**

Q fever  
 Qigong

**R**

Rabies  
 Radial keratotomy  
 Radiation injuries  
 Radiation therapy  
 Radical neck dissection  
 Radioactive implants  
 Rape and sexual assault  
 Rashes  
 Rat-bite fever  
 Raynaud's disease  
 Recompression treatment  
 Rectal cancer  
 Rectal examination  
 Rectal polyps  
 Rectal prolapse  
 Recurrent miscarriage  
 Red blood cell indices  
 Red reflex testing  
 Reflex sympathetic dystrophy  
 Reflex tests  
 Reflexology  
 Rehabilitation  
 Reiki  
 Reiter's syndrome  
 Relapsing fever  
 Relapsing polychondritis  
 Renal artery occlusion  
 Renal artery stenosis  
 Renal tubular acidosis  
 Renal vein thrombosis  
 Renovascular hypertension  
 Respiratory acidosis  
 Respiratory alkalosis  
 Respiratory distress syndrome  
 Respiratory failure  
 Respiratory syncytial virus infection  
 Restless legs syndrome

Restrictive cardiomyopathy  
 Reticulocyte count  
 Retinal artery occlusion  
 Retinal detachment  
 Retinal hemorrhage  
 Retinal vein occlusion  
 Retinitis pigmentosa  
 Retinoblastoma  
 Retinopathies  
 Retrograde cystography  
 Retrograde ureteropyelography  
 Retrograde urethrography  
 Retropubic suspension  
 Reye's syndrome  
 Rheumatic fever  
 Rheumatoid arthritis  
 Rhinitis  
 Rhinoplasty  
 Riboflavin deficiency  
 Rickets  
 Rickettsialpox  
 Ringworm  
 Rocky Mountain spotted fever  
 Rolfering  
 Root canal treatment  
 Rosacea  
 Roseola  
 Ross River Virus  
 Rotator cuff injury  
 Rotavirus infections  
 Roundworm infections  
 Rubella  
 Rubella test

**S**

Sacroiliac disease  
 Salivary gland scan  
 Salivary gland tumors  
 Salmonella food poisoning  
 Salpingectomy  
 Salpingo-oophorectomy  
 Sarcoidosis  
 Sarcomas  
 Saw palmetto  
 Scabies

Scarlet fever	Shingles	Spinal cord injury
Scars	Shock	Spinal cord tumors
Schistosomiasis	Shortness of breath	Spinal instrumentation
Schizoaffective disorder	Shy-Drager syndrome	Spinal stenosis
Schizophrenia	Shyness	Spirometry
Sciatica	Sick sinus syndrome	Splenectomy
Scleroderma	Sickle cell disease	Splenic trauma
Sclerotherapy for esophageal varices	Sideroblastic anemia	Sporotrichosis
Scoliosis	Sudden infant death syndrome	Sports injuries
Scrotal nuclear medicine scan	Sigmoidoscopy	Sprains and strains
Scrotal ultrasound	Sildenafil citrate	Sputum culture
Scrub typhus	Silicosis	Squamous cell carcinoma of the skin
Scurvy	Single photon emission computed tomography	St. John's wort
Seasonal affective disorder	Sinus endoscopy	Stanford-Binet intelligence scales
Seborrheic dermatitis	Sinusitis	Stapedectomy
Secondary polycythemia	Situs inversus	Staphylococcal infections
Sedation	Sitz bath	Staphylococcal scalded skin syndrome
Seizure disorder	Sjogren's syndrome	Starvation
Selective serotonin reuptake inhibitors	Skin biopsy	Stem cell transplantation
Self-mutilation	Skin cancer, non-melanoma	Steroids
Semen analysis	Skin culture	Stillbirth
Seniors' health	Skin grafting	Stockholm syndrome
Sensory integration disorder	Skin lesion removal	Stomach cancer
Sepsis	Skin lesions	Stomach flushing
Septic shock	Skin pigmentation disorders	Stomachache
Septoplasty	Skin resurfacing	Stomatitis
Serum sickness	Skull x rays	Stool culture
Severe acute respiratory syndrome (SARS)	Sleep apnea	Stool fat test
Severe combined immunodeficiency	Sleep deprivation	Stool O and P test
Sex hormones tests	Sleep disorders	Strabismus
Sex reassignment surgery	Sleeping sickness	Strep throat
Sex therapy	Small intestine biopsy	Streptococcal antibody tests
Sexual abuse	Smallpox	Streptococcal infections
Sexual addiction	Smelling disorders	Stress
Sexual dysfunction	Smoke inhalation	Stress reduction
Sexual perversions	Smoking-cessation drugs	Stress test
Sexually transmitted diseases	Smoking	Stridor
Sexually transmitted diseases cultures	Snoring	Stroke
Shaken baby syndrome	Sodium	Stuttering
Shiatsu	Somatoform disorders	Subacute sclerosing panencephalitis
Shigellosis	Sore throat	Subarachnoid hemorrhage
Shin splints	South American blastomycosis	Subdural hematoma
	Speech disorders	Substance abuse and dependence
	Speech therapy	Sudden cardiac death

Suicide	Thoracoscopy	Transfusion
Sulfonamides	Threadworm infection	Transhepatic biliary catheterization
Sunburn	Throat culture	Transient ischemic attack
Sunscreens	Thrombocytopenia	Transplant surgery
Superior vena cava syndrome	Thrombocytosis	Transposition of the great arteries
Surfactant	Thrombolytic therapy	Transurethral bladder resection
Swallowing disorders	Thrombophlebitis	Transvaginal ultrasound
Swollen glands	Thymoma	Transverse myelitis
Sydenham's chorea	Thyroid biopsy	Traumatic amputations
Sympathectomy	Thyroid cancer	Traveler's diarrhea
Syphilis	Thyroid function tests	Tremors
Systemic lupus erythematosus	Thyroid hormones	Trench fever
<hr/>		
<b>T</b>		
Tai chi	Thyroid nuclear medicine scan	Trichinosis
Tanning	Thyroid ultrasound	Trichomoniasis
Tapeworm diseases	Thyroidectomy	Tricuspid valve insufficiency
Tardive dyskinesia	Thyroiditis	Tricuspid valve stenosis
Tarsorrhaphy	Tilt table test	Trigeminal neuralgia
Tay-Sachs disease	Tinnitus	Trigger finger
Technetium heart scan	Tissue typing	Triglycerides
Teeth whitening	Tonsillectomy and adenoidectomy	Triglycerides test
Teething	Tonsillitis	Triple screen
Temporal arteritis	Tooth decay	Tropical spastic paraparesis
Temporomandibular joint disorders	Tooth extraction	Troponins test
Tendinitis	Tooth replacements and restorations	Tubal ligation
Tennis elbow	Toothache	Tube compression of the esophagus and stomach
Tensilon test	Topical anesthesia	Tube feedings
Tension headache	TORCH test	Tuberculin skin test
Testicular cancer	Torticollis	Tuberculosis
Testicular self-examination	Total parenteral nutrition	Tularemia
Testicular surgery	Tourette syndrome	Tumor markers
Testicular torsion	Toxic epidermal necrolysis	Tumor removal
Tetanus	Toxic shock syndrome	Turner syndrome
Tetracyclines	Toxoplasmosis	2,3-diphosphoglycerate test
Tetralogy of Fallot	Trabeculectomy	Typhoid fever
Thalassemia	Tracheoesophageal fistula	Typhus
Thallium heart scan	Tracheotomy	Tzanck preparation
Thematic apperception test	Trachoma	
Therapeutic baths	Traction	
Therapeutic touch	Traditional Chinese medicine	
Thoracentesis	Trager psychophysical integration	
Thoracic outlet syndrome	Trans fatty acids	
Thoracic surgery	Transcranial Doppler ultrasonography	

**U**

- Ulcer surgery
- Ulcers (digestive)
- Ultraviolet light treatment
- Umbilical cord blood banking
- Umbilical hernia repair

Undernutrition  
Undescended testes  
Upper GI exam  
Ureteral stenting  
Urethritis  
Uric acid tests  
Urinalysis  
Urinary anti-infectives  
Urinary catheterization  
Urinary diversion surgery  
Urinary incontinence  
Urinary tract infection  
Urine culture  
Urine flow test  
Uterine fibroid embolization  
Uterine fibroids  
Uveitis

**V**

Vaccination  
Vaginal pain  
Vaginismus  
Vagotomy  
Valsalva maneuver  
Valvular heart disease  
Varicose veins  
Vascular disease  
Vascular surgery  
Vasculitis  
Vasectomy  
Vasodilators  
Vegetarianism  
Vegetative state  
Velopharyngeal insufficiency  
Vena cava filter  
Venography

Venous access  
Venous insufficiency  
Ventricular aneurysm  
Ventricular assist device  
Ventricular ectopic beats  
Ventricular fibrillation  
Ventricular septal defect  
Ventricular shunt  
Ventricular tachycardia  
Vesicoureteral reflux  
Vibriosis  
Vision training  
Visual impairment  
Vitamin A deficiency  
Vitamin B6 deficiency  
Vitamin D deficiency  
Vitamin E deficiency  
Vitamin K deficiency  
Vitamin tests  
Vitamin toxicity  
Vitamins  
Vitiligo  
Vitrectomy  
Vocal cord nodules and polyps  
Vocal cord paralysis  
Vomiting  
Von Willebrand disease  
Vulvar cancer  
Vulvodynia  
Vulvovaginitis

**W**

Waldenström's  
macroglobulinemia  
Warts  
Wechsler intelligence test

Wegener's granulomatosis  
Weight loss drugs  
West Nile virus  
Wheezing  
Whiplash  
White blood cell count and  
differential  
Whooping cough  
Wilderness medicine  
Wilms' tumor  
Wilson disease  
Wiskott-Aldrich syndrome  
Withdrawal syndromes  
Wolff-Parkinson-White  
syndrome  
Women's health  
Wound culture  
Wound flushing  
Wounds

**X**

X-linked agammaglobulinemia  
X rays of the orbit

**Y**

Yaws  
Yellow fever  
Yersiniosis  
Yoga

**Z**

Zellweger syndrome  
Zoonosis

## **PLEASE READ—IMPORTANT INFORMATION**

The *Gale Encyclopedia of Medicine, Fourth Edition* is a health reference product designed to inform and educate readers about a wide variety of health topics such as diseases, disorders and conditions, treatments and diagnostic tests, diets, alternative treatments, and prevention. Gale, Cengage Learning believes the product to be comprehensive, but not necessarily definitive. It is intended to supplement, not replace, consultation with a physician or other healthcare practitioners. While Gale, Cengage Learning has made substantial efforts to provide information that is accurate, comprehensive, and up-to-date, Gale, Cengage Learning

makes no representations or warranties of any kind, including without limitation, warranties of merchantability or fitness for a particular purpose, nor does it guarantee the accuracy, comprehensiveness, or timeliness of the information contained in this product. Readers should be aware that the universe of medical knowledge is constantly growing and changing, and that differences of opinion exist among authorities. Readers are also advised to seek professional diagnosis and treatment for any medical condition, and to discuss information obtained from this book with their healthcare provider.

# INTRODUCTION

The *Gale Encyclopedia of Medicine 4 (GEM4)* is a one-stop source for medical information on common medical disorders, conditions, tests, treatments, drugs, and other health-related topics, including high-profile diseases such as AIDS, Alzheimer's disease, cancer, and heart disease. This encyclopedia avoids medical jargon and uses language that laypersons can understand, while still providing thorough coverage of each topic. The *Gale Encyclopedia of Medicine 4* fills a gap between basic consumer health resources, such as single-volume family medical guides, and highly technical professional materials.

## Scope

More than 1,800 full-length articles are included in the *Gale Encyclopedia of Medicine 4*, including disorders/conditions, tests/procedures, and treatments/therapies. Many common drugs are also covered, with generic drug names appearing first and brand names following in parentheses—e.g., acetaminophen (Tylenol). Prominent individuals in medicine are highlighted as sidebar biographies that accompany the main topical essays. Articles follow a standardized format that provides information at a glance. Rubrics include:

Disorders/Conditions	Tests/Treatments
Definition	Definition
Demographics	Purpose
Description	Precautions
Causes and symptoms	Description
Diagnosis	Preparation
Treatment	Aftercare
Prognosis	Risks
Prevention	Normal/abnormal results
Resources	Resources
Key terms	Key terms

In recent years, there has been a resurgence of interest in holistic medicine that emphasizes the connection between mind and body. Aimed at achieving

and maintaining good health rather than just eliminating disease, this approach has come to be known as alternative medicine. The *Gale Encyclopedia of Medicine 4* includes a number of essays on alternative therapies, ranging from traditional Chinese medicine to homeopathy and from meditation to aromatherapy. In addition to full essays on alternative therapies, the encyclopedia features specific **Alternative treatment** sections for diseases and conditions that may be helped by complementary therapies. The *Gale Encyclopedia of Medicine 4* also includes entries on diets, nutrition, and general wellness.

## Inclusion Criteria

A preliminary list of diseases, disorders, tests, and treatments was compiled from a wide variety of sources, including professional medical guides and textbooks as well as consumer guides and encyclopedias. The general advisory board, made up of public librarians, medical librarians, and consumer health experts, evaluated the topics and made suggestions for inclusion. The list was sorted by category and sent to *GEM4* medical advisors, certified physicians with various medical specialities, for review. Final selection of topics to include was made by the medical advisors in conjunction with the Gale, Cengage Learning editor.

## About the Contributors

The essays were compiled by experienced medical writers, including physicians, pharmacists, nurses, and other health care professionals. *GEM4* medical advisors reviewed the completed essays to ensure that they are appropriate, up to date, and medically accurate.

## How to Use this Book

The *Gale Encyclopedia of Medicine 4* has been designed with ready reference in mind.

- Straight **alphabetical arrangement** allows users to locate information quickly.
- Bold-faced terms function as **print hyperlinks** that point the reader to related entries in the encyclopedia.
- **Cross-references** placed throughout the encyclopedia direct readers to where information on subjects without entries can be found. Synonyms and acronyms are also cross-referenced.
- Lists of **key terms** are provided where appropriate to define unfamiliar terms or concepts. A **glossary** of key terms is also included at the back of Volume 6.
- Valuable **contact information** for organizations and support groups is included with each entry. The appendix

contains an extensive list of organizations arranged in alphabetical order.

- The **resources section** directs users to additional sources of medical information on a topic.
- A comprehensive **general index** allows users to easily target detailed aspects of any topic, including Latin names.

## Graphics

The *Gale Encyclopedia of Medicine 4* is enhanced with 765 images, including photos, charts, tables, and detailed illustrations.

## ADVISORY BOARD

An advisory board comprised of medical specialists from a variety of backgrounds provided invaluable assistance in the formulation of this encyclopedia. This advisory board performed a myriad of duties, from defining the scope of coverage to reviewing individual entries for accuracy and accessibility. We would therefore like to express our sincere thanks and appreciation for all of their contributions.

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# A

Abdominal aorta ultrasound see **Abdominal ultrasound**

Abdominal aortic aneurysm see **Aortic aneurysm**

Abdominal hernia see **Hernia**

Abdominal thrust see **Heimlich maneuver**

ultrasound is also routinely used for general abdominal imaging. It has great advantage over x-ray imaging technologies in that it does not damage tissues with ionizing radiation. Ultrasound is also generally far better than plain x rays at distinguishing the subtle variations of soft tissue structures, and can be used in any of several modes, depending on the need at hand.

As an imaging tool, abdominal ultrasound generally is warranted for patients afflicted with: chronic or acute abdominal **pain**; abdominal trauma; an obvious or suspected abdominal mass; symptoms of **liver disease**, pancreatic disease, **gallstones**, spleen disease, **kidney disease** and urinary blockage; or symptoms of an abdominal **aortic aneurysm**. Specifically:

- Abdominal pain. Whether acute or chronic, pain can signal a serious problem—from organ malfunction or injury to the presence of malignant growths. Ultrasound scanning can help doctors quickly sort through potential causes when presented with general or ambiguous symptoms. All of the major abdominal organs can be studied for signs of disease that appear as changes in size, shape and internal structure.
- Abdominal trauma. After a serious accident, such as a car crash or a fall, internal bleeding from injured abdominal organs is often the most serious threat to survival. Neither the injuries nor the bleeding are immediately apparent. Ultrasound is very useful as an initial scan when abdominal trauma is suspected, and it can be used to pinpoint the location, cause, and severity of hemorrhaging. In the case of puncture wounds, from a bullet for example, ultrasound can locate the foreign object and provide a preliminary survey of the damage. The easy portability and versatility of ultrasound technology has brought it into common emergency room use, and even into limited ambulance service.
- Abdominal mass. Abnormal growths—tumors, cysts, abscesses, scar tissue and accessory organs—can be located and tentatively identified with ultrasound. In particular, potentially malignant solid tumors can be

## Abdominal ultrasound

### Definition

Ultrasound technology allows doctors to “see” inside a patient without resorting to surgery. A transmitter sends high frequency sound waves into the body, where they bounce off the different tissues and organs to produce a distinctive pattern of echoes. A receiver “hears” the returning echo pattern and forwards it to a computer, which translates the data into an image on a television screen. Because ultrasound can distinguish subtle variations between soft, fluid-filled tissues, it is particularly useful in providing diagnostic images of the abdomen. Ultrasound can also be used in treatment.

### Purpose

The potential medical applications of ultrasound were first recognized in the 1940s as an outgrowth of the sonar technology developed to detect submarines during World War II. The first useful medical images were produced in the early 1950s, and, by 1965, ultrasound quality had improved to the point that it came into general medical use. Improvements in the technology, application, and interpretation of ultrasound continue. Its low cost, versatility, safety and speed have brought it into the top drawer of medical imaging techniques.

While **pelvic ultrasound** is widely known and commonly used for fetal monitoring during **pregnancy**,

distinguished from benign fluid-filled cysts and abscesses. Masses and malformations in any organ or part of the abdomen can be found.

- Liver disease. The types and underlying causes of liver disease are numerous, though jaundice tends to be a general symptom. Ultrasound can differentiate between many of the types and causes of liver malfunction, and is particularly good at identifying obstruction of the bile ducts and cirrhosis, which is characterized by abnormal fibrous growths and reduced blood flow.
- Pancreatic disease. Inflammation and malformation of the pancreas are readily identified by ultrasound, as are pancreatic stones (calculi), which can disrupt proper functioning.
- Gallstones. Gallstones cause more hospital admissions than any other digestive malady. These calculi can cause painful inflammation of the gallbladder and also obstruct the bile ducts that carry digestive enzymes from the gallbladder and liver to the intestines. Gallstones are readily identifiable with ultrasound.
- Spleen disease. The spleen is particularly prone to injury during abdominal trauma. It may also become painfully inflamed when beset with infection or cancer. These conditions also lend themselves well to ultrasonic inspection and diagnosis.
- Kidney disease. The kidneys are also prone to traumatic injury and are the organs most likely to form calculi, which can block the flow of urine and cause blood poisoning (uremia). A variety of diseases causing distinct changes in kidney morphology can also lead to complete kidney failure. Ultrasound imaging has proven extremely useful in diagnosing kidney disorders.
- Abdominal aortic aneurysm. This is a bulging weak spot in the abdominal aorta, which supplies blood directly from the heart to the entire lower body. These aneurysms are relatively common and increase in prevalence with age. A burst aortic aneurysm is imminently life-threatening. However, they can be readily identified and monitored with ultrasound before acute complications result.

Ultrasound technology can also be used for treatment purposes, most frequently as a visual aid during surgical procedures—such as guiding needle placement to drain fluid from a cyst, or to extract tumor cells for biopsy. Increasingly, direct therapeutic applications for ultrasound are being developed.

The direct therapeutic value of ultrasonic waves lies in their mechanical nature. They are shock waves, just like audible sound, and vibrate the materials through which they pass. These vibrations are mild, virtually unnoticeable at the frequencies and intensities

used for imaging. Properly focused however, high-intensity ultrasound can be used to heat and physically agitate targeted tissues.

High-intensity ultrasound is used routinely to treat soft tissue injuries, such as strains, tears and associated scarring. The heating and agitation are believed to promote rapid healing through increased circulation. Strongly focused, high-intensity, high-frequency ultrasound can also be used to physically destroy certain types of tumors, as well as gallstones and other types of calculi. Developing new treatment applications for ultrasound is an active area of medical research.

## Precautions

Properly performed, ultrasound imaging is virtually without risk or side effects. Some patients report feeling a slight **tingling** and/or warmth while being scanned, but most feel nothing at all. Ultrasound waves of appropriate frequency and intensity are not known to cause or aggravate any medical condition, though any woman who thinks she might be pregnant should raise the issue with her doctor before undergoing an abdominal ultrasound.

The value of ultrasound imaging as a medical tool, however, depends greatly on the quality of the equipment used and the skill of the medical personnel operating it. Improperly performed and/or interpreted, ultrasound can be worse than useless if it indicates that a problem exists where there is none, or fails to detect a significant condition. Basic ultrasound equipment is relatively inexpensive to obtain, and any doctor with the equipment can perform the procedure whether qualified or not. Patients should not hesitate to verify the credentials of technicians and doctors performing ultrasounds, as well as the quality of the equipment used and the benefits of the proposed procedure.

In cases where ultrasound is used as a treatment tool, patients should educate themselves about the proposed procedure with the help of their doctors, as is appropriate before any surgical procedure. Also, any abdominal ultrasound procedure, diagnostic or therapeutic, may be hampered by a patient's body type or other factors, such as the presence of excessive bowel gas (which is opaque to ultrasound). In particular, very obese people are often not good candidates for abdominal ultrasound.

## Description

Ultrasound includes all sound waves above the frequency of human hearing—about 20 thousand hertz, or cycles per second. Medical ultrasound generally uses frequencies between one and 10 million hertz

## KEY TERMS

**Accessory organ**—A lump of tissue adjacent to an organ that is similar to it, but which serves no important purpose, if functional at all. While not necessarily harmful, such organs can cause problems if they grow too large or become cancerous. In any case, their presence points to an underlying abnormality in the parent organ.

**Benign**—In medical usage, benign is the opposite of malignant. It describes an abnormal growth that is stable, treatable and generally not life-threatening.

**Biopsy**—The surgical removal and analysis of a tissue sample for diagnostic purposes. Usually, the term refers to the collection and analysis of tissue from a suspected tumor to establish malignancy.

**Calculus**—Any type of hard concretion (stone) in the body, but usually found in the gallbladder, pancreas and kidneys. They are formed by the accumulation of excess mineral salts and other organic material such as blood or mucous. Calculi (pl.) can cause problems by lodging in and obstructing the proper flow of fluids, such as bile to the intestines or urine to the bladder.

**Cirrhosis**—A chronic liver disease characterized by the invasion of connective tissue and the degeneration of proper functioning—jaundice is often an accompanying symptom. Causes of cirrhosis include alcoholism, metabolic diseases, syphilis and congestive heart disease.

**Common bile duct**—The branching passage through which bile—a necessary digestive enzyme—travels from the liver and gallbladder into the small intestine. Digestive enzymes from the pancreas also enter the intestines through the common bile duct.

**Computed tomography scan (CT scan)**—A specialized type of x-ray imaging that uses highly focused and relatively low energy radiation to produce detailed two-dimensional images of soft tissue structures, particularly the brain. CT scans are the chief competitor to ultrasound and can yield higher quality images not disrupted by bone or gas. They are, however, more cumbersome, time consuming and

expensive to perform, and they use ionizing electromagnetic radiation.

**Doppler**—The Doppler effect refers to the apparent change in frequency of sound wave echoes returning to a stationary source from a moving target. If the object is moving toward the source, the frequency increases; if the object is moving away, the frequency decreases. The size of this frequency shift can be used to compute the object's speed—be it a car on the road or blood in an artery. The Doppler effect holds true for all types of radiation, not just sound.

**Frequency**—Sound, whether traveling through air or the human body, produces vibrations—molecules bouncing into each other—as the shock wave travels along. The frequency of a sound is the number of vibrations per second. Within the audible range, frequency means pitch—the higher the frequency, the higher a sound's pitch.

**Ionizing radiation**—Radiation that can damage living tissue by disrupting and destroying individual cells at the molecular level. All types of nuclear radiation—x rays, gamma rays and beta rays—are potentially ionizing. Sound waves physically vibrate the material through which they pass, but do not ionize it.

**Jaundice**—A condition that results in a yellow tint to the skin, eyes and body fluids. Bile retention in the liver, gallbladder and pancreas is the immediate cause, but the underlying cause could be as simple as obstruction of the common bile duct by a gallstone or as serious as pancreatic cancer. Ultrasound can distinguish between these conditions.

**Malignant**—The term literally means growing worse and resisting treatment. It is used as a synonym for cancerous and connotes a harmful condition that generally is life-threatening.

**Morphology**—Literally, the study of form. In medicine, morphology refers to the size, shape and structure rather than the function of a given organ. As a diagnostic imaging technique, ultrasound facilitates the recognition of abnormal morphologies as symptoms of underlying conditions.

(1–10 MHz). Higher frequency ultrasound waves produce more detailed images, but are also more readily absorbed and so cannot penetrate as deeply into the body. Abdominal ultrasound imaging is generally performed at frequencies between 2–5 MHz.

An ultrasound machine consists of two parts: the transducer and the analyzer. The transducer both produces the sound waves that penetrate the body and receives the reflected echoes. Transducers are built around piezoelectric ceramic chips. (Piezoelectric

refers to electricity that is produced when you put pressure on certain crystals such as quartz). These ceramic chips react to electric pulses by producing sound waves (they are transmitting waves) and react to sound waves by producing electric pulses (receiving). Bursts of high frequency electric pulses supplied to the transducer causes it to produce the scanning sound waves. The transducer then receives the returning echoes, translates them back into electric pulses and sends them to the analyzer—a computer that organizes the data into an image on a television screen.

Because sound waves travel through all the body's tissues at nearly the same speed—about 3,400 miles per hour—the microseconds it takes for each echo to be received can be plotted on the screen as a distance into the body. The relative strength of each echo, a function of the specific tissue or organ boundary that produced it, can be plotted as a point of varying brightness. In this way, the echoes are translated into a picture. Tissues surrounded by bone or filled with gas (the stomach, intestines and bowel) cannot be imaged using ultrasound, because the waves are blocked or become randomly scattered.

Four different modes of ultrasound are used in medical imaging:

- A-mode. This is the simplest type of ultrasound in which a single transducer scans a line through the body with the echoes plotted on screen as a function of depth. This method is used to measure distances within the body and the size of internal organs. Therapeutic ultrasound aimed at a specific tumor or calculus is also A-mode, to allow for pinpoint accurate focus of the destructive wave energy.
- B-mode. In B-mode ultrasound, a linear array of transducers simultaneously scans a plane through the body that can be viewed as a two-dimensional image on screen. Ultrasound probes containing more than 100 transducers in sequence form the basis for these most commonly used scanners, which cost about \$50,000.
- M-Mode. The M stands for motion. A rapid sequence of B-mode scans whose images follow each other in sequence on screen enables doctors to see and measure range of motion, as the organ boundaries that produce reflections move relative to the probe. M-mode ultrasound has been put to particular use in studying heart motion.
- Doppler mode. Doppler ultrasonography includes the capability of accurately measuring velocities of moving material, such as blood in arteries and veins. The principle is the same as that used in radar guns that measure the speed of a car on the highway. Doppler capability is most often combined with

B-mode scanning to produce images of blood vessels from which blood flow can be directly measured. This technique is used extensively to investigate valve defects, arteriosclerosis and hypertension, particularly in the heart, but also in the abdominal aorta and the portal vein of the liver. These machines cost about \$250,000.

The actual procedure for a patient undergoing an abdominal ultrasound is relatively simple, regardless of the type of scan or its purpose. **Fasting** for at least eight hours prior to the procedure ensures that the stomach is empty and as small as possible, and that the intestines and bowels are relatively inactive. Fasting also allows the gall bladder to be seen, as it contracts after eating and may not be seen if the stomach is full. In some cases, a full bladder helps to push intestinal folds out of the way so that the gas they contain does not disrupt the image. The patient's abdomen is then greased with a special gel that allows the ultrasound probe to glide easily across the skin while transmitting and receiving ultrasonic pulses.

This procedure is conducted by a doctor with the assistance of a technologist skilled in operating the equipment. The probe is moved around the abdomen to obtain different views of the target areas. The patient will likely be asked to change positions from side to side and to hold their breath as necessary to obtain the desired views. Discomfort during the procedure is minimal.

The many types and uses of ultrasound technology makes it difficult to generalize about the time and costs involved. Relatively simple imaging—scanning a suspicious abdominal mass or a suspected abdominal aortic aneurysm—will take about half an hour to perform and will cost a few hundred dollars or more, depending on the quality of the equipment, the operator and other factors. More involved techniques such as multiple M-mode and Doppler-enhanced scans, or cases where the targets not well defined in advance, generally take more time and are more expensive.

Regardless of the type of scan used and the potential difficulties encountered, ultrasound remains faster and less expensive than **computed tomography scans** (CT), its primary rival in abdominal imaging. Furthermore, as abdominal ultrasounds are generally undertaken as “medically necessary” procedures designed to detect the presence of suspected abnormalities, they are covered under most types of major medical insurance. As always, though, the patient would be wise to confirm that their coverage extends to the specific procedure proposed. For nonemergency situations, most underwriters stipulate prior approval as a condition of coverage.

Specific conditions for which ultrasound may be selected as a treatment option—certain types of tumors, lesions, **kidney stones** and other calculi, muscle and ligament injuries, etc.—are described in detail under the appropriate entries in this encyclopedia.

## Preparation

A patient undergoing abdominal ultrasound will be advised by their physician about what to expect and how to prepare. As mentioned above, preparations generally include fasting and arriving for the procedure with a full bladder, if necessary. This preparation is particularly useful if the gallbladder, ovaries or veins are to be examined.

## Aftercare

In general, no aftercare related to the abdominal ultrasound procedure itself is required.

## Risks

Abdominal ultrasound carries with it no recognized risks or side effects, if properly performed using appropriate frequency and intensity ranges. Sensitive tissues, particularly those of the reproductive organs, could possibly sustain damage if violently vibrated by overly intense ultrasound waves. In general though, such damage would only result from improper use of the equipment.

Any woman who thinks she might be pregnant should raise this issue with her doctor before undergoing an abdominal ultrasound, as a fetus in the early stages of development could be injured by ultrasound meant to probe deeply recessed abdominal organs.

## Normal results

As a diagnostic imaging technique, a normal abdominal ultrasound is one that indicates the absence of the suspected condition that prompted the scan. For example, symptoms such as a persistent **cough**, labored breathing, and upper abdominal pain suggest the possibility of, among other things, an abdominal aortic aneurysm. An ultrasound scan that indicates the absence of an aneurysm would rule out this life-threatening condition and point to other, less serious causes.

## Abnormal results

Because abdominal ultrasound imaging is generally undertaken to confirm a suspected condition, the results of a scan often will prove abnormal—that is they will confirm the diagnosis, be it kidney stones, **cirrhosis** of the liver or an aortic aneurysm. At that

point, appropriate medical treatment as prescribed by a patient's doctor is in order. See the relevant disease and disorder entries in this encyclopedia for more information.

## ORGANIZATIONS

American College of Gastroenterology, P. O. Box 342260, Bethesda, MD, 20827-2260, (301) 263-9000, <http://www.acg.gi.org>.

American Institute of Ultrasound in Medicine, 14750 Sweitzer Lane, Suite 100, Laurel, MD, 20707-5906, (301) 498-4100, (301) 498-4450, <http://www.aium.org>.

American Society of Radiologic Technologists, 15000 Central Ave., SE, Albuquerque, NM, 87123-3909, (505) 298-4500, (505) 298-5063, (800) 444-2778, member services@asrt.org, <https://www.asrt.org/>.

Kurt Richard Sternlof

# Abdominal wall defects

## Definition

Abdominal wall defects are birth (congenital) defects that allow the stomach or intestines to protrude. It occurs when a child's abdomen does not develop fully while in the womb. This allows the intestine to develop outside the abdomen. Early in all pregnancies, the intestine develops inside the umbilical cord and then usually moves inside the abdomen a few weeks later. Occasionally, the intestine stays inside the umbilical cord and so develops outside the abdominal wall. There are various types of abdominal wall defect. If the intestine is contained inside a covering of membrane, this process is called an omphalocele, which can be either small or large. If the intestine is not inside a covering of membrane, this formation is called a gastroschisis.

## Demographics

Abdominal wall defects are very rare. Omphalocele occurs in about one in every 3,500 births, and gastroschisis is even more rare. Omphalocele is often associated with other problems. An ultrasound is the best method for the detection of the condition and can occur as early as 11 to 14 weeks of gestation.

## Description

Many unexpected and fascinating events occur during the development of a fetus inside the womb. The stomach and intestines begin development outside the baby's abdomen and only later does the abdominal

## KEY TERMS

**Hernia**—Movement of a structure into a place it does not belong.

**Umbilical**—Referring to the opening in the abdominal wall where the blood vessels from the placenta enter.

**Viscera**—Any of the body's organs located in the chest or abdomen.

wall enclose them. Occasionally, either the umbilical opening is too large, or it develops improperly, allowing the bowels or stomach to remain outside or squeeze through the abdominal wall.

### Causes and symptoms

There are many causes for **birth defects** that still remain unclear. Presently, the cause(s) of abdominal wall defects is unknown, and any symptoms the mother may have to indicate that the defects are present in the fetus are nondescript.

### Diagnosis

At birth, the problem is obvious, because the base of the umbilical cord at the navel bulges or, in worse cases, contain viscera (internal organs). Before birth, an ultrasound examination may detect the problem. It is always necessary in children with one birth defect to look for others, because birth defects are usually multiple.

### Treatment

Abdominal wall defects are effectively treated with surgical repair. Unless there are accompanying anomalies, the surgical procedure is not overly complicated. The organs are normal, just misplaced. However, if the defect is large, it may be difficult to fit all the viscera into the small abdominal cavity.

### Prognosis

If there are no other defects, the prognosis after surgical repair of this condition is relatively good. However, 10% of those with more severe or additional abnormalities die from it. The organs themselves are fully functional; the difficulty lies in fitting them inside the abdomen. The condition is, in fact, a **hernia** requiring only replacement and strengthening of the passageway through which it occurred. After surgery,

increased pressure in the stretched abdomen can compromise the function of the organs inside.

### Prevention

Some, but by no means all, birth defects are preventable by early and attentive prenatal care, good **nutrition**, supplemental **vitamins**, diligent avoidance of all unnecessary drugs and chemicals—especially tobacco—and other elements of a healthy lifestyle.

### Resources

#### BOOKS

Moore, Keith L., et al. *Before We Are Born: Essentials of Embryology and Birth Defects*. Kent, UK: Elsevier, Health Sciences Division, 2002.

Turnage, R.H., K.A. Richardson, B.D. Li, and J.C. McDonald. "Abdominal Wall, Umbilicus, Peritoneum, Mesenteries, Omentum, and Retroperitoneum." In: C.M. Townsend, R.D. Beauchamp, B.M. Evers, and K.L. Mattox, editors. *Sabiston Textbook of Surgery*, 18th ed. Philadelphia, Pa: Saunders Elsevier, 2007, chapter 43.

#### PERIODICALS

Dunn, J. C., and E. W. Fonkalsrud. "Improved Survival of Infants with Omphalocele." *American Journal of Surgery* 173 (April 1997): 284–7.

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Karl Finley

Abnormal heart rhythms see **Arrhythmias**

ABO blood typing see **Blood typing and crossmatching**

ABO incompatibility see **Erythroblastosis fetalis**

Abortion, habitual see **Recurrent miscarriage**

## Abortion, partial birth

### Definition

Partial birth abortion, medically known as intact dilation and extraction (IDX), is a method of late-term abortion that ends a **pregnancy** and results in the **death** and intact removal of a fetus from the uterus. In the United States, the procedure is illegal.

## Purpose

Partial birth abortion, or IDX, is performed to end a pregnancy in the mid to late second trimester. It is typically performed between weeks 19 and 26 of pregnancy. IDX is highly controversial. Some physicians argue that IDX has advantages that make it preferable to other late-term abortion procedures in some circumstances. One advantage is that the fetus is removed largely intact, allowing for better evaluation and **autopsy** of the fetus in cases of fetal abnormalities. Intact removal of the fetus also may carry a lower risk of puncturing the uterus or damaging the cervix. Another perceived advantage is that IDX ends the pregnancy without requiring the woman to go through labor. This may reduce the emotional trauma of ending the pregnancy when compared to other methods of late-term abortion. In addition, IDX may offer a lower cost and shorter procedure time. Regardless of any perceived advantages, the procedure is illegal in the United States. Even before the procedure became illegal, it was performed only rarely.

## Legal Controversies

Before 2003, the legality of IDX rested with each individual state. In 2003, U. S. President George W. Bush signed into law the federal Partial-Birth Abortion Ban Act banning partial birth abortions nationwide and implementing fines or jail terms for physicians who perform them. A federal judge then declared the law unconstitutional so that the government was not able to enforce it. A series of court battles over the constitutionality of the law continued until 2007. One legal issue centered on the fact that the legislation did not provide for exceptions in life-threatening cases where the procedure was needed to protect the mother's health. Another issue was the breadth and scope of the definition of partial-birth abortion. Three federal appeals courts ruled that the law was unconstitutional. Nevertheless, in April 2007, the U. S. Supreme Court upheld the law, ruling that it was constitutional, thus allowing for its enforcement.

## Precautions

IDX is illegal in the United States. Women considering IDX in countries where the procedure is legal should be aware of the highly controversial nature of this procedure. One controversy common to this and all late-term abortions is determining at what point in the pregnancy the fetus is viable (able to survive outside the mother' body). In technologically advanced countries, fetuses generally are viable at 28 weeks of pregnancy; some fetuses as young as 24 weeks survive. Another area of controversy specific to IDX is that fetal death does

## KEY TERMS

**Cervix**—The narrow outer end of the uterus that separates the uterus from the vaginal canal.

**Footling breech**—A position of the fetus while in the uterus where the feet of the fetus are nearest the cervix and will be the first part of the fetus to exit the uterus, with the head of the fetus being the last part to exit the uterus.

**Laminaria**—A medical product made from a certain type of seaweed that is physically placed near the cervix to cause it to dilate.

not occur until after most of the fetus's body has exited the uterus. Because of these concerns, many physicians who perform abortions do not perform IDX; this tends to limit the availability of the procedure.

## Description

IDX first involves administration of medications to cause the cervix to dilate. Dilation usually occurs over the course of several days. Next, the physician rotates the fetus to a footling breech position. The body of the fetus is then drawn out of the uterus feet first, until only the head remains inside the uterus. The physician then uses an instrument to puncture the base of the skull, which collapses the fetal head. Typically, the contents of the fetal head are then partially suctioned out, which results in the death of the fetus and reduces the size of the fetal head enough to allow it to pass through the cervix. The dead but otherwise intact fetus is then removed from the woman's body.

## Preparation

Medical preparation for IDX involves an outpatient visit to administer dilation medications such as *laminaria*. Psychological preparation is desirable.

In addition, preparation may involve fulfilling local legal requirements, such as a mandatory waiting period, counseling, or an informed consent procedure reviewing stages of fetal development, **childbirth**, alternative abortion methods, and adoption.

## Aftercare

IDX typically does not require an overnight hospital stay. A follow-up doctor's visit usually is scheduled to monitor the woman for any complications.

## Risks

With all abortion, the later in pregnancy an abortion is performed, the more complicated the procedure and the greater the risk of injury to the woman. In addition to associated emotional reactions, IDX carries the risk of injury to the woman, including heavy bleeding, **blood clots**, damage to the cervix or uterus, pelvic infection, and anesthesia-related complications. There also is a risk of incomplete abortion, meaning that the fetus is not dead when removed from the woman's body. Possible long-term risks include difficulty becoming pregnant or carrying a future pregnancy to term.

## Normal results

The expected outcome of IDX is the termination of a pregnancy and death of the fetus.

## Resources

### OTHER

Mears, Bill. "Justices Uphold Ban on Abortion Procedure." *CNN.com* April 18, 2007 [cited December 6, 2008]. <http://www.cnn.com/2007/LAW/04/18/scotus.abortion/index.html>

### ORGANIZATIONS

Planned Parenthood Federation of America, Inc., 434 West 33rd St., New York, NY, 10001, (212) 541-7800, (212) 245-1845, (800) 230-7526, <http://search.plannedparenthood.org>.

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## Abortion, selective

### Definition

Selective abortion, also known as selective reduction, refers to choosing to abort a fetus, typically in a multi-fetal **pregnancy**, to decrease the health risks to the mother in carrying and giving birth to more than one or two babies, and also to decrease the risk of complications to the remaining fetus(es). The term selective abortion also refers to choosing to abort a fetus for reasons such as the woman is carrying a fetus which likely will be born with some birth defect or impairment, or because the sex of the fetus is not preferred by the individual.

## KEY TERMS

**Multi-fetal pregnancy**—A pregnancy of two or more fetuses.

**Selective reduction**—Typically referred to in cases of multifetal pregnancy, when one or more fetuses are aborted to preserve the viability of the remaining fetuses and decrease health risks to the mother.

## Purpose

A woman may decide to abort for health reasons, for example, if she is at higher risk for complications during pregnancy because of a disorder or disease such as diabetes. A 2004 case reported on an embryo embedded in a **cesarean section** scar. Although rare, it can be life threatening to the mother. In this case, selective abortion was successful at saving the mother and the remaining embryos.

However, selective reduction is recommended often in cases of multi-fetal pregnancy, or the presence of more than one fetus, typically, at least three or more fetuses. In the general population, multi-fetal pregnancy happens in only about 1–2% of pregnant women. But multi-fetal pregnancies occur far more often in women using fertility drugs.

## Precautions

Because women or couples who use fertility drugs have made an extra effort to become pregnant, it is possible that the individuals may be unwilling or uncomfortable with the decision to abort a fetus in cases of multi-fetal pregnancy. Individuals engaging in fertility treatment should be made aware of the risk of multi-fetal pregnancy and consider the prospect of recommended reduction before undergoing fertility treatment.

## Description

Selective reduction is usually performed between 9 and 12 weeks of pregnancy and is most successful when performed in early pregnancy. It is a simple procedure and can be performed on an outpatient basis. A needle is inserted into the woman's stomach or vagina and potassium chloride is injected into the fetus.

## Preparation

Individuals who have chosen selective reduction to safeguard the remaining fetuses should be counseled prior to the procedure. Individuals should

receive information regarding the risks of a multi-fetal pregnancy to both the fetuses and the mother compared with the risks after the reduction.

Individuals seeking an abortion for any reason should consider the ethical implications whether it be because the fetus is not the preferred sex or because the fetus would be born with a severe birth defect.

## Aftercare

Counseling should continue after the abortion because it is a traumatic event. Individuals may feel guilty about choosing one fetus over another. Mental health professionals should be consulted throughout the process.

## Risks

About 75% of women who undergo selective reduction will go into **premature labor**. About 4–5% of women undergoing selective reduction also miscarry one or more of the remaining fetuses. The risks associated with multi-fetal pregnancy are considered higher.

## Normal results

In cases where a multi-fetal pregnancy of three or more fetuses is reduced to two fetuses, the remaining twin fetuses typically develop as they would if they had been conceived as twins.

## Resources

### PERIODICALS

“Multiple Pregnancy Associated With Infertility Therapy.” *American Society for Reproductive Medicine, A Practice Committee Report* (November 2000): 1-8.

“Selective Reduction Eliminates an Embryo Embedded in a Cesarean Scar.” *Women’s Health Weekly* (April 8, 2004): 117.

### ORGANIZATIONS

The Alan Guttmacher Institute, 120 Wall Street, New York, NY, 10005, (212) 248-1111, <http://www.agi-usa.org>.

The American Society for Reproductive Medicine, 1209 Montgomery Highway, Birmingham, AL, 35216-2809, (205) 978-5000, <http://www.asrm.org>.

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Abortion, spontaneous see **Miscarriage**

## Abortion, therapeutic

### Definition

Therapeutic abortion is the intentional termination of a **pregnancy** before the fetus can live independently. Abortion has been a legal procedure in the United States since 1973.

### Purpose

An abortion may be performed whenever there is some compelling reason to end a pregnancy. Women have abortions because continuing the pregnancy would cause them hardship, endanger their life or health, or because prenatal testing has shown that the fetus will be born with severe abnormalities.

Abortions are safest when performed within the first six to 10 weeks after the last menstrual period. The calculation of this date is referred to as the gestational age and is used in determining the stage of pregnancy. For example, a woman who is two weeks late having her period is said to be six weeks pregnant, because it is six weeks since she last menstruated.

About 90% of women who have abortions do so before 13 weeks and experience few complications. Abortions performed between 13–24 weeks have a higher rate of complications. Abortions after 24 weeks are extremely rare and are usually limited to situations where the life of the mother is in danger.

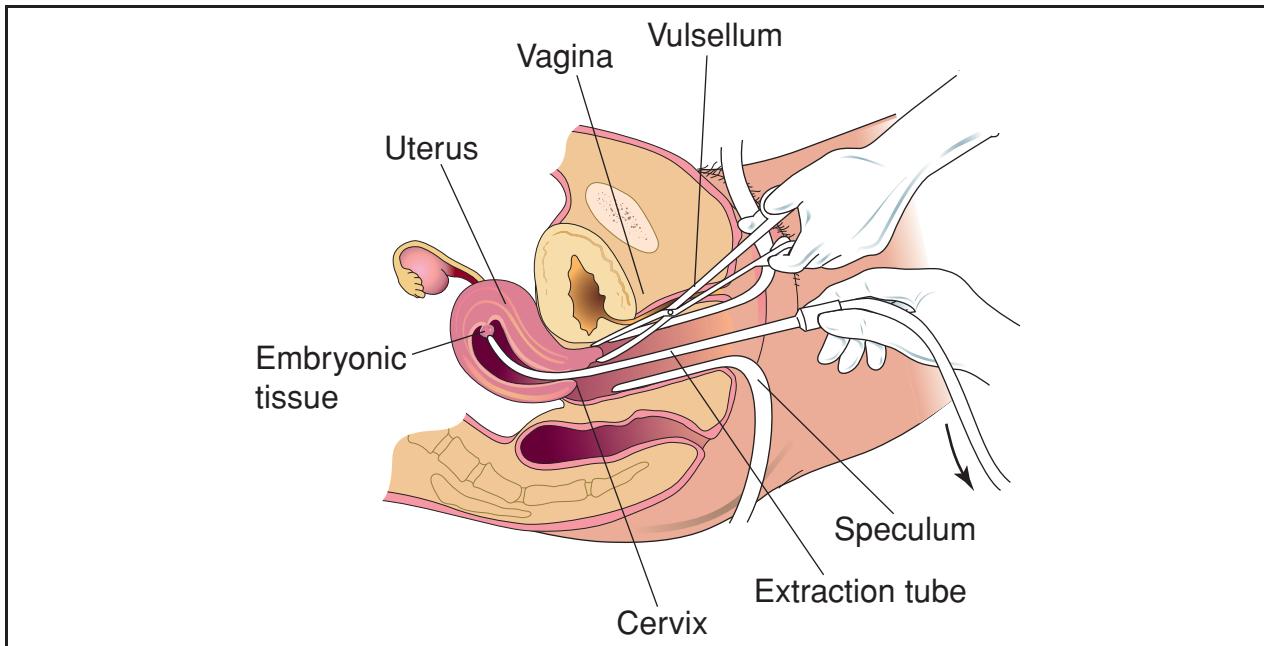
### Precautions

Most women are able to have abortions at clinics or outpatient facilities if the procedure is performed early in pregnancy. Women who have stable diabetes, controlled **epilepsy**, mild to moderate high blood pressure, or who are HIV positive can often have abortions as outpatients if precautions are taken. Women with heart disease, previous **endocarditis**, **asthma**, lupus erythematosus, uterine fibroid tumors, blood clotting disorders, poorly controlled epilepsy, or some psychological disorders usually need to be hospitalized in order to receive special monitoring and medications during the procedure.

### Description

#### *Very early abortions*

Between five and seven weeks, a pregnancy can be ended by a procedure called menstrual extraction. This procedure is also sometimes called menstrual regulation, mini-suction, or preemptive abortion. The contents of the uterus are suctioned out through



**Between 5 and 7 weeks, a pregnancy can be ended by a procedure called menstrual extraction. The contents of the uterus are suctioned out through a thin extraction tube that is inserted through the undilated cervix.** (*Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.*)

a thin (3–4 mm) plastic tube that is inserted through the undilated cervix. Suction is applied either by a bulb syringe or a small pump.

Another method is called the “morning after” pill, or **emergency contraception**. Basically, it involves taking high doses of birth control pills within 24 to 48 hours of having unprotected sex. The high doses of hormones causes the uterine lining to change so that it will not support a pregnancy. Thus, if the egg has been fertilized, it is simply expelled from the body.

There are two types of emergency **contraception**. One type is identical to ordinary birth control pills, and uses the hormones estrogen and progestin. This type is available with a prescription under the brand name Preven. But women can even use their regular birth control pills for emergency contraception, after they check with their doctor about the proper dose. About half of women who use birth control pills for emergency contraception get nauseated and 20% vomit. This method cuts the risk of pregnancy 75%.

The other type of morning-after pill contains only one hormone: progestin, and is available under the brand name Plan B. It is more effective than the first type with a lower risk of **nausea and vomiting**. It reduces the risk of pregnancy 89 percent.

Women should check with their physicians regarding the proper dose of pills to take, as it depends on the brand of birth control pill. Not all birth control pills will work for emergency contraception.

Menstrual extractions are safe, but because the amount of fetal material is so small at this stage of development, it is easy to miss. This results in an incomplete abortion that means the pregnancy continues.

#### ***First trimester abortions***

The first trimester of pregnancy includes the first 13 weeks after the last menstrual period. In the United States, about 90% of abortions are performed during this period. It is the safest time in which to have an abortion, and the time in which women have the most choice of how the procedure is performed.

**MEDICAL ABORTIONS.** Medical abortions are brought about by taking medications that end the pregnancy. The advantages of a first trimester medical abortion are:

- The procedure is non-invasive; no surgical instruments are used.
- Anesthesia is not required.
- Drugs are administered either orally or by injection.
- The procedure resembles a natural miscarriage.

## KEY TERMS

**Endocarditis**—An infection of the inner membrane lining of the heart.

**Fibroid tumors**—Fibroid tumors are non-cancerous (benign) growths in the uterus. They occur in 30–40% of women over age 40, and do not need to be removed unless they are causing symptoms that interfere with a woman's normal activities.

**Lupus erythematosus**—A chronic inflammatory disease in which inappropriate immune system reactions cause abnormalities in the blood vessels and connective tissue.

**Prostaglandin**—Oxygenated unsaturated cyclic fatty acids responsible for various hormonal reactions such as muscle contraction.

**Rh negative**—Lacking the Rh factor, genetically determined antigens in red blood cells that produce immune responses. If an Rh negative woman is pregnant with an Rh positive fetus, her body will produce antibodies against the fetus's blood, causing a disease known as Rh disease. Sensitization to the disease occurs when the woman's blood is exposed to the fetus's blood. Rh immune globulin (RhoGAM) is a vaccine that must be given to a woman after an abortion, miscarriage, or prenatal tests in order to prevent sensitization to Rh disease.

Disadvantages of a medical abortion are:

- The effectiveness decreases after the seventh week.
- The procedure may require multiple visits to the doctor.
- Bleeding after the abortion lasts longer than after a surgical abortion.
- The woman may see the contents of her womb as it is expelled.

Two different medications can be used to bring about an abortion. Methotrexate (Rheumatrex) works by stopping fetal cells from dividing which causes the fetus to die.

On the first visit to the doctor, the woman receives an injection of methotrexate. On the second visit, about a week later, she is given misoprostol (Cytotec), an oxygenated unsaturated cyclic fatty acid responsible for various hormonal reactions such as muscle contraction (prostaglandin), that stimulates contractions of the uterus. Within two weeks, the woman will expel the contents of her uterus, ending the pregnancy. A follow-up visit to the doctor is necessary to assure that the abortion is complete.

With this procedure, a woman will feel cramping and may feel nauseated from the misoprostol. This combination of drugs is 90–96% effective in ending pregnancy.

**Mifepristone** (RU-486), which goes by the brand name Mifeprex, works by blocking the action of progesterone, a hormone needed for pregnancy to continue, then stimulates uterine contractions thus ending the pregnancy. It can be taken as much as 49 days after the first day of a woman's last period. On the first visit to the doctor, a woman takes a mifepristone pill. Two days later she returns and, if the **miscarriage** has not occurred, takes two misoprostol pills, which causes the uterus to contract. Five percent of women won't need to take misoprostol. After an observation period, she returns home.

Within four days, 90% of women have expelled the contents of their uterus and completed the abortion. Within 14 days, 95–97% of women have completed the abortion. A third follow-up visit to the doctor is necessary to confirm through observation or ultrasound that the procedure is complete. In the event that it is not, a surgical abortion is performed. Studies show that 4.5 to 8% of women need surgery or a blood **transfusion** after taking mifepristone, and the pregnancy persists in about 1% of women. In this case, surgical abortion is recommended because the fetus may be damaged. Side effects include **nausea**, vaginal bleeding and heavy cramping. The bleeding is typically heavier than a normal period and may last up to 16 days.

Mifepristone is not recommended for women with **ectopic pregnancy**, an **IUD**, who have been taking long-term steroid therapy, have bleeding abnormalities or on blood-thinners such as Coumadin.

### Surgical abortions

First trimester surgical abortions are performed using vacuum aspiration. The procedure is also called dilation and evacuation (D & E), suction dilation, vacuum curettage, or suction curettage.

Advantages of a vacuum aspiration abortion are:

- It is usually done as a one-day outpatient procedure.
- The procedure takes only 10–15 minutes.
- Bleeding after the abortion lasts five days or less.
- The woman does not see the products of her womb being removed.

Disadvantages include:

- The procedure is invasive; surgical instruments are used.
- Infection may occur.

During a vacuum aspiration, the woman's cervix is gradually dilated by expanding rods inserted into the cervical opening. Once dilated, a tube attached to a suction pump is inserted through the cervix and the contents of the uterus are suctioned out. The procedure is 97–99% effective. The amount of discomfort a woman feels varies considerably. **Local anesthesia** is often given to numb the cervix, but it does not mask uterine cramping. After a few hours of rest, the woman may return home.

### **Second trimester abortions**

Although it is better to have an abortion during the first trimester, some second trimester abortions may be inevitable. The results of **genetic testing** are often not available until 16 weeks. In addition, women, especially teens, may not have recognized the pregnancy or come to terms with it emotionally soon enough to have a first trimester abortion. Teens make up the largest group having second trimester abortions.

Some second trimester abortions are performed as a D & E. The procedures are similar to those used in the first trimester, but a larger suction tube must be used because more material must be removed. This increases the amount of cervical dilation necessary and increases the risk of the procedure. Many physicians are reluctant to perform a D & E this late in pregnancy, and for some women is it not a medically safe option.

The alternative to a D & E in the second trimester is an abortion by induced labor. Induced labor may require an overnight stay in a hospital. The day before the procedure, the woman visits the doctor for tests, and to either have rods inserted in her cervix to help dilate it or to receive medication that will soften the cervix and speed up labor.

On the day of the abortion, drugs, usually prostaglandins to induce contractions, and a salt water solution, are injected into the uterus. Contractions begin, and within eight to 72 hours the woman delivers the fetus.

Side effects of this procedure include nausea, **vomiting**, and **diarrhea** from the prostaglandins, and **pain** from uterine cramps. Anesthesia of the sort used in **childbirth** can be given to mask the pain. Many women are able to go home a few hours after the procedure.

Very early abortions cost between \$200–\$400. Later abortions cost more. The cost increases about \$100 per week between the thirteenth and sixteenth week. Second trimester abortions are much more costly because they often involve more risk, more

services, anesthesia, and sometimes a hospital stay. Insurance carriers and HMOs may or may not cover the procedure. Federal law prohibits federal funds including Medicaid funds, from being used to pay for an elective abortion.

### **Preparation**

The doctor must know accurately the stage of a woman's pregnancy before an abortion is performed. The doctor will ask the woman questions about her menstrual cycle and also do a **physical examination** to confirm the stage of pregnancy. This may be done at an office visit before the abortion or on the day of the abortion. Some states require a waiting period before an abortion can be performed. Others require parental or court consent for a child under age 18 to receive an abortion.

Despite the fact that almost half of all women in the United States have had at least one abortion by the time they reach age 45, abortion is surrounded by controversy. Women often find themselves in emotional turmoil when deciding if an abortion is a procedure they wish to undergo. Pre-abortion counseling is important in helping a woman resolve any questions she may have about having the procedure.

### **Aftercare**

Regardless of the method used to perform the abortion, a woman will be observed for a period of time to make sure her blood pressure is stable and that bleeding is controlled. The doctor may prescribe **antibiotics** to reduce the chance of infection. Women who are Rh negative (lacking genetically determined antigens in their red blood cells that produce immune responses) should be given a human Rh immune globulin (RhoGAM) after the procedure unless the father of the fetus is also Rh negative. This prevents blood incompatibility complications in future pregnancies.

Bleeding will continue for about five days in a surgical abortion and longer in a medical abortion. To decrease the risk of infection, a woman should avoid intercourse and not use tampons and douches for two weeks after the abortion.

A follow-up visit is a necessary part of the woman's aftercare. Contraception will be offered to women who wish to avoid future pregnancies, because menstrual periods normally resume within a few weeks.

### **Risks**

Serious complications resulting from abortions performed before 13 weeks are rare. Of the 90% of

women who have abortions in this time period, 2.5% have minor complications that can be handled without hospitalization. Less than 0.5% have complications that require a hospital stay. The rate of complications increases as the pregnancy progresses.

Complications from abortions can include:

- uncontrolled bleeding
- infection
- blood clots accumulating in the uterus
- a tear in the cervix or uterus
- missed abortion where the pregnancy continues
- incomplete abortion where some material from the pregnancy remains in the uterus

Women who experience any of the following symptoms of post-abortion complications should call the clinic or doctor who performed the abortion immediately.

- severe pain
- fever over 100.4 °F (38.2 °C)
- heavy bleeding that soaks through more than one sanitary pad per hour
- foul-smelling discharge from the vagina
- continuing symptoms of pregnancy

## Normal results

Usually the pregnancy is ended without complication and without altering future fertility.

## Resources

### BOOKS

Carlson, Karen J., Stephanie A. Eisenstat, and Terra Ziporyn. "Abortion." In *The New Harvard Guide to Women's Health*. Cambridge, MA: Harvard University Press, 2004.

Debra Gordon

**Abrasions** see **Wounds**

**Abruption placentae** see **Placental abruption**

## Description

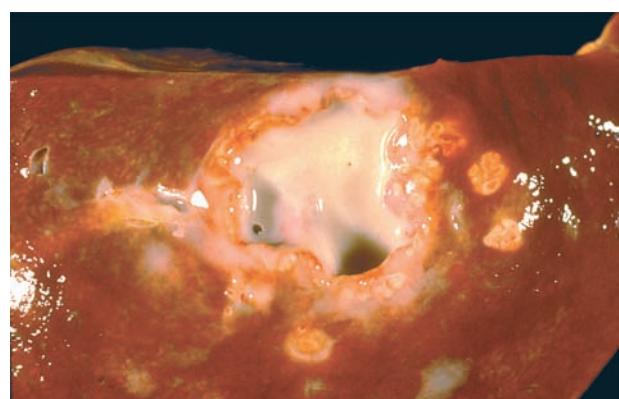
There are two types of abscesses, septic and sterile. Most abscesses are septic, which means that they are the result of an infection. Septic abscesses can occur anywhere in the body. Only a germ and the body's immune response are required. In response to the invading germ, white blood cells gather at the infected site and begin producing chemicals called enzymes that attack the germ by digesting it. These enzymes act like acid, killing the germs and breaking them down into small pieces that can be picked up by the circulation and eliminated from the body. Unfortunately, these chemicals also digest body tissues. In most cases, the germ produces similar chemicals. The result is a thick, yellow liquid-pus-containing digested germs, digested tissue, white blood cells, and enzymes.

An abscess is the last stage of a tissue infection that begins with a process called inflammation. Initially, as the invading germ activates the body's immune system, several events occur:

- Blood flow to the area increases
- The temperature of the area increases due to the increased blood supply
- The area swells due to the accumulation of water, blood, and other liquids
- It turns red
- It hurts, because of the irritation from the swelling and the chemical activity

These four signs—heat, swelling, redness, and pain—characterize inflammation

As the process progresses, the tissue begins to turn to liquid, and an abscess forms. It is the nature of an abscess to spread as the chemical digestion liquefies more and more tissue. Furthermore, the spreading follows the path of least resistance—the tissues most easily



An amoebic abscess caused by *Entameoba histolytica*.  
(© Phototake. — All rights reserved.)

## KEY TERMS

**Cellulitis**—Inflammation of tissue due to infection.

**Enzyme**—Any of a number of protein chemicals that can change other chemicals.

**Fallopian tubes**—Part of the internal female anatomy that carries eggs from the ovaries to the uterus.

**Flora**—Living inhabitants of a region or area.

**Pyogenic**—Capable of generating pus. *Streptococcus*, *Staphylococcus*, and bowel bacteria are the primary pyogenic organisms.

**Sebaceous glands**—Tiny structures in the skin that produce oil (sebum). If they become plugged, sebum collects inside and forms a nurturing place for germs to grow.

**Septicemia**—The spread of an infectious agent throughout the body by means of the blood stream.

**Sinus**—A tubular channel connecting one body part with another or with the outside.

digested. A good example is an abscess just beneath the skin. It most easily continues along beneath the skin rather than working its way through the skin where it could drain its toxic contents. The contents of the abscess also leak into the general circulation and produce symptoms just like any other infection. These include chills, **fever**, aching, and general discomfort.

Sterile abscesses are sometimes a milder form of the same process caused not by germs but by non-living irritants such as drugs. If an injected drug like penicillin is not absorbed, it stays where it was injected and may cause enough irritation to generate a sterile abscess—sterile because there is no infection involved. Sterile abscesses are quite likely to turn into hard, solid lumps as they scar, rather than remaining pockets of pus.

### Causes and symptoms

Many different agents cause abscesses. The most common are the pus-forming (pyogenic) bacteria like *Staphylococcus aureus*, which is nearly always the cause of abscesses under the skin. Abscesses near the large bowel, particularly around the anus, may be caused by any of the numerous bacteria found within the large bowel. Brain abscesses and liver abscesses can be caused by any organism that can travel there through the circulation. Bacteria, amoeba, and certain fungi can travel in this fashion. Abscesses in other parts of the body are caused by organisms that normally inhabit nearby structures or that infect them. Some common causes of specific abscesses are:

- skin abscesses by normal skin flora
- dental and throat abscesses by mouth flora
- lung abscesses by normal airway flora, pneumonia germs, or tuberculosis
- abdominal and anal abscesses by normal bowel flora

### Specific types of abscesses

Listed below are some of the more common and important abscesses.

- Carbuncles and other boils. Skin oil glands (sebaceous glands) on the back or the back of the neck are the ones usually infected. The most common germ involved is *Staphylococcus aureus*. Acne is a similar condition of sebaceous glands on the face and back.
- Pilonidal abscess. Many people have as a birth defect a tiny opening in the skin just above the anus. Fecal bacteria can enter this opening, causing an infection and subsequent abscess.
- Retropharyngeal, parapharyngeal, peritonsillar abscess. As a result of throat infections like strep throat and tonsillitis, bacteria can invade the deeper tissues of the throat and cause an abscess. These abscesses can compromise swallowing and even breathing.
- Lung abscess. During or after pneumonia, whether it's due to bacteria [common pneumonia], tuberculosis, fungi, parasites, or other germs, abscesses can develop as a complication.
- Liver abscess. Bacteria or amoeba from the intestines can spread through the blood to the liver and cause abscesses.
- Psoas abscess. Deep in the back of the abdomen on either side of the lumbar spine lie the psoas muscles. They flex the hips. An abscess can develop in one of these muscles, usually when it spreads from the appendix, the large bowel, or the fallopian tubes.

### Diagnosis

The common findings of inflammation—heat, redness, swelling, and pain—easily identify superficial abscesses. Abscesses in other places may produce only generalized symptoms such as fever and discomfort. If the patient's symptoms and **physical examination** do

not help, a physician may have to resort to a battery of tests to locate the site of an abscess, but usually something in the initial evaluation directs the search. Recent or chronic disease in an organ suggests it may be the site of an abscess. Dysfunction of an organ or system—for instance, seizures or altered bowel function—may provide the clue. **Pain** and tenderness on physical examination are common findings. Sometimes a deep abscess will eat a small channel (sinus) to the surface and begin leaking pus. A sterile abscess may cause only a painful lump deep in the buttock where a shot was given.

## Treatment

Since skin is very resistant to the spread of infection, it acts as a barrier, often keeping the toxic chemicals of an abscess from escaping the body on their own. Thus, the pus must be drained from the abscess by a physician. The surgeon determines when the abscess is ready for drainage and opens a path to the outside, allowing the pus to escape. Ordinarily, the body handles the remaining infection, sometimes with the help of **antibiotics** or other drugs. The surgeon may leave a drain (a piece of cloth or rubber) in the abscess cavity to prevent it from closing before all the pus has drained out.

## Alternative treatment

If an abscess is directly beneath the skin, it will be slowly working its way through the skin as it is more rapidly working its way elsewhere. Since chemicals work faster at higher temperatures, applications of hot compresses to the skin over the abscess will hasten the digestion of the skin and eventually result in its breaking down, releasing the pus spontaneously. This treatment is best reserved for smaller abscesses in relatively less dangerous areas of the body—limbs, trunk, back of the neck. It is also useful for all superficial abscesses in their very early stages. It will “ripen” them.

Contrast **hydrotherapy**, alternating hot and cold compresses, can also help assist the body in resorption of the abscess. There are two homeopathic remedies that work to rebalance the body in relation to abscess formation, *Silica* and *Hepar sulphuris*. In cases of septic abscesses, bentonite clay packs (bentonite clay and a small amount of *Hydrastis* powder) can be used to draw the infection from the area.

## Prognosis

Once the abscess is properly drained, the prognosis is excellent for the condition itself. The reason for the abscess (other diseases the patient has) will determine the overall outcome. If, on the other hand, the abscess ruptures into neighboring areas or permits the

infectious agent to spill into the bloodstream, serious or fatal consequences are likely. Abscesses in and around the nasal sinuses, face, ears, and scalp may work their way into the brain. Abscesses within an abdominal organ such as the liver may rupture into the abdominal cavity. In either case, the result is life threatening. Blood poisoning is a term commonly used to describe an infection that has spilled into the blood stream and spread throughout the body from a localized origin. Blood poisoning, known to physicians as septicemia, is also life threatening.

Abscesses in the hand are more serious than they might appear. Due to the intricate structure and the overriding importance of the hand, any hand infection must be treated promptly and competently.

## Prevention

Infections that are treated early with heat (if superficial) or antibiotics will often resolve without the formation of an abscess. It is even better to avoid infections altogether by taking prompt care of open injuries, particularly puncture **wounds**. **Bites** are the most dangerous of all, even more so because they often occur on the hand.

## Resources

### BOOKS

Fauci, Anthony S., et al., editors. *Harrison's Principles of Internal Medicine*. 17th ed. New York: McGraw-Hill Professional, 2008.

J. Ricker Polsdorfer MD

Abscess drainage see **Abscess incision and drainage**

## Abscess incision and drainage

### Definition

An infected skin nodule that contains pus may need to be drained via a cut if it does not respond to **antibiotics**. This allows the pus to escape, and the infection to heal.

### Purpose

An **abscess** is a pus-filled sore, usually caused by a bacterial infection. The pus is made up of both live and dead organisms and destroyed tissue from the white blood cells that were carried to the area to fight the infection. Abscesses are often found in the soft tissue

under the skin, such as the armpit or the groin. However, they may develop in any organ, and are commonly found in the breast and gums. Abscesses are far more serious and call for more specific treatment if they are located in deep organs such as the lung, liver or brain.

Because the lining of the abscess cavity tends to interfere with the amount of the drug that can penetrate the source of infection from the blood, the cavity itself may require draining. Once an abscess has fully formed, it often does not respond to antibiotics. Even if the antibiotic does penetrate into the abscess, it doesn't function as well in that environment.

### Precautions

An abscess can usually be diagnosed visually, although an imaging technique such as a computed tomography scan may be used to confirm the extent of the abscess before drainage. Such procedures may also

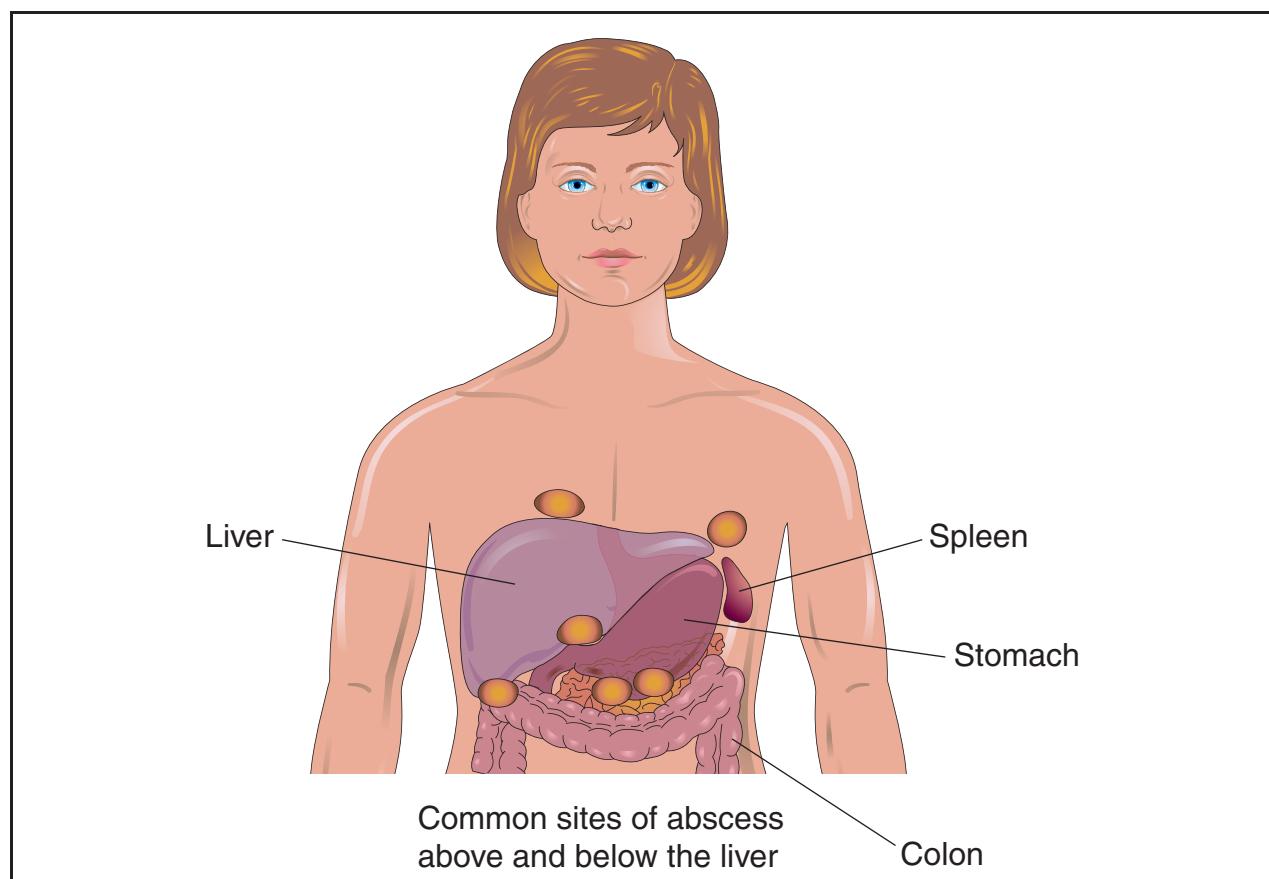
be needed to localize internal abscesses, such as those in the abdominal cavity or brain.

### Description

A doctor will cut into the lining of the abscess, allowing the pus to escape either through a drainage tube or by leaving the cavity open to the skin. How big the incision is depends on how quickly the pus is encountered.

Once the abscess is opened, the doctor will clean and irrigate the wound thoroughly with saline. If it is not too large or deep, the doctor may simply pack the abscess wound with gauze for 24–48 hours to absorb the pus and discharge.

If it is a deeper abscess, the doctor may insert a drainage tube after cleaning out the wound. Once the tube is in place, the surgeon closes the incision with simple stitches, and applies a sterile dressing. Drainage is maintained for several days to help prevent the abscess from reforming.



Although abscesses are often found in the soft tissue under the skin, such as the armpit or the groin, they may develop in any organ, such as the liver. (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

## KEY TERMS

**White blood cells**—Cells that protect the body against infection.

### Preparation

The skin over the abscess will be cleansed by swabbing gently with an antiseptic solution.

### Aftercare

Much of the **pain** around the abscess will be gone after the surgery. Healing is usually very fast. After the tube is taken out, antibiotics may be continued for several days. Applying heat and keeping the affected area elevated may help relieve inflammation.

### Risks

If there is any scarring, it is likely to become much less noticeable as time goes on, and eventually almost invisible. Occasionally, an abscess within a vital organ (such as the brain) damages enough surrounding tissue that there is some permanent loss of normal function.

### Normal results

Most abscesses heal after drainage alone; others require drainage and antibiotic drug treatment.

### Resources

#### BOOKS

Cunningham, G., et al. *Williams Obstetrics*. 22nd ed. New York, NY: McGraw-Hill, 2005.

#### ORGANIZATIONS

National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS), 1 AMS Circle, Bethesda, MD, 20892-3675, (301) 495-4484, (301) 718-6366, (877) 226-4267, NIAMSinfo@mail.nih.gov, <http://www.niams.nih.gov/>.

Carol A. Turkington

## Abuse

### Definition

Abuse is defined as any action that intentionally harms or injures another person. Abuse also encompasses inappropriate use of any substance, especially

those that alter consciousness (e.g., alcohol, **cocaine**, methamphetamines).

### Description

There are several major types of abuse: physical abuse, **sexual abuse**, **substance abuse**, **elder abuse**, and psychological abuse. All forms of abuse in the United States are illegal and have the potential to carry serious criminal penalties.

#### Physical abuse

Physical abuse is the infliction of injury by another person. Physical abuse can happen to both children and adults of either gender and of any sexual orientation. The injuries can be inflicted by punching, kicking, biting, burning, beating, or use of a weapon such as a baseball bat or knife. Physical abuse can result in **bruises**, **burns**, **poisoning**, broken bones, and internal hemorrhages.

According to the United States Department of Health and Human Services Administration for Children and Families, in 2006 in the United States there were 1,530 child fatalities that resulted from **child abuse** (a rate of just over 2 deaths per 100,000 children). Of these, about three-quarters of the children were under four years old, with the largest number of deaths occurring in infants under one year old. In addition, about 905,000 children were victims of nonfatal maltreatment (a rate of about 12 children 12 per 1,000 population). Nearly three-quarters of these children were victims of repeated maltreatment. Nearly 83% of abused children were abused by a parent or a parent acting with another individual.

Physical abuse of adults primarily occurs against women. The United Nations Development Fund for Women estimates that one-third of all women in the world will be beaten, coerced into sex, or otherwise abused during their lifetime. Sixty-nine percent of women worldwide report that at some time during their life they have been abused by a spouse or man with whom they are intimate. Intimate partners also commit the majority of murders of women. Violence against women tends to increase in times of economic downturns and political or social chaos (e.g., when a country is at war). Domestic violence is also strongly linked to substance abuse among the perpetrators. The U. S. Department of Justice found that in domestic violence cases, 61% of the perpetrators and 36% of the victims had a substance abuse problem. The most common substance abused was alcohol. Males can be victims of physical abuse, especially in homosexual

## KEY TERMS

**Encopresis**—Abnormalities relating to bowel movements that can occur as a result of stress or fear.

relationships, but the statistics for abuse against men are more poorly documented than for abuse against women and children.

### *Sexual abuse*

Sexual abuse of a child refers to sexual behavior between an adult and child or between two children, one of whom is forcefully dominant or significantly older. Sexual behaviors can include touching breasts, genitals, and buttocks while the victim is either dressed or undressed. Sexual abuse behavior also includes exhibitionism, cunnilingus, fellatio, or penetration of the vagina or anus with sexual organs or objects. Pornographic photography also is a form of sexual abuse of children. The U.S. Department of Justice estimates that one in six victims of a **sexual assault** are under age 12. Despite publicity surrounding cases where a child is assaulted by a stranger, almost all sexual assaults against children are perpetrated by a family member (e.g. father, stepfather, aunt, uncle, sibling, cousin) or family intimate (e.g., a live-in lover or friend of the parent).

Sexual abuse also can take the form of **rape**. The legal definition of rape includes only slight penile penetration in the victim's outer vulva area. Complete erection and ejaculation are not necessary. Rape is the perpetration of an act of sexual intercourse when:

- will is overcome by force or fear (from threats, use of weapons, or use of drugs)
- mental impairment renders the victim incapable of rational judgment
- if the victim is below the legal age established for consent

The National Coalition Against Domestic Violence (NCADV) estimates that 1 in 5 women and 1 in 33 men will be the victim of a rape or an attempted rape during their lifetime. According the U.S. Department of Justice, 54% of all rapes are of women under age 18. Rape can occur within the context of marriage. Marital rape accounts for about 25% of all rapes in the United States. Marital rape is often accompanied

by physical and psychological abuse. In 90% of all rapes, the woman knows the rapist. Women who are victims of a sexual assault have a high chance of experiencing depression, **post-traumatic stress disorder**, developing substance abuse, and of becoming suicidal.

### *Substance abuse*

Substance abuse is an abnormal pattern of substance usage leading to significant distress or impairment. Alcohol, street drugs, and prescription drugs are common substances of abuse. Substance abuse is often a contributing factor in physical and sexual abuse. Children of parents who are substance abusers are more likely to experience abuse than children living in households where there is no substance abuse. The National Committee to Prevent Child Abuse found that in the United States, 80% of child abuse cases were associated with substance abuse by the perpetrator.

The criteria for substance abuse is one or more of the following occurring within a 12-month period:

- recurrent substance use resulting in failure to fulfill obligations at home, work, or school
- using substance in situations that are physically dangerous (i.e., while driving or operating machinery)
- recurrent substance-related legal problems
- continued usage despite recurrent social and interpersonal problems (i.e., arguments and fights with significant other)

### *Elder abuse*

Abuse of the elderly is common and occurs mostly because of caregiver burnout due to the high level of dependency and continuous care that frail, elderly individuals often require. The NCADV estimates that in 2007 there were 2.1 million cases of elder abuse in the United States but that only one out of every 14 cases was reported to authorities. Victims tend to be over age 50 and highly dependent on their caregivers because of physical or mental disabilities. In 90% of the cases, the abuser is a family member.

Elder abuse can take the form of physical abuse, psychological abuse, sexual abuse, or financial abuse. Examples of elder abuse include:

- withholding food, water, or medicines
- delaying needed medical care

- coercing or deceiving an elderly person into signing legal documents
- wrongful use of the elderly individual's money
- removing or selling the elderly individual's property without permission
- initiating non-consensual sexual contact
- pushing, hitting or tying the individual in a bed or chair
- screaming, emotionally manipulating, intentionally humiliating, or intentionally confusing the individual

### ***Psychological abuse***

Victims of psychological abuse can be of any age or gender. This form of abuse is often difficult to prove. It includes threatening the victim with violence, harassing them when they are outside the home (e.g., at school or work), denying the victim access to others (e.g., refusing to allow the victim to see friends, preventing use of the telephone), confining the victim to home, or destroying the victim's property. A woman with a physical disability has a greatly increased likelihood of being psychologically abused. Men who are unemployed but living in a household where the woman works are most likely to be psychological abusers. Almost all men who physically abuse women also psychologically abuse them.

### ***Causes and symptoms***

Children who have been abused usually exhibit a variety of symptoms that encompass behavioral, emotional, and psychosomatic problems (body problems caused by emotional or psychological disturbance). Children who have been physically abused tend to be more aggressive, angry, hostile, depressed, and have low self-esteem. Additionally, they exhibit fear, **anxiety**, and nightmares. Severe psychological problems may result in suicidal behavior or posttraumatic stress disorder. Physically abused children may complain of physical illness even in the absence of a cause. They also may develop **eating disorders** or **encopresis**. Children who are sexually abused may exhibit abnormal sexual behavior in the form of aggressiveness and hyperarousal. Adolescents may display promiscuity, sexual acting out, and homosexual exploration. Children who are psychologically abused or who witness psychological abuse are more likely to become psychological abusers as adults.

Physical abuse directed toward adults can ultimately lead to **death**. Approximately 50% of women murdered in the United States were killed by a former

or current male partner. Approximately one-third of emergency room visits by women are prompted by an incident of domestic violence. Female victims who are assaulted by an intimate partner also have a higher rate of internal injuries and loss of consciousness than victims of stranger assault (e.g., mugging, robbery). As well as showing physical signs of abuse, adults who are abused often have poor health, difficulty concentrating, suicidal thoughts, clinical depression, low self-esteem, and a high rate of substance abuse. Many victims of abuse are afraid or unwilling to admit the abuse is occurring and will go to great lengths to disguise their situation.

### ***Diagnosis***

Physical abuse should be suspected whenever children or adults have unexplained injuries, especially when these injuries occur with an unexpectedly high frequency. A report may be filed with the local family social services agency that will initiate investigations. A police report may also be made. The authorities normally will follow up the allegation of abuse.

Sexual abuse of both a child and an adult may be identified from information given by the victim. Victims can be assessed for signs of ejaculatory evidence from the perpetrator. Ejaculatory specimens can be retrieved from the mouth, rectum, and clothing. Tests for **sexually transmitted diseases** may be performed.

Elder abuse should be suspected if a dependent individual demonstrates a fear of the caregiver. Additionally, elder abuse can be suspected if there are signs indicating intentional delay of required medical care, an unexpected change in medical status, or a significant change in the elderly individual's financial status.

Substance abuse usually causes behavioral changes such as failure to perform expected tasks or inability to meet reasonable work and family responsibilities. It should be suspected in a person who continues to use their drug of choice despite recurrent negative consequences. The diagnosis can be made after administration of a comprehensive physical exam and a chemical abuse assessment by a therapist.

### ***Treatment***

Both children and adults who are victims of physical or sexual abuse typically require immediate medical attention and long-term **psychotherapy**. Many victims of abuse, especially children who are sexually abused, take years to come to terms with the

abuse. Therapists who specialize in treating victims of physical and sexual abuse can help the individual understand what has happened and suggest ways to make positive steps toward moving past the abuse. Support groups can be helpful for some victims. When children are abused by the adults they live with, they may be removed from the abuser's home and placed in foster care or a group home. Psychological counseling and anger management should also be made available to the abuser. The effects of all types of abuse can last for years even with good mental health care. Children witnessing abuse, even if they were not abused themselves, also are often adversely affected and can benefit from psychotherapy.

Substance abusers may elect treatment or be sent to a treatment facility as part of a law enforcement proceeding. Treatment for substance abusers can be at either an inpatient or outpatient facility, depending on severity of **addiction**. Psychological counseling, behavior modification strategies, and medications may be used to assist in abstinence. The individual should be encouraged to participate in community-centered support groups (e.g., Alcoholics Anonymous, **Narcotics Anonymous**). Support groups also exist for family members of substance abusers.

Toll-free telephone hotlines available 24 hours a day, 7 days a week can provide referrals and counseling for people in an abuse crisis situation. People calling these hotlines may choose to remain anonymous. A list of national hotlines in the United States can be found in the reference section of this article.

## Prognosis

How an individual progresses after experiencing an abuse situation depends on the individual's personality, the type of abuse, the length of time the individual was abused, family support, and the professional support services available. Usually victims of abuse require extensive psychotherapy to deal with emotional distress associated with the incident. Perpetrators require further psychological evaluation and treatment. Victims of abuse may have a variety of emotional problems including depression, acts of **suicide**, **post-traumatic stress disorder**, and anxiety disorder. Many turn to substance abuse as a way to avoid dealing with their emotions. Children who experience sexual abuse may enter abusive relationships or have problems with intimacy as adults. Substance abusers may experience relapses since the cardinal feature of all addictive disorders is a tendency to return to symptoms. Elderly individuals may suffer from further

medical problems and/or anxiety; in some cases neglect may precipitate death.

## Prevention

Prevention programs are geared to education and awareness. Detection of initial symptoms or characteristic behaviors may assist in identifying some potential abuse situations. Certain professionals in the United States are required by law to report suspected child abuse. These include teachers, social workers, law officers, and some medical personnel. In some cases treatment may be sought before incident. The professional treating the abused persons must develop a clear sense of the relationship dynamics and the chances for continued harm.

## ORGANIZATIONS

Childhelp National Child Abuse Hotline, 15757 N. 78th St., Suite B., Scottsdale, AZ, 85260, (480) 922-8212, (480) 922-7061, (800) 422-4453, <http://www.childhelp.org>. Help for children who are being abused or adults who are concerned that a child they know is being abused or neglected.

Elder Abuse Hotline, (800) 252-8966, .Assistance in reporting and counseling about elder abuse.

National Coalition Against Domestic Violence, 1120 Lincoln Street, Suite 1603, Denver, CO, 80203, (303) 839-1852, (303) 831-9251, <http://www.ncadv.org/>.

National Domestic Violence Hotline, P. O. box 161810, Austin, TX, 78716, (512) 794-1133, (800) 799-SAFE (7233), <http://www.thehotline.org>.Help for both men and women who are victims of domestic violence.

Rape, Abuse and Incest National Network (RAINN), 2000 L Street NW, Suite 406, Washington, DC, 20036, (202) 544-1034, (202) 544-3556, (800) 656-HOPE (4673), <http://www.rainn.org/get-help/national-sexual-assault-online-hotline>.Online counseling and referral to local rape crisis centers using anonymous instant messaging or telephone.

Substance Abuse Treatment Referral Hotline, P.O. Box 2345, Rockville, MD, 20847-2345, (800) 662-HELP (4357), <http://www.samhsa.gov>.Information, support, treatment options, and referrals to local rehab centers for any drug or alcohol problem.

Laith Farid Gulli M.D.  
Bilal Nasser M.Sc.  
Tish Davidson A. M.

Acceleration-deceleration cervical injury see  
**Whiplash**

ACE inhibitors see **Angiotensin-converting enzyme inhibitors**

# Acetaminophen

## Definition

Acetaminophen, paracetamol, is a medicine that is sold over the counter, and combined with stronger **pain** relievers by prescription, to relieve mild to moderate pain.

## Purpose

Acetaminophen and **aspirin** are equally effective as pain relievers. But, unlike aspirin, acetaminophen does not reduce inflammation.

## Description

Acetaminophen is sold under various brand names: Tylenol, Panadol, Aspirin Free Anacin, and Bayer Select Maximum Strength **Headache** Pain Relief Formula.

Over the counter acetaminophen is available as tablets, chewable tablets, capsules, oral suspension and drops, and as rectal suppositories.

Acetaminophen, in usual doses and for short periods of time, is considered safe for use during **pregnancy** and nursing.

Many multi-symptom cold, flu, and sinus medicines contain acetaminophen. The labels list acetaminophen, if present, and the amount per dose.

## Recommended dosage

The usual dose for adults and children above age 12 is 650 mg three to four times a day.

The maximum safe dose for adults without **liver disease** is 4 grams (4000 mg) per 24 hours.

For children of average size, below age 12, the following can serve as a guide for maximum doses:

- Infants 3 months or less – 40mg three times a day
- Infants 4 to 12 months – 80mg three times a day
- Toddlers 1-2 years – 120mg three to four times a day
- Children 2-3 years – 160mg three to four times a day
- Children 4-5 years – 240mg three to four times a day
- Children 6-8 years – 320mg three to four times a day
- Children 9-10 years – 400mg three to four times a day
- Children 11 years – 480mg three to four times a day

## Precautions

Take with food or milk to reduce the possibility of stomach upset.

Acetaminophen is combined with **narcotics** and strong non-narcotic pain relievers in prescription products. It is also combined with cold and flu products sold over the counter. Thus, caution is advised when taking prescription and over the counter products together to avoid unknowingly overdosing on the drug.

In acute conditions with pain and **fever**, acetaminophen should be used only for one to two days before seeking medical attention.

If there is a **sore throat**, fever, rash, headache, **nausea** and/or **vomiting**, immediate medical attention should be sought.

People who consume three or more alcoholic beverages a day are at greater risk of liver disease if they take acetaminophen.

Acetaminophen interferes with the results of some laboratory tests. Check with your doctor if you take acetaminophen and are scheduled for tests.

Acetaminophen does not reduce inflammation, swelling, or have anti-rheumatic effects.

## Side effects

Common side effects of acetaminophen include generalized rash, **hives**, **itching** and hoarseness. If difficulty breathing develops, there may be an allergic reaction and immediate medical attention is needed.

Acute overdoses of acetaminophen may cause nausea, **vomiting**, sweating, exhaustion, upper abdominal pain and flu-like symptoms.

Overdoses of acetaminophen, more than 4000mg/day, can cause liver damage and failure. Chronic, daily use of moderate to large doses of acetaminophen and/or combining acetaminophen with moderately heavy use of alcohol can result in liver damage and failure.

Liver failure symptoms include **fatigue**, **jaundice**, and unusual bleeding or bruising.

## Interactions

Acetaminophen may increase the effects of the blood thinner warfarin (Coumadin).

The toxicity and effects of acetaminophen may be increased by the anti-tuberculosis drug isoniazid and imatinib.

The toxicity and effectiveness of acetaminophen may be decreased by phenytoin (Dilantin), **barbiturates**, the cholesterol-lowering drug cholestyramine resin (Questran), and carbamazepine.

## KEY TERMS

**Botulinum toxin**—Any of a group of potent bacterial toxins or poisons produced by different strains of the bacterium *Clostridium botulinum*. The toxins cause muscle paralysis.

**Dysphagia**—Difficulty in swallowing.

**Endoscopy**—A test in which a viewing device and a light source are introduced into the esophagus by means of a flexible tube. Endoscopy permits visual inspection of the esophagus for abnormalities.

**Esophageal manometry**—A test in which a thin tube is passed into the esophagus to measure the degree of pressure exerted by the muscles of the esophageal wall.

**Esophageal sphincter**—A circular band of muscle that closes the last few centimeters of the esophagus and prevents the backward flow of stomach contents.

**Esophagomyotomy**—A surgical incision through the muscular tissue of the esophagus.

**Esophagus**—The muscular tube that leads from the back of the throat to the entrance of the stomach.

**Peristalsis**—The coordinated, rhythmic wave of smooth muscle contraction that forces food through the digestive tract.

**Reflux**—An abnormal backward or return flow of a fluid.

## Resources

### OTHER

Medline Plus: [www.nlm.nih.gov/medlineplus/druginfo/meds](http://www.nlm.nih.gov/medlineplus/druginfo/meds)

James Waun MD, RPh

Acetylsalicylic acid see **Aspirin**

Normal peristalsis is interrupted and food cannot enter the stomach.

## Causes and symptoms

### Causes

Achalasia is caused by degeneration of the nerve cells that normally signal the brain to relax the esophageal sphincter. The ultimate cause of this degeneration is unknown. Autoimmune disease or hidden infection is suspected.

### Symptoms

Dysphagia, or difficulty swallowing, is the most common symptom of achalasia. The person with achalasia usually has trouble swallowing both liquid and solid foods, often feeling that food “gets stuck” on the way down. The person has chest **pain** that is often mistaken for angina pectoris (cardiac pain). Heartburn and difficulty belching are common. Symptoms usually get steadily worse. Other symptoms may include nighttime **cough** or recurrent **pneumonia** caused by food passing into the lower airways.

## Diagnosis

Diagnosis of achalasia begins with a careful medical history. The history should focus on the timing of symptoms and on eliminating other medical conditions that may cause similar symptoms. Tests used to diagnose achalasia include:

- Esophageal manometry. In this test, a thin tube is passed into the esophagus to measure the pressure exerted by the esophageal sphincter.

- X ray of the esophagus. Barium may be swallowed to act as a contrast agent. Barium reveals the outlines of the esophagus in greater detail and makes it easier to see its constriction at the sphincter.
- Endoscopy. In this test, a tube containing a lens and a light source is passed into the esophagus. Endoscopy is used to look directly at the surface of the esophagus. This test can also detect tumors that cause symptoms like those of achalasia. Cancer of the esophagus occurs as a complication of achalasia in 2–7% of patients.

## Treatment

The first-line treatment for achalasia is balloon dilation. In this procedure, an inflatable membrane or balloon is passed down the esophagus to the sphincter and inflated to force the sphincter open. Dilation is effective in about 70% of patients.

Three other treatments are used for achalasia when balloon dilation is inappropriate or unacceptable.

- Botulinum toxin injection. Injected into the sphincter, botulinum toxin paralyzes the muscle and allows it to relax. Symptoms usually return within one to two years.
- Esophagomyotomy. This surgical procedure cuts the sphincter muscle to allow the esophagus to open. Esophagomyotomy is becoming more popular with the development of techniques allowing very small abdominal incisions.
- Drug therapy. Nifedipine, a calcium-channel blocker, reduces muscle contraction. Taken daily, this drug provides relief for about two-thirds of patients for as long as two years.

## Prognosis

Most patients with achalasia can be treated effectively. Achalasia does not reduce life expectancy unless esophageal carcinoma develops.

## Prevention

There is no known way to prevent achalasia.

## Resources

### BOOKS

Greenberger, Norton, Richard Blumberg, and Robert Burakoff. *Current Diagnosis & Treatment in Gastroenterology, Hepatology, & Endoscopy*. New York: McGraw-Hill Medical, 2009.

Richard Robinson

# Achondroplasia

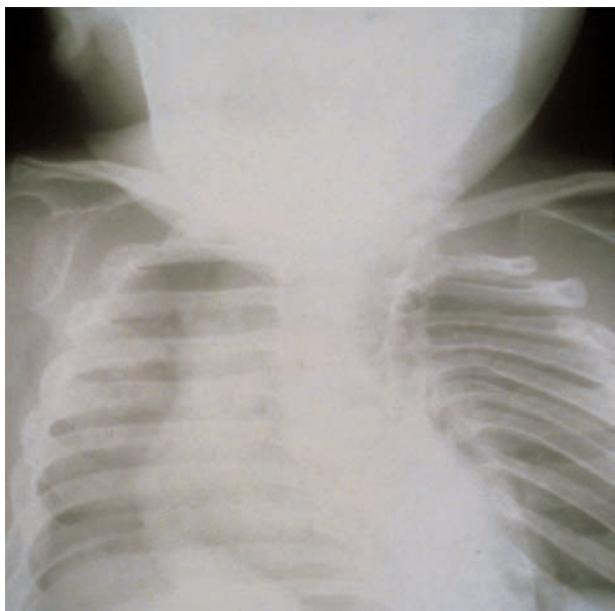
## Definition

Achondroplasia is the most common cause of dwarfism, or significantly abnormal short stature.

## Description

Achondroplasia is one of a number of chondodystrophies, in which the development of cartilage, and therefore, bone is disturbed. The disorder appears in approximately one in every 10,000 births. Achondroplasia is usually diagnosed at birth, owing to the characteristic appearance of the newborn.

Normal bone growth depends on the production of cartilage (a fibrous connective tissue). Over time, **calcium** is deposited within the cartilage, causing it to harden and become bone. In achondroplasia, abnormalities of this process prevent the bones (especially those in the limbs) from growing as long as they normally should, at the same time allowing the bones to become abnormally thickened. The bones in the trunk of the body and the skull are mostly not affected, although the opening from the skull through which the spinal cord passes (foramen magnum) is often narrower than normal, and the opening (spinal canal) through which the spinal cord runs in the back



An x-ray image of an achondroplastic person's head and chest. (Custom Medical Stock Photo, Inc. Reproduced by permission.)

## KEY TERMS

**Cartilage**—A flexible, fibrous type of connective tissue which serves as a base on which bone is built.

**Foramen magnum**—The opening at the base of the skull, through which the spinal cord and the brain-stem pass.

**Hydrocephalus**—An abnormal accumulation of fluid within the brain. This accumulation can be destructive by pressing on brain structures and damaging them.

**Mutation**—A new, permanent change in the structure of a gene, which can result in abnormal structure or function somewhere in the body.

**Spinal canal**—The opening that runs through the center of the column of spinal bones (vertebrae), and through which the spinal cord passes.

**Vertebrae**—The individual bones of the spinal column which are stacked on top of each other. There is a hole in the center of each bone, through which the spinal cord passes.

bones (vertebrae) becomes increasingly and abnormally small down the length of the spine.

### Causes and symptoms

Achondroplasia is caused by a genetic defect. It is a dominant trait, meaning that anybody with the genetic defect will display all the symptoms of the disorder. A parent with the disorder has a 50% chance of passing it on to the offspring. Although achondroplasia can be passed on to subsequent offspring, the majority of cases occur due to a new mutation (change) in a gene. Interestingly enough, the defect seen in achondroplasia is one of only a few defects known to increase in frequency with increasing age of the father (many genetic defects are linked to increased age of the mother).

People with achondroplasia have abnormally short arms and legs. Their trunk is usually of normal size, as is their head. The appearance of short limbs and normal head size actually makes the head appear to be oversized. The bridge of the nose often has a scooped out appearance termed “saddle nose.” The lower back has an abnormal curvature, or sway back. The face often displays an overly prominent forehead, and a relative lack of development of the face in the area of the upper jaw. Because the foramen magnum and spinal canal are abnormally narrowed, nerve damage may occur if the spinal cord or nerves become compressed. The narrowed foramen magnum may disrupt the normal flow of fluid between the brain and the spinal cord, resulting in the accumulation of too much fluid in the brain (**hydrocephalus**). Children with achondroplasia have a very high risk of serious and repeated middle ear infections, which can result in **hearing loss**. The disease does not affect either mental capacity, or reproductive ability.

### Diagnosis

Diagnosis is often made at birth due to the characteristically short limbs, and the appearance of a large head. X-ray examination will reveal a characteristic appearance to the bones, with the bones of the limbs appearing short in length, yet broad in width. A number of measurements of the bones in x-ray images will reveal abnormal proportions.

### Treatment

No treatment will reverse the defect present in achondroplasia. All patients with the disease will be short, with abnormally proportioned limbs, trunk, and head. Treatment of achondroplasia primarily addresses some of the complications of the disorder, including problems due to nerve compression, hydrocephalus, bowed legs, and abnormal curves in the spine. Children with achondroplasia who develop middle ear infections (acute **otitis media**) will require quick treatment with **antibiotics** and careful monitoring in order to avoid hearing loss.

### Prognosis

Achondroplasia is a disease that causes considerable deformity. However, with careful attention paid to the development of dangerous complications (nerve compression, hydrocephalus), most people are in good health, and can live a normal lifespan.

### Prevention

The only form of prevention is through **genetic counseling**, which could help parents assess their risk of having a child with achondroplasia.

## Resources

### BOOKS

*Achondroplasia—A Medical Dictionary, Bibliography, and Annotated Research Guide to Internet References.* 2nd ed. San Diego, CA: ICON, 2009.

### ORGANIZATIONS

Little People of America, Inc., 250 El Camino Real, Suite 201, Tustin, CA, 92780, (714) 368-3689, (714) 368-3367, (888) LPA-2001 (572-2001), <http://www.lpaonline.org>.

Rosalyn Carson-DeWitt MD

Achromatopsia see **Color blindness**

Acid indigestion see **Heartburn**

## KEY TERMS

**Enzyme**—A substance needed to trigger specific chemical reactions.

**Metastasize**—Spread to other parts of the body; usually refers to cancer.

**Prostate gland**—A gland of the male reproductive system.

### Precautions

This is not a screening test for prostate cancer. Acid phosphatase levels rise only after prostate cancer has metastasized.

### Description

Laboratory testing measures the amount of acid phosphatase in a person's blood, and can determine from what tissue the enzyme is coming. For example, it is important to know if the increased acid phosphatase is from the prostate or red blood cells. Acid phosphatase from the prostate, called prostatic acid phosphatase (PAP), is the most medically significant type of acid phosphatase.

Subtle differences between prostatic acid phosphatase and acid phosphatases from other tissues cause them to react differently in the laboratory when mixed with certain chemicals. For example, adding the chemical tartrate to the test mixture inhibits the activity of prostatic acid phosphatase but not red blood cell acid phosphatase. Laboratory test methods based on these differences reveal how much of a person's total acid phosphatase is derived from the prostate. Results are usually available the next day.

### Preparation

This test requires drawing about 5–10 mL of blood. The patient should not have a rectal exam or prostate massage for two to three days prior to the test.

### Aftercare

Discomfort or bruising may occur at the puncture site, and the person may feel dizzy or faint. Applying pressure to the puncture site until the bleeding stops will reduce bruising. Warm packs on the puncture site will relieve discomfort.

## Normal results

Normal results vary based on the laboratory and the method used.

## Abnormal results

The highest levels of acid phosphatase are found in metastasized prostate cancer. Diseases of the bone, such as Paget's disease or **hyperparathyroidism**; diseases of blood cells, such as **sickle cell disease** or **multiple myeloma**; or lysosomal disorders, such as Gaucher's disease, will show moderately increased levels.

Certain medications can cause temporary increases or decreases in acid phosphatase levels. Manipulation of the prostate gland through massage, biopsy, or rectal exam before a test can increase the level.

## Resources

### PERIODICALS

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Nancy J. Nordenson

**Acid reflux** see **Gastroesophageal reflux disease**

**Acidosis** see **Respiratory acidosis; Renal tubular acidosis; Metabolic acidosis**

## Acne

### Definition

Acne is a common skin condition characterized by pimples on the face, chest, and back. It occurs when the pores of the skin become clogged with oil, dead skin cells, and bacteria.

### Demographics

*Acne vulgaris*, or common acne, is the most prevalent of all skin diseases. It affects nearly 17 million people in the United States. Nearly 85% of young people develop acne at some time between the ages of 12 and 25 years. It usually begins at **puberty** and worsens during adolescence, occurring most often between

the ages of 14 and 18. However, acne can arise at any age, including in newborns and older adults. It is more common and often more severe in males than in females. Although acne usually resolves on its own during early adulthood, some people continue to have acne outbreaks well into adulthood.

### Description

Acne originates in the oil or sebaceous glands that lie just beneath the surface of the skin, within the hair follicles. These glands produce an oil called sebum—the skin's natural moisturizer—which also helps preserve the flexibility of the hair. These sebaceous follicles open onto the skin through pores, allowing the sebum to reach the hair and skin surface. The most common sites of acne are the face, chest,



**Acne vulgaris** affecting a woman's face. Acne is the general name given to a skin disorder in which the sebaceous glands become inflamed. (© Biophoto Associates/Photo Researchers, Inc.)

## KEY TERMS

**Androgens**—Male sex hormones that are linked to the development of acne.

**Anti-androgens**—Drugs that inhibit the production of androgens.

**Antibiotics**—Medications that kill bacteria.

**Comedo, comedone**—A hard plug composed of sebum and dead skin cells.

**Comedolytic**—A drug that breaks up comedones and opens clogged pores.

**Corticosteroids**—A group of hormones produced by the adrenal glands with various functions, including regulation of fluid balance, androgen activity, and reaction to inflammation.

**Estrogens**—Hormones produced by the ovaries, the female sex glands.

**Follicles**—Structures in the skin containing oil glands and hair; the source of pimples.

**Isotretinoin**—A drug for severe acne that decreases sebum production and dries up pimples.

**Papule**—An inflamed pimple near the surface of the skin.

***Propionibacterium acnes***—Skin bacteria that infect sebaceous follicles, causing acne.

**Pustule**—A pus-filled pimple.

**Sebaceous follicles**—Structures in the skin that contain oil-producing glands and hair follicles and which give rise acne.

**Sebum**—An oily skin moisturizer produced by sebaceous glands.

**Tretinoin**—A naturally occurring retinoid, derived from vitamin A, that treats acne by increasing the turnover (death and replacement) of skin cells.

shoulders, and back since these have the most sebaceous follicles.

At puberty increased levels of androgens (male hormones) cause the sebaceous glands to overproduce sebum. The excess sebum cannot be cleared from the pores efficiently. In addition, cells lining the follicle are shed too quickly and the dead cells clump together. When the excess sebum combines with the dead, sticky skin cells, a hard plug—called a comedo—forms and blocks the pore. There are two types of comedones in mild noninflammatory acne: whiteheads and blackheads. When the plugged follicle begins to bulge as a small whitish bump mostly under the skin, it is called a whitehead. If the comedo opens up, the top surface of the plug darkens as it is exposed to the air and it is referred to as a blackhead.

Moderate and severe inflammatory acnes result from infection of plugged follicles with *Propionibacterium acnes*, bacteria that normally live on the skin. Other microorganisms can also be involved. The bacteria produce chemicals and enzymes that cause inflammation. Pimples form when infected whiteheads or blackheads weaken and burst, releasing sebum, bacteria, and skin and white blood cells into the surrounding tissues. Inflamed pimples near the skin surface are called papules. Deeper pimples that fill with pus are called pustules. The most severe type of acne occurs when the infected follicles continue to enlarge

without rupturing, forming nodules and cysts. Cysts are closed sacs that form lumps under the skin. Nodules are large hard swellings deep within the skin. Cysts and nodules can be painful and scarring can occur when new skin cells are laid down to replace damaged cells.

Acne is not a serious health threat. However, it can negatively affect appearance and has the potential of causing permanent scarring. Some people, especially teenagers, become quite upset about their acne and this distress can contribute to social or psychological problems.

### ***Risk factors***

Risk factors for acne include:

- Age. Teenagers are most susceptible to acne because of hormonal changes.
- Gender. Acne is more common in boys than in girls and boys tend to have more severe cases.
- Heredity. Acne runs in families.
- Hormonal changes in females. Acne can flare up right before menstruation, when levels of estrogen (female hormones that reduce oil production) drop, and during pregnancy and menopause.
- Disease. Hormonal disorders can complicate acne in girls.

- Personal hygiene. Abrasive soaps, hard scrubbing, or picking at pimples will worsen acne.
- Cosmetics. Oil-based makeup and sunscreen—which clog pores—and hairsprays can aggravate acne.
- Environment. Exposure to oils and grease, polluted air, and sweating in hot weather aggravate acne.
- Diet. Although foods do not cause acne, certain foods may cause flare-ups or worsen the condition.
- Drugs. Acne can be a side effect of drugs including tranquilizers, antidepressants, antibiotics, oral contraceptives, and steroid drugs, including anabolic steroids, which are chemically similar to the male hormone testosterone.
- Stress. Emotional stress may contribute to acne.
- Friction. Continual pressure or rubbing of the skin—for example by bicycle helmets, backpacks, or tight clothing—can worsen acne.

## Causes and symptoms

The exact cause of most cases of acne is unknown. Contrary to popular myth, acne is not caused or aggravated by dirt, by eating greasy foods or chocolate, or by sexual activity. Many factors, including heredity, can contribute to the development of acne. The interactions between the body's hormones, skin proteins and secretions, and bacteria determine the course of acne.

Excess male hormone production in women can cause acne. Flare-ups of acne are also influenced by a woman's menstrual cycle. One study found that women over age 33 actually had a higher incidence of premenstrual acne than teenage girls.

Some alternative medical practitioners assert that acne is often related to toxicity in the intestines or liver due to:

- the presence of bacteria such as *Clostridia spp.* and *Yersinia enterocolitica*
- a low-fiber diet
- a deficiency in healthy gut flora such as *Lactobacillus spp.*
- an intestinal overgrowth of the yeast *Candida albicans*
- food allergies

In teenagers acne often occurs on the forehead, nose, and chin. As people age the condition tends to appear towards the outer part of the face. Adult women may have acne on their chins and around their mouths. The elderly often develop whiteheads and blackheads on the upper cheeks and skin around the eyes.

Although acne is usually a superficial condition, inflamed lesions may cause tenderness, **itching**, **pain**, or swelling. The most troubling aspects of these lesions are their negative effect on appearance and the potential for scarring. Some people, especially teenagers who may be particularly self-conscious, are emotionally distressed by their acne, leading to difficulties with school, employment, or relationships.

## Diagnosis

### Examination

Acne has a characteristic appearance and is not difficult to diagnose. The doctor takes a complete medical history, including questions about skin care, diet, factors that seem to improve or exacerbate the condition, medication use, and prior treatment. A **physical examination** includes the face, upper neck, chest, shoulders, back, and other affected areas. Under good lighting the doctor determines the number and types of blemishes, whether they are inflamed, whether they are deep or superficial, and whether there is skin discoloration or scarring.

### Tests

Laboratory tests are not performed unless the acne appears to be caused by a hormonal disorder or other underlying medical problem. In these cases, blood analyses or other tests may be ordered. Stool tests can be helpful in determining whether there is a bacterial or yeast overgrowth contributing to the condition. Food-allergy testing may also be considered. Most insurance plans cover the costs of diagnosing and treating acne.

## Treatment

### Traditional

Acne cannot be cured, but it can be controlled. The goal of acne treatment is to reduce sebum and keratin production, remove dead skin cells to help unclog the pores, and kill bacteria with topical drugs and oral medications. Treatment choice depends upon whether the acne is mild, moderate, or severe. Severe cases are referred to a dermatologist or an endocrinologist who treats diseases of the glands and the hormones. Most dermatologists use a combination of treatments, depending on the individual. Counseling may be necessary to clear up misconceptions about the condition and to offer support regarding the negative effect of acne on physical appearance.

In addition to medications, treatments for severe acne or the resulting **scars** include:

- Comedone extraction. The comedo is removed from the pore with a special tool.
- Chemical peels. Glycolic acid is applied to peel off the top layer of skin to reduce scarring.
- Dermabrasion. The affected skin is frozen with a chemical spray and removed by brushing or planing.
- Punch grafting. Deep scars are excised and the area repaired with small skin grafts.
- Intralesional injection. Corticosteroids are injected directly into inflamed cysts.
- Collagen injection. Shallow scars are elevated by collagen protein injections.
- Laser treatments. There are two types of laser treatments for removing acne scars.

### **Drugs**

Mild non-inflammatory acne is usually treated with topical over-the-counter acne medications that reduce the formation of new comedones. These may contain:

- benzoyl peroxide (Clearasil, Fostex)
- salicylic acid (Stridex)
- sulfur (Therac lotion)
- resorcinol (Acnomel cream)

Treatment with stronger topical medications requires a doctor's prescription. Such medications include comedolytics, which are agents that loosen hard plugs and open pores. These include concentrated formulas of salicylic acid, resorcinol, and sulfur. They also include topical retinoids—natural or synthetic vitamin A derivatives—which increase turnover (**death** and replacement) of skin cells. Topical retinoids are considered a cornerstone of acne treatment:

- adapalene (Differin)
- tretinoin (Retin-A, Avita, Renova Emollient)
- tazarotene (Tazorac)

**Topical antibiotics** to kill bacteria may be added to the treatment regimen if inflammation is present. These include:

- erythromycin
- clindamycin (Cleocin-T)
- mecloxycline (Meclan)
- sodium sulfacetamide

Topical medications that act as both comedolytics and **antibiotics** include:

- benzoyl peroxide
- azelaic acid (Azelex), a naturally occurring skin substance

- benzoyl peroxide plus erythromycin (Benzamycin)

Topical medications are available as creams, gels, lotions, soaps, or pads of varying strengths. The medications are applied to the entire affected skin area once or twice per day after washing with mild soap. Possible side effects include mild redness, peeling, irritation, dryness, and an increased sensitivity to sunlight that requires the use of a sunscreen. Medications may be used for months or years to control acne.

The goal of treating moderate acne is to decrease inflammation as well as prevent new comedone formation. Common treatments are topical tretinoin combined with a topical or oral antibiotic or topical benzoyl peroxide and erythromycin. The treatment is maintained for at least two to four months.

When acne is severe and the lesions are deep, oral antibiotics may be taken daily to reduce the spread of bacteria:

- tetracycline, which is the most common antibiotic for treating acne but which should not be taken while pregnant or breastfeeding
- erythromycin
- minocycline, which may have fewer side effects than other antibiotics
- doxycycline for inflammatory acne

Antibiotics must be used for up to three months to affect severe acne. They can cause side effects including:

- dizziness
- photosensitivity
- gastrointestinal upset
- skin darkening
- allergic reactions
- yeast infections
- tooth discoloration
- folliculitis

Oral isotretinoin (Accutane) reduces sebum production and cell stickiness. It is reserved for the treatment of very severe acne with cysts and nodules or if antibiotic therapy is unsuccessful. Isotretinoin is sometimes used in combination with topical or oral antibiotics. Treatment may continue for four to five months and may be repeated or replaced with topical drugs or oral antibiotics if the acne returns. Lower dosages require a longer course of therapy.

Women who might become pregnant should use isotretinoin with extreme caution, since it can cause **birth defects** and **miscarriage** up to a month after stopping the medication. Strict attention should be

paid to **pregnancy** tests and contraceptive requirements for women of childbearing age who take this medication.

Side effects of isotretinoin are very common and may include:

- temporary worsening of the acne
- dry eyes, lips, skin, and genital mucosa
- nosebleeds
- vision disorders
- elevated liver enzymes, blood fats, and cholesterol

Monthly blood tests are necessary to ensure that the medication is not causing serious harm.

Anti-androgens—drugs that inhibit androgen production—and estrogens (female hormones) are used to treat women whose acne is unresponsive to other therapies. Certain types of **oral contraceptives**, such as norgestimate/ethynodiol dihydrogesterone (Ortho-Tri-Cyclen), have been shown to improve acne. Both ultra-low-dose birth-control pills (Alesse) and those with higher doses of estrogen can be effective in treating acne.

Other drugs, such as spironolactone and oral **corticosteroids** or anti-inflammatory drugs, may be used to reduce hormone activity in the adrenal glands, thereby reducing production of sebum. This is the treatment of choice for an extremely severe but rare type of inflammatory acne called *acne fulminans*, which primarily affects adolescent males. *Acne conglobata* is a more common form of severe inflammation characterized by numerous, deep, inflammatory nodules that heal with scarring. It is treated with oral isotretinoin and corticosteroids.

### **Alternative**

In addition to proper cleansing to keep the skin free of oil, alternative treatments for acne include:

- a well-balanced diet high in fiber, zinc, and raw foods
- intermittent fasting
- an elimination diet with the avoidance of alcohol, dairy products, caffeine, sugar, processed foods, and foods high in iodine, which appear to contribute to acne
- avoidance of smoking

### **Nutritional supplements** for treating acne include:

- essential fatty acids
- vitamin B complex
- vitamin A or beta-carotene
- zinc
- chromium

Supplementation with herbs that are blood cleansers or blood purifiers, strengthen the action of the liver and the kidneys, and help with **detoxification** and excretion are used to treat acne. These include:

- dandelion (*Taraxacum officinale*) root tincture
- burdock root (*Arctium lappa*), also known as gobo, which can be purchased fresh at health-food grocers or in Asian markets and can be used raw or cooked in salads, stir fries, or other vegetable dishes or as a tincture
- red clover (*Trifolium pratense*), which can be consumed as a tea throughout the day
- milk thistle (*Silybum marianum*) seed which can be taken as a tincture or ground up and eaten in combination with hot cereal, granola, or other foods

Other herbs useful in the treatment of acne include:

- *Echinacea spp.*
- goldenseal (*Hydrastis canadensis*), which is particularly helpful for clearing up underlying intestinal toxicity and killing bacteria
- traditional Chinese herbal remedies such as cnidium seed (*Cnidium monnieri*) and honeysuckle flower (*Lonicera japonica*). Wholistic physicians or nutritionists can recommend the proper amounts of these herbs.

Bowel toxicity may contribute to acne flare-ups. *Lactobacillus acidophilus* and *Lactobacillus bulgaricus* can be obtained from yogurt or as capsules to maintain a healthy balance of intestinal flora. Allergic foods should be identified and removed from the diet. Dietary fiber, such as oat and wheat bran, beans, fruits and vegetables and their skins, and psyllium seed, should be increased. The fiber absorbs toxins and carries them through the colon for excretion.

Individuals with acne may want to participate in a **movement therapy**, such as **yoga** or **t'ai chi**, or begin an **exercise** regimen. **Stress reduction** or **meditation** can also be helpful.

### **Home remedies**

Washing the acne-affected area with a mild germicidal soap and an abrasive sponge can help dislodge the material plugging the gland. However manipulating or squeezing acne pustules can cause deep and permanent scarring.

### **Prognosis**

Acne is not curable, but it can be controlled by proper treatment. Improvement takes time and the

results of specific treatments vary with the individual. Over-the-counter treatments for mild non-inflammatory acne can help prevent new blemishes, although it often takes 8–10 weeks to see improvement, as old blemishes take time to heal. Inflammatory acne that is treated with a topical comedolytic in combination with an antibiotic usually improves within four to six weeks. Acne tends to reappear when treatment stops, but spontaneously improves over time. Inflammatory acne can leave scars that require further treatment.

Oral isotretinoin clears up resistant cysts and nodules in up to 90% of patients and prevents scarring. Long-term control is achieved in up to 60% of patients treated for four to five months. Another 20% of patients require a second course of isotretinoin and the final 20% may require only topical drugs or oral antibiotics. Improvement with anti-androgens may take up to four months.

## Prevention

There is no sure way to prevent acne, but the following steps may help minimize flare-ups:

- washing affected areas gently with lukewarm water twice every day, using just the fingertips and a mild soap containing sulfur, *Calendula officinalis*, or other substances that are useful against acne
- washing gently after sweating
- waiting 5–15 minutes after washing to apply acne medication
- avoiding abrasive soaps, facial scrubs, toners, astringents, and masks, which can irritate the skin and cause breakouts
- limiting use of makeup and moisturizers; applying any medications before applying makeup
- using only skin and hair products that are labeled “oil-free,” “nonacnegenic,” or “noncomedogenic,” meaning that they do not clog pores
- shampooing often and wearing hair up and away from the face
- eating a healthy well-balanced diet of fresh fruits and vegetables
- avoiding foods that trigger flare-ups
- exposing the affected skin to sunlight on a limited basis, unless otherwise advised
- avoiding the handling of affected areas or picking or squeezing pimples, as this can contribute to scarring and spread the acne
- reducing stress

## Resources

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- Harper, Julie C. “Acne Vulgaris.” *eMedicine*. <http://www.emedicine.com/DERM/topic2.htm>.

### ORGANIZATIONS

- American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168, (847) 240-1280 (866) 503-SKIN (7546) (847) 240-1859 <http://www.aad.org>.

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Acne rosacea see **Rosacea**

Acoustic neurinoma see **Acoustic neuroma**

## Acoustic neuroma

### Definition

An acoustic neuroma is a benign tumor involving cells of the myelin sheath that surrounds the vestibulocochlear nerve (eighth cranial nerve).

### Description

The vestibulocochlear nerve extends from the inner ear to the brain and is made up of a vestibular branch, often called the vestibular nerve, and a cochlear branch, called the cochlear nerve. The vestibular and cochlear nerves lie next to one another. They also run along side other cranial nerves. People possess two of each type of vestibulocochlear nerve, one that extends from the left ear and one that extends from the right ear.

The vestibular nerve transmits information concerning balance from the inner ear to the brain and the cochlear nerve transmits information about hearing. The vestibular nerve, like many nerves, is surrounded by a cover called a myelin sheath. A tumor, called a schwannoma, can sometimes develop from the cells of the myelin sheath. A tumor is an abnormal growth of tissue that results from the uncontrolled growth of cells. Acoustic neuromas are often called vestibular schwannomas because they are tumors that arise from the myelin sheath that surrounds the vestibular nerve. Acoustic neuromas are considered benign (non-cancerous) tumors since they do not spread to other parts of the body. They can occur anywhere along the vestibular nerve but are most likely to occur where the vestibulocochlear nerve passes through the tiny bony canal that connects the brain and the inner ear.

An acoustic neuroma can arise from the left vestibular nerve or the right vestibular nerve. A unilateral tumor is a tumor arising from one nerve and a bilateral tumor arises from both vestibular nerves. Unilateral acoustic neuromas usually occur spontaneously (by chance). Bilateral acoustic neuromas occur as part of a hereditary condition called **Neurofibromatosis Type 2** (NF2). A person with NF2 has inherited a predisposition for developing acoustic neuromas and other tumors of the nerve cells.

Acoustic neuromas usually grow slowly and can take years to develop. Some acoustic neuromas remain so small that they do not cause any symptoms. As the acoustic neuroma grows it can interfere with the functioning of the vestibular nerve and can cause vertigo and balance difficulties. If the acoustic nerve grows large enough to press against the cochlear nerve, then **hearing loss** and a ringing (**tinnitus**) in the affected ear will

usually occur. If untreated and the acoustic neuroma continues to grow it can press against other nerves in the region and cause other symptoms. This tumor can be life threatening if it becomes large enough to press against and interfere with the functioning of the brain.

### Causes and symptoms

#### Causes

An acoustic neuroma is caused by a change or absence of both of the NF2 tumor suppressor genes in a nerve cell. Every person possesses a pair of NF2 genes in every cell of their body including their nerve cells. One NF2 gene is inherited from the egg cell of the mother and one NF2 gene is inherited from the sperm cell of the father. The NF2 gene is responsible for helping to prevent the formation of tumors in the nerve cells. In particular the NF2 gene helps to prevent acoustic neuromas.

Only one unchanged and functioning NF2 gene is necessary to prevent the formation of an acoustic neuroma. If both NF2 genes become changed or missing in one of the myelin sheath cells of the vestibular nerve then an acoustic neuroma will usually develop. Most unilateral acoustic neuromas result when the NF2 genes become spontaneously changed or missing. Someone with a unilateral acoustic neuroma that has developed spontaneously is not at increased risk for having children with an acoustic neuroma. Some unilateral acoustic neuromas result from the hereditary condition NF2. It is also possible that some unilateral acoustic neuromas may be caused by changes in other genes responsible for preventing the formation of tumors.

Bilateral acoustic neuromas result when someone is affected with the hereditary condition NF2. A person with NF2 is typically born with one unchanged and one changed or missing NF2 gene in every cell of their body. Sometimes they inherit this change from their mother or father. Sometimes the change occurs spontaneously when the egg and sperm come together to form the first cell of the baby. The children of a person with NF2 have a 50% chance of inheriting the changed or missing NF2 gene.

A person with NF2 will develop an acoustic neuroma if the remaining unchanged NF2 gene becomes spontaneously changed or missing in one of the myelin sheath cells of their vestibular nerve. People with NF2 often develop acoustic neuromas at a younger age. The mean age of onset of acoustic neuroma in NF2 is 31 years of age versus 50 years of age for sporadic acoustic neuromas. Not all people with NF2, however, develop acoustic neuromas. People with NF2 are at

## KEY TERMS

**Benign tumor**—A localized overgrowth of cells that does not spread to other parts of the body.

**Chromosome**—A microscopic structure, made of a complex of proteins and DNA, that is found within each cell of the body.

**Computed tomography (CT)**—An examination that uses a computer to compile and analyze the images produced by x rays projected at a particular part of the body.

**Cranial nerves**—The set of twelve nerves found on each side of the head and neck that control the sensory and muscle functions of a number of organs such as the eyes, nose, tongue face and throat.

**DNA testing**—Testing for a change or changes in a gene or genes.

**Gene**—A building block of inheritance, made up of a compound called DNA (deoxyribonucleic acid) and containing the instructions for the production of a particular protein. Each gene is found on a specific location on a chromosome.

**Magnetic resonance imaging (MRI)**—A test that uses an external magnetic field instead of x rays to visualize different tissues of the body.

**Myelin sheath**—The cover that surrounds many nerve cells and helps to increase the speed by which information travels along the nerve.

**Neurofibromatosis type 2 (NF2)**—A hereditary condition associated with an increased risk of bilateral acoustic neuromas, other nerve cell tumors and cataracts.

**Protein**—A substance produced by a gene that is involved in creating the traits of the human body such as hair and eye color or is involved in controlling the basic functions of the human body.

**Schwannoma**—A tumor derived from the cells of the myelin sheath that surrounds many nerve cells.

**Tinnitus**—A ringing sound or other noise in the ear.

**Vertigo**—A feeling of spinning or whirling.

**Vestibulocochlear nerve (Eighth cranial nerve)**—Nerve that transmits information, about hearing and balance from the ear to the brain.

increased risk for developing **cataracts** and tumors in other nerve cells.

Most people with a unilateral acoustic neuroma are not affected with NF2. Some people with NF2, however, only develop a tumor in one of the vestibulocochlear nerves. Others may initially be diagnosed with a unilateral tumor but may develop a tumor in the other nerve a number of years later. NF2 should be considered in someone under the age of 40 who has a unilateral acoustic neuroma. Someone with a unilateral acoustic neuroma and other family members diagnosed with NF2 probably is affected with NF2. Someone with a unilateral acoustic neuroma and other symptoms of NF2 such as cataracts and other tumors may also be affected with NF2. On the other hand, someone over the age of 50 with a unilateral acoustic neuroma, no other tumors and no family history of NF2 is very unlikely to be affected with NF2.

Recent studies in Europe have suggested a possible connection between the widespread use of mobile phones and an increased risk of developing acoustic neuromas. Some observers, however, question whether mobile phones have been in use long enough to be an identifiable risk factor.

### Symptoms

Small acoustic neuromas usually only interfere with the functioning of the vestibulocochlear nerve. The most common first symptom of an acoustic neuroma is hearing loss, which is often accompanied by a ringing sound (tinnitus). People with acoustic neuromas sometimes report difficulties in using the phone and difficulties in perceiving the tone of a musical instrument or sound even when their hearing appears to be otherwise normal. In most cases the hearing loss is initially subtle and worsens gradually over time until deafness occurs in the affected ear. In approximately 10% of cases the hearing loss is sudden and severe.

Acoustic neuromas can also affect the functioning of the vestibular branch of the vestibulocochlear nerve and can cause vertigo and dysequilibrium. Twenty percent of small tumors are associated with periodic vertigo, which is characterized by **dizziness** or a whirling sensation. Larger acoustic neuromas are less likely to cause vertigo but more likely to cause dysequilibrium. Dysequilibrium, which is characterized by minor clumsiness and a general feeling of instability, occurs in nearly 50% of people with an acoustic neuroma.

As the tumor grows larger it can press on the surrounding cranial nerves. Compression of the fifth cranial nerve can result in facial **pain** and/or **numbness**. Compression of the seventh cranial nerve can cause spasms, weakness or **paralysis** of the facial muscles. Double vision is a rare symptom but can result when the 6th cranial nerve is affected. Swallowing and/or speaking difficulties can occur if the tumor presses against the 9th, 10th, or 12th cranial nerves.

If left untreated, the tumor can become large enough to press against and affect the functioning of the brain stem. The brain stem is the stalk like portion of the brain that joins the spinal cord to the cerebrum, the thinking and reasoning part of the brain. Different parts of the brainstem have different functions such as the control of breathing and muscle coordination. Large tumors that impact the brain stem can result in headaches, walking difficulties (gait ataxia) and involuntary shaking movements of the muscles (**tremors**). In rare cases when an acoustic neuroma remains undiagnosed and untreated it can cause **nausea**, **vomiting**, lethargy and eventually **coma**, respiratory difficulties and **death**. In the vast majority of cases, however, the tumor is discovered and treated long before it is large enough to cause such serious manifestations.

## Diagnosis

Anyone with symptoms of hearing loss should undergo hearing evaluations. Pure tone and speech **audiometry** are two screening tests that are often used to evaluate hearing. Pure tone audiometry tests to see how well someone can hear tones of different volume and pitch and speech audiometry tests to see how well someone can hear and recognize speech. An acoustic neuroma is suspected in someone with unilateral hearing loss or hearing loss that is less severe in one ear than the other ear (asymmetrical).

Sometimes an auditory brainstem response (ABR, BAER) test is performed to help establish whether someone is likely to have an acoustic neuroma. During the ABR examination, a harmless electrical impulse is passed from the inner ear to the brainstem. An acoustic neuroma can interfere with the passage of this electrical impulse and this interference can sometimes be identified through the ABR evaluation. A normal ABR examination does not rule out the possibility of an acoustic neuroma. An abnormal ABR examination increases the likelihood that an acoustic neuroma is present but other tests are necessary to confirm the presence of a tumor.

If an acoustic neuroma is strongly suspected then **magnetic resonance imaging** (MRI) is usually performed. The MRI is a very accurate evaluation that

is able to detect nearly 100% of acoustic neuromas. Computerized tomography (CT scan, CAT scan) is unable to identify smaller tumors; but it can be used when an acoustic neuroma is suspected and an MRI evaluation cannot be performed.

Once an acoustic neuroma is diagnosed, an evaluation by genetic specialists such as a geneticist and genetic counselor may be recommended. The purpose of this evaluation is to obtain a detailed family history and check for signs of NF2. If NF2 is strongly suspected then DNA testing may be recommended. DNA testing involves checking the blood cells obtained from a routine blood draw for the common gene changes associated with NF2.

## Treatment

The three treatment options for acoustic neuroma are surgery, radiation, and observation. The physician and patient should discuss the pros and cons of the different options prior to making a decision about treatment. The patient's, physical health, age, symptoms, tumor size, and tumor location should be considered.

### Microsurgery

The surgical removal of the tumor or tumors is the most common treatment for acoustic neuroma. In most cases the entire tumor is removed during the surgery. If the tumor is large and causing significant symptoms, yet there is a need to preserve hearing in that ear, then only part of the tumor may be removed. During the procedure the tumor is removed under microscopic guidance and general anesthetic. Monitoring of the neighboring cranial nerves is done during the procedure so that damage to these nerves can be prevented. If preservation of hearing is a possibility, then monitoring of hearing will also take place during the surgery.

Most people stay in the hospital four to seven days following the surgery. Total recovery usually takes four to six weeks. Most people experience **fatigue** and head discomfort following the surgery. Problems with balance and head and neck stiffness are also common. The mortality rate of this type of surgery is less than 2% at most major centers. Approximately 20% of patients experience some degree of post-surgical complications. In most cases these complications can be managed successfully and do not result in long term medical problems. Surgery brings with it a risk of **stroke**, damage to the brain stem, infection, leakage of spinal fluid and damage to the cranial nerves. Hearing loss and/or tinnitus often result from the surgery. A follow-up MRI is recommended one to

five years following the surgery because of possible regrowth of the tumor.

### Stereotactic radiation therapy

During stereotactic **radiation therapy**, also called radiosurgery or radiotherapy, many small beams of radiation are aimed directly at the acoustic neuroma. The radiation is administered in a single large dose, under local anesthetic and is performed on an outpatient basis. This results in a high dose of radiation to the tumor but little radiation exposure to the surrounding area. This treatment approach is limited to small or medium tumors. The goal of the surgery is to cause tumor shrinkage or at least limit the growth of the tumor. The long-term efficacy and risks of this treatment approach are not known; however, more and more patients diagnosed with acoustic neuromas are choosing this form of therapy. Periodic MRI monitoring throughout the life of the patient is therefore recommended.

Radiation therapy can cause hearing loss, which can sometimes occur even years later. Radiation therapy can also cause damage to neighboring cranial nerves, which can result in symptoms such as numbness, pain or paralysis of the facial muscles. In many cases these symptoms are temporary. Radiation treatment can also induce the formation of other benign or malignant schwannomas. This type of treatment may therefore be contraindicated in the treatment of acoustic neuromas in those with NF2 who are predisposed to developing schwannomas and other tumors.

### Observation

Acoustic neuromas are usually slow growing and in some cases they will stop growing and even become smaller or disappear entirely. It may therefore be appropriate in some cases to hold off on treatment and to periodically monitor the tumor through MRI evaluations. Long-term observation may be appropriate, for example, in an elderly person with a small acoustic neuroma and few symptoms. Periodic observation may also be indicated for someone with a small and asymptomatic acoustic neuroma that was detected through an evaluation for another medical problem. Observation may also be suggested for someone with an acoustic neuroma in the only hearing ear or in the ear that has better hearing. The danger of an observational approach is that as the tumor grows larger it can become more difficult to treat.

### Prognosis

The prognosis for someone with a unilateral acoustic neuroma is usually quite good provided the

tumor is diagnosed early and appropriate treatment is instituted. Long term-hearing loss and tinnitus in the affected ear are common, even if appropriate treatment is provided. Many patients also experience facial weakness, balance problems, and headaches. Regrowth of the tumor is also a possibility following surgery or radiation therapy and repeat treatment may be necessary. The prognosis can be poorer for those with NF2 who have an increased risk of bilateral acoustic neuromas and other tumors.

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Acoustic Neuroma Association, 600 Peachtree Pkwy, Suite 108, Cumming, GA, (770) 205-8211, (770) 205-0239, <http://anausa.org>.

Acoustic Neuroma Association of Canada, 6192 Main Street, Ottawa, Canada, ON, K1S 1C2, (800) 561-2622, [info@anac.ca](mailto:info@anac.ca), <http://www.anac.ca>.

Lisa Andres MS, CGC  
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Acquired hypogammaglobulinemia see  
**Common variable immunodeficiency**

Acquired immunodeficiency syndrome see  
**AIDS**

## Acrocyanosis

### Definition

Acrocyanosis is a decrease in the amount of oxygen delivered to the extremities. The hands and feet turn blue because of the lack of oxygen. Decreased blood supply to the affected areas is caused by constriction or spasm of small blood vessels.

### Description

Acrocyanosis is a painless disorder caused by constriction or narrowing of small blood vessels in the skin of affected patients. The spasm of the blood vessels decreases the amount of blood that passes through them, resulting in less blood being delivered to the hands and feet. The hands may be the main area affected. The affected areas turn blue and become cold and sweaty. Localized swelling may also occur. Emotion and cold temperatures can worsen the symptoms, while warmth can decrease symptoms. The disease is seen mainly in women and the effect of the disorder is mainly cosmetic. People with the disease tend to be uncomfortable, with sweaty, cold, bluish colored hands and feet.

### Causes and symptoms

The sympathetic nerves cause constriction or spasms in the peripheral blood vessels that supply blood to the extremities. The spasms are a contraction of the muscles in the walls of the blood vessels. The contraction decreases the internal diameter of the blood vessels, thereby decreasing the amount of blood flow through the affected area. The spasms occur on a persistent basis, resulting in long term reduction of blood supply to the hands and feet. Sufficient blood still passes through the blood vessels so that the tissue in the affected areas does not starve for oxygen or die. Mainly, blood vessels near the surface of the skin are affected.

### Diagnosis

Diagnosis is made by observation of the main clinical symptoms, including persistently blue and sweaty hands and/or feet and a lack of **pain**. Cooling the hands increases the blueness, while warming the hands decreases the blue color. The acrocyanosis patient's pulse is normal, which rules out obstructive diseases. **Raynaud's disease** differs from acrocyanosis in that it causes white and red skin coloration phases, not just bluish discoloration.

### KEY TERMS

**Sympathetic nerve**—A nerve of the autonomic nervous system that regulates involuntary and automatic reactions, especially to stress.

### Treatment

Acrocyanosis usually isn't treated. Drugs that block the uptake of **calcium (calcium channel blockers)** and alpha-one antagonists reduce the symptoms in most cases. Drugs that dilate blood vessels are only effective some of the time. Sweating from the affected areas can be profuse and require treatment. Surgery to cut the sympathetic nerves is performed rarely.

### Prognosis

Acrocyanosis is a benign and persistent disease. The main concern of patients is cosmetic. Left untreated, the disease does not worsen.

### Resources

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John T. Lohr PhD

## Acromegaly and gigantism

### Definition

Acromegaly is a disorder in which the abnormal release of a particular chemical from the pituitary gland in the brain causes increased growth in bone and soft tissue, as well as a variety of other disturbances throughout the body. This chemical released from the pituitary gland is called growth hormone (GH). The body's ability to process and use nutrients like fats and sugars is also altered. In children whose bony growth plates have not closed, the chemical changes of acromegaly result in exceptional growth of long bones. This variant is called gigantism, with the additional bone growth causing unusual height. When the abnormality occurs after bone growth stops, the disorder is called acromegaly.



**A comparison of the right hand of a person afflicted with acromegaly (left) and the hand of a normal-sized person.**  
*(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

## Description

Acromegaly is a relatively rare disorder, occurring in approximately 50 out of every 1 million people (50/1,000,000). Both men and women are affected. Because the symptoms of acromegaly occur so gradually, diagnosis is often delayed. The majority of patients are not identified until they are middle aged.

## Causes and symptoms

The pituitary is a small gland located at the base of the brain. A gland is a collection of cells that releases certain chemicals, or hormones, which are important to the functioning of other organs or body systems. The pituitary hormones travel throughout the body and are involved in a large number of activities, including the regulation of growth and reproductive functions. The cause of acromegaly can be traced to the pituitary's production of GH.

Under normal conditions, the pituitary receives input from another brain structure, the hypothalamus, located at the base of the brain. This input from the hypothalamus regulates the pituitary's release of hormones. For example, the hypothalamus produces growth hormone-releasing hormone (GHRH), which directs the pituitary to release GH. Input from the hypothalamus should also direct the pituitary to stop releasing hormones.

In acromegaly, the pituitary continues to release GH and ignores signals from the hypothalamus. In the liver, GH causes production of a hormone called insulin-like growth factor 1 (IGF-1), which is responsible for growth throughout the body. When the pituitary refuses to stop producing GH, the levels of IGF-1 also reach abnormal peaks. Bones, soft tissue, and organs throughout the



**Enlarged feet is one deformity caused by acromegaly.**  
*(Custom Medical Stock Photo, Inc. Reproduced by permission.)*

body begin to enlarge, and the body changes its ability to process and use nutrients like sugars and fats.

In acromegaly, an individual's hands and feet begin to grow, becoming thick and doughy. The jaw line, nose, and forehead also grow, and facial features are described as "coarsening." The tongue grows larger, and because the jaw is larger, the teeth become more widely spaced. Due to swelling within the structures of the throat and sinuses, the voice becomes deeper and sounds more hollow, and patients may develop loud **snoring**. Various hormonal changes cause symptoms such as:

- heavy sweating
- oily skin
- increased coarse body hair
- improper processing of sugars in the diet (and sometimes actual diabetes)
- high blood pressure

## KEY TERMS

**Adenoma**—A type of noncancerous (benign) tumor that often involves the overgrowth of certain cells found in glands.

**Gland**—A collection of cells that releases certain chemicals, or hormones, that are important to the functioning of other organs or body systems.

**Hormone**—A chemical produced in one part of the body that travels to another part of the body in order to exert an effect.

**Hypothalamus**—A structure within the brain responsible for a large number of normal

functions throughout the body, including regulating sleep, temperature, eating, and sexual development. The hypothalamus also regulates the functions of the pituitary gland by directing the pituitary to stop or start production of its hormones.

**Pituitary**—A gland located at the base of the brain that produces a number of hormones, including those that regulate growth and reproductive functions. Overproduction of the pituitary hormone called growth hormone (GH) is responsible for the condition known as acromegaly.

- increased calcium in the urine (sometimes leading to kidney stones)
- increased risk of gallstones; and
- swelling of the thyroid gland

People with acromegaly have more skin tags, or outgrowths of tissue, than normal. This increase in skin tags is also associated with the development of growths, called polyps, within the large intestine that may eventually become cancerous. Patients with acromegaly often suffer from headaches and arthritis. The various swellings and enlargements throughout the body may press on nerves, causing sensations of local **tingling** or burning, and sometimes result in muscle weakness.

The most common cause of this disorder (in 90% of patients) is the development of a noncancerous tumor within the pituitary, called a pituitary adenoma. These tumors are the source of the abnormal release of GH. As these tumors grow, they may press on nearby structures within the brain, causing headaches and changes in vision. As the adenoma grows, it may disrupt other pituitary tissue, interfering with the release of other hormones. These disruptions may be responsible for changes in the menstrual cycle of women, decreases in the sexual drive in men and women, and the abnormal production of breast milk in women. In rare cases, acromegaly is caused by the abnormal production of GHRH, which leads to the increased production of GH. Certain tumors in the pancreas, lungs, adrenal glands, thyroid, and intestine produce GHRH, which in turn triggers production of an abnormal quantity of GH.

### Diagnosis

Because acromegaly produces slow changes over time, diagnosis is often significantly delayed. In fact, the

characteristic coarsening of the facial features is often not recognized by family members, friends, or long-time family physicians. Often, the diagnosis is suspected by a new physician who sees the patient for the first time and is struck by the patient's characteristic facial appearance. Comparing old photographs from a number of different time periods will often increase suspicion of the disease.

Because the quantity of GH produced varies widely under normal conditions, demonstrating high levels of GH in the blood is not sufficient to merit a diagnosis of acromegaly. Instead, laboratory tests measuring an increase of IGF-1 (3–10 times above the normal level) are useful. These results, however, must be carefully interpreted because normal laboratory values for IGF-1 vary when the patient is pregnant, undergoing **puberty**, elderly, or severely malnourished. Normal patients will show a decrease in GH production when given a large dose of sugar (glucose). Patients with acromegaly will not show this decrease, and will often show an increase in GH production. **Magnetic resonance imaging (MRI)** is useful for viewing the pituitary, and for identifying and locating an adenoma. When no adenoma can be located, the search for a GHRH-producing tumor in another location begins.

### Treatment

The first step in treatment of acromegaly is removal of all or part of the pituitary adenoma. Removal requires surgery, usually performed by entering the skull through the nose. While this surgery can cause rapid improvement of many acromegaly symptoms, most patients will also require additional treatment with medication. Bromocriptine (Parlodel) is a medication that can be taken by mouth, while

octreotide (Sandostatin) must be injected every eight hours. Both of these medications are helpful in reducing GH production, but must often be taken for life and produce their own unique side effects. Some patients who cannot undergo surgery are treated with **radiation therapy** to the pituitary in an attempt to shrink the adenoma. Radiating the pituitary may take up to 10 years, however, and may also injure/destroy other normal parts of the pituitary.

## Prognosis

Without treatment, patients with acromegaly will most likely die early because of the disease's effects on the heart, lungs, brain, or due to the development of **cancer** in the large intestine. With treatment, however, a patient with acromegaly may be able to live a normal lifespan.

## Resources

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### ORGANIZATIONS

Pituitary Network Association, P.O. Box 1958, Thousand Oaks, CA, 91358, (805) 499-9973, (805) 480-0633, info@pituitary.org, <http://www.pituitary.org>.

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**ACT** see **Alanine aminotransferase test**

**ACTH** test see **Adrenocorticotrophic hormone test**

*Actinomyces israelii* infection see  
**Actinomycosis**

## Actinomycosis

### Definition

Actinomycosis is an infection primarily caused by the bacterium *Actinomyces israelii*. Infection most often occurs in the face and neck region and is characterized by the presence of a slowly enlarging, hard, red lump.

### Description

Actinomycosis is a relatively rare infection occurring in one out of 300,000 (1/300,000) people per year. It is characterized by the presence of a lump or mass that often forms, draining sinus tracts to the skin surface. Fifty percent of actinomycosis cases are of the head and

## KEY TERMS

**Biopsy**—The process that removes a sample of tissue for microscopic examination to aid in the diagnosis of a disease.

**Sinus tract**—A narrow, elongated channel in the body that allows the escape of fluid.

neck region (also called “lumpy jaw” and “cervicofacial actinomycosis”), 15% are in the chest, 20% are in the abdomen, and the rest are in the pelvis, heart, and brain. Men are three times more likely to develop actinomycosis than women.

### Causes and symptoms

Actinomycosis is usually caused by the bacterium *Actinomyces israelii*. This bacterium is normally present in the mouth but can cause disease if it enters tissues following an injury. *Actinomyces israelii* is an anaerobic bacterium which means it dislikes oxygen but grows very well in deep tissues where oxygen levels are low. **Tooth extraction**, tooth disease, **root canal treatment**, jaw surgery, or poor dental hygiene can allow *Actinomyces israelii* to cause an infection in the head and neck region.

The main symptom of cervicofacial actinomycosis is the presence of a hard lump on the face or neck. The lump may or may not be red. **Fever** occurs in some cases.

### Diagnosis

Cervicofacial actinomycosis can be diagnosed by a family doctor or dentist and the patient may be referred to an oral surgeon or **infectious disease** specialist. The diagnosis of actinomycosis is based upon several things. The presence of a red lump with draining sinuses on the head or neck is strongly suggestive of cervicofacial actinomycosis. A recent history of tooth extraction or signs of **tooth decay** or poor dental hygiene aid in the diagnosis. Microscopic examination of the fluid draining from the sinuses shows the characteristic “sulfur Granules” (small yellow colored material in the fluid) produced by *Actinomyces israelii*. A biopsy may be performed to remove a sample of the infected tissue. This procedure can be performed under **local anesthesia** in the doctor’s office. Occasionally the bacteria can be cultured from the sinus tract fluid or from samples of the infected tissue.

Actinomycosis in the lungs, abdomen, pelvis, or brain can be very hard to diagnose since the symptoms often mimic those of other diseases. Actinomycosis of the lungs or abdomen can resemble **tuberculosis** or **cancer**. Diagnostic x-ray results, the presence of draining sinus tracts, and microscopic analysis and culturing of infected tissue assist in the diagnosis.

## Treatment

Actinomycosis is difficult to treat because of its dense tissue location. Surgery is often required to drain the lesion and/or to remove the site of infection. To kill the bacteria, standard therapy has included large doses of penicillin given through a vein daily for two to six weeks followed by six to twelve months of penicillin taken by mouth. Tetracycline, clindamycin, or erythromycin may be used instead of penicillin. The antibiotic therapy must be completed to ensure that the infection does not return. However, a report in 2004 on several cases of actinomycosis said that therapy depends on the individual case and that many patients today will be diagnosed in earlier stages of the disease. Sometimes, shorter courses of antibiotic treatment are effective, with close diagnostic x-ray monitoring. Hyperbaric oxygen (oxygen under high pressure) therapy in combination with the antibiotic therapy has been successful.

## Prognosis

Complete recovery is achieved following treatment. If left untreated, the infection may cause localized bone destruction.

## Prevention

The best prevention is to maintain good dental hygiene.

## Resources

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Belinda Rowland PhD  
Teresa G. Odle

Activated charcoal see **Charcoal, activated**

Activated partial thromboplastin time see  
**Partial thromboplastin time**

## Acupressure

### Definition

Acupressure is a form of touch therapy that utilizes the principles of **acupuncture** and Chinese medicine. In acupressure, the same points on the body are used as in acupuncture, but are stimulated with finger pressure instead of with the insertion of needles. Acupressure is used to relieve a variety of symptoms and pain.

### Purpose

Acupressure massage performed by a therapist can be very effective both as prevention and as a treatment for many health conditions, including headaches, general aches and pains, colds and flu, arthritis, **allergies**, **asthma**, nervous tension, menstrual cramps, sinus problems, sprains, **tennis elbow**, and toothaches, among others. Unlike acupuncture which requires a visit to a professional, acupressure can be performed by a layperson. Acupressure techniques are fairly easy to learn, and have been used to provide quick, cost-free, and effective relief from many symptoms. Acupressure points can also be stimulated to increase energy and feelings of well-being, reduce **stress**, stimulate the immune system, and alleviate **sexual dysfunction**.

### Description

#### Origins

One of the oldest text of Chinese medicine is the *Huang Di*, The Yellow Emperor's Classic of Internal Medicine, which may be at least 2,000 years old. Chinese medicine has developed acupuncture, acupressure, herbal remedies, diet, **exercise**, lifestyle changes, and other remedies as part of its healing methods. Nearly all of the forms of Oriental medicine that are used in the West today, including acupuncture, acupressure, **shiatsu**, and Chinese herbal medicine, have their roots in Chinese medicine. One legend has it that acupuncture and acupressure evolved as early Chinese healers studied the puncture **wounds** of Chinese warriors, noting that certain points on the body created interesting results when stimulated. The oldest known text specifically on acupuncture points, the *Systematic Classic of Acupuncture*, dates back to 282 A.D. Acupressure is the non-invasive form of acupuncture, as Chinese physicians determined that stimulating points on the body with massage and pressure could be effective for treating certain problems.



Therapist working acupressure points on a woman's shoulder. (Photo Researchers, Inc.)

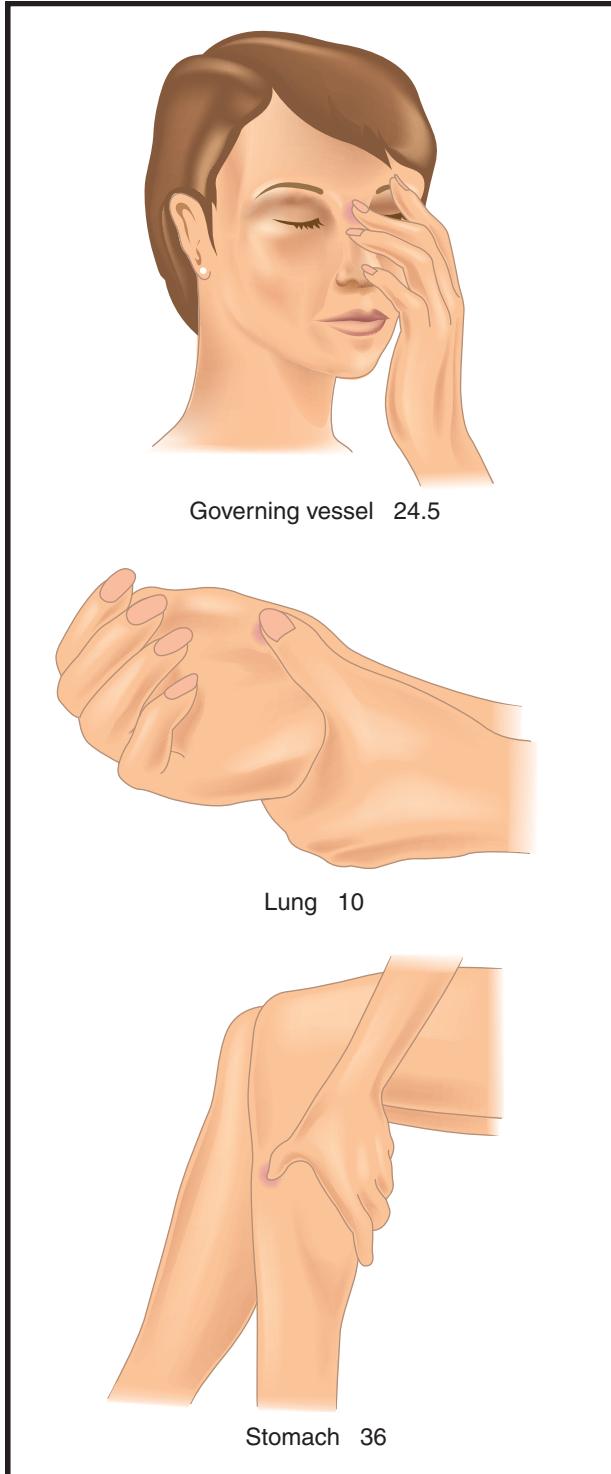
Outside of Asian-American communities, Chinese medicine remained virtually unknown in the United States until the 1970s, when Richard Nixon became the first U.S. president to visit China. On Nixon's trip, journalists were amazed to observe major operations being performed on patients without the use of anesthetics. Instead, wide-aware patients were being operated on, with only acupuncture needles inserted into them to control pain. At that time, a famous columnist for the *New York Times*, James Reston, had to undergo surgery and elected to use acupuncture for anesthesia. Later, he wrote some convincing stories on its effectiveness. Despite being neglected by mainstream medicine and the American Medical Association (AMA), acupuncture and Chinese medicine became a central to alternative medicine practitioners in the United States. Today, there are millions of patients who attest to its effectiveness, and nearly 9,000 practitioners in all 50 states.

Acupressure is practiced as a treatment by Chinese medicine practitioners and acupuncturists, as well as by massage therapists. Most massage schools in the United States include acupressure techniques as part

of their bodywork programs. Shiatsu massage is very closely related to acupressure, working with the same points on the body and the same general principles, although it was developed over centuries in Japan rather than in China. **Reflexology** is a form of body-work based on acupressure concepts. Jin Shin Do is a bodywork technique with an increasing number of practitioners in America that combines acupressure and shiatsu principles with **qigong**, Reichian theory, and **meditation**.

#### *Acupressure and Chinese medicine*

Chinese medicine views the body as a small part of the universe, subject to laws and principles of harmony and balance. Chinese medicine does not make as sharp a distinction as Western medicine does between mind and body. The Chinese system believes that emotions and mental states are every bit as influential on disease as purely physical mechanisms, and considers factors like work, environment, and relationships as fundamental to a patient's health. Chinese medicine also uses very different symbols and ideas to discuss the body and health. While Western medicine typically describes



**Press on point governing vessel 24.5, the top of the bridge of the nose, lightly for two minutes to relieve hay fever symptoms. Press on lung 10, the center of the thumb pad, for one minute to alleviate a sore throat. To ease heartburn, apply pressure to stomach 36, four finger-widths below the kneecap outside the shinbone. Use on both legs. (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)**

health as mainly physical processes composed of chemical equations and reactions, the Chinese use ideas like yin and yang, chi, and the organ system to describe health and the body.

Everything in the universe has properties of yin and yang. Yin is associated with cold, female, passive, downward, inward, dark, wet. Yang can be described as hot, male, active, upward, outward, light, dry, and so on. Nothing is either completely yin or yang. These two principles always interact and affect each other, although the body and its organs can become imbalanced by having either too much or too little of either.

Chi (pronounced *chee*, also spelled *qi* or *ki* in Japanese shiatsu) is the fundamental life energy. It is found in food, air, water, and sunlight, and it travels through the body in channels called *meridians*. There are 12 major meridians in the body that transport chi, corresponding to the 12 main organs categorized by Chinese medicine.

Disease is viewed as an imbalance of the organs and chi in the body. Chinese medicine has developed intricate systems of how organs are related to physical and mental symptoms, and it has devised corresponding treatments using the meridian and pressure point networks that are classified and numbered. The goal of acupressure, and acupuncture, is to stimulate and unblock the circulation of chi, by activating very specific points, called pressure points or *acupoints*. Acupressure seeks to stimulate the points on the chi meridians that pass close to the skin, as these are easiest to unblock and manipulate with finger pressure.

Acupressure can be used as part of a Chinese physician's prescription, as a session of **massage therapy**, or as a self-treatment for common aches and illnesses. A Chinese medicine practitioner examines a patient very thoroughly, looking at physical, mental and emotional activity, taking the pulse usually at the wrists, examining the tongue and complexion, and observing the patient's demeanor and attitude, to get a complete diagnosis of which organs and meridian points are out of balance. When the imbalance is located, the physician will recommend specific pressure points for acupuncture or acupressure. If acupressure is recommended, the patient might opt for a series of treatments from a massage therapist.

In massage therapy, acupressurists will evaluate a patient's symptoms and overall health, but a massage therapist's diagnostic training isn't as extensive as a Chinese physician's. In a massage therapy treatment, a person usually lies down on a table or mat, with thin

## KEY TERMS

- Acupoint**—A pressure point stimulated in acupressure.
- Chi**—Basic life energy.
- Meridian**—A channel through which chi travels in the body.
- Moxibustion**—An acupuncture technique that burns the herb moxa or mugwort.
- Shiatsu**—Japanese form of acupressure massage.
- Yin/yang**—Universal characteristics used to describe aspects of the natural world.

clothing on. The acupressurist will gently feel and palpate the abdomen and other parts of the body to determine energy imbalances. Then, the therapist will work with different meridians throughout the body, depending on which organs are imbalanced in the abdomen. The therapist will use different types of finger movements and pressure on different acupoints, depending on whether the chi needs to be increased or dispersed at different points. The therapist observes and guides the energy flow through the patient's body throughout the session. Sometimes, special herbs (*Artemesia vulgaris* or moxa) may be placed on a point to warm it, a process called *moxibustion*. A session of acupressure is generally a very pleasant experience, and some people experience great benefit immediately. For more chronic conditions, several sessions may be necessary to relieve and improve conditions.

Acupressure massage usually costs from \$30–\$70 per hour session. A visit to a Chinese medicine physician or acupuncturist can be more expensive, comparable to a visit to an allopathic physician if the practitioner is an MD. Insurance reimbursement varies widely, and consumers should be aware if their policies cover alternative treatment, acupuncture, or massage therapy.

### **Self-treatment**

Acupressure is easy to learn, and there are many good books that illustrate the position of acupoints and meridians on the body. It is also very versatile, as it can be done anywhere, and it's a good form of treatment for spouses and partners to give to each other and for parents to perform on children for minor conditions.

While giving self-treatment or performing acupressure on another, a mental attitude of calmness and attention is important, as one person's energy

can be used to help another's. Loose, thin clothing is recommended. There are three general techniques for stimulating a pressure point.

- Tonifying is meant to strengthen weak chi, and is done by pressing the thumb or finger into an acupoint with a firm, steady pressure, holding it for up to two minutes.
- Dispersing is meant to move stagnant or blocked chi, and the finger or thumb is moved in a circular motion or slightly in and out of the point for two minutes.
- Calming the chi in a pressure point utilizes the palm to cover the point and gently stroke the area for about two minutes.

There are many pressure points that are easily found and memorized to treat common ailments from headaches to colds.

- For headaches, toothaches, sinus problems, and pain in the upper body, the “LI4” point is recommended. It is located in the web between the thumb and index finger, on the back of the hand. Using the thumb and index finger of the other hand, apply a pinching pressure until the point is felt, and hold it for two minutes. Pregnant women should never press this point.
- To calm the nerves and stimulate digestion, find the “CV12” point that is four thumb widths above the navel in the center of the abdomen. Calm the point with the palm, using gentle stroking for several minutes.
- To stimulate the immune system, find the “TH5” point on the back of the forearm two thumb widths above the wrist. Use a dispersing technique, or circular pressure with the thumb or finger, for two minutes on each arm.
- For headaches, sinus congestion, and tension, locate the “GB20” points at the base of the skull in the back of the head, just behind the bones in back of the ears. Disperse these points for two minutes with the fingers or thumbs. Also find the “yintang” point, which is in the middle of the forehead between the eyebrows. Disperse it with gentle pressure for two minutes to clear the mind and to relieve headaches.

### **Precautions**

Acupressure is a safe technique, but it is not meant to replace professional health care. A physician should always be consulted when there are doubts about medical conditions. If a condition is chronic, a professional should be consulted; purely

symptomatic treatment can exacerbate chronic conditions. Acupressure should not be applied to open wounds, or where there is swelling and inflammation. Areas of scar tissue, blisters, **boils**, **rashes**, or **varicose veins** should be avoided. Finally, certain acupressure points should not be stimulated on people with high or low blood pressure and on pregnant women.

## Research and general acceptance

In general, Chinese medicine has been slow to gain acceptance in the West, mainly because it rests on ideas very foreign to the scientific model. For instance, Western scientists have trouble with the idea of chi, the invisible energy of the body, and the idea that pressing on certain points can alleviate certain conditions seems sometimes too simple for scientists to believe.

Western scientists, in trying to account for the action of acupressure, have theorized that chi is actually part of the neuroendocrine system of the body. Celebrated orthopedic surgeon Robert O. Becker, who was twice nominated for the Nobel Prize, wrote a book on the subject called *Cross Currents: The Promise of Electromedicine; The Perils of Electropollution*. By using precise electrical measuring devices, Becker and his colleagues showed that the body has a complex web of electromagnetic energy, and that traditional acupressure meridians and points contained amounts of energy that non-acupressure points did not.

The mechanisms of acupuncture and acupressure remain difficult to document in terms of the biochemical processes involved; numerous testimonials are the primary evidence backing up the effectiveness of acupressure and acupuncture. However, a body of research is growing that verifies the effectiveness in acupressure and acupuncture techniques in treating many problems and in controlling pain.

## Resources

### OTHER

American Association of Acupuncture and Oriental Medicine. December 28, 2000. <http://www.aaaomonline.org/>  
National Acupuncture and Oriental Medicine Alliance. December 28, 2000. <http://www.acuall.org>.

Douglas Dupler MA

Acupressure, foot see **Reflexology**

# Acupuncture

## Definition

Acupuncture is one of the main forms of treatment in **traditional Chinese medicine**. It involves the use of sharp, thin needles that are inserted in the body at very specific points. This process is believed to adjust and alter the body's energy flow into healthier patterns, and is used to treat a wide variety of illnesses and health conditions.

## Purpose

The World Health Organization (WHO) recommends acupuncture as an effective treatment for more than forty medical problems, including **allergies**, respiratory conditions, gastrointestinal disorders, gynecological problems, nervous conditions, and disorders of the eyes, nose and throat, and childhood illnesses, among others. Acupuncture has been used in the treatment of **alcoholism** and **substance abuse**. It is an effective and low-cost treatment for headaches and chronic **pain**, associated with problems like back injuries and arthritis. It has also been used to supplement invasive Western treatments like **chemotherapy** and surgery. Acupuncture is generally most effective when used as prevention or before a health condition becomes acute, but it has been used to help patients suffering from **cancer** and **AIDS**. Acupuncture is limited in treating conditions or traumas that require surgery or emergency care (such as for broken bones).

## Description

### Origins

The original text of Chinese medicine is the *Nei Ching, The Yellow Emperor's Classic of Internal Medicine*, which is estimated to be at least 2,500 years old. Thousands of books since then have been written on the subject of Chinese healing, and its basic philosophies spread long ago to other Asian civilizations. Nearly all of the forms of Oriental medicine which are used in the West today, including acupuncture, **shiatsu**, **acupressure** massage, and macrobiotics, are part of or have their roots in Chinese medicine. Legend has it that acupuncture developed when early Chinese physicians observed unpredicted effects of puncture **wounds** in Chinese warriors. The oldest known text on acupuncture, the *Systematic Classic of Acupuncture*, dates back to 282 A.D. Although acupuncture is its best known technique, Chinese medicine traditionally utilizes herbal remedies, dietary



Woman undergoing facial acupuncture. (© Yoav Levy/Phototake. — All rights reserved.)

therapy, lifestyle changes and other means to treat patients.

In the early 1900s, only a few Western physicians who had visited China were fascinated by acupuncture, but outside of Asian-American communities it remained virtually unknown until the 1970s, when Richard Nixon became the first U.S. president to visit China. On Nixon's trip, journalists were amazed to observe major operations being performed on patients without the use of anesthetics. Instead, wide-awake patients were being operated on with only acupuncture needles inserted into them to control pain. During that time, a famous columnist for the *New York Times*, James Reston, had to undergo surgery and elected to use acupuncture instead of pain medication, and he wrote some convincing stories on its effectiveness.

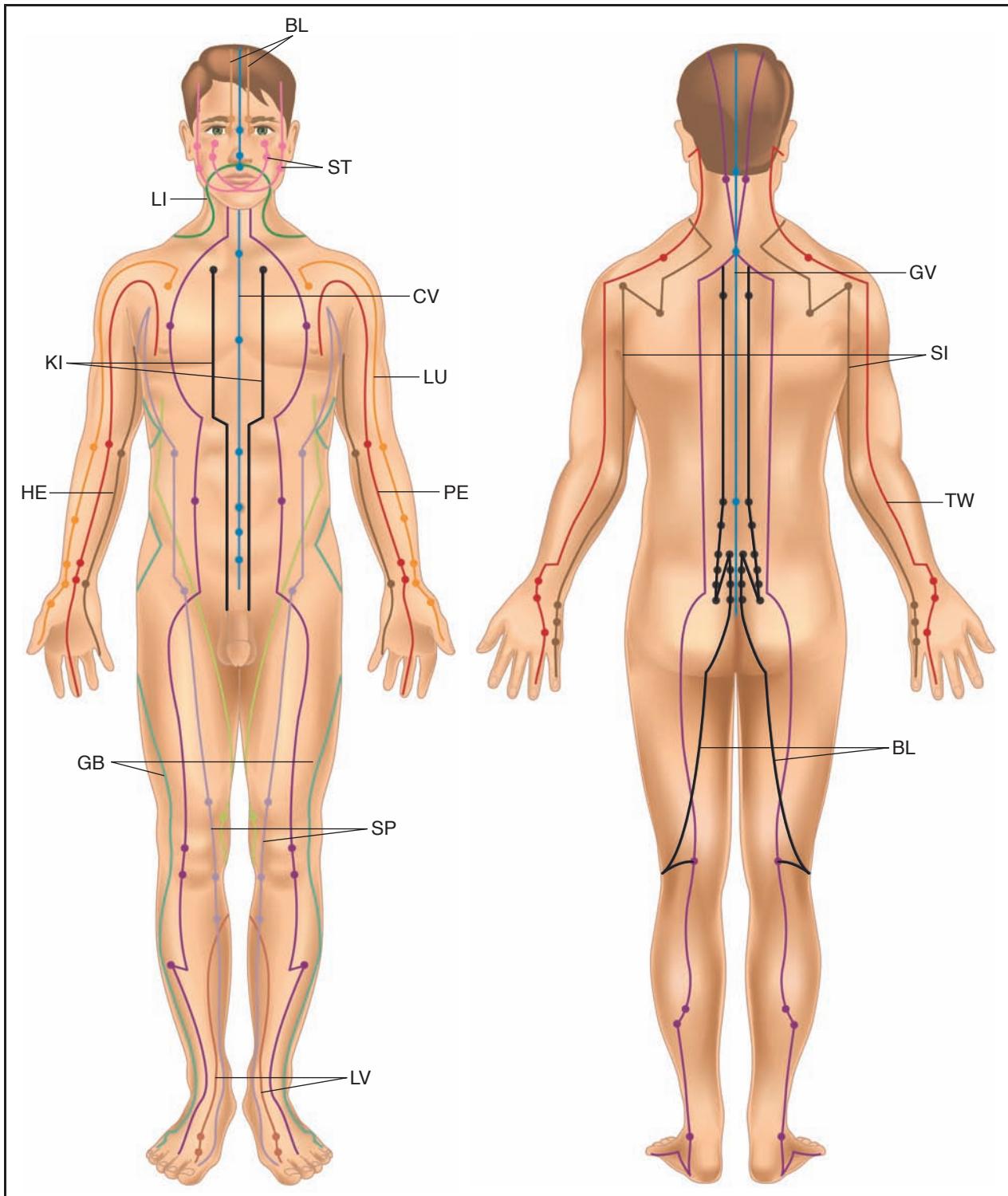
Today, acupuncture is being practiced in all 50 states by more than 9,000 practitioners, with over 4,000 MDs including it in their practices. Acupuncture has shown notable success in treating many conditions, and more than 15 million Americans have

used it as a therapy. Acupuncture, however, remains largely unsupported by the medical establishment. The American Medical Association has been resistant to researching it, as it is based on concepts very different from the Western scientific model.

Several forms of acupuncture are being used today in the United States. Japanese acupuncture uses extremely thin needles and does not incorporate herbal medicine in its practice. Auricular acupuncture uses acupuncture points only on the ear, which are believed to stimulate and balance internal organs. In France, where acupuncture is very popular and more accepted by the medical establishment, neurologist Paul Nogier developed a system of acupuncture based on neuroendocrine theory rather than on traditional Chinese concepts, which is gaining some use in America.

#### *Basic ideas of Chinese medicine*

Chinese medicine views the body as a small part of the universe, and subject to universal laws and principles of harmony and balance. Chinese medicine does



Acupuncture sites and meridians on the body. Points are shown on the bladder (BL), conception vessel (CV), gall bladder (GB), governing vessel (GV), heart (HE), kidney (KI), large intestine (LI), liver (LV), lung (LU), pericardium (PE), small intestine (SI), spleen (SP), stomach (ST), and triple warmer (TW) meridians. (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

## KEY TERMS

**Acupressure**—Form of massage using acupuncture points.

**Auricular acupuncture**—Acupuncture using only points found on the ears.

**Chi**—Basic life energy.

**Meridian**—Channel through which chi travels in the body.

**Moxibustion**—Acupuncture technique which burns the herb moxa or mugwort.

**Tonification**—Acupuncture technique for strengthening the body.

**Yin/Yang**—Universal characteristics used to describe aspects of the natural world.

not draw a sharp line, as Western medicine does, between mind and body. The Chinese system believes that emotions and mental states are every bit as influential on disease as purely physical mechanisms, and considers factors like work, environment, lifestyle and relationships as fundamental to the overall picture of a patient's health. Chinese medicine also uses very different symbols and ideas to discuss the body and health. While Western medicine typically describes health in terms of measurable physical processes made up of chemical reactions, the Chinese use ideas like yin and yang, chi, the organ system, and the five elements to describe health and the body. To understand the ideas behind acupuncture, it is worthwhile to introduce some of these basic terms.

**YIN AND YANG.** According to Chinese philosophy, the universe and the body can be described by two separate but complementary principles, that of yin and yang. For example, in temperature, yin is cold and yang is hot. In gender, yin is female and yang is male. In activity, yin is passive and yang is active. In light, yin is dark and yang is bright; in direction yin is inward and downward and yang is outward and up, and so on. Nothing is ever completely yin or yang, but a combination of the two. These two principles are always interacting, opposing, and influencing each other. The goal of Chinese medicine is not to eliminate either yin or yang, but to allow the two to balance each other and exist harmoniously together. For instance, if a person suffers from symptoms of high blood pressure, the Chinese system would say that the heart organ might have too much yang, and would recommend

methods either to reduce the yang or to increase the yin of the heart, depending on the other symptoms and organs in the body. Thus, acupuncture therapies seek to either increase or reduce yang, or increase or reduce yin in particular regions of the body.

**CHI.** Another fundamental concept of Chinese medicine is that of chi (pronounced *chee*, also spelled *qi*). Chi is the fundamental life energy of the universe. It is invisible and is found in the environment in the air, water, food and sunlight. In the body, it is the invisible vital force that creates and animates life. We are all born with inherited amounts of chi, and we also get acquired chi from the food we eat and the air we breathe. The level and quality of a person's chi also depends on the state of physical, mental and emotional balance. Chi travels through the body along channels called *meridians*.

**THE ORGAN SYSTEM.** In the Chinese system, there are twelve main organs: the lung, large intestine, stomach, spleen, heart, small intestine, urinary bladder, kidney, liver, gallbladder, pericardium, and the "triple warmer," which represents the entire torso region. Each organ has chi energy associated with it, and each organ interacts with particular emotions on the mental level. As there are twelve organs, there are twelve types of chi that can move through the body, and these move through twelve main channels or meridians. Chinese doctors connect symptoms to organs. That is, symptoms are caused by yin/yang imbalances in one or more organs, or by an unhealthy flow of chi to or from one organ to another. Each organ has a different profile of symptoms it can manifest.

**THE FIVE ELEMENTS.** Another basis of Chinese theory is that the world and body are made up of five main elements: wood, fire, earth, metal, and water. These elements are all interconnected, and each element either generates or controls another element. For instance, water controls fire and earth generates metal. Each organ is associated with one of the five elements. The Chinese system uses elements and organs to describe and treat conditions. For instance, the kidney is associated with water and the heart is associated with fire, and the two organs are related as water and fire are related. If the kidney is weak, then there might be a corresponding fire problem in the heart, so treatment might be made by acupuncture or herbs to cool the heart system and/or increase energy in the kidney system.

The Chinese have developed an intricate system of how organs and elements are related to physical and mental symptoms, and the above example is a very

simple one. Although this system sounds suspect to Western scientists, some interesting parallels have been observed. For instance, Western medicine has observed that with severe heart problems, kidney failure often follows, but it still does not know exactly why. In Chinese medicine, this connection between the two organs has long been established.

**MEDICAL PROBLEMS AND ACUPUNCTURE.** In Chinese medicine, disease as seen as imbalances in the organ system or chi meridians, and the goal of any remedy or treatment is to assist the body in reestablishing its innate harmony. Disease can be caused by internal factors like emotions, external factors like the environment and weather, and other factors like injuries, trauma, diet, and germs. However, infection is seen not as primarily a problem with germs and viruses, but as a weakness in the energy of the body which is allowing a sickness to occur. In Chinese medicine, no two illnesses are ever the same, as each body has its own characteristics of symptoms and balance. Acupuncture is used to open or adjust the flow of chi throughout the organ system, which will strengthen the body and prompt it to heal itself.

**A VISIT TO THE ACUPUNCTURIST.** The first thing an acupuncturist will do is get a thorough idea of a patient's medical history and symptoms, both physical and emotional. This is done with a long questionnaire and interview. Then the acupuncturist will examine the patient to find further symptoms, looking closely at the tongue, the pulse at various points in the body, the complexion, general behavior, and other signs like coughs or pains. From this, the practitioner will be able to determine patterns of symptoms, which indicate which organs and areas are imbalanced. Depending on the problem, the acupuncturist will insert needles to manipulate chi on one or more of the twelve organ meridians. On these twelve meridians, there are nearly 2,000 points which can be used in acupuncture, with around 200 points being most frequently used by traditional acupuncturists. During an individual treatment, one to twenty needles may be used, depending on which meridian points are chosen.

Acupuncture needles are always sterilized and acupuncture is a very safe procedure. The depth of insertion of needles varies, depending on which chi channels are being treated. Some points barely go beyond superficial layers of skin, while some acupuncture points require a depth of 1–3 in (2.5–7.5 cm) of needle. The needles generally do not cause pain. Patients sometimes report pinching sensations and often pleasant sensations, as the body experiences

healing. Depending on the problem, the acupuncturist might spin or move the needles, or even pass a slight electrical current through some of them. *Moxibustion* may be sometimes used, in which an herbal mixture (moxa or mugwort) is either burned like incense on the acupuncture point or on the end of the needle, which is believed to stimulate chi in a particular way. Also, acupuncturists sometimes use *cupping*, during which small suction cups are placed on meridian points to stimulate them.

How long the needles are inserted also varies. Some patients only require a quick in and out insertion to clear problems and provide *tonification* (strengthening of health), while some other conditions might require needles inserted up to an hour or more. The average visit to an acupuncturist takes about thirty minutes. The number of visits to the acupuncturist varies as well, with some conditions improved in one or two sessions and others requiring a series of six or more visits over the course of weeks or months.

Costs for acupuncture can vary, depending on whether the practitioner is an MD. Initial visits with non-MD acupuncturists can run from \$50–\$100, with follow-up visits usually costing less. Insurance reimbursement also varies widely, depending on the company and state. Regulations have been changing often. Some states authorize Medicaid to cover acupuncture for certain conditions, and some states have mandated that general coverage pay for acupuncture. Consumers should be aware of the provisions for acupuncture in their individual policies.

### Precautions

Acupuncture is generally a very safe procedure. If a patient is in doubt about a medical condition, more than one physician should be consulted. Also, a patient should always feel comfortable and confident that their acupuncturist is knowledgeable and properly trained.

### Research and general acceptance

Mainstream medicine has been slow to accept acupuncture; although more MDs are using it, the American Medical Association does not recognize it as a specialty. The reason for this is that the mechanism of acupuncture is difficult to scientifically understand or measure, such as the invisible energy of chi in the body. Western medicine, admitting that acupuncture works in many cases, has theorized that the energy meridians are actually part of the nervous

system and that acupuncture relieves pain by releasing endorphins, or natural pain killers, into the bloodstream. Despite the ambiguity in the biochemistry involved, acupuncture continues to show effectiveness in clinical tests, from reducing pain to alleviating the symptoms of chronic illnesses, and research in acupuncture is currently growing. The Office of Alternative Medicine of the National Institute of Health is currently funding research in the use of acupuncture for treating depression and attention-deficit disorder.

## Resources

### OTHER

American Association of Acupuncture and Oriental Medicine. <http://www.aaaomonline.org/>.

North American Society of Acupuncture and Alternative Medicine. <http://www.nasa-altmed.com>.

Douglas Dupler MA

**Acute glomerulonephritis** see **Acute poststreptococcal glomerulonephritis**

Acute homeopathic remedies see **Homeopathic remedies, acute prescribing**

Unlike **chronic kidney failure**, which is long term and irreversible, acute kidney failure is a temporary condition. With proper and timely treatment, it can typically be reversed. Often there is no permanent damage to the kidneys. Acute kidney failure appears most frequently as a complication of serious illness, like **heart failure**, liver failure, **dehydration**, severe **burns**, and excessive bleeding (hemorrhage). It may also be caused by an obstruction to the urinary tract or as a direct result of **kidney disease**, injury, or an adverse reaction to a medicine.

## Causes and symptoms

Acute kidney failure can be caused by many different illnesses, injuries, and infections. These conditions fall into three main categories: *prerenal*, *postrenal*, and *intrarenal* conditions.

Prerenal conditions do not damage the kidney, but can cause diminished kidney function. They are the most common cause of acute renal failure, and include:

- dehydration
- hemorrhage
- septicemia, or sepsis
- heart failure
- liver failure
- burns

Postrenal conditions cause kidney failure by obstructing the urinary tract. These conditions include:

- inflammation of the prostate gland in men (prostatitis)
- enlargement of the prostate gland (benign prostatic hypertrophy)
- bladder or pelvic tumors
- kidney stones (calculi)

Intrarenal conditions involve kidney disease or direct injury to the kidneys. These conditions include:

- lack of blood supply to the kidneys (ischemia)
- use of radiocontrast agents in patients with kidney problems
- drug abuse or overdose
- long-term use of nephrotoxic medications, like certain pain medicines
- acute inflammation of the glomeruli, or filters, of the kidney (glomerulonephritis)
- kidney infections (pyelitis or pyelonephritis).

## Acute kidney failure

### Definition

Acute kidney failure occurs when illness, infection, or injury damages the kidneys. Temporarily, the kidneys cannot adequately remove fluids and wastes from the body or maintain the proper level of certain kidney-regulated chemicals in the bloodstream.

### Description

The kidneys are the body's natural filtration system. They perform the critical task of processing approximately 200 quarts of fluid in the bloodstream every 24 hours. Waste products like urea and toxins, along with excess fluids, are removed from the bloodstream in the form of urine. Kidney (or renal) failure occurs when kidney functioning becomes impaired. Fluids and toxins begin to accumulate in the bloodstream. As fluids build up in the bloodstream, the patient with acute kidney failure may become puffy and swollen (edematous) in the face, hands, and feet. Their blood pressure typically begins to rise, and they may experience **fatigue** and **nausea**.

## KEY TERMS

**Blood urea nitrogen (BUN)**—A waste product that is formed in the liver and collects in the bloodstream; patients with kidney failure have high BUN levels.

**Creatinine**—A protein produced by muscle that healthy kidneys filter out.

**Extracorporeal**—Outside of, or unrelated to, the body.

**Ischemia**—A lack of blood supply to an organ or tissue.

**Nephrotoxic**—Toxic, or damaging, to the kidney.

**Radiocontrast agents**—Dyes administered to a patient for the purposes of a radiologic study.

**Sepsis**—A bacterial infection of the bloodstream.

**Vasopressors**—Medications that constrict the blood vessels.

Common symptoms of acute kidney failure include:

- anemia. The kidneys are responsible for producing erythropoietin (EPO), a hormone that stimulates red blood cell production. If kidney disease causes shrinking of the kidney, red blood cell production is reduced, leading to anemia.
- bad breath or bad taste in mouth. Urea in the saliva may cause an ammonia-like taste in the mouth.
- bone and joint problems. The kidneys produce vitamin D, which helps the body absorb calcium and keeps bones strong. For patients with kidney failure, bones may become brittle. In children, normal growth may be stunted. Joint pain may also occur as a result of high phosphate levels in the blood. Retention of uric acid may cause gout.
- edema. Puffiness or swelling in the arms, hands, feet, and around the eyes.
- frequent urination.
- foamy or bloody urine. Protein in the urine may cause it to foam significantly. Blood in the urine may indicate bleeding from diseased or obstructed kidneys, bladder, or ureters.
- headaches. High blood pressure may trigger headaches.
- hypertension, or high blood pressure. The retention of fluids and wastes causes blood volume to increase. This makes blood pressure rise.
- increased fatigue. Toxic substances in the blood and the presence of anemia may cause the patient to feel exhausted.
- itching. Phosphorus, normally eliminated in the urine, accumulates in the blood of patients with kidney failure. An increased phosphorus level may cause the skin to itch.

• lower back pain. Patients suffering from certain kidney problems (like kidney stones and other obstructions) may have pain where the kidneys are located, in the small of the back below the ribs.

• nausea. Urea in the gastric juices may cause upset stomach.

### Diagnosis

Kidney failure is diagnosed by a doctor. A nephrologist, a doctor that specializes in the kidney, may be consulted to confirm the diagnosis and recommend treatment options. The patient who is suspected of having acute kidney failure will have blood and urine tests to determine the level of kidney function. A blood test will assess the levels of creatinine, blood urea nitrogen (BUN), uric acid, phosphate, **sodium**, and potassium. The kidney regulates these agents in the blood. Urine samples will also be collected, usually over a 24-hour period, to assess protein loss and/or creatinine clearance.

Determining the cause of kidney failure is critical to proper treatment. A full assessment of the kidneys is necessary to determine if the underlying disease is treatable and if the kidney failure is chronic or acute. X rays, **magnetic resonance imaging (MRI)**, computed tomography scan (CT), ultrasound, renal biopsy, and/or arteriogram of the kidneys may be used to determine the cause of kidney failure and level of remaining kidney function. X rays and ultrasound of the bladder and/or ureters may also be needed.

### Treatment

Treatment for acute kidney failure varies. Treatment is directed to the underlying, primary medical condition that has triggered kidney failure. Prerenal conditions may be treated with replacement fluids

given through a vein, **diuretics**, blood **transfusion**, or medications. Postrenal conditions and intrarenal conditions may require surgery and/or medication.

Frequently, patients in acute kidney failure require *hemodialysis*, *hemofiltration*, or *peritoneal dialysis* to filter fluids and wastes from the bloodstream until the primary medical condition can be controlled.

## Hemodialysis

Hemodialysis involves circulating the patient's blood outside of the body through an extracorporeal circuit (ECC), or dialysis circuit. The ECC is made up of plastic blood tubing, a filter known as a dialyzer (or artificial kidney), and a dialysis machine that monitors and maintains blood flow and administers dialysate. Dialysate is a sterile chemical solution that is used to draw waste products out of the blood. The patient's blood leaves the body through the vein and travels through the ECC and the dialyzer, where fluid removal takes place.

During dialysis, waste products in the bloodstream are carried out of the body. At the same time, electrolytes and other chemicals are added to the blood. The purified, chemically-balanced blood is then returned to the body.

A dialysis "run" typically lasts three to four hours, depending on the type of dialyzer used and the physical condition of the patient. Dialysis is used several times a week until acute kidney failure is reversed.

Blood pressure changes associated with hemodialysis may pose a risk for patients with heart problems. Peritoneal dialysis may be the preferred treatment option in these cases.

## Hemofiltration

Hemofiltration, also called continuous renal replacement therapy (CRRT), is a slow, continuous blood filtration therapy used to control acute kidney failure in critically ill patients. These patients are typically very sick and may have heart problems or circulatory problems. They cannot handle the rapid filtration rates of hemodialysis. They also frequently need **antibiotics**, **nutrition**, vasopressors, and other fluids given through a vein to treat their primary condition. Because hemofiltration is continuous, prescription fluids can be given to patients in kidney failure without the risk of fluid overload.

Like hemodialysis, hemofiltration uses an ECC. A hollow fiber hemofilter is used instead of a dialyzer to remove fluids and toxins. Instead of a dialysis machine, a blood pump makes the blood flow through the ECC. The volume of blood circulating through the ECC in hemofiltration is less than that in hemodialysis. Filtration rates are slower and gentler on the circulatory system. Hemofiltration treatment will generally be used until kidney failure is reversed.

## Peritoneal dialysis

Peritoneal dialysis may be used if an acute kidney failure patient is stable and not in immediate crisis. In peritoneal dialysis (PD), the lining of the patient's abdomen, the peritoneum, acts as a blood filter. A flexible tube-like instrument (catheter) is surgically inserted into the patient's abdomen. During treatment, the catheter is used to fill the abdominal cavity with dialysate. Waste products and excess fluids move from the patient's bloodstream into the dialysate solution. After a certain time period, the waste-filled dialysate is drained from the abdomen, and replaced with clean dialysate. There are three type of peritoneal dialysis, which vary according to treatment time and administration method.

Peritoneal dialysis is often the best treatment option for infants and children. Their small size can make vein access difficult to maintain. It is not recommended for patients with abdominal **adhesions** or other abdominal defects (like a **hernia**) that might reduce the efficiency of the treatment. It is also not recommended for patients who suffer frequent bouts of an inflammation of the small pouches in the intestinal tract (**diverticulitis**).

## Prognosis

Because many of the illnesses and underlying conditions that often trigger acute kidney failure are critical, the prognosis for these patients many times is not good. Studies have estimated overall **death** rates for acute kidney failure at 42–88%. Many people, however, die because of the primary disease that has caused the kidney failure. These figures may also be misleading because patients who experience kidney failure as a result of less serious illnesses (like **kidney stones** or dehydration) have an excellent chance of complete recovery. Early recognition and prompt, appropriate treatment are key to patient recovery.

Up to 10% of patients who experience acute kidney failure will suffer irreversible kidney damage. They will eventually go on to develop chronic kidney

failure or end-stage renal disease. These patients will require long-term dialysis or **kidney transplantation** to replace their lost renal functioning.

### Prevention

Since acute kidney failure can be caused by many things, prevention is difficult. Medications that may impair kidney function should be given cautiously. Patients with pre-existing kidney conditions who are hospitalized for other illnesses or injuries should be carefully monitored for kidney failure complications. Treatments and procedures that may put them at risk for kidney failure (like diagnostic tests requiring radio-contrast agents or dyes) should be used with extreme caution.

### ORGANIZATIONS

National Kidney Foundation, Inc., 30 East 33rd Street, New York, NY, 10016, (212) 889-2210, (212) 689-9261, (800) 622-9010, <http://www.kidney.org/>

Paula Anne Ford-Martin

Acute leukemias see **Leukemias, acute**

## KEY TERMS

**Biopsy**—The process that removes a sample of diseased or infected tissue for microscopic examination to aid in diagnosis.

**Lymphatic system**—A component of the immune system consisting of vessels and nodes. Waste materials from organs drain into the lymphatic vessels and are filtered by the lymph nodes.

**Septicemia**—Disease caused by the presence and growth of bacteria in the bloodstream.

of the bacteria occurs so rapidly that the immune system does not respond fast enough to stop the infection.

If left untreated, the bacteria can cause tissue destruction in the area of the infection. A pus-filled, painful lump called an **abscess** may be formed in the infected area. **Cellulitis**, a generalized infection of the lower skin layers, may also occur. In addition, the bacteria may invade the bloodstream and cause septicemia. Lay people, for that reason, often call the red streaks seen in the skin “blood poisoning.” Septicemia is a very serious illness and may be fatal.

### Causes and symptoms

Acute lymphangitis is most often caused by the bacterium *Streptococcus pyogenes*. This potentially dangerous bacterium also causes **strep throat**, infections of the heart, spinal cord, and lungs, and in the 1990s has been called the “flesh-eating bacterium.” Staphylococci bacteria may also cause lymphangitis.

Although anyone can develop lymphangitis, some people are more at risk. People who have had radical **mastectomy** (removal of a breast and nearby lymph nodes), a leg vein removed for coronary bypass surgery, or recurrent lymphangitis caused by *tinea pedis* (a fungal infection on the foot) are at an increased risk for lymphangitis.

The characteristic symptoms of acute lymphangitis are the wide, red streaks which travel from the site of infection to the armpit or groin. The affected areas are red, swollen, and painful. Blistering of the affected skin may occur. The bacterial infection causes a **fever** of 100–104 °F (38–40 °C). In addition, a general ill feeling, muscle aches, **headache**, chills, and loss of appetite may be felt.

### Description

Acute lymphangitis affects a critical member of the immune system—the lymphatic system. Waste materials from nearly every organ in the body drain into the lymphatic vessels and are filtered in small organs called lymph nodes. Foreign bodies, such as bacteria or viruses, are processed in the lymph nodes to generate an immune response to fight an infection.

In acute lymphangitis, bacteria enter the body through a cut, scratch, insect bite, surgical wound, or other skin injury. Once the bacteria enter the lymphatic system, they multiply rapidly and follow the lymphatic vessel like a highway. The infected lymphatic vessel becomes inflamed, causing red streaks that are visible below the skin surface. The growth

## Diagnosis

If lymphangitis is suspected, the person should call his or her doctor immediately or go to an emergency room. Acute lymphangitis could be diagnosed by the family doctor, **infectious disease** specialist, or an emergency room doctor. The painful, red streaks just below the skin surface and the high fever are diagnostic of acute lymphangitis. A sample of blood would be taken for culture to determine whether the bacteria have entered the bloodstream. A biopsy (removal of a piece of infected tissue) sample may be taken for culture to identify which type of bacteria is causing the infection. Diagnosis is immediate because it is based primarily on the symptoms. Most insurance policies should cover the expenses for the diagnosis and treatment of acute lymphangitis.

## Treatment

Because of the serious nature of this infection, treatment would begin immediately even before the bacterial culture results were available. The only treatment for acute lymphangitis is to give very large doses of an antibiotic, usually penicillin, through the vein. Growing streptococcal bacteria are usually eliminated rapidly and easily by penicillin. The antibiotic clindamycin may be included in the treatment to kill any streptococci that are not growing and are in a resting state. Alternatively, a "broad spectrum" antibiotic may be used which would kill many different kinds of bacteria.

## Prognosis

Complete recovery is expected if antibiotic treatment is begun at an early stage of the infection. However, if untreated, acute lymphangitis can be a very serious and even deadly disease. Acute lymphangitis that goes untreated can spread, causing tissue damage. Extensive tissue damage would need to be repaired by **plastic surgery**. Spread of the infection into the bloodstream could be fatal.

## Prevention

Although acute lymphangitis can occur in anyone, good hygiene and general health may help to prevent infections.

## Resources

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Belinda Rowland PhD

Acute pericarditis see **Pericarditis**

## Acute poststreptococcal glomerulonephritis

### Definition

Acute poststreptococcal **glomerulonephritis** (APSGN) is an inflammation of the kidney tubules (glomeruli) that filter waste products from the blood, following a streptococcal infection such as **strep throat**. APSGN is also called postinfectious glomerulonephritis.

### Description

APSGN develops after certain streptococcal bacteria (group A beta-hemolytic streptococci) have infected the skin or throat. Antigens from the dead streptococci clump together with the antibodies that killed them. These clumps are trapped in the kidney tubules, cause the tubules to become inflamed, and impair that organs' ability to filter and eliminate body wastes. The onset of APSGN usually occurs one to six weeks (average two weeks) after the streptococcal infection.

APSGN is a relatively uncommon disease affecting about one of every 10,000 people, although four or five times that many may actually be affected by it but show no symptoms. APSGN is most prevalent among boys between the ages of 3 and 7, but it can occur at any age.

### Causes and symptoms

Frequent sore throats and a history of streptococcal infection increase the risk of acquiring APSGN. Symptoms of APSGN include:

- fluid accumulation and tissue swelling (edema) initially in the face and around the eyes, later in the legs
- low urine output (oliguria)
- blood in the urine (hematuria)
- protein in the urine (proteinuria)
- high blood pressure
- joint pain or stiffness

### Diagnosis

Diagnosis of APSGN is made by taking the patient's history, assessing his/her symptoms, and performing certain laboratory tests. **Urinalysis** usually shows blood and protein in the urine. Concentrations of urea and creatinine (two waste products normally filtered out of the blood by the kidneys) in the blood are often high, indicating impaired kidney function. A reliable, inexpensive blood test called the anti-streptolysin-O test can confirm that a patient has or has had a

## KEY TERMS

**Streptococcus**—A gram-positive, round or oval bacteria in the genus *Streptococcus*. Group A streptococci cause a number of human diseases including strep throat, impetigo, and ASPGN.

streptococcal infection. A **throat culture** may also show the presence of group A beta-hemolytic streptococci.

### Treatment

Treatment of ASPGN is designed to relieve the symptoms and prevent complications. Some patients are advised to stay in bed until they feel better and to restrict fluid and salt intake. **Antibiotics** may be prescribed to kill any lingering streptococcal bacteria, if their presence is confirmed. Antihypertensives may be given to help control high blood pressure and **diuretics** may be used to reduce fluid retention and swelling. **Kidney dialysis** is rarely needed.

### Prognosis

Most children (up to 95%) fully recover from ASPGN in a matter of weeks or months. Most adults (up to 70%) also recover fully. In those who do not recover fully, chronic or progressive problems of kidney function may occur. Kidney failure may result in some patients.

### Prevention

Receiving prompt treatment for **streptococcal infections** may prevent ASPGN.

### Resources

#### BOOKS

Wessel, Michael R. "Streptococcal and Enterococcal Infections." In Fauci, Anthony S., et al., eds. *Harrison's Principles of Internal Medicine*. 17th ed. New York: McGraw-Hill Professional, 2008.

#### ORGANIZATIONS

American Kidney Fund (AKF), 6110 Executive Boulevard, Suite 1010, Rockville, MD, 20852, (800) 638-8299, <http://www.kidneyfund.org>.

National Kidney Foundation, Inc., 30 East 33rd Street, New York, NY, 10016, (212) 889-2210, (212) 689-9261, (800) 622-9010, <http://www.kidney.org/>.

Maureen Haggerty

Acute respiratory distress syndrome see  
**Adult respiratory distress syndrome**

## Acute stress disorder

### Definition

Acute **stress** disorder (ASD) is an **anxiety** disorder characterized by a cluster of dissociative and anxiety symptoms occurring within one month of a traumatic event. (Dissociation is a psychological reaction to trauma in which the mind tries to cope by "sealing off" some features of the trauma from conscious awareness).

### Description

Acute stress disorder is a new diagnostic category that was introduced in 1994 to differentiate time-limited reactions to trauma from **post-traumatic stress disorder** (PTSD).

### Causes and symptoms

Acute stress disorder is caused by exposure to trauma, which is defined as a stressor that causes intense fear and, usually, involves threats to life or serious injury to oneself or others. Examples are **rape**, mugging, combat, natural disasters, etc.

The symptoms of stress disorder include a combining of one or more dissociative and anxiety symptoms with the avoidance of reminders of the traumatic event. Dissociative symptoms include emotional detachment, temporary loss of memory, depersonalization, and derealization.

Anxiety symptoms connected with acute stress disorder include irritability, physical restlessness, sleep problems, inability to concentrate, and being easily startled.

### Diagnosis

Diagnosis of acute stress disorder is based on a combination of the patient's history and a **physical examination** to rule out diseases that can cause anxiety. The essential feature is a traumatic event within one month of the onset of symptoms. Other diagnostic criteria include:

- The symptoms significantly interfere with normal social or vocational functioning
- The symptoms last between two days and four weeks.

### Treatment

Treatment for acute stress disorder usually includes a combination of antidepressant medications and short-term **psychotherapy**.

## KEY TERMS

**Depersonalization**—A dissociative symptom in which the patient feels that his or her body is unreal, is changing, or is dissolving.

**Derealization**—A dissociative symptom in which the external environment is perceived as unreal.

**Dissociation**—A reaction to trauma in which the mind splits off certain aspects of the trauma from conscious awareness. Dissociation can affect the patient's memory, sense of reality, and sense of identity.

**Trauma**—In the context of ASD, a disastrous or life-threatening event.

## Prognosis

The prognosis for recovery is influenced by the severity and duration of the trauma, the patient's closeness to it, and the patient's previous level of functioning. Favorable signs include a short time period between the trauma and onset of symptoms, immediate treatment, and appropriate social support. If the patient's symptoms are severe enough to interfere with normal life and have lasted longer than one month, the diagnosis may be changed to PTSD. If the symptoms have lasted longer than one month but are not severe enough to meet the definition of PTSD, the diagnosis may be changed to adjustment disorder.

Patients who do not receive treatment for acute stress disorder are at increased risk for **substance abuse** or major **depressive disorders**.

## Prevention

Traumatic events cannot usually be foreseen and, thus, cannot be prevented. However, in theory, professional intervention soon after a major trauma might reduce the likelihood or severity of ASD. In addition, some symptoms of acute stress disorder result from biochemical changes in the central nervous system, muscles, and digestive tract that are not subject to conscious control.

## Resources

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Lewis-Fernández, Roberto, et al. *Anxiety Disorders: Theory, Research and Clinical Perspectives*. Cambridge, UK: Cambridge University Press, 2010.

Rebecca J. Frey PhD

Acute stress gastritis see **Gastritis**

Acute transverse myelitis see **Transverse myelitis**

Acyclovir see **Antiviral drugs**

## Addiction

### Definition

Addiction is a disease of the brain that causes dependence upon or a persistent, compulsive need to use a habit-forming substance or an irresistible urge to engage in an activity, despite harmful consequences. Addictions are characterized by the increasing need for more of the substance or activity to obtain the same effect. Abstinence from the addiction may cause unpleasant or even life-threatening withdrawal symptoms.

### Demographics

Addiction to substances and activities is very widespread in the United States, Canada, and around the world. **Substance abuse** and addiction costs Americans more than \$484 billion annually in health-care costs, lost earnings, accidents, and crime. Every year Americans suffer approximately 40 million debilitating illnesses or injuries as a result of tobacco, alcohol, and other addictive drug use. Likewise about one in ten Canadians age 15 and older are addicted to alcohol or drugs. Men are more than twice as likely as women to be addicted to a substance. However gender differences are much less pronounced among adolescents: teenage girls are almost as likely as boys to abuse a substance. Approximately 20% of people with addictions have other mental disorders as well.

Nicotine dependence is the most common type of addiction. It is estimated that worldwide tobacco use results in five million deaths annually. Cigarette **smoking** is the leading preventable cause of **death** in the United States, with 483,000 deaths annually, which is about one out of every five deaths. An additional 38,000 deaths annually are caused by exposure to secondhand smoke. As of 2007, about 19.8% of American adults smoked cigarettes. In addition about 23%

### Substance addiction and treatment

In 2009, 20.9 million people needed treatment for a substance addiction, but only 5.1% perceived this need and fewer still (1.8%) actually pursued treatment.

Dependence on specific drugs included:

Marijuana	4.2 million users
Pain relievers	1.8 million
Cocaine	1.1 million
Tranquilizers	481,000
Heroin	399,000
Stimulants	371,000
Hallucinogens	371,000
Inhalants	164,000
Sedatives	147,000

SOURCE: Substance Abuse and Mental Health Services Administration, Office of Applied Studies, *Results from the 2009 National Survey on Drug Use and Health: Volume I Summary of National Findings* (September 2010).

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of American high-school students and 8% of middle-school students smoked cigarettes.

**Alcoholism** is the most common addiction to a psychoactive substance. Alcohol addiction affects both sexes and all races and nationalities. In the United States 17.6 million people—about one in 12 adults—abuse or are addicted to alcohol. Alcohol addiction rates are highest among young adults aged 18–29 and lowest among those 65 and older.

An estimated four million Americans over the age of 12 use prescription **pain** relievers, sedatives, or stimulants for nonmedical reasons during any given month. In 2008, 15.4% of twelfth-graders reported using prescription drugs nonmedically. These included amphetamines, sedatives/barbiturates, tranquilizers, and opiates other than heroin.

Addictions most often first appear in adolescence. In a 2006 national survey, 14.9% of high school students reported having used an illicit drug in the previous month. Young people aged 15–24 are more likely to report addictions than those in other age groups. However the use of illegal drugs among American teenagers declined by 24% between 2001 and 2007. Cigarette smoking and alcohol use among American youth also declined significantly over the first decade of the twenty-first century.

Statistics on addictive activities are more difficult to obtain because these behaviors are less clearly defined than substance addiction. However a Harvard University study found that an estimated

15.4 million Americans suffered from a gambling addiction. More than one-half (7.9 million) were adolescents.

### Description

Addiction most commonly refers to the compulsive use or abuse of or physical or psychological dependence on addictive substances, including:

- tobacco
- alcohol
- cocaine, including crack cocaine
- amphetamines, including methamphetamine or “crank,” an extremely addictive substance
- heroin
- prescription medications Prescription painkillers, such as the opiates Vicodin and OxyContin, have emerged as drugs of special concern because of their widespread use by high-school students.

In recent years the term “addiction” has been used to describe a wide and complex range of behaviors. These so-called process addictions are compulsive behaviors involving activities such as:

- gambling
- eating
- working
- exercising
- shopping or otherwise spending money
- sex
- internet use, especially online gaming

Most addictions are associated with mood modification. Initially, at least, they make the addict feel better. Addicts often describe a release of tension or feelings of euphoria when using the substance or engaging in the activity. Most addictions are progressive syndromes—without treatment their severity increases over time. Furthermore many addicts are addicted to more than one substance or activity. Addictions are characterized by frequent relapse—a return to the abused substance or activity following recovery.

Some substances are more addictive than others, either because they produce a rapid and intense change in mood or because they produce painful withdrawal symptoms when stopped suddenly. Drugs that are smoked or injected, giving an immediate short-lived “high,” tend to be more addictive than substances that are ingested.

The American Psychiatric Association’s *Diagnostic and Statistical Manual of Mental Disorders (DSM-*

*IV-TR*) classifies **substance abuse and dependence** as psychological disorders that are major clinical syndromes (called “Axis 1”). Over time repeated drug use changes brain structure and function in fundamental and long-lasting ways. Evidence suggests that these long-lasting brain changes are responsible for the distortions of cognitive and emotional functioning that characterize addicts, particularly the compulsion to use drugs. This explains why many addicts cannot stop using drugs by force of will alone.

### Risk factors

Risk factors for addiction include:

- inherited factors
- adolescence
- addictive behavior in the home or among family members or peers
- early substance use
- early aggressive behavior
- academic failure
- lack of parental supervision
- poor social skills
- other mental disorders or illnesses
- substance abuse
- substance availability
- poverty

### Causes and symptoms

For much of the twentieth century addiction was viewed as a moral failing; however today addiction is widely viewed as a disease. The disease model of alcohol and drug addiction was first introduced in the late 1940s by E. M. Jellinek and was adopted by the American Medical Association in 1956. According to the disease model, the compulsion to use alcohol and/or drugs is genetically and physiologically based and, although the disease can be arrested, it is progressive, chronic, and fatal if unchecked. However some experts argue that addiction is better understood as a learned behavior and that the negative behavior can be unlearned and replaced by learning new positive behaviors. The causes of addiction remain the subject of ongoing research and debate.

The initial positive consequences of substance use or a potentially addictive activity can “hook” a susceptible person and turn into an addiction. Addiction comes about through an array of changes in the brain and the strengthening of new memory connections. The anterior cingulated cortex in the frontal lobe of

the brain is the area responsible for the long-term craving in addicts that triggers relapse.

Many experts believe that addictive substances and activities affect neurotransmitters in the brain. The primary pathway involved in the development and persistence of addiction is the brain reward or mesolimbic pathway, which operates via a neurotransmitter called dopamine. Dopamine pathways may interact with those of other neurotransmitters, including opioid pathways. These neuronal pathways have been identified as underlying both substance and process addictions.

Whatever the brain chemistry involved in addiction, it usually results from the interaction of several factors:

- Social learning. This may be the most important single factor in addiction and includes patterns of substance use and activities in the addict’s family or subculture, peer pressure, and advertising or media influence.
- Availability. There are marked increases in addiction rates when tobacco, alcohol, or drugs are inexpensive or readily available.
- Individual development. Before the 1980s, addiction was blamed on an “addictive personality,” which was described as escapist, impulsive, dependent, devious, manipulative, and self-centered. Although individual development may play a role in addiction, many doctors now believe that these character traits develop in addicts as a result of the addiction, rather than causing the addiction.
- Genetic factors. It is estimated that genetic factors account for 40–60% of an individual’s vulnerability to addiction. Twin studies have shown that addiction has a strong inherited component. Some forms of addiction seem to run in families and some people appear to be more vulnerable to addiction because of their body chemistry.

The continued use of an addictive substance or engagement in an addictive activity causes the addict’s body to adjust and develop tolerance. Increasing amounts of the substance or more frequent engagement in the activity are needed to produce the same effect. In some cases addicts routinely use amounts of a substance that would be lethal in someone who had not developed a tolerance.

The inability to hold a steady job and disruptions of social and familial relationships are common symptoms of all types of addiction. Over time the physical symptoms of an addiction increase and withdrawal

## KEY TERMS

**Addictive personality**—The concept that addiction is the result of pre-existing character defects.

**Dopamine**—A neurotransmitter in the brain.

**Methamphetamine (Meth, Methadrine, “Speed”)**—A highly addictive medication that is used to treat attention deficit disorder and obesity, but is widely abused as a stimulant.

**Neurotransmitter**—A chemical that transmits impulses across a synapse between nerves.

**Process addiction**—Addiction to certain mood-altering behaviors, such as eating, gambling, sexual activity, overwork, and shopping.

**Relapse**—A recurrence of symptoms after a period of improvement or recovery.

**Tolerance**—The requirement for higher doses of a substance or more frequent engagement in an activity to achieve the same effect.

**Withdrawal**—The unpleasant, sometimes life-threatening physiological changes that occur due to the discontinuation of some drugs after prolonged regular use.

symptoms can become more severe. These symptoms vary with the individual and with the substance or activity.

According to the *DSM-IV-TR*, alcohol abuse progresses through a series of stages from social drinking to chronic alcoholism. Danger signs that indicate the probable onset of addiction to alcohol include:

- a frequent desire to drink
- increasing alcohol consumption
- memory lapses (blackouts)
- morning drinking
- hiding alcohol from family and coworkers
- drinking in secret

Alcoholic psychoses are symptoms of late-stage alcohol addiction and include:

- alcohol withdrawal delirium (delirium tremens)
- hallucinations
- Korsakoff's psychosis, an irreversible brain disorder involving severe memory loss

Symptoms of withdrawal from alcohol and some drugs may include:

- flu-like aches and pains
- digestive upset
- seizures
- hallucinatory sensations, such as the feeling of bugs crawling over one's skin
- damage to organs, including the brain and liver
- dementia

### Diagnosis

#### *Examination*

Addictions are usually readily diagnosed by their symptoms and by lifestyle factors. Alcoholism is usually diagnosed when drinking impairs a person's life, personal relationships, work, and/or health. A physician, psychologist, or social worker usually makes a diagnosis of addiction based on the following criteria:

- a pattern of frequent and compulsive substance use or engagement in an activity
- preoccupation with acquiring and using an abused substance
- tolerance or escalation of the substance use or activity
- loss of willpower
- harmful consequences
- unmanageable lifestyle
- withdrawal symptoms

The examination may include probing for underlying conditions such as depression, emotional upset, anxiety or stress. A physician may also look for signs of malnutrition or other medical problems resulting from substance abuse.

#### *Tests*

Blood and urine tests may be ordered to check for substance use or for liver or other organ damage resulting from substance abuse.

#### *Procedures*

Imaging tests may be ordered to check for organ damage resulting from substance abuse.

## Treatment

Addictions are notoriously difficult to treat. Treatment often requires a combination of medical, psychological, and social approaches.

### *Traditional*

Although addiction treatment may be provided by practicing clinicians such as psychiatrists, psychologists, and social workers, it is more often provided by specialized addiction treatment programs and clinics. These programs usually rely upon confrontational tactics and re-education, often employing former or recovering addicts to treat newly admitted addicts. Residential settings can be effective in helping addicted individuals to stay away from the many cues—including people and places—that form the setting for their addiction. Substance addicts may need hospital treatment to manage withdrawal symptoms.

Individual or group **psychotherapy** is often helpful for treating addictions after the substance use or addictive activity has ceased. Many of the negative behaviors and personality problems associated with addictions disappear when the substance use or activity ceases. **Family therapy** can be helpful for addressing and changing “enabling behaviors” by family members who help maintain the addiction by providing money, food, shelter, and/or emotional support.

The effectiveness of addiction treatment based on behavioral and other psychotherapeutic methods is well-documented. Specific therapies to treat addiction include:

- cognitive-behavioral approaches to prevent relapse by helping addicts recognize, avoid, and cope with situations that encourage their addictions
- motivation-enhancing strategies that utilize positive reinforcement and incentives
- motivational interviewing that uses strategies to promote behavior changes
- solution-oriented and other brief therapy techniques
- harm-reduction approaches

### *Drugs*

Research continues into pharmacological treatments for easing withdrawal and treating various addictions. Some promising drugs boost the levels of neurotransmitters in the brain. Medications that are used to treat addiction include:

- nicotine replacement therapies including gum, patches, and inhalers
- bupropion (**Zyban**), an antidepressant, for tobacco addiction
- varenicline, which blocks the pleasant effects of nicotine on the brain
- disulfiram (**Antabuse**) and acamprosate (**Campral**) for treating alcoholism
- naltrexone (**Depade**, **ReVia**) for preventing relapse in alcohol and opioid addicts
- methadone, which blocks the euphoric effect of opiates
- buprenorphine (**Subutex**) or buprenorphine and naloxone (**Suboxone**) to prevent withdrawal symptoms and to treat addiction to opioids including heroin and narcotic painkillers
- sedatives for reducing anxiety and withdrawal symptoms
- antidepressants for treating underlying problems in addicts who have been “self-medicating”

### *Alternative*

During the past several decades alternatives to the complete abstinence model have arisen. Controlled-use programs allow addicted individuals to reduce their use without committing to complete abstinence. This alternative is highly controversial and the prevailing belief is that recovery is only possible by committing to complete lifelong abstinence from all substance use.

### *Home remedies*

Many people turn to self-help groups such as Alcoholics Anonymous (AA) and **Narcotics Anonymous** (NA) to treat their addictions. The approach of one addict helping another to stay “clean,” with or without additional professional help, is widely accepted in the United States and around the world.

The most frequently recommended social outpatient treatment is the 12-step program. The number of visits to 12-step self-help groups exceeds the number of visits to all mental health professionals combined. There are 12-step groups for all major substance and process addictions.

The 12 steps consist of:

- Admit powerlessness over the addiction
- Believe that a power greater than oneself can restore sanity
- Make a decision to turn your will and your life over to the care of your higher power

- Make a searching and fearless moral inventory of self
- Admit to your higher power, yourself, and another human being the exact nature of your wrongs
- Become willing to have your higher power remove all these defects from your character
- Humbly ask your higher power to remove your shortcomings
- Make a list of all persons harmed by your wrongs and become willing to make amends to them all
- Make direct amends to such people, whenever possible, except when to do so would injure them or others
- Continue to take personal inventory and promptly admit any future wrongdoings
- Seek to improve contact with the higher power of your understanding through meditation and prayer
- Carry the message of spiritual awakening to others and practice these principles in all your affairs

## Prognosis

The prognosis for recovery from any addiction depends on the substance or process, the individual's circumstances, and the underlying personality structure. Patterns of relapse tend to be very similar regardless of the specific addiction. Two-thirds of all relapses occur within the first 90 days following treatment. Substance abusers often make repeated attempts to quit before they are successful. Physical addictions alter a person's brain chemistry in ways that make it difficult to be exposed to the addictive substance again without relapsing and cravings may persist for years. Between 40 and 60% of drug addicts relapse following treatment. Multi-drug users have the worst prognosis for recovery.

Substance abuse can damage organs, including the brain and liver, and can lead to serious and even fatal illness, as well as mental disorders such as **dementia**. Drug addiction puts the addict at risk for:

- cardiovascular disease
- stroke
- cancer
- HIV/AIDS
- hepatitis B and C
- lung disease
- obesity
- other mental disorders

## Prevention

Preventive approaches are most effective when targeted at young teenagers between the ages of 11 and 13. It is during these years that most young people are likely to first experiment with drugs and alcohol. Hence reducing experimentation during this critical period holds promise for reducing the number of adults with addictions. Effective prevention programs focus on the concerns of young people with regard to the effects of tobacco, alcohol, and drugs. Training older adolescents to help younger adolescents resist peer pressure has shown considerable effectiveness in preventing experimentation.

Preventative measures against addiction include:

- fostering self-control and positive relationships
- promoting parental monitoring and support
- promoting anti-addiction policies
- educational programs for the public
- building strong communities

The most effective form of prevention appears to be a stable family that models responsible attitudes toward mood-altering substances and behaviors.

## Resources

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#### OTHER

- "Drugs, Brains, and Behavior—The Science of Addiction." *National Institute on Drug Abuse*. <http://www.nida.nih.gov/scienceofaddiction>.

#### ORGANIZATIONS

- Al-Anon/Alateen, 1600 Corporate Landing Parkway, Virginia Beach, VA, 23454-5617, (757) 563-1600 (757) 563-1655wso@al-anon.org, <http://www.al-anon.alateen.org>.
- Alcoholics Anonymous, PO Box 459, New York, NY, 10163, (212) 870-3400<http://www.aa.org>.
- American Psychiatric Association, 1000 Wilson Blvd., Ste. 1825, Arlington, VA, 22209-3901, (703) 907-7300apa@psych.org, <http://www.psych.org>.
- Center for Internet Addiction Recovery, P.O. Box 72, Bradford, PA, 16701, (814) 451-2405 (814) 368-9560<http://www.netaddiction.com>.
- Centre for Addiction and Mental Health, 33 Russell St., Toronto, Ontario, Canada, M5S 2S1, (416) 535-8501 (800) 463-6273<http://www.camh.net>.
- European Cities Against Drugs, Hantverkargatan 3D, City Hall, S-105-35, Stockholm, Sweden, 46-8-5082-9362 46-8-5082-9436cad@ecad.net, <http://www.ecad.net>.
- National Center on Addiction and Substance Abuse at Columbia University, 633 Third Avenue, 19th Floor, New York, NY, 10017-6706, (212) 841-5200<http://www.casacolumbia.org>.

- National Clearinghouse for Alcohol and Drug Information, P.O. Box 2345, Rockville, MD, 20847-2345, (877) SAMHSA-7 (240) 221-4292, <http://ncadi.samhsa.gov>.
- National Institute on Alcohol Abuse and Alcoholism (NIAAA), 5635 Fishers Lane, MSC 9304, Bethesda, MD, 20892-9304 (301) 443-3860, <http://www.niaaa.nih.gov>.
- National Institute on Drug Abuse (NIDA), 6001 Executive Boulevard, Room 5213, Bethesda, MD, 20892-9561, (301) 443-1124information@nida.nih.gov, <http://www.drugabuse.gov/NIDAHome.html>.

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## Addison's disease

### Definition

Addison's disease is a disorder involving disrupted functioning of the part of the adrenal gland called the cortex. This results in decreased production of two important chemicals (hormones) normally released by the adrenal cortex: cortisol and aldosterone.

### Description

The adrenals are two glands, each perched on the upper part of the two kidneys. The outer part of the gland is known as the cortex; the inner part is known as the medulla. Each of these parts of the adrenal gland is responsible for producing different types of hormones.

Cortisol is a very potent hormone produced by the adrenal cortex. It is involved in regulating the functioning of nearly every type of organ and tissue throughout the body, and is considered to be one of the few hormones absolutely necessary for life. Cortisol is involved in:

- the very complex processing and utilization of many nutrients, including sugars (carbohydrates), fats, and proteins
- the normal functioning of the circulatory system and the heart
- the functioning of muscles
- normal kidney function
- production of blood cells

## KEY TERMS

**Gland**—A collection of cells whose function is to release certain chemicals, or hormones, which are important to the functioning of other, sometimes distantly located, organs or body systems.

**Hormone**—A chemical produced in one part of the body, which travels to another part of the body in order to exert its effect.

- the normal processes involved in maintaining the skeletal system
- proper functioning of the brain and nerves
- the normal responses of the immune system

Aldosterone, also produced by the adrenal cortex, plays a central role in maintaining the appropriate proportions of water and salts in the body. When this balance is upset, the volume of blood circulating throughout the body will fall dangerously low, accompanied by a drop in blood pressure.

Addison's disease is also called primary adrenocortical insufficiency. In other words, some process interferes directly with the ability of the adrenal cortex to produce its hormones. Levels of both cortisol and aldosterone drop, and numerous functions throughout the body are disrupted.

Addison's disease occurs in about four in every 100,000 people. It strikes both men and women of all ages.

### Causes and symptoms

The most common cause of Addison's disease is the destruction and/or shrinking (atrophy) of the adrenal cortex. In about 70% of all cases, this atrophy is believed to occur due to an autoimmune disorder. In an autoimmune disorder, the immune system of the body, responsible for identifying foreign invaders such as viruses or bacteria and killing them, accidentally begins to identify the cells of the adrenal cortex as foreign, and destroy them. In about 20% of all cases, destruction of the adrenal cortex is caused by **tuberculosis**. The remaining cases of Addison's disease may be caused by fungal infections, such as **histoplasmosis**, coccidiomycosis, and **cryptococcosis**, which affect the adrenal gland by producing destructive, tumor-like masses called granulomas; a disease called **amyloidosis**, in which a starchy substance called amyloid is deposited in abnormal places throughout the body,

interfering with the function of whatever structure it is present within; or invasion of the adrenal glands by **cancer**.

In about 75% of all patients, Addison's disease tends to be a very gradual, slowly developing disease. Significant symptoms are not noted until about 90% of the adrenal cortex has been destroyed. The most common symptoms include **fatigue** and loss of energy, decreased appetite, **nausea**, **vomiting**, **diarrhea**, abdominal **pain**, weight loss, muscle weakness, **dizziness** when standing, **dehydration**, unusual areas of darkened (pigmented) skin, and dark freckling. As the disease progresses, the patient may appear to have very tanned, or bronzed skin, with darkening of the lining of the mouth, vagina, and rectum, and dark pigmentation of the area around the nipples (aereola). As dehydration becomes more severe, the blood pressure will continue to drop and the patient will feel increasingly weak and light-headed. Some patients have psychiatric symptoms, including depression and irritability. Women lose pubic and underarm hair, and stop having normal menstrual periods.

When a patient becomes ill with an infection, or stressed by an injury, the disease may suddenly and rapidly progress, becoming life-threatening. Symptoms of this "Addisonian crisis" include abnormal heart rhythms, severe pain in the back and abdomen, uncontrollable **nausea and vomiting**, a drastic drop in blood pressure, kidney failure, and unconsciousness. About 25% of all Addison's disease patients are identified due to the development of Addisonian crisis.

### Diagnosis

Many patients do not recognize the slow progression of symptoms and the disease is ultimately identified when a physician notices the areas of increased pigmentation of the skin. Once suspected, a number of blood tests can lead to the diagnosis of Addison's disease. It is not sufficient to demonstrate low blood cortisol levels, as normal levels of cortisol vary quite widely. Instead, patients are given a testing dose of another hormone called corticotropin (ACTH). ACTH is produced in the body by the pituitary gland, and normally acts by promoting growth within the adrenal cortex and stimulating the production and release of cortisol. In Addison's disease, even a dose of synthetic ACTH does not increase cortisol levels.

To distinguish between primary adrenocortical insufficiency (Addison's disease) and secondary

adrenocortical insufficiency (caused by failure of the pituitary to produce enough ACTH), levels of ACTH in the blood are examined. Normal or high levels of ACTH indicate that the pituitary is working properly, but the adrenal cortex is not responding normally to the presence of ACTH. This confirms the diagnosis of Addison's disease.

## Treatment

Treatment of Addison's disease involves replacing the missing or low levels of cortisol. In the case of Addisonian crisis, this will be achieved by injecting a potent form of steroid preparation through a needle placed in a vein (intravenous or IV). Dehydration and salt loss will also be treated by administering carefully balanced solutions through the IV. Dangerously low blood pressure may require special medications to safely elevate it until the **steroids** take effect.

Patients with Addison's disease will need to take a steroid preparation (hydrocortisone) and a replacement for aldosterone (fludrocortisone) by mouth for the rest of their lives. When a patient has an illness that causes nausea and **vomiting** (such that they cannot hold down their medications), he or she will need to enter a medical facility where IV medications can be administered. When a patient has any kind of infection or injury, the normal dose of hydrocortisone will need to be doubled.

## Prognosis

Prognosis for patients appropriately treated with hydrocortisone and aldosterone is excellent. These patients can expect to enjoy a normal lifespan. Without treatment, or with substandard treatment, patients are always at risk of developing Addisonian crisis.

## Resources

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National Adrenal Diseases Foundation, 505 Northern Boulevard, Suite 200, Great Neck, NY, 11021, (516) 487-4992, <http://www.nadf.us>.

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# Adenoid hyperplasia

## Definition

Adenoid hyperplasia, or sometimes also commonly called adenoid hypertrophy or enlarged adenoids, is the overenlargement (or, unusual growth) of the lymph glands (lymphatic tissue) located between the nose and the back of the mouth. The tissues are similar in characteristics to the tonsils.

## Demographics

The condition is one that occurs quite frequently in childhood. The adenoidal tissue is small at birth and grows until children attain adolescence. Normally, it then begins to atrophy (shrink). However, in some cases the tissue continues to grow abnormally, resulting in adenoid hyperplasia.

## Description

Located at the back of the mouth above and below the soft palate are two pairs of lymph glands. The tonsils below are clearly visible behind the back teeth; the adenoids lie just above them and are hidden from view by the palate. Together these four arsenals of immune defense guard the major entrance to the body from foreign invaders—the germs humans breathe and eat. In contrast to the rest of the body's tissues, lymphoid tissue reaches its greatest size in mid-childhood (around five years of age) and recedes thereafter (generally by seven years). In this way children are best able to develop the immunities they need to survive in a world full of infectious diseases.

Beyond its normal growth pattern, lymphoid tissue grows excessively (hypertrophies) during an acute infection, as it suddenly increases its immune activity to fight off invaders. Often it does not completely return to its former size. Each subsequent infection leaves behind a larger set of tonsils and adenoids. To make matters worse, the sponge-like structure of these hypertrophied glands can produce safe havens for germs where the body cannot reach and eliminate them. Before **antibiotics** and the reduction in infectious childhood diseases over the past few generations, tonsils and adenoids caused greater health problems.

## Causes and symptoms

Most tonsil and adenoid hypertrophy is simply caused by the normal growth pattern for that type of tissue. Less often, the hypertrophy is due to repeated throat infections by cold viruses, **strep throat**,

## KEY TERMS

**Eustacian tube**—A tube connecting the middle ear with the back of the nose, allowing air pressure to equalize within the ear whenever it opens, such as with yawning.

**Hyperplastic**—Overgrown.

**Hypertrophy**—Overgrowth.

**Strep throat**—An infection of the throat caused by bacteria of the *Streptococcus* family, which causes tonsillitis.

**Ulcerated**—Damaged so that the surface tissue is lost and/or necrotic (dead).

mononucleosis, and, in times gone by, **diphtheria**. The acute infections are usually referred to as **tonsillitis**, the adenoids getting little recognition because they cannot be seen without special instruments. Symptoms include painful, bright red, often ulcerated tonsils, enlargement of lymph nodes (glands) beneath the jaw, **fever**, and general discomfort.

After the acute infection subsides, symptoms are generated simply by the size of the glands. Extremely large tonsils can impair breathing and swallowing, although that condition is quite rare. Large adenoids can block air passages and, thus, impair nose breathing and require a child to breathe through the mouth. **Snoring** during sleep may occur, along with frequent nasal congestion/nasal discharge when both awake and asleep. **Fatigue**, uneasy and restless sleep, daytime sleepiness, lessened appetite, **bad breath**, dry and cracked lips, nasally sounding voice, and fever may also occur. Because they encircle the only connection between the middle ear and the Eustachian tube, hypertrophied adenoids can also obstruct it and cause middle ear infections. Such infections are caused by abnormally high bacterial counts and build up of fluids in the middle ear. These fluids can drip onto sensitive vocal cords, which may lead to irritations and coughing.

## Diagnosis

A simple tongue blade depressing the tongue allows an adequate view of the tonsils. Enlarged tonsils may have deep pockets (crypts) containing dead tissue (necrotic debris). Viewing adenoids requires a small mirror or fiber optic endoscope. X rays of the skull, along with computed tomography (CT) and **magnetic resonance imaging** (MRI) scans, taken laterally can show

the adenoids. A child with recurring middle ear infections may well have large adenoids. A **throat culture** or mononucleosis test will usually reveal the identity of the germ.

## Treatment

It used to be standard practice to remove tonsils and/or adenoids after a few episodes of acute throat or ear infection. The surgery is called **tonsillectomy and adenoidectomy** (T and A). Opinion changed as it was realized that this tissue is beneficial to the development of immunity. For instance, children without tonsils and adenoids produce only half the immunity to oral **polio** vaccine. In addition, treatment of ear and throat infections with antibiotics and of recurring ear infections with surgical drainage through the eardrum (tympanostomy) has greatly reduced the incidence of surgical removal of these lymph glands. When performed today, the procedure is usually used to correct nasal obstructions and reduce chronic middle ear infections and fluids.

## Alternative treatment

There are many botanical/herbal remedies that can be used alone or in formulas to locally assist the tonsils and adenoids in their immune function at the opening of the oral cavity and to tone these glands. Keeping the Eustachian tubes open is an important contribution to optimal function in the tonsils and adenoids. **Food allergies** are often the culprits for recurring ear infections, as well as tonsillitis and adenoiditis. Identification and removal of the allergic food(s) can greatly assist in alleviating the cause of the problem. Acute tonsillitis also benefits from warm saline gargles. Alternative treatments should be used with care, as the benefits of many such treatments have not been confirmed by scientific research.

## Prognosis

Hypertrophied adenoids are a normal part of growing up and should be respected for their important role in the development of immunity. Only when their size causes problems by obstructing breathing or middle ear drainage do they demand intervention.

## Prevention

Prevention could be concentrated toward timely evaluation and appropriate treatment of sore throats to prevent overgrowth of adenoid tissue. Avoiding other children with acute respiratory illness will also reduce the spread of these common illnesses.

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Adenoid hypertrophy see **Adenoid hyperplasia**

Adenoid removal see **Tonsillectomy and adenoidectomy**

Adenoidectomy see **Tonsillectomy and adenoidectomy**

respiratory illnesses in civilian adults. They are more apt to cause infection among military recruits and other young people who live in institutional environments. Outbreaks among children are frequently reported at boarding schools and summer camps. Another example includes an increased outbreak of **gastroenteritis** among cruise passengers since 2002.

## Description

Adenovirus infections most often cause illness of the respiratory system; however, they may also cause various other illnesses, such as **gastroenteritis**, **conjunctivitis**, **cystitis**, and rash illness. This virus was first recognized among military recruits during World War II, and is believed to be caused by conditions of crowding and **stress**.

In one mode of adenovirus infection (called lytic infection because it destroys large numbers of cells), adenoviruses kill healthy cells and replicate up to one million new viruses per cell killed (of which 1–5% are infectious). People with this kind of infection feel sick. In chronic or latent infection, a much smaller number of viruses are released and healthy cells can multiply more rapidly than they are destroyed. People who have this kind of infection do not seem to be sick. This is probably why many adults have immunity to adenoviruses without realizing they have been infected.

### *Acquired immunity*

Most children have been infected by at least one adenovirus by the time they reach school age. Most adults have acquired immunity to multiple adenovirus types due to infections they had as children.

### *Childhood infections*

In children, adenoviruses most often cause acute upper respiratory infections with **fever** and runny nose. Adenovirus types 1, 2, 3, 5, and 6 are responsible for most of these infections. Occasionally more serious lower respiratory diseases, such as **pneumonia**, may occur.

Adenoviruses also cause acute pharyngoconjunctival fever in children. This disease is most often caused by types 3 and 7. Symptoms, which appear suddenly and usually disappear in less than a week, include:

- inflammation of the lining of the eyelid (conjunctivitis)
- fever
- sore throat (pharyngitis)
- runny nose
- inflammation of lymph glands in the neck (cervical adenitis)

## Adenovirus infections

### Definition

Adenoviruses are DNA viruses (small infectious agents) that cause upper respiratory tract infections, **conjunctivitis**, and several other infections in humans. They usually infect the tissue lining of the respiratory tract.

### Demographics

Adenoviruses were discovered in 1953. About 47 different types have been identified since then, and about half of them are believed to cause human diseases. Infants and children are most commonly affected by adenoviruses. Adenovirus infections can occur throughout the year, but seem to be most common from fall to spring.

Adenoviruses are responsible for 3–5% of acute respiratory infections in children and 2% of

Adenoviruses also cause acute **diarrhea** in young children, characterized by fever and watery stools. This condition is caused by adenovirus types 40 and 41 and can last as long as two weeks.

As much as 51% of all hemorrhagic cystitis (inflammation of the bladder and of the tubes that carry urine to the bladder from the kidneys) in American and Japanese children can be attributed to adenovirus infection. A child who has hemorrhagic cystitis has bloody urine for about three days, and invisible traces of blood can be found in the urine a few days longer. The child will feel the urge to urinate frequently—but find it difficult to do so—for about the same length of time.

### *Adult infections*

In adults, the most frequently reported adenovirus infection is acute respiratory disease (ARD, caused by types 4 and 7) in military recruits. Influenza-like symptoms including fever, **sore throat**, runny nose, and **cough** are almost always present; weakness, chills, **headache**, and swollen lymph glands in the neck also may occur. The symptoms typically last three to five days.

Epidemic keratoconjunctivitis (EKC, caused by adenovirus types 8, 19, and 37) was first seen in shipyard workers whose eyes had been slightly injured by chips of rust or paint. This inflammation of tissues lining the eyelid and covering the front of the eyeball also can be caused by using contaminated contact lens solutions or by drying the hands or face with a towel used by someone who has this infection.

The inflamed, sticky eyelids characteristic of conjunctivitis develop 4–24 days after exposure and last between one and four weeks. Only 5–8% of patients with epidemic keratoconjunctivitis experience respiratory symptoms. One or both eyes may be affected. As symptoms of conjunctivitis subside, eye **pain** and watering and blurred vision develop. These symptoms of **keratitis** may last for several months, and about 10% of these infections spread to at least one other member of the patient's household.

Other illnesses associated with adenovirus include:

- encephalitis (inflammation of the brain) and other infections of the central nervous system (CNS)
- gastroenteritis (inflammation of the stomach and intestines)
- acute mesenteric lymphadenitis (inflammation of lymph glands in the abdomen)

## KEY TERMS

**Conjunctivitis**—Inflammation of the conjunctiva, the mucous membrane lining the inner surfaces of the eyelid and the front of the eyeball.

**Gastroenteritis**—An acute inflammation of the lining of the stomach and intestines, characterized by nausea, diarrhea, abdominal pain and weakness, which has various causes, including food poisoning due to infection with such organisms as *Escherichia coli*, *Staphylococcus aureus*, and *Salmonella* species, consumption of irritating food or drink, or psychological factors such as anger, stress, and fear.

**Virus**—A small infectious agent consisting of a core of genetic material (DNA or RNA) surrounded by a shell of protein.

- chronic interstitial fibrosis (abnormal growth of connective tissue between cells)
- intussusception (a type of intestinal obstruction)
- pneumonia that does not respond to antibiotic therapy
- whooping cough syndrome when *Bordetella pertussis* (the bacterium that causes classic whooping cough) is not found

### **Causes and symptoms**

Specific adenovirus infections can be traced to particular sources and produce distinctive symptoms. In general, however, adenovirus infection is caused by:

- inhaling airborne viruses
- getting the virus in the eyes by swimming in contaminated water, using contaminated eye solutions or instruments, wiping the eyes with contaminated towels, or rubbing the eyes with contaminated fingers.
- not washing the hands after using the bathroom, and then touching the mouth or eyes

Symptoms common to most types of adenovirus infections include:

- cough
- fever
- runny nose
- sore throat
- watery eyes

## Diagnosis

Although symptoms may suggest the presence of adenovirus, distinguishing these infections from other viruses can be difficult. A definitive diagnosis is based on culture or detection of the virus in eye secretions, sputum, urine, or stool.

The extent of infection can be estimated from the results of blood tests that measure increases in the quantity of antibodies the immune system produces to fight it. Antibody levels begin to rise about a week after infection occurs and remain elevated for about a year.

## Treatment

Treatment of adenovirus infections is usually supportive and aimed at relieving symptoms of the illness. Bed rest may be recommended along with medications to reduce fever and/or pain. (**Aspirin** should not be given to children because of concerns about Reye's syndrome.) Eye infections may benefit from topical **corticosteroids** to relieve symptoms and shorten the course of the disease. Hospitalization is usually required for severe pneumonia in infants and for EKC (to prevent blindness). No effective **antiviral drugs** have been developed.

## Prognosis

Adenovirus infections are rarely fatal. Most patients recover fully. Immunocompromised children have a greater chance of serious side effects and **death**, with fatality rates as high as 50–69% (depending on the cause and extent of **immunodeficiency**).

## Prevention

Practicing good personal hygiene and avoiding people with infectious illnesses can reduce the risk of developing adenovirus infection. Proper handwashing can prevent the spread of the virus by oral-fecal transmission. Sterilization of instruments and solutions used in the eye can prevent the spread of EKC, as can adequate chlorination of swimming pools.

A vaccine for pertussis has been developed and is in use in combination with **diphtheria** and **tetanus** vaccines for infants. It is shown to have nearly 90% efficacy. A vaccine containing live adenovirus types 4 and 7 is used to control disease in military recruits, but it is not recommended or available for civilian use. A recent resurgence of the adenovirus was found in a military population as soon as the **vaccination** program was halted. Vaccines

prepared from purified subunits of adenovirus are under investigation.

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## Adhesions

### Definition

Adhesions are fibrous bands of scar tissue that form between internal organs and tissues, joining them together abnormally.

### Description

Adhesions are made up of blood vessels and fibroblasts—connective tissue cells. They form as a normal part of the body's healing process and help to limit the spread of infection. However when adhesions cause the wrong tissues to grow into each other, many different complex inflammatory disorders can arise. Worldwide, millions of people suffer **pain** and dysfunction due to adhesion disease.

Depending on their location, the most common types of adhesions may called:

- abdominal adhesions
- intestinal adhesions
- intraperitoneal adhesions
- pelvic adhesions
- intrauterine adhesions or Asherman's syndrome.

Adhesions can form between various tissues in the body including:

- loops of the intestines

## KEY TERMS

**Asherman's syndrome**—The cessation of menstruation and/or infertility caused by intrauterine adhesions.

**Computed axial tomography; CT or CAT scan**—A computer reconstruction of scanned x rays used to diagnose intestinal obstructions.

**Endometriosis**—A condition in which the endometrial tissue that lines the uterus begins to invade other parts of the body.

**Endoscope**—A device with a light that is used to look into a body cavity or organ.

**Fibroblast**—A connective-tissue cell.

**Glaucoma**—A group of eye diseases characterized by increased pressure within the eye that can damage the optic nerve and cause gradual loss of vision.

**Hysteroscopy**—A procedure in which an endoscope is inserted through the cervix to view the cervix and uterus.

**Hysterosalpingography; HSG**—X ray of the uterus and fallopian tubes following the injection of a contrast dye.

**Irido corneal endothelial syndrome; ICE**—A type of glaucoma in which cells from the back of the cornea spread over the surface of the iris and tissue that drains the eye, forming adhesions that bind the iris to the cornea.

**Laparoscopic surgery; keyhole surgery**—Surgery that utilizes a laparoscope with a video camera and surgical instruments inserted through small incisions.

**Laparoscopy**—A procedure that utilizes an endoscope to view contents of the abdominal cavity.

**Pelvic inflammatory disease; PID**—Inflammation of the female reproductive organs and associated structures.

**Peritoneum**—The membrane lining the walls of the abdominal and pelvic cavities and enclosing their organs.

**Small bowel obstruction; SBO**—An obstruction of the small intestine that prevents the free passage of material; sometimes caused by postoperative adhesions.

- the intestines and other abdominal organs or the abdominal wall
- abdominal organs such as the liver or bladder and the abdominal wall
- tissues of the uterus

Although adhesions can be congenital (present at birth) or result from inflammation, injury, or infection, the vast majority of adhesions form following surgery. Adhesions are a major complication of many common surgical procedures and may occur in 55% to more than 90% of patients, depending on the type of surgery.

All abdominal surgeries carry the risk of adhesion formation. Abdominal adhesions are rare in people who have not had abdominal surgery and very common in people who have had multiple abdominal surgeries. Adhesions are more common following procedures involving the intestines, colon, appendix, or uterus. They are less common following surgeries involving the stomach, gall bladder, or pancreas. Although most abdominal adhesions do not cause problems, they can be painful when stretched or pulled because the scar tissue is not elastic.

Postoperative intestinal adhesions are a major cause of intestinal or small bowel obstruction (SBO). In a small number of people the scar tissue pulls sections of the small or large intestines out of place and partially or completely blocks the passage of food and fluids. Thus SBOs can result from abdominal surgery and also are one of the most common reasons for abdominal surgery. Although intestinal obstruction is fatal in about 5% of patients, the mortality rate associated with SBO has decreased dramatically over the past century.

Intrauterine adhesions are relatively common in women and the majority of women undergoing gynecological surgery develop postoperative adhesions. Sometimes these pelvic adhesions cause chronic pelvic pain and/or infertility.

Adhesions can cause a rare form of glaucoma called irido corneal endothelial (ICE) syndrome. In this disorder cells from the back surface of the cornea of the eye spread over the surface of the iris and the tissue that drains the eye, forming adhesions that bind the iris to the cornea and causing further blockage of the drainage channels. This blockage increases the pressure inside the eye, which may damage the optic nerve. ICE syndrome occurs most often in light-skinned females.

## Causes and symptoms

### *Post-surgical adhesions*

Common causes of postoperative adhesions include:

- abdominal surgery
- gynecological surgery
- thoracic surgery
- orthopedic surgery
- plastic surgery

Abdominal adhesions most often result from surgeries in which the organs are handled or temporarily moved. Intrauterine adhesions form after surgeries involving the uterus, particularly curettage—the scraping of the uterine contents. Surgery to control uterine bleeding after giving birth also can lead to intrauterine adhesions. Such adhesions can cause Asherman's syndrome, closing the uterus and preventing menstruation.

### *Other causes of adhesions*

Any inflammation or infection of the membranes that line the abdominal and pelvic walls and enclose the organs—the peritoneum—can cause adhesions. **Peritonitis**, a severe infection that can result from **appendicitis**, may lead to adhesions. In addition to surgery or injury, pelvic adhesions can be caused by inflammation resulting from an infection such as **pelvic inflammatory disease (PID)**.

### *Symptoms*

In the majority of people adhesions do not cause symptoms or serious problems. However in some people adhesions can lead to a variety of disorders. The symptoms depend on the type of adhesion and the tissues that are involved. Adhesions may cause pain and/or **fever** in some people.

**ABDOMINAL OBSTRUCTION.** If a loop of intestine becomes trapped under an adhesion, the intestine may become partially or completely blocked. The symptoms of intestinal obstruction or SBOs due to adhesions depend on the degree and location of the obstruction. Partial or off-and-on intestinal obstruction due to adhesions may result in intermittent periods of painful abdominal cramping and other symptoms, including **diarrhea**.

Symptoms of significant intestinal obstruction due to adhesions include:

- severe abdominal pain and cramping
- nausea and vomiting
- abdominal distension (swelling)

- constipation and the inability to pass gas

- symptoms of dehydration

Symptoms of **dehydration** include:

- dry mouth and tongue
- severe thirst
- infrequent urination
- dry skin
- fast heart rate
- low blood pressure

In about 10% of SBOs, part of the intestine twists tightly and repeatedly around a band of adhesions, cutting off the blood supply to the intestine and resulting in strangulation and **death** of the twisted bowel. The mortality rate for strangulation of the bowel may be as high as 37%.

Symptoms of bowel strangulation due to adhesions include:

- severe abdominal pain, either cramping or constant
- abdominal distension due to the inability to pass stool and gas
- an extremely tender abdomen
- signs of systemic (body-wide) illness, including fever, fast heart rate, and low blood pressure

When a portion of the obstructed bowel begins to die from lack of blood flow, fluids and bacteria that help digest food can leak out of the intestinal wall and into the abdominal cavity causing peritonitis.

**PELVIC ADHESIONS.** Pelvic adhesions can interfere with the functioning of the ovaries and fallopian tubes and are among the common causes of female infertility. Adhesions on the ovaries or fallopian tubes can prevent **pregnancy** by trapping the released egg. Adhesions resulting from **endometriosis** can cause pelvic pain, particularly during menstruation, as well as fertility problems.

## Diagnosis

Adhesions are diagnosed based on the symptoms, surgical history, and a **physical examination**. The physician examines the abdomen and rectum and performs a pelvic examination on women. Blood tests and chest and abdominal x rays are taken. Sometimes exploratory surgery is used to locate the adhesions and sources of pain.

Abdominal computed axial tomography—a CT or CAT scan—is the most common diagnostic tool for SBO and intestinal strangulation due to adhesions. In this procedure a computer reconstructs a portion of the abdomen from x-ray scans. Barium contrast x-ray

studies also may be used to locate an obstruction. The ingestion of a barium solution provides better visualization of the abdominal organs. However sometimes intestinal obstruction or strangulation cannot be confirmed without abdominal surgery.

Exploratory **laparoscopy** may be used to detect either abdominal or pelvic adhesions. This procedure usually is performed in a hospital under local or **general anesthesia**. A small incision is made near the naval and carbon dioxide gas is injected to raise the abdominal wall. A tube called a trocar is inserted into the abdomen. The laparoscope, equipped with a light and a small video camera, is passed through the trocar for visualization of the peritoneal cavity and the abdominal or pelvic organs.

Pelvic adhesions also may be detected by **hysteroscopy**. In this procedure a uterine endoscope is inserted through the cervix to visualize the cervix and uterine cavity. With **hysterosalpingography** (HSG) a radiopaque or contrast dye is injected through a catheter in the cervix and x rays are taken of the uterus and fallopian tubes.

## Treatment

Although the symptoms of adhesion disease sometimes disappear on their own, adhesions are permanent without a surgical procedure called adhesion lysis to disrupt or remove the tissue.

### *Abdominal adhesions*

Sometimes an adhesion-trapped intestine frees itself spontaneously. Surgery may be used to reposition the intestine to relieve symptoms. Various other techniques include using suction to decompress the intestine; however, untreated intestinal adhesions may lead to bowel obstruction.

Although dilation with an endoscope may be used to widen the region around an intestinal obstruction to relieve symptoms, SBOs caused almost always require immediate surgery. In cases of a partial obstruction or a complete obstruction without severe symptoms, surgery may be delayed for 12–24 hours so that a dehydrated patient can be treated with intravenous fluids. A small suction tube may be placed through the nose into the stomach to remove the stomach contents to relieve pain and **nausea** and prevent further bloating.

If an adhesion-related SBO disrupts the blood supply to part of the intestine, gangrene—tissue death—can occur. Strangulation of the bowel usually requires emergency abdominal surgery to remove the adhesions and restore blood flow to the intestine. Intestinal obstruction repair is performed under

general anesthesia. An incision is made in the abdomen, the obstruction is located, and the adhesions are cut away, releasing the intestine. The bowel is examined for injury or tissue death. If possible, injured and dead sections are removed and the healthy ends of the intestine are stitched together (resected). If resectioning is not possible, the ends of the intestine are brought through an opening in the abdomen called an **ostomy**.

In some cases laparoscopic surgery can be used to removed damaged portions of the intestines. Five or six small incisions—0.2–0.4 in. (5–10 mm) in length—are made in the abdomen. The laparoscope, equipped with its light and camera, and surgical instruments are inserted through the incisions. The laparoscope guides the surgeon by projecting images of the abdominal organs on a video monitor. However the existence of multiple adhesions may preclude the use of laparoscopic surgery.

### *Other types of adhesions*

Adhesions caused by endometriosis may be removed by either traditional open abdominal or pelvic surgery or by laparoscopic surgery. In the latter technique the laparoscope includes a laser for destroying the tissue with heat. Although untreated gynecological adhesions can lead to infertility, both types of surgeries also can result in adhesion formation.

ICE-type glaucoma caused by adhesions is difficult to treat; however untreated ICE syndrome can lead to blindness. Treatment usually includes medication and/or filtering surgery. Filtering microsurgery involves cutting a tiny hole in the white of the eye (the sclera) to allow fluid to drain, thereby lowering the pressure in the eye and preventing or reducing damage to the optic nerve.

## Alternative treatment

In cases where the intestines are partially blocked by adhesions, a diet low in fiber—called a low-residue diet—may enable food to move more easily through the obstruction.

## Prognosis

Intestinal obstruction surgery usually has a favorable outcome if the surgery is performed before tissue damage or death occurs. Surgery to remove adhesions and to free or reconnect the intestine often is sufficient for reducing symptoms and returning normal function to the intestine or other organ. However, the risk of new adhesion formation increases with each additional surgery. Thus abdominal adhesions can become

a recurring problem. Adhesions reform in 11–21% of patients who have surgery to remove an adhesion-related intestinal obstruction. The risk of recurrence is particularly high among survivors of bowel strangulation.

## Prevention

Abdominal and gynecological laparoscopic surgeries—also known as “keyhole” surgeries—reduce the size of the incision and the amount of contact with the organs, thereby lowering the risk of adhesion formation. Sometimes the intestines are fixed in place during surgery so as to promote benign adhesions that will not cause obstructions.

Within five days after surgery the disturbed tissue surfaces have formed a new lining of mesothelial cells that prevent adhesions from forming. Therefore biodegradable barrier membranes, films, gels, or sprays can be used to physically separate the tissues after surgery to prevent the formation of postoperative adhesions. However these gels and other barrier agents may:

- suppress the immune system
- cause infection
- impair healing

Systemic anti-inflammatory medications may be used to help prevent adhesion formation. Recent studies suggest that the common oral arthritis drug, Celebrex, an anti-inflammatory COX-2 inhibitor, taken before and immediately after surgery, may help prevent abdominal adhesions. Celebrex is known to inhibit both the formation of blood vessels and fibroblast activity, which are necessary for the formation of scar tissue.

Recent research has focused on the incorporation of anti-inflammatory and anti-proliferation drugs into polymeric films used for preventing and treating post-surgical adhesions. New types of gels to prevent post-operative adhesions also are under development.

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## ORGANIZATIONS

National Digestive Diseases Information Clearinghouse (NDDIC), 2 Information Way, Bethesda, MD, 20892-3570, (703) 738-4929, (800) 891-5389, <http://digestive.niddk.nih.gov>.

Margaret Alic Ph.D.

## Adjustment disorders

### Definition

Adjustment disorders (ADs) are a group of disorders in which a person’s psychological response to a stressor elicits symptoms that warrant clinical attention. This uniting feature of the adjustment disorders can manifest as emotional distress that exceeds what is an expected norm or by notable impairment of the person’s functioning in the world, socially, academically, and/or occupationally.

Ajustment disorders are considered subthreshold mental disorders, which means that they are less well defined and share some of their features with other diagnostic categories. This relative vagueness of definition allows for the classification of psychiatric conditions that are clinically significant but do not meet the full criteria for major syndromes. Another way of explaining adjustment disorders is that they are located on a continuum between normal **stress** reactions and specific psychiatric disorders.

### Demographics

Even though adjustment disorders are so commonly diagnosed, there have been few large-scale epidemiological studies targeting adjustment disorders. Adjustment disorder appears to be fairly common in

the American population; it is estimated that about 22% of adults seeking outpatient psychological treatment have one of the subtypes of this disorder. As many as 70% of children in psychiatric inpatient settings may be diagnosed with an adjustment disorder. In a questionnaire sent to child psychiatrists, 55% admitted to giving children the diagnosis of an adjustment disorder to avoid the stigma associated with other disorders.

There are no current studies of differences in the frequency of adjustment disorder in different racial or ethnic groups. There is, however, some potential for bias in diagnosis, particularly when the diagnostic criteria concern abnormal responses to stressors. The *DSM-IV-TR* specifies that clinicians must take a patient's cultural background into account when evaluating his or her responses to stressors. There is evidence that patients with average to higher-than-average incomes are more often diagnosed with AD than patients who lack socioeconomic stability or security.

## Description

Often, a person experiences a stressful event as one that changes his or her world in some fundamental way. An adjustment disorder represents significant difficulty in adjusting to the new reality. Subsets of this disorder make up the most frequent psychiatric diagnoses among mentally ill populations, with features that include diagnosis of adjustment disorder. This difficulty, according to some experts, lies in the presentation of disorders in the *Diagnostic and Statistical Manual of Mental Disorders-IV, Text Revision* (also known as the *DSM-IV-TR*) as a dichotomy between what happens in the mind and what occurs physically in the body. Research results increasingly support that the dichotomy may not be tenable.

The category of adjustment disorder first appeared in the revised third edition of DSM (*DSM-III-R*) and included nine subtypes. The current edition, the *DSM-IV-TR*, lists six subtypes of adjustment disorder, generally based on what feature best characterizes the person's symptoms. These six subtypes are: adjustment disorder with depressed mood (thought to be the most common subtype); AD with **anxiety**; AD with mixed anxiety and depressed mood; AD with disturbance of conduct; AD with disturbance of emotions and conduct; or adjustment disorder not otherwise specified (ADNOS). This last subtype is applied when one of the other five simply does not fit the manifestations.

The criteria for these disorders also include time parameters. One of the criteria for diagnosing an

adjustment disorder is that it is an acute response to stress lasting six or fewer months. In some special cases, the response can be chronic, lasting longer than six months, usually when the stressor has lasting consequences, such as divorce or **death** in the family.

The stressful events that precipitate an adjustment disorder vary widely. They may include the loss of a job; the end of a romantic relationship; a life transition such as a career change or retirement; the death of a pet; or a serious accident or sickness. Some are acute "one-time" stressors, such as relocating to a new area, while others are chronic, such as caring for a child with **mental retardation** or living in a crime-ridden neighborhood.

In spite of the disagreement among professionals about the validity of the diagnosis of adjustment disorder, many researchers consider the category useful for three reasons: (1) an adjustment disorder may be an early sign of a major mental disorder and allow for early treatment and intervention; (2) adjustment disorders are "situational" or "reactive" and do not imply that the patient has an underlying brain disease; and (3) the category does not carry the social stigma associated with such diagnostic categories as major depression; thus, it is less likely to affect the patient's employment or educational opportunities.

## Risk factors

Risk factors for adjustment disorders include:

- More than one stressful life event within a relatively short time period
- History of abusive parenting, family disruption, fetal alcohol syndrome, or frequent moves in early childhood
- Concurrent mental health problems
- Exposure to war or criminal violence
- Poverty, homelessness, or other difficult life circumstances
- Being socially isolated or lacking a family or friendship network

## Causes and symptoms

### Causes

The processes leading to disruption of an individual patient's ability to adapt to change are not well understood. In the initial edition of the *DSM-IV*, the identifiable stressor was described as being "psychosocial," a category that excludes physical illnesses and natural disasters. In the *DSM-IV-TR*, the word "psychosocial" was deleted to make the point that any stressful event can lead to an adjustment disorder. It

## KEY TERMS

**Cognitive-behavioral therapy**—An approach to psychotherapy that emphasizes the correction of distorted thinking patterns and changing one's behaviors accordingly.

**Decision tree**—A decision support model used in medical and psychiatric diagnosis that consists of a tree-like chart or diagram including various symptoms, tentative diagnoses, diagnostic decisions, and their possible consequences.

**Group therapy**—Group interaction designed to provide support, correction through feedback, constructive criticism, and a forum for consultation and reference.

**Interpersonal therapy**—An approach that includes psychoeducation about the sick role, and emphasis on the present and improving interpersonal dynamics and relationships. Interpersonal therapy is effective in treating adjustment disorders related to physical illness.

**Psychosocial**—A term that refers to the emotional and social aspects of psychological disorders.

**Solution-focused therapy**—A type of therapy that involves concrete goals and an emphasis on future direction rather than past experiences.

**Stressor**—A stimulus or event that provokes a stress response in an organism. Stressors can be categorized as acute or chronic, and as external or internal to the organism.

**Subthreshold**—A term used in psychiatry to describe a condition that has significant clinical features but does not meet the full criteria of major disorders. Adjustment disorders are considered subthreshold disorders.

**Support group**—A group whose primary purpose is the provision of empathy and emotional support for its members. Support groups are less formal and less goal-directed than group therapy.

is important to recognize, however, that while adjustment disorders are triggered by external stressors, the symptoms result from the person's interpretation of and adaptation to the stressful event or circumstances. Beliefs, perceptions, fears, and expectations influence the development of an adjustment disorder.

People with chronic physical illnesses appear to have an increased risk of developing adjustment disorders, particularly one with depressed mood. This connection has been demonstrated among **cancer** patients. The relationship between chronic **pain** (as is commonly experienced by cancer patients) and depressive symptoms is still being studied.

### Symptoms

Unlike many other disorders categorized in the *DMS-IV-TR*, adjustment disorders do not have an accompanying clearly delineated symptom profile, which has led to its being perceived as a "transitional" diagnosis, awaiting the manifestation of symptoms more clearly related to some other, better-defined disorder. This ambiguity arises from the difficulty in establishing what defines a reaction within the norms of a population. The *DSM-IV-TR* states that the symptoms of an adjustment disorder must appear within three months of a stressor; and that they must meet at least one of the following criteria: (1) the distress is greater than what would be expected in

response to that particular stressor; or (2) the patient experiences significant impairment in social relationships or in occupational or academic settings. Moreover, the symptoms cannot represent **bereavement**, as normally experienced after the death of a loved one and cannot be an exacerbation of another, preexisting disorder and does not meet the criteria for another disorder.

Each of the six subtypes of adjustment disorder is characterized by its own predominant symptoms:

- With depressed mood: The chief manifestations are feelings of sadness and depression, with a sense of accompanying hopelessness. The patient may be tearful and have uncontrollable bouts of crying.
- With anxiety: The patient is troubled by feelings of apprehension, nervousness, and worry. He or she may also feel jittery and unable to control his or her thoughts of doom. Children with this subtype may express fears of separation from parents or other significant people, and refuse to go to sleep alone or attend school.
- With mixed anxiety and depressed mood: The patient has a combination of symptoms from the previous two subtypes.
- With disturbance of conduct: This subtype involves such noticeable behavioral changes as shoplifting, truancy, reckless driving, aggressive outbursts, or sexual promiscuity. The patient disregards the rights

of others or previously followed rules of conduct with little concern, guilt or remorse.

- With mixed disturbance of emotions and conduct: The patient exhibits sudden changes in behavior combined with feelings of depression or anxiety. He or she may feel or express guilt about the behavior, but then repeat it shortly thereafter.
- AD not otherwise specified: This subtype covers patients who are adjusting poorly to stress but who do not fit into the other categories. These patients may complain of physical illness and pull away from social contact.

Adjustment disorders may lead to **suicide** or suicidal thinking. Researchers have also found that the suicidal process moves faster and evolves more rapidly in patients with adjustment disorders than in those with major depression. Adjustment disorders may also complicate the treatment of other diseases when, for instance, a sufferer loses interest in taking medication as prescribed or adhering to **diets** or **exercise** regimens.

An adjustment disorder can occur at any stage of life; however, the risk of an AD appears to increase during periods of life associated with major life changes, such as late adolescence, midlife, and retirement.

## Diagnosis

Adjustment disorders are almost always diagnosed as the result of an interview with a psychiatrist. The psychiatrist will take a history, including identification of the stressor that has triggered the adjustment disorder, and evaluate the patient's responses to the stressor. The patient's primary physician may give him or her a thorough **physical examination** to rule out a previously undiagnosed medical illness.

The American Psychiatric Association considers adjustment disorder to be a residual category, meaning that the diagnosis is given only when an individual does not meet the criteria for a major mental disorder. For example, if a person fits the more stringent criteria for major depressive disorder, the diagnosis of adjustment disorder is not given. If the patient is diagnosed with an adjustment disorder but continues to have symptoms for more than six months after the stressor and its consequences have ceased, the diagnosis is changed to another mental disorder. The one exception to this time limit is situations in which the stressor itself is chronic or has enduring consequences. In that case, the adjustment disorder would be considered chronic and the diagnosis could stand beyond six months.

The lack of a diagnostic checklist or decision tree for adjustment disorders distinguishes these disorders from either **post-traumatic stress disorder** or **acute stress disorder**. All three require the presence of a stressor, but the latter two define the extreme stressor and specific patterns of symptoms. With adjustment disorder, the stressor may be any event that is significant to the patient, and the disorder may take very different forms in different patients.

Adjustment disorders must also be distinguished from **personality disorders**, which are caused by enduring personality traits that are inflexible and cause social, interpersonal, and occupational impairment. A personality disorder that has not yet surfaced may be made worse by a stressor and may mimic an adjustment disorder. A clinician must separate relatively stable traits in a patient's personality from passing disturbances. In some cases, however, the patient may be given both diagnoses. Again, it is important for psychiatrists to be sensitive to the role of cultural factors in the presentation of the patient's symptoms.

If the stressor is a physical illness, diagnosis is further complicated. It is important to recognize the difference between an adjustment disorder and the direct physiological effects of a general medical condition (e.g. the usual temporary functional impairment associated with **chemotherapy**). This distinction can be clarified through communication with the patient's physician or by education about the medical condition and its treatment. For some individuals, however, both may occur and reinforce each other.

## Examination

An office physical examination of a patient with an adjustment disorder will not usually lead to any significant findings unless the patient is suffering from a concurrent physical illness or injury.

## Tests

There are no laboratory or imaging tests that can be used to diagnose adjustment disorder.

## Treatment

### Traditional

There have been few research studies of significant scope to compare the efficacy of different treatments for adjustment disorder. The relative lack of outcome studies is partially due to the lack of specificity in the diagnosis itself. Because there is such variability in the types of stressors involved in adjustment disorders, it has proven difficult to design effective studies. As a

result, there is no consensus regarding the most effective treatments for adjustment disorder.

There are, however, guidelines for effective treatment of people with adjustment disorders. Effective treatments include stress-reduction approaches; therapies that teach coping strategies for stressors that cannot be reduced or removed; and those that help patients build support networks of friends, family, and people in similar circumstances. Psychodynamic **psychotherapy** may be helpful in clarifying and interpreting the meaning of the stressor for a particular patient. For example, if the person has cancer, he or she may become more dependent on others, which may be threatening for people who place a high value on self-sufficiency. By exploring those feelings, the patient can then begin to recognize all that is not lost and regain a sense of self-worth.

Therapies that encourage the patient to express the fear, anxiety, rage, helplessness, and hopelessness of dealing with the stressful situation may be helpful. These approaches include journaling, certain types of **art therapy**, and movement or dance therapy. Support groups and **group therapy** allow patients to gain perspective on the adversity and establish relationships with others who share their problem. Psychoeducation and medical crisis counseling can assist individuals and families facing stress caused by a medical illness.

Such types of brief therapy as **family therapy**, **cognitive-behavioral therapy**, solution-focused therapy, and interpersonal therapy have all met with some success in treating adjustment disorder.

### Drugs

Clinicians do not agree on the role of medications in treating adjustment disorder. Some argue that medication is not necessary for adjustment disorders because of their brief duration. In addition, they maintain that medications may be counterproductive by undercutting the patient's sense of responsibility and his or her motivation to find effective solutions. At the other end of the spectrum, other clinicians maintain that medication by itself is the best form of treatment, particularly for patients with medical conditions, those who are terminally ill, and those resistant to psychotherapy. Others advocate a middle ground of treatment that combines medication and psychotherapy.

### Alternative

Spiritual and religious counseling can be helpful, particularly for people coping with existential issues related to physical illness or with moral conflicts

related to difficult personal decisions (divorce, abortion, withdrawing **life support** from a dying family member, etc.).

Some herbal remedies appear to be helpful to some patients with adjustment disorders. For adjustment disorder with anxiety, a randomized controlled trial found that the 91 patients receiving Euphytose (an herbal preparation containing a combination of plant extracts including Crataegus, Ballota, Passiflora, Valeriana, Cola, and Paullinia) showed significant improvement over the 91 patients taking a placebo. There have been no reported follow-up studies confirming these findings.

### Prognosis

Most adults who are diagnosed with adjustment disorder have a favorable prognosis. For most people, an adjustment disorder is temporary and will either resolve by itself or respond to treatment. For some, however, the stressor will remain chronic and the symptoms may worsen. In addition, patients with adjustment disorders engage in deliberate self-harm at a rate that surpasses most other mental disorders. They may also be at an increased risk for future **substance abuse** disorders. Still other patients may develop a major depressive disorder even in the absence of an additional stressor.

Studies have been conducted to follow up on patients five years after their initial diagnosis. At that time, 71% of adults were completely well with no residual symptoms, while 21% had developed a major depressive disorder or **alcoholism**. For children aged 8–13, adjustment disorder did not predict future psychiatric disturbances. For adolescents, however, the prognosis is more grim. After five years, 43% had developed a major psychiatric disorder, often of far greater severity. These disorders included **schizophrenia**, **schizoaffective disorder**, major depression, substance use disorders, or personality disorders. In contrast with adults, the adolescents' behavioral symptoms and the type of adjustment disorder predicted future mental disorders.

Researchers have noted that once an adjustment disorder is diagnosed, psychotherapy, medication, or both can prevent the development of a more serious mental disorder. Effective treatment is critical, as adjustment disorder is associated with an increased risk of suicide attempts, completed suicide, substance abuse, and various unexplained physical complaints. Patients with chronic stressors may require ongoing treatment for continued symptom management. While patients may not become symptom-free,

treatment can halt the progression toward a more serious mental disorder by enhancing the patient's ability to cope.

## Prevention

In many cases, there is little possibility of preventing the stressors that trigger adjustment disorders. One preventive strategy that is helpful to many patients, however, is learning to be proactive in managing ordinary life stress, and maximizing problem-solving abilities when they are not in crisis. In addition, the general availability of counseling following a large-scale stressful event may ameliorate some stress responses.

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## ORGANIZATIONS

- American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209-3901 703-907-7300, [apa@psych.org](mailto:apa@psych.org), <http://www.psych.org/>.
- National Alliance on Mental Illness (NAMI), 2107 Wilson Blvd., Suite 300, Arlington, VA, 22201-3042 703-524-7600 Hotline: 800-950-NAMI (6264) 703-524-9094, <http://www.nami.org/Hometemplate.cfm>.
- National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD, 20892-9663 301-443-4513 866-615-6464 301-443-4279, [nimhinfo@nih.gov](mailto:nimhinfo@nih.gov), <http://www.nimh.nih.gov/index.shtml>.

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## Adrenal gland cancer

### Definition

Adrenal gland cancers are rare cancers occurring in the endocrine tissue of the adrenals. They are characterized by overproduction of adrenal gland hormones. Tumors that arise from the adrenal cortex are termed adrenocortical carcinoma while tumors that develop in the adrenal medulla are known as pheochromocytomas.

### Demographics

Cancers of the adrenal gland are very rare. The estimated annual incidence of adrenocortical carcinoma in the United States is 1 case in 1 million people. However, incidence of this type of **cancer** is 10 times higher in children in southern Brazil. This higher incidence rate is linked to a combination of environmental and genetic risk factors. Pheochromocytomas are also rare tumors.

### Description

The adrenal gland is a hormone-producing endocrine gland with two main parts, the cortex and the medulla. The main hormone of the adrenal cortex is cortisol and the main hormone of the adrenal medulla is epinephrine. When tumors develop in the adrenal gland, they secrete excess amounts of these hormones. A cancer that arises in the adrenal cortex is called

an adrenocortical carcinoma and can produce high blood pressure, weight gain, excess body hair, weakening of the bones and diabetes. Although rare, adrenocortical carcinomas are aggressive cancers that are typically diagnosed in later stages of advanced disease.

A cancer in the adrenal medulla is called a **pheochromocytoma** and can cause high blood pressure, **headache**, **palpitations**, and excessive perspiration.

There is a bimodal incidence pattern related to adrenocortical carcinoma with one incidence peak occurring prior to age five and a second peak manifesting between the fourth and fifth decades. The average age at diagnosis for pheochromocytoma in one report of more than 199 patients diagnosed with the disease was 47 years.

### Risk factors

Although the specific causes of adrenal gland cancers are not known some cases of adrenocortical carcinomas have been linked to several hereditary cancer syndromes such as:

- Li-Fraumeni syndrome
- Beckwith-Wiedemann syndrome
- Multiple Endocrine Neoplasia type 1 (MEN1)
- SBLA (sarcoma, breast cancer, lung cancer, adrenocortical carcinoma) syndrome

Some cases of pheochromocytoma are also associated with hereditary cancer syndromes such as multiple endocrine neoplasia type 2 (MEN2) and von Hippel-Lindau disease.

### Causes and symptoms

It is not known what causes most cases of adrenal gland cancer, but some cases are associated with hereditary or familial syndromes. Symptoms of adrenal cancer are related to the specific hormones produced by that tumor. An adrenocortical carcinoma typically secretes high amounts of cortisol, producing **Cushing's syndrome**. This syndrome produces progressive weight gain, rounding of the face, and increased blood pressure. These symptoms usually develop very quickly often within a span of three to six months. Women can experience menstrual cycle alterations and men can experience feminization, although this is a rare occurrence (less than 10% in men.)

The symptoms of pheochromocytoma include **hypertension**, although 5–15% of patients may have normal blood pressure; headache; generalized sweating; heart palpitations; and weakness. Because of

### KEY TERMS

**Cortisol**—A hormone produced by the adrenal cortex. It is partially responsible for regulating blood sugar levels.

**Diabetes**—A disease characterized by low blood sugar.

**Epinephrine**—A hormone produced by the adrenal medulla. It is important in the response to stress and partially regulates heart rate and metabolism. It is also called adrenaline.

**Laparoscopy**—The insertion of a tube through the abdominal wall. It can be used to visualize the inside of the abdomen and for surgical procedures.

the hormones produced by this type of tumor, **anxiety** and panic attack-type symptoms are often present as well.

### Diagnosis

#### Tests

Diagnosis of adrenal cancer usually begins with blood tests to evaluate the hormone levels. Specific tests used to diagnosis adrenocortical carcinoma include evaluation of blood tests such as **fasting** blood glucose, serum potassium, fasting serum cortisol, serum estradiol, estrone, and adrenal androgens. A urine test that requires a 24-hour collection of urine, the 24-hour urinary free cortisol test, may also be ordered. Radiographic studies used to diagnose the tumor include computed tomography (CT) scans; **magnetic resonance imaging** (MRI); and, if a malignancy is suspected, **PET** scanning with fluorodeoxyglucose (FDG). Adrenocortical tumors of the adrenal gland tend to metastasize to the liver, lungs, lymph nodes and bones. These areas will be evaluated by radiographic imaging scans.

There is no consensus as to the best test to diagnosis pheochromocytoma. Some clinicians advocate the best approach to testing should be based upon the patient's clinical presentation and should include 24-hour urine collection to determine catecholamine (dopamine, norepinephrine, and epinephrine) and metanephrines (metanephrine and normetanephrine) levels and the plasma fractionated metanephrine test. Once the tumor has been confirmed using biochemical tests, radiologic tests such as CT and MRI to locate the tumor should be employed. Other radiologic tests used to support the

biochemical evidence of pheochromocytoma include 123-I-metiodobenzylguanidine (MIBG) scans, which can detect tumors not detected by CT or MRI, and other scans such as total body MRI and PET scanning.

### **Procedures**

Fine-needle aspiration biopsy to obtain specimen from the suspected adrenal tumor may also be performed as part of the diagnostic evaluation.

### **Treatment**

#### *Traditional*

When possible, total surgical removal (resection) of the adrenal gland is the recommended treatment for adrenocortical carcinoma. However, recurrent disease (nearly 80% of cases) is common even after total resection. Open laparotomy for **adrenalectomy** (removal of the adrenal gland) is the current standard of care. Removal of small tumors in which there is no evidence of metastasis may be accomplished by laparoscopic resection.

**Radiation therapy** may be used in patients at high risk for local recurrence and for palliative management of adrenocortical tumors that have metastasized to the bone or brain.

#### **Drugs**

The drug mitotane (Lysodren) remains the major chemotherapeutic option for the primary and adjuvant treatment of adrenocortical carcinoma. This drug is also used to treat recurrent or relapsed disease. Mitotane can be used to treat inoperable adrenocortical cancers as well. Other **chemotherapy** agents that may be used include streptozotocin, in combination with mitotane, and cisplatin-based chemotherapy when treatment with mitotane fails.

The recommended treatment of malignant pheochromocytoma also includes surgical removal. However, patients with malignant pheochromocytoma require pre-surgical medical management prior to surgery to control blood pressure and tachycardia. Typically, patients are ready for surgery 10-14 days after starting alpha- and beta-adrenergic blockade therapy. Surgery to remove this type of tumor is considered to be a high risk surgical procedure and should be attempted only by an experienced surgeon and surgical team. Surgery to remove the tumor can be accomplished by the laparoscopic approach if there is only one tumor and if the tumor is less than 8 cm in diameter. The goal of surgery is to remove as much tumor as possible. Open adrenalectomy may

be required if the tumor is large or if it has metastasized.

If the pheochromocytoma is considered to be aggressive, combination chemotherapy may be initiated with the drugs cyclophosphamide, vincristine, and dacarbazine.

### **Prognosis**

The prognosis for adrenal gland cancer is variable. For localized pheochromocytomas the five-year survival rate approaches 95%. This rate decreases with aggressive tumors that have metastasized. The overall five-year survival rate is less than 50% after surgical removal of the tumor. However, some patients have achieved prolonged survival. Disease recurrence is more likely in patients with familial pheochromocytoma.

For adrenocortical cancer, the five-year survival rate is highly dependent upon the stage of the disease at the time of diagnosis. Overall, the five-year survival estimates for adrenocortical carcinoma are 20-35%. The presence of distant metastasis significantly diminishes survival rates; about 50% of patients with metastasis die within 12 months regardless of treatment.

### **Prevention**

Since little is known about the cause of adrenal gland cancer, it is not known if it can be prevented. Individuals at high risk because of familial or hereditary syndromes associated with the development of these cancers should speak with their physicians about recommendations related to screening for and early detection of the cancer.

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Adrenal gland removal see **Adrenalectomy**

## Adrenal gland scan

### Definition

The adrenal gland scan is a nuclear medicine evaluation of the medulla (inner tissue) of the adrenal gland.

### Purpose

The adrenal glands are a pair of small organs located just above the kidney, which contain two types of tissue. The adrenal cortex produces hormones that affect water balance and metabolism in the body. The adrenal medulla produces adrenaline and noradrenaline (also called epinephrine and norepinephrine).

An adrenal gland scan is done when too much adrenaline and noradrenaline is produced in the body and a tumor in the adrenal gland is suspected. One such situation in which a tumor might be suspected is when high blood pressure (**hypertension**) does not respond to medication. Tumors that secrete adrenaline and noradrenaline can also be found outside the adrenal gland. An adrenal gland scan usually covers the abdomen, chest, and head.

### Precautions

Adrenal gland scans are not recommended for pregnant women because of the potential harm to the developing fetus. A pregnant woman should discuss with her doctor the risks of the procedure against the benefits of the information it can provide in evaluating her individual medical situation.

People who have recently undergone tests that use barium must wait until the barium has been eliminated from their system in order to obtain accurate results from the adrenal gland scan.

### Description

The adrenal gland scan takes several days. On the first day, a radiopharmaceutical is injected intravenously into the patient. On the second, third, and fourth day the patient is positioned under the camera for imaging. The scanning time each day takes approximately 30 minutes. It is essential that the patient remain still during imaging.

Occasionally, the scanning process may involve fewer than three days, or it may continue several days longer. The area scanned extends from the pelvis and lower abdomen to the lower chest. Sometimes the upper legs, thighs, and head are also included.

### Preparation

For two days before and ten days after the injection of the radiopharmaceutical, patients are given

## KEY TERMS

**Adrenal cortex**—The outer tissue of the adrenal gland. It produces a group of chemically related hormones called corticosteroids that control mineral and water balance in the body and include aldosterone and cortisol.

**Adrenal medulla**—The inner tissue of the adrenal gland. It produces the hormones adrenaline and noradrenaline.

**Lugol's solution**—A strong iodine solution.

either Lugol's solution or potassium iodine. This prevents the thyroid from taking up radioactive iodine and interfering with the scan.

### Aftercare

The patient should not feel any adverse effects of the test and can resume normal activity immediately. Follow-up tests that might be ordered include a nuclear scan of the bones or kidney, a computed tomography scan (CT) of the adrenals, or an ultrasound of the pelvic area.

### Risks

The main risk associated with this test is to the fetus of a pregnant woman.

### Normal results

Normal results will show no unusual areas of hormone secretion and no tumors.

### Abnormal results

Abnormal results will show evidence of a tumor where there is excessive secretion of adrenaline or noradrenaline. More than 90% of these tumors are in the abdomen.

### Resources

#### BOOKS

Fishback, Francis, ed. *A Manual of Laboratory and Diagnostic Tests*. 8th ed. Philadelphia: Lippincott Williams & Wilkins, 2008.

Tish Davidson A.M.

Adrenal hypofunction see **Addison's disease**

Adrenal insufficiency see **Addison's disease**

## Adrenal virilism

### Definition

Adrenal virilism is the development or premature development of male secondary sexual characteristics caused by male sex hormones (androgens) excessively produced by the adrenal gland. This disorder can occur before birth and can lead to sexual abnormalities in newborns. It can also occur in girls and women later in life.

### Description

In the normal human body, there are two adrenal glands. They are small structures that lie on top of the kidneys. The adrenal glands produce many hormones that regulate body functions. These hormones include androgens, or male hormones. Androgens are produced in normal girls and women. Sometimes, one or both of the adrenal glands becomes enlarged or overactive, producing more than the usual amount of androgens. The excess androgens create masculine characteristics.

### Causes and symptoms

In infants and children, adrenal virilism is usually the result of adrenal gland enlargement that is present at birth. This is called **congenital adrenal hyperplasia**. The cause is usually a genetic problem that leads to severe enzyme deficiencies. In rare cases, adrenal virilism is caused by an adrenal gland tumor. The tumor can be benign (adrenal adenoma) or cancerous (adrenal carcinoma). Sometimes virilism is caused by a type of tumor on a woman's ovary (arrhenoblastoma).

Newborn girls with adrenal virilism have external sex organs that seem to be a mixture of male and female organs (called female pseudohermaphroditism). Newborn boys with the disorder have enlarged external sex organs, and these organs develop at an abnormally rapid pace.

Children with congenital adrenal hyperplasia begin growing abnormally fast, but they stop growing earlier than normal. Later in childhood, they are typically shorter than normal but have well-developed trunks.

Women with adrenal virilization may develop facial hair. Typically, their menstrual cycles are infrequent or absent. They may also develop a deeper voice, a more prominent Adam's apple, and other masculine signs.

### Diagnosis

Endocrinologists, doctors who specialize in the diagnosis and treatment of glandular disorders, have

### KEY TERMS

**Glucocorticoid**—A hormone produced by the adrenal gland; this hormone leads to an increase in blood sugar and creation of sugar molecules by the liver.

**Hydrocortisone**—A hormone in the group of glucocorticoid hormones.

**Prednisone**—A drug that functions as a glucocorticoid hormone.

the most expertise to deal with adrenal virilization. Some doctors who treat disorders of the internal organs (internists) and doctors who specialize in treating the reproductive system of women (gynecologists) may also be able to help patients with this disorder.

Diagnosis involves performing many laboratory tests on blood samples from the patient. These tests measure the concentration of different hormones. Different abnormalities of the adrenal gland produce a different pattern of hormonal abnormalities. These tests can also help determine if the problem is adrenal or ovarian. If a tumor is suspected, special x rays may be done to visualize the tumor in the body. Final diagnosis may depend on obtaining a tissue sample from the tumor (biopsy), and examining it under a microscope in order to verify its characteristics.

### Treatment

Adrenal virilism caused by adrenal hyperplasia is treated with daily doses of a glucocorticoid. Usually prednisone is the drug of choice, but in infants hydrocortisone is usually given. Laboratory tests are usually needed from time to time to adjust the dosage. Girls with pseudohermaphroditism may require surgery to make their external sex organs appear more normal. If a tumor is causing the disorder, the treatment will depend on the type and location of the tumor. Information about the tumor cell type and the spread of the tumor is used to decide the best kind of treatment for a particular patient. If the tumor is cancerous, the patient will require special treatment depending on how far the **cancer** has advanced. Treatment can be a combination of surgery, medications used to kill cancer cells (**chemotherapy**), and x rays or other high energy rays used to kill cancer cells (**radiation therapy**). Sometimes the doctor must remove the adrenal gland and the surrounding tissues. If the tumor is benign, then surgically removing the tumor may be the best option.

## Prognosis

Ongoing glucocorticoid treatment usually controls adrenal virilism in cases of adrenal hyperplasia, but there is no cure. If a cancerous tumor has caused the disorder, patients have a better prognosis if they have an early stage of cancer that is diagnosed quickly and has not spread.

## Resources

### PERIODICALS

Willensy, D. "The Endocrine System." *American Health* April 1996: 92-3.

### OTHER

Medline Plus: The Endocrine System. <http://www.nlm.nih.gov/medlineplus/endocrinesystem.html>.

Richard H. Lampert

## KEY TERMS

**Laparoscope**—An instrument that enables the surgeon to see inside the abdominal cavity by means of a thin tube that carries an image to a television monitor.

**Pancreas**—An organ that secretes a number of digestive hormones and also secretes insulin to regulate blood sugar.

**Pheochromocytoma**—A tumor of specialized cells of the adrenal gland.

**Spleen**—An organ that traps and breaks down red blood cells at the end of their useful life and manufactures some key substances used by the immune system.

**Vena cava**—The large vein that drains directly into the heart after gathering incoming blood from the entire body.

## Adrenalectomy

### Definition

Adrenalectomy is the surgical removal of one or both of the adrenal glands. The adrenal glands are paired endocrine glands, one located above each kidney, that produce hormones such as epinephrine, norepinephrine, androgens, estrogens, aldosterone, and cortisol. Adrenalectomy is usually performed by conventional (open) surgery, but in selected patients surgeons may use **laparoscopy**. With laparoscopy, adrenalectomy can be accomplished through four very small incisions.

### Purpose

Adrenalectomy is usually advised for patients with tumors of the adrenal glands. Adrenal gland tumors may be malignant or benign, but all typically excrete excessive amounts of one or more hormones. A successful procedure will aid in correcting hormone imbalances, and may also remove cancerous tumors that can invade other parts of the body. Occasionally, adrenalectomy may be recommended when hormones produced by the adrenal glands aggravate another condition such as **breast cancer**.

### Precautions

The adrenal glands are fed by numerous blood vessels, so surgeons need to be alert to extensive bleeding during surgery. In addition, the adrenal glands lie close to one of the body's major blood vessels (the

vena cava), and to the spleen and the pancreas. The surgeon needs to remove the gland(s) without damaging any of these important and delicate organs.

### Description

#### *Open adrenalectomy*

The surgeon may operate from any of four directions, depending on the exact problem and the patient's body type.

In the anterior approach, the surgeon cuts into the abdominal wall. Usually the incision will be horizontal, just under the rib cage. If the surgeon intends to operate on only one of the adrenal glands, the incision will run under just the right or the left side of the rib cage. Sometimes a vertical incision in the middle of the abdomen provides a better approach, especially if both adrenal glands are involved.

In the posterior approach, the surgeon cuts into the back, just beneath the rib cage. If both glands are to be removed, an incision is made on each side of the body. This approach is the most direct route to the adrenal glands, but it does not provide quite as clear a view of the surrounding structures as the anterior approach.

In the flank approach, the surgeon cuts into the patient's side. This is particularly useful in massively obese patients. If both glands need to be removed, the surgeon must remove one gland, repair the surgical wound, turn the patient onto the other side, and repeat the entire process.

The last approach involves an incision into the chest cavity, either with or without part of the incision into the abdominal cavity. It is used when the surgeon anticipates a very large tumor, or if the surgeon needs to examine or remove nearby structures as well.

### Laparoscopic adrenalectomy

This technique does not require the surgeon to open the body cavity. Instead, four small incisions (about 1/2 in diameter each) are made into a patient's flank, just under the rib cage. A laparoscope, which enables the surgeon to visualize the inside of the abdominal cavity on a television monitor, is placed through one of the incisions. The other incisions are for tubes that carry miniaturized versions of surgical tools. These tools are designed to be operated by manipulations that the surgeon makes outside the body.

### Preparation

Most aspects of preparation are the same as in other major operations. In addition, hormone imbalances are often a major challenge. Whenever possible, physicians will try to correct hormone imbalances through medication in the days or weeks before surgery. Adrenal tumors may cause other problems such as **hypertension** or inadequate potassium in the blood, and these problems also should be resolved if possible before surgery is performed. Therefore, a patient may take specific medicines for days or weeks before surgery.

Most adrenal tumors can be imaged very well with a CT scan or MRI, and benign tumors tend to look different on these tests than do cancerous tumors. Surgeons may order a CT scan, MRI, or scintigraphy (viewing of the location of a tiny amount of radioactive agent) to help locate exactly where the tumor is.

The day before surgery, patients will probably have an enema to clear the bowels. In patients with lung problems or clotting problems, physicians may advise special preparations.

### Aftercare

Patients stay in the hospital for various lengths of time after adrenalectomy. The longest hospital stays are required for open surgery using an anterior approach; hospital stays of about three days are indicated for open surgery using the posterior approach or for laparoscopic adrenalectomy.

The special concern after adrenalectomy is the patient's hormone balance. There may be several sets of lab tests to define hormone problems and monitor the results of drug treatment. In addition, blood

pressure problems and infections are more common after removal of certain types of adrenal tumors.

As with most open surgery, surgeons are also concerned about **blood clots** forming in the legs and traveling to the lungs (venous thromboembolism), bowel problems, and postoperative **pain**. With laparoscopic adrenalectomy, these problems are somewhat less difficult, but they are still present.

### Risks

The special risks of adrenalectomy involve major hormone imbalances, caused by the underlying disease, the surgery, or both. These can include problems with wound healing itself, blood pressure fluctuations, and other metabolic problems.

Other risks are typical of many operations. These include:

- bleeding
- damage to adjacent organs (spleen, pancreas)
- loss of bowel function
- blood clots in the lungs
- lung problems
- surgical infections
- pain
- extensive scarring

### Resources

#### BOOKS

Sippel, Rebecca S. "Endocrine Surgery" In Chen, Herbert. *Illustrative Handbook of General Surgery*. New York: Springer, 2010.

Richard H. Lampert

Adrenocortical insufficiency see **Addison's disease**

## Adrenocorticotrophic hormone test

### Definition

Adrenocorticotrophic hormone test (also known as an ACTH test or a corticotropin test) measures pituitary gland function.

## KEY TERMS

**Adrenal glands**—A pair of endocrine glands that lie on top of the kidneys.

**Pituitary gland**—The most important of the endocrine glands, glands that release hormones directly into the bloodstream; sometimes called the master gland.

### Purpose

The pituitary gland produces the hormone ACTH, which stimulates the outer layer of the adrenal gland (the adrenal cortex). ACTH causes the release of the hormones hydrocortisone (cortisol), aldosterone, and androgen. The most important of these hormones released is cortisol. The ACTH test is used to determine if too much cortisol is being produced (**Cushing's syndrome**) or if not enough cortisol is being produced (**Addison's disease**).

### Precautions

ACTH has diurnal variation, meaning that the levels of this hormone vary according to the time of day. The highest levels occur in the morning hours. Testing for normal secretion, as well as for Cushing's disease, may require multiple samples. For sequential follow-up, a blood sample analyzed for ACTH should always be drawn at the same time each day.

ACTH can be directly measured by an analyzing method (immunoassay) in many large laboratories. However, smaller laboratories are usually not equipped to perform this test and they may need to send the blood sample to a larger laboratory. Because of this delay, results may take several days to obtain.

### Description

ACTH production is partly controlled by an area in the center of the brain (the hypothalamus) and partly controlled by the level of cortisol in the blood. When ACTH levels are too high, cortisol production increases to suppress ACTH release from the pituitary gland. If ACTH levels are too low, the hypothalamus produces corticotropin-releasing hormone (CRH) to stimulate the pituitary gland to make more ACTH. ACTH levels rise in response to **stress**, emotions, injury, infection, **burns**, surgery, and decreased blood pressure.

### Cushing's syndrome

Cushing's syndrome is caused by an abnormally high level of circulating hydrocortisone. The high level may be the result of an adrenal gland tumor or enlargement of both adrenal glands due to a pituitary tumor. The high level of hydrocortisone may be the result of taking corticosteroid drugs for a long time. Corticosteroid drugs are widely used for inflammation in disorders like **rheumatoid arthritis**, inflammatory bowel disease, and **asthma**.

### Addison's disease

Addison's disease is a rare disorder in which symptoms are caused by a deficiency of hydrocortisone and aldosterone. The most common cause of this disease is an autoimmune disorder. The immune system normally fights foreign invaders in the body like bacteria. In an autoimmune disorder, the immune system attacks the body. In this case, the immune system produces antibodies that attack the adrenal glands. Addison's disease generally progresses slowly, with symptoms developing gradually over months or years. However, acute episodes, called Addisonian crises, are brought on by infection, injury, or other stresses. Diagnosis is generally made if the patient fails to respond to an injection of ACTH, which normally stimulates the secretion of hydrocortisone.

### Preparation

A person's ACTH level is determined from a blood sample. The patient must fast from midnight until the test the next morning. This means that the patient cannot eat or drink anything after midnight except water. The patient must also avoid radioisotope scanning tests or recently administered radioisotopes prior to the blood test.

### Risks

The risks associated with this test are minimal. They may include slight bleeding from the location where the blood was drawn. The patient may feel faint or lightheaded after the blood is drawn. Sometimes the patient may have an accumulation of blood under the puncture site (hematoma) after the test.

### Normal results

Each laboratory will have its own set of normal values for this test. The normal values can range from: Morning (4–8 a.m.) 8–100 pg/mL or 10–80 ng/L (SI units); Evening (8–10 p.m.) less than 50 pg/mL or less than 50 ng/L (SI units).

## Abnormal results

In Cushing's syndrome, high levels of ACTH may be caused by ACTH-producing tumors. These tumors may be either in the pituitary or in another area (like tumors from lung **cancer** or **ovarian cancer**). Low ACTH levels may be caused by adrenal enlargement due to high levels of cortisol and feedback to the pituitary.

In Addison's disease, high levels of ACTH may be caused by adrenal gland diseases. These diseases decrease adrenal hormones and the pituitary attempts to increase functioning. Low levels of ACTH may occur because of decreased pituitary function.

## Resources

### BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Janis O. Flores

Adrenogenital syndrome see **Adrenal virilism**

## KEY TERMS

**Amniocentesis**—The collection of amniotic fluid through a needle inserted through the abdomen. Used to collect fetal cells for genetic analysis.

**Ataxia**—Loss of coordination of muscular movement.

**Hypertonia**—Having excessive muscular tone.

**Myelin**—A layer that encloses nerve cells and some axons and is made largely of lipids and lipoproteins.

**Neuropathy**—A disease or abnormality of the peripheral nerves.

coordination, **fatigue**, increased skin pigmentation, and progressive **dementia**.

The adult-onset form of the disease, also called adrenomyeloneuropathy, is milder, progresses slowly, is usually associated with a normal life span, and usually appears between ages 21–35. Symptoms may include progressive stiffness, weakness, or **paralysis** of the lower limbs and loss of coordination. Brain function deterioration may also be seen. Women who are carriers of the disease occasionally experience the same symptoms, as well as others, including ataxia, hypertonia (excessive muscle tone), mild **peripheral neuropathy**, and urinary problems. The neonatal form affects both male and female infants and may produce **mental retardation**, facial abnormalities, seizures, retinal degeneration, poor muscle tone, enlarged liver, and adrenal dysfunction. Neonatal ALD usually progresses rapidly.

## Causes and symptoms

The genetic defect in ALD causes a decrease in the ability to degrade very long chain fatty acids. These build up in the adrenal glands, brain, plasma, and fibroblasts. The build-up of very long chain fatty acids interferes with the ability of the adrenal gland to convert cholesterol into **steroids** and causes demyelination of nerves in the white matter of the brain. Demyelinated nerve cells are unable to function properly.

## Diagnosis

Diagnosis is made based on observed symptoms, a biochemical test, and a family history. The biochemical test detects elevated levels of very long chain fatty acids in samples from **amniocentesis**, chorionic villi,

plasma, red blood cells, or fibroblasts. A family history may indicate the likelihood of ALD because the disease is carried on the X-chromosome by the female lineage of families.

### Treatment

Treatment for all forms of ALD consists of treating the symptoms and supporting the patient with **physical therapy**, psychological counseling, and special education in some cases. There is no cure for this disease, and there are no drugs that can reverse demyelination of nerve and brain cells. Dietary measures consist of reducing the intake of foods high in fat, which are a source of very long chain fatty acids. A mixture called Lorenzo's Oil has been shown to reduce the level of long chain fatty acids if used long term; however, the rate of myelin loss is unaffected. Experimental **bone marrow transplantation** has not been very effective.

### Prognosis

Prognosis for childhood and neonatal ALD patients is poor because of the progressive myelin degeneration. Death usually occurs between one and ten years after onset of symptoms.

### Prevention

Since ALD is a genetic disease, prevention is largely limited to **genetic counseling** and fetal monitoring through amniocentesis or **chorionic villus sampling**.

### Resources

#### BOOKS

Beers, Mark H., Robert S. Porter, and Thomas V. Jones, eds. *The Merck Manual of Diagnosis and Therapy*. 18th ed. Whitehouse Station, NJ: Merck Research Laboratories, 2006.

John T. Lohr PhD

Adrenomyeloneuropathy see

**Adrenoleukodystrophy**

disease that causes large amounts of fluid to collect in the lungs. ARDS is not itself a specific disease, but a syndrome, a group of symptoms and signs that make up one of the most important forms of lung or **respiratory failure**. It can develop quite suddenly in persons whose lungs have been perfectly normal. Very often ARDS is a true medical emergency. The basic fault is a breakdown of the barrier, or membrane, that normally keeps fluid from leaking out of the small blood vessels of the lung into the breathing sacs (the alveoli).

### Description

Another name for ARDS is shock lung. Its formal name is misleading, because children, as well as adults, may be affected. In the lungs the smallest blood vessels, or capillaries, make contact with the alveoli, tiny air sacs at the tips of the smallest breathing tubes (the bronchi). This is the all-important site where oxygen passes from air that is inhaled to the blood, which carries it to all parts of the body. Any form of lung injury that damages this point of contact, called the alveolo-capillary junction, will allow blood and tissue fluid to leak into the alveoli, eventually filling them so that air cannot enter. The result is the type of breathing distress called ARDS. ARDS is one of the major causes of excess fluid in the lungs, the other being **heart failure**.

Along with fluid there is a marked increase in inflamed cells in the lungs. There also is debris left over from damaged lung cells, and fibrin, a semi-solid material derived from blood in the tissues. Typically these materials join together with large molecules in the blood (proteins), to form hyaline membranes. These membranes are very prominent in premature infants who develop respiratory distress syndrome; it is often called hyaline membrane disease. If ARDS is very severe or lasts a long time, the lungs do not heal, but rather become scarred, a process known as fibrosis. The lack of a normal amount of oxygen causes the blood vessels of the lung to become narrower, and in time they, too, may become scarred and filled with clotted blood. The lungs as a whole become very "stiff," and it becomes much harder for the patient to breathe.

### Causes and symptoms

A very wide range of diseases or toxic substances, including some drugs, can cause ARDS. They include:

- Breathing in (aspiration) of the stomach contents when regurgitated, or salt water or fresh water from nearly drowning
- Inhaling smoke, as in a fire; toxic materials in the air, such as ammonia or hydrocarbons; or too much oxygen, which itself can injure the lungs

## Adult respiratory distress syndrome

### Definition

Adult **respiratory distress syndrome** (ARDS), also called acute respiratory distress syndrome, is a type of lung (pulmonary) failure that may result from any

## KEY TERMS

**Alveoli**—The tiny air sacs at the ends of the breathing tubes of the lung where oxygen normally is taken up by the capillaries to enter the circulation.

**Aspiration**—The process in which solid food, liquids, or secretions that normally are swallowed are, instead, breathed into the lungs.

**Capillaries**—The smallest arteries which, in the lung, are located next to the alveoli so that they can pick up oxygen from inhaled air.

**Face mask**—The simplest way of delivering a high level of oxygen to patients with ARDS or other low-oxygen conditions.

**Steroids**—A class of drugs resembling normal body substances that often help control inflammation in the body tissues.

**Ventilator**—A mechanical device that can take over the work of breathing for a patient whose lungs are injured or are starting to heal.

- Infection by a virus or bacterium, or sepsis, a widespread infection that gets into the blood
- Massive trauma, with severe injury to any part of the body
- Shock with persistently low blood pressure may not in itself cause ARDS, but it can be an important factor
- A blood clotting disorder called disseminated intravascular coagulation, in which blood clots form in vessels throughout the body, including the lungs
- A large amount of fat entering the circulation and traveling to the lungs, where it lodges in small blood vessels, injuring the cells lining the vessel walls
- An overdose of a narcotic drug, a sedative, or, rarely, aspirin
- Inflammation of the pancreas (pancreatitis), when blood proteins, called enzymes, pass to the lungs and injure lung cells
- Severe burn injury
- Injury of the brain, or bleeding into the brain, from any cause may be a factor in ARDS for reasons that are not clear. Convulsions also may cause some cases

Usually ARDS develops within one to two days of the original illness or injury. The person begins to take rapid but shallow breaths. The doctor who listens to the patient's chest with a stethoscope may hear "crackling" or **wheezing** sounds. The low blood oxygen content may cause the skin to appear mottled or even blue. As fluid continues to fill the breathing sacs, the patient may have great trouble breathing, take very rapid breaths, and gasp for air.

### Diagnosis

A simple test using a device applied to the ear will show whether the blood is carrying too little oxygen, and this can be confirmed by analyzing blood taken from an artery. The **chest x ray** may be normal in the early stages, but, in a short time, fluid will be seen where

it does not belong. The two lungs are about equally affected. A heart of normal size indicates that the problem actually is ARDS and not heart failure. Another way a physician can distinguish between these two possibilities is to place a catheter into a vein and advance it into the main artery of the lung. In this way, the pressure within the pulmonary capillaries can be measured. Pressure within the pulmonary capillaries is elevated in heart failure, but normal in ARDS.

### Treatment

The three main goals in treating patients with ARDS are:

- To treat whatever injury or disease has caused ARDS. Examples are: to treat septic infection with the proper antibiotics, and to reduce the level of oxygen therapy if ARDS has resulted from a toxic level of oxygen.
- To control the process in the lungs that allows fluid to leak out of the blood vessels. At present there is no certain way to achieve this. Certain steroid hormones have been tried because they can combat inflammation, but the actual results have been disappointing.
- To make sure the patient gets enough oxygen until the lung injury has had time to heal. If oxygen delivered by a face mask is not enough, the patient is placed on a ventilator, which takes over breathing, and, through a tube placed in the nose or mouth (or an incision in the windpipe), forces oxygen into the lungs. This treatment must be closely supervised, and the pressure adjusted so that too much oxygen is not delivered.

Patients with ARDS should be cared for in an intensive care unit, where experienced staff and all needed equipment are available. Enough fluid must be provided, by vein if necessary, to prevent **dehydration**. Also, the patient's nutritional state must be maintained, again by vein, if oral intake is not sufficient.

## Prognosis

If the patient's lung injury does not soon begin to heal, the lack of sufficient oxygen can injure other organs, such as the kidneys. There always is a risk that bacterial **pneumonia** will develop at some point. Without prompt treatment, as many as 90% of patients with ARDS can be expected to die. With modern treatment, however, about half of all patients will survive. Those who do live usually recover completely, with little or no long-term breathing difficulty. Lung scarring is a risk after a long period on a ventilator, but it may improve in the months after the patient is taken off ventilation. Whether a particular patient will recover depends to a great extent on whether the primary disease that caused ARDS to develop in the first place can be effectively treated.

## Prevention

The only way to prevent ARDS is to avoid those diseases and harmful conditions that damage the lung. For instance, the danger of aspirating stomach contents into the lungs can be avoided by making sure a patient does not eat shortly before receiving **general anesthesia**. If a patient needs **oxygen therapy**, as low a level as possible should be given. Any form of lung infection, or infection anywhere in the body that gets into the blood, must be treated promptly to avoid the lung injury that causes ARDS.

## Resources

### BOOKS

Mehta, Manish. "Adult Respiratory Distress Syndrome." In Mehta, Manish, and Arun Matthews. *The Hospitalist Manual*. Shelton, CT: pmph usa, 2009.

### ORGANIZATIONS

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, <http://www.nhlbi.nih.gov>.

National Respiratory Distress Syndrome Foundation, P.O. Box 723, Montgomeryville, PA, 18936, (215) 822-3585, <http://membrane.com/phylanet/rds/>.

David A. Cramer MD

**AFP test** see **Alpha-fetoprotein test**

African American health see **Minority health**

African sleeping sickness see **Sleeping sickness**

African trypanosomiasis see **Sleeping sickness**

Agammaglobulinemia see **Common variable immunodeficiency**

Aggression see **Conduct disorder**

## Aging

### Definition

Starting at what is commonly called middle age, operations of the human body begin to be more vulnerable to daily wear and tear; there is a general decline in physical, and possibly mental, functioning. The length of life is often into the 70s. The upward limit of the life span, however, can be as high as 120 years. During the latter half of life, an individual is more prone to having problems with the various functions of the body and to develop any number of chronic or fatal diseases. The cardiovascular, digestive, excretory, nervous, reproductive and urinary systems are particularly affected. The most common diseases of aging include Alzheimer's, arthritis, **cancer**, diabetes, depression, and heart disease.

### Description

Human beings reach a peak of growth and development around the time of their mid 20s. Aging is the normal transition time after that flurry of activity. Although there are quite a few age-related changes that tax the body, disability is not necessarily a part of aging. Health and lifestyle factors together with the genetic makeup of the individual, and determines the response to these changes. Body functions that are most often affected by age include:

- Hearing, which declines especially in relation to the highest pitched tones
- The proportion of fat to muscle, which may increase by as much as 30%. Typically, the total padding of body fat directly under the skin thins out and accumulates around the stomach. The ability to excrete fats is impaired, and therefore the storage of fats increases, including cholesterol and fat-soluble nutrients
- The amount of water in the body decreases, which therefore decreases the absorption of water-soluble nutrients. Also, there is less saliva and other lubricating fluids
- The liver and the kidneys cannot function as efficiently, thus affecting the elimination of wastes

- A decrease in the ease of digestion, with a decrease in stomach acid production
- A loss of muscle strength and coordination, with an accompanying loss of mobility, agility, and flexibility
- A decline in sexual hormones and sexual functioning
- A decrease in the sensations of taste and smell
- Changes in the cardiovascular and respiratory systems, leading to decreased oxygen and nutrients throughout the body
- Decreased functioning of the nervous system so that nerve impulses are not transmitted as efficiently, reflexes are not as sharp, and memory and learning are diminished
- A decrease in bone strength and density
- Hormone levels, which gradually decline. The thyroid and sexual hormones are particularly affected
- Declining visual abilities. Age-related changes may lead to diseases such as macular degeneration
- A compromised ability to produce vitamin D from sunlight
- A reduction in protein formation leading to shrinkage in muscle mass and decreased bone formation, possibly leading to osteoporosis

### Causes and symptoms

There are several theories as to why the aging body loses functioning. It may be that several factors work together or that one particular factor is at work more than others in a given individual.

- Programmed senescence, or aging clock, theory. The aging of the cells of each individual is programmed into the genes, and there is a preset number of possible rejuvenations in the life of a given cell. When cells die at a rate faster than they are replaced, organs do not function properly, and they are soon unable to maintain the functions necessary for life.
- Genetic theory. Human cells maintain their own seed of destruction at the level of the chromosomes.
- Connective tissue, or cross-linking theory. Changes in the make-up of the connective tissue alter the stability of body structures, causing a loss of elasticity and functioning, and leading to symptoms of aging.
- Free-radical theory. The most commonly held theory of aging, it is based on the fact that ongoing chemical reactions of the cells produce free radicals. In the presence of oxygen, these free radicals cause the cells of the body to break down. As time goes on, more cells die or lose the ability to function, and the body soon ceases to function as a whole.

### KEY TERMS

**Antioxidants**—Substances that reduce the damage of the highly reactive free radicals that are the byproducts of the cells.

**Alzheimer's disease**—A condition causing a decline in brain function that interferes with the ability to reason and to perform daily activities.

**Senescence**—Aging.

**Vata**—One of the three main constitutional types found under Ayurvedic principles. Keeping one's particular constitution in balance is considered important in maintaining health.

- Immunological theory. There are changes in the immune system as it begins to wear out, and the body is more prone to infections and tissue damage, which may finally cause death. Also, as the system breaks down, the body is more apt to have autoimmune reactions, in which the body's own cells are mistaken for foreign material and are destroyed or damaged by the immune system.

### Diagnosis

Many problems can arise due to age-related changes in the body. Although there is no one test to be given, a thorough physical exam and a basic blood screening and blood chemistry panel can point to areas in need of further attention. When older people become ill, the first signs of disease are often nonspecific. Further exams should be conducted if any of the following occur:

- diminished or lack of desire for food
- increasing confusion
- failure to thrive
- urinary incontinence
- dizziness
- weight loss
- falling

### Treatment

For the most part, doctors prescribe medications to control the symptoms and diseases of aging. In the United States, about two-thirds of people 65 and older take medications for various complaints. More women than men use these medications. The most common drugs used by the elderly are painkillers, **diuretics** or water pills, sedatives, cardiac drugs, **antibiotics**, and mental health drugs.

Estrogen replacement therapy (ERT) is commonly prescribed to postmenopausal women for symptoms of aging. It is often used in conjunction with progesterone. ERT functions to help keep bones strong, reduce risk of heart disease, restore vaginal lubrication, and improve skin elasticity. Evidence suggests that it may also help maintain mental functions.

## Expected results

Aging is unavoidable, but major physical impairment is not. People can lead a healthy, disability-free life well through their later years. A well established support system of family, friends, and health care providers, together with focus on good **nutrition** and lifestyle habits and good **stress** management, can prevent disease and lessen the impact of chronic conditions.

## Alternative treatment

### Nutritional supplements

Consumption of a high quality multivitamin is recommended. Common nutritional deficiencies connected with aging include B **vitamins**, vitamins A and C, **folic acid**, **calcium**, magnesium, zinc, iron, chromium, and trace **minerals**. Since stomach acids may be decreased, it is suggested that the use of a powdered multivitamin formula in gelatin capsules be used, as this form is the easiest to digest. Such formulas may also contain enzymes for further help with digestion.

**Antioxidants** can help to neutralize damage by the free radical actions thought to contribute to problems of aging. They are also helpful in preventing and treating cancer and in treating **cataracts** and glaucoma. Supplements that serve as antioxidants include:

- Vitamin E, 400–1,000 IUs daily. Protects cell membranes against damage. It shows promise in prevention against heart disease, and Alzheimer's and Parkinson's diseases.
- Selenium, 50 mg taken twice daily. Research suggests that selenium may play a role in reducing the risk of cancer.
- Beta-carotene, 25,000–40,000 IUs daily. May help in treating cancer, colds and flu, arthritis, and immune support.
- Vitamin C, 1,000–2,000 mg per day. It may cause diarrhea in large doses. If this occurs, however, all that is needed is a decrease in the dosage.

Other supplements that are helpful in treating age-related problems including:

- B<sub>12</sub>/B-complex vitamins; studies show that B<sub>12</sub> may help reduce mental symptoms, such as confusion, memory loss, and depression.
- Coenzyme Q10 may be helpful in treating heart disease, as up to three-quarters cardiac patients have been found to be lacking in this heart enzyme.

### Hormones

The following hormone supplements may be taken to prevent or to treat various age-related problems. However, caution should be taken before beginning treatment, and the patient should consult his or her health care professional.

DHEA improves brain functioning and serves as a building block for many other important hormones in the body. It may be helpful in restoring declining hormone levels and in building up muscle mass, strengthening the bones, and maintaining a healthy heart.

Melatonin may be helpful for **insomnia**. It has also been used to help fight viruses and bacterial infections, reduce the risk of heart disease, improve sexual functioning, and to protect against cancer.

Human growth hormone (hGH) has been shown to regulate blood sugar levels and to stimulate bone, cartilage, and muscle growth while reducing fat.

### Herbs

Garlic (*Allium sativa*) is helpful in preventing heart disease, as well as improving the tone and texture of skin. Garlic stimulates liver and digestive system functions, and also helps in dealing with heart disease and high blood pressure.

Siberian **ginseng** (*Eleutherococcus senticosus*) supports the adrenal glands and immune functions. It is believed to be helpful in treating problems related to stress. Siberian ginseng also increases mental and physical performance, and may be useful in treating **memory loss**, **chronic fatigue**, and immune dysfunction.

Proanthocyanidins, or PCO, are Pycnogenol, derived from grape seeds and skin, and from pine tree bark, and may help in the prevention of cancer and poor vision.

In **Ayurvedic medicine**, aging is described as a process of increased vata, in which there is a tendency to become thinner, drier, more nervous, more restless, and more fearful, while having a loss of appetite as well as sleep. Bananas, almonds, avocados, and coconuts are some of the foods used in correcting such conditions. One of the main herbs used for such conditions is gotu kola (*Centella asiatica*),

which is used to revitalize the nervous system and brain cells and to fortify the immune system. Gotu kola is also used to treat memory loss, **anxiety**, and insomnia.

In Chinese medicine, most symptoms of aging are regarded as symptoms of a yin deficiency. Moistening foods such as millet, barley soup, tofu, mung beans, wheat germ, spirulina, potatoes, black sesame seeds, walnuts, and flax seeds are recommended. Jing tonics may also be used. These include deer antler, dodder seeds, processed rehmannia, longevity soup, mussels, and chicken.

## Prevention

Preventive health practices such as healthy diet, daily **exercise**, stress management, and control of life-style habits such as **smoking** and drinking, can lengthen the life span and improve the quality of life as people age. Exercise can improve the appetite, the health of the bones, the emotional and mental outlook, and the digestion and circulation.

Drinking plenty of fluids aids in maintaining healthy skin, good digestion, and proper elimination of wastes. Up to eight glasses of water should be consumed daily, along with plenty of herbal teas, diluted fruit and vegetable juices, and fresh fruits and vegetables with high water content.

Because of a decrease in the sense of taste, older people often increase their intake of salt, which can contribute to high blood pressure and nutrient loss. Use of sugar is also increased. Seaweeds and small amounts of honey can be used as replacements.

Alcohol, nicotine, and **caffeine** all have potential damaging effects, and should be limited or completely eliminated from consumption.

A diet high in fiber and low in fat is recommended. Processed foods should be replaced by complex carbohydrates, such as whole grains. If chewing becomes a problem, there should be an increased intake of protein drinks, freshly juiced fruits and vegetables, and creamed cereals.

## Resources

### OTHER

“Anti-Aging-Nutritional Program.” <http://www.healthy.net/hwlibrarybooks/haas/perform/antiagin.htm>.

“Effects of Hormone in the Body.” [http://www.antiaging.org/Effects\\_hGH.html](http://www.antiaging.org/Effects_hGH.html).

“The Elderly-Nutritional Programs.” <http://www.healthy.net/hwlibrarybooks/haas/lifestage/elderly.htm>.

“Evaluating the Elderly Patient: the Case for Assessment Technology.” <http://text.nlm.nih.gov/nih/ta/www/01.html>.

“Herbal Phytotherapy and the Elderly.” <http://www.healthy.net/hwlibrarybooks/hoffman/elders/elders.htm>.

“Pharmacokinetics.” Merck & Co., Inc. (1995-2000). <http://www.merck.com/pubs/mmanual/section22/chapter304/304a.htm>.

“To a Long and Healthy Life.” <http://www.healthy.net/hwlibraryarticles/aesoph/longandhealthy.htm>.

Patience Paradox

## Agoraphobia

### Definition

The word agoraphobia is derived from Greek words literally meaning “fear of the marketplace.” The term is used to describe an irrational and often disabling fear of being out in public.

### Description

Agoraphobia is just one type of phobia, or irrational fear. People with **phobias** feel dread or panic when they face certain objects, situations, or activities. People with agoraphobia frequently also experience panic attacks, but panic attacks, or **panic disorder**, are not a requirement for a diagnosis of agoraphobia. The defining feature of agoraphobia is **anxiety** about being in places from which escape might be embarrassing or difficult, or in which help might be unavailable. The person suffering from agoraphobia usually avoids the anxiety-provoking situation and may become totally housebound.

### Causes and symptoms

Agoraphobia is the most common type of phobia, and it is estimated to affect between 5–12% of Americans within their lifetime. Agoraphobia is twice as common in women as in men and usually strikes between the ages of 15–35.

The symptoms of the panic attacks that may accompany agoraphobia vary from person to person, and may include trembling, sweating, heart **palpitations** (a feeling of the heart pounding against the chest), jitters, **fatigue**, **tingling** in the hands and feet, **nausea**, a rapid pulse or breathing rate, and a sense of impending doom.

## KEY TERMS

**Benzodiazepines**—A group of tranquilizers often used to treat anxiety.

**Desensitization**—A treatment for phobias that involves exposing the phobic person to the feared situation. It is often used in conjunction with relaxation techniques.

**Phobia**—An intense and irrational fear of a specific object, activity, or situation.

Agoraphobia and other phobias are thought to be the result of a number of physical and environmental factors. For instance, they have been associated with biochemical imbalances, especially related to certain neurotransmitters (chemical nerve messengers) in the brain. People who have a panic attack in a given situation (e.g., a shopping mall) may begin to associate the panic with that situation and learn to avoid it. According to some theories, irrational anxiety results from unresolved emotional conflicts. All of these factors may play a role to varying extents in different cases of agoraphobia.

### Diagnosis

People who suffer from panic attacks should discuss the problem with a physician. The doctor can diagnose the underlying panic or anxiety disorder and make sure the symptoms aren't related to some other underlying medical condition.

The doctor makes the diagnosis of agoraphobia based primarily on the patient's description of his or her symptoms. The person with agoraphobia experiences anxiety in situations where escape is difficult or help is unavailable—or in certain situations, such as being alone. While many people are somewhat apprehensive in these situations, the hallmark of agoraphobia is that a person's active avoidance of the feared situation impairs his or her ability to work, socialize, or otherwise function.

### Treatment

Treatment for agoraphobia usually consists of both medication and **psychotherapy**. Usually, patients can benefit from certain antidepressants, such as amitriptyline (Elavil), or **selective serotonin reuptake inhibitors**, such as paroxetine (Paxil), fluoxetine (Prozac), or sertraline (Zoloft). In addition,

patients may manage panic attacks in progress with certain tranquilizers called **benzodiazepines**, such as alprazolam (Xanax) or clonazepam (Klonipin).

The mainstay of treatment for agoraphobia and other phobias is cognitive behavioral therapy. A specific technique that is often employed is called desensitization. The patient is gradually exposed to the situation that usually triggers fear and avoidance, and, with the help of breathing or relaxation techniques, learns to cope with the situation. This helps break the mental connection between the situation and the fear, anxiety, or panic. Patients may also benefit from psychodynamically oriented psychotherapy, discussing underlying emotional conflicts with a therapist or support group.

### Prognosis

With proper medication and psychotherapy, 90% of patients will find significant improvement in their symptoms.

### ORGANIZATIONS

American Psychiatric Association (APA), 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (888) 357-7924, [apa@psych.org](mailto:apa@psych.org), <http://www.psych.org>.

Anxiety Disorders Association of America, 8730 Georgia Ave. Suite 600, Silver Spring, MD, 20910, (240) 485-1001, (140) 485-1035, <http://www.adaa.org>.

National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD 20892-9663, <http://www.nimh.nih.gov/site-info/contact-nimh.shtml>.

Robert Scott Dinsmoor

Agranulocytosis see **Neutropenia**

## AIDS

### Definition

AIDS, or acquired immune deficiency syndrome, is the end stage of an **infectious disease** caused by the human **immunodeficiency** virus, or HIV. There are two variants of the HIV virus, HIV-1 and HIV-2, both of which ultimately cause AIDS. The virus damages the immune system, leaving the patient vulnerable to certain cancerous tumors and increasingly severe opportunistic infections. HIV can be transmitted whenever a body fluid containing the virus—semen, saliva, blood, or breast milk—comes into contact with a mucous membrane or the bloodstream itself.

Risk of acquiring HIV infection by entry site			
Entry site	Risk virus reaches entry site	Risk virus enters	Risk inoculated
Conjunctiva	Moderate	Moderate	Very low
Oral mucosa	Moderate	Moderate	Low
Nasal mucosa	Low	Low	Very low
Lower respiratory	Very low	Very low	Very low
Anus	Very high	Very high	Very high
Skin, intact	Very low	Very low	Very low
Skin, broken	Low	High	High
<b>Sexual:</b>			
Vagina	Low	Low	Moderate
Penis	High	Low	Low
Ulcers (STD)	High	High	Very high
<b>Blood:</b>			
Products	High	High	High
Shared needles	High	High	Very high
Accidental needle	Low	High	Low
Traumatic wound	Moderate	High	High
Perinatal	High	High	High

(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

A person can get AIDS through sexual intercourse, anal or oral sex, **childbirth**, **breastfeeding**, blood **transfusion**, **tattoos** or body **piercing**, or sharing hypodermic needles.

## Demographics

As of 2009, about 0.6% of the world's population was infected with HIV, or about 35 million people. Ninety-five percent of these cases are in Africa or southeastern Asia. About 25 million people have died of AIDS since 1981, making the disease one of the deadliest pandemics in history. In the United States, the CDC's recently revised estimates indicate that about 945,000 people have been diagnosed with AIDS since 1981, and about 1.2 million are currently living with HIV infection. About a quarter of these people are unaware that they are infected with the virus. The CDC estimates that there are 56,300 new cases of HIV infection in the United States each year.

The CDC gives the following statistics for specific groups within the United States:

- Males account for 74% of persons with HIV infection in the United States, although worldwide, the figure for males is 50%.
- In terms of race or ethnicity, 47% of persons with HIV infection are African American, 34% are Caucasian, 17% are Hispanic, and 2% are Native American or Asian American.

- In terms of method of transmission, 50% of infected persons are men who had sex with men; 33% had high-risk heterosexual sex; 13% are injection drug users; and the remainder are people who engaged in more than one high-risk behavior.

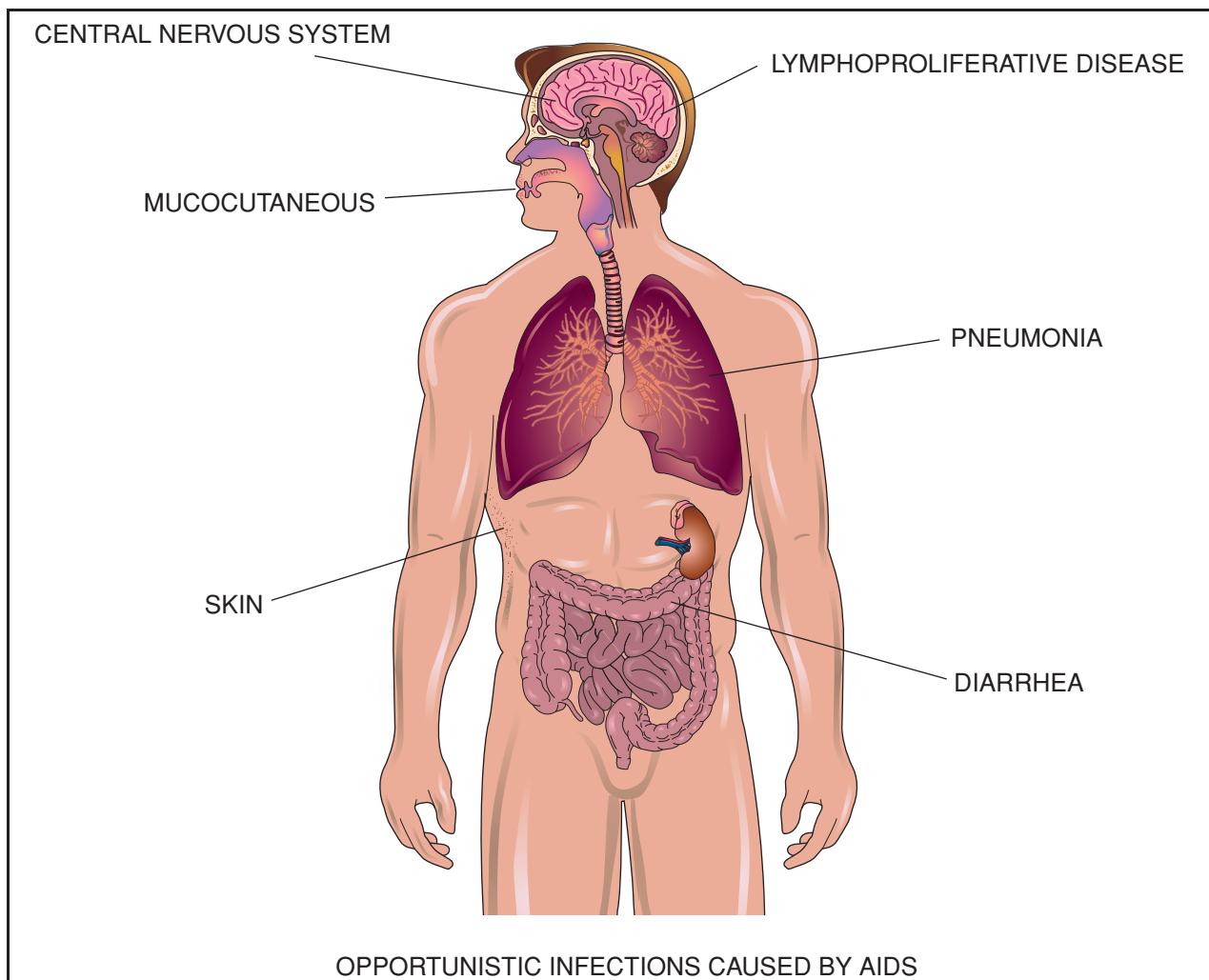
- In terms of age group, one percent of infected persons are under 13 years of age; 15% are between the ages of 13 and 24; 26% are between the ages of 25 and 34; 32% are between the ages of 35 and 44; 20% are between the ages of 45 and 54; 8% are 55 or older.

A worrisome new trend as of 2009 is the return and increase of high-risk behaviors among men who have sex with men in Canada and the United States. This trend appears to have been triggered by the spread of **methamphetamine addiction** from the West Coast to the Eastern Seaboard since the early 2000s.

## AIDS in women

Women exposed to HIV infection through heterosexual contact are the most rapidly growing risk group in the United States. The gender demographics of HIV infection within the United States are changing, with women accounting for more new cases in 2009 than was the case in 1999. The percentage of AIDS cases diagnosed in American women has risen from 7% in 1985 to about 26% in 2006, the last year for which data are available. According to the CDC, in 2006 approximately 278,400 women in the United States were living with HIV/AIDS. The rate was highest among black women, who had 23 times as many cases as Caucasian women and 4 times as many cases as Hispanic women. About 75% of these women contracted HIV through high-risk heterosexual activity; almost all of the remainder acquired the infection through needle sharing.

The prevalence of women with HIV in the United States is low, however, compared to the rate in many countries in the developing world. Worldwide, about half the people living with HIV are women. According to the United Nations, in 2005 about 59% of women living in sub-Saharan Africa are infected with HIV. The vast majority of them were infected through having unprotected sex with an infected male partner. One theory that has been proposed to explain the higher rate of AIDS in women in Africa is the prevalence of **schistosomiasis** in the region. Schistosomiasis is a parasitic disease caused by a trematode (a type of flatworm) that affects as many as 50% of women in some parts of Africa; while it is rarely fatal, schistosomiasis



**Because the immune system cells are destroyed by the AIDS virus, many different types of infections and cancers can develop, taking advantage of a person's weakened immune system.** (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

damages the tissues lining the vagina, making them more vulnerable to the AIDS virus.

#### *AIDS in children*

Since AIDS can be transmitted from an infected mother to a fetus during **pregnancy** or to an infant during the birth process or through breastfeeding, all infants born to HIV-positive mothers are considered a high-risk group. However, prenatal drug treatment of HIV-positive mothers in developed countries has reduced the number of children born infected with HIV. In the developing world, drug treatment is either not available or not affordable. According to the United Nations Children's Fund (UNICEF) worldwide 2.3 million children under age 13 were living with HIV in 2006. The previous year, about 380,000 children

died of AIDS and more than half a million children were newly infected. UNICEF estimates that at least 15 million children have lost at least one parent to AIDS.

AIDS is the leading cause of **death** in children under age five in many parts of Africa and Southeast Asia. One reason for this tragedy is that only 1% of sexually active women in these regions get tested for HIV infection, and these women can become pregnant before they develop symptoms of the disease. The interval between exposure to HIV and the development of AIDS is shorter in children than in adults. Infants infected with HIV have a high chance of developing AIDS within one year and dying before age three. In the remainder, AIDS progresses more slowly; the average child patient survives to about seven years of age. Some survive into early adolescence.

## AIDS in older adults

The demographics of HIV infection among the elderly have changed since the early days of the AIDS epidemic. In the mid-1980s, most cases of AIDS among older adults in the United States were the result of transfusions with contaminated blood. The introduction of effective screening tests for blood products has virtually eliminated this path of HIV transmission, however; as of 2009, almost all cases of AIDS in seniors are the result of sexual activity. In the United States, about 10% of all cases of AIDS occur in people over 50, and 3% in people over 60. About 35% of seniors who develop AIDS are homosexual or bisexual men; others are heterosexual men living in urban areas who engage in high-risk sex with prostitutes. In addition, the number of older adults with HIV/AIDS is rising; the CDC estimates that by 2015, half of all persons living with HIV/AIDS in North America will be over the age of 50.

One reason that sexually active seniors are particularly at risk for HIV infection is that they are rarely concerned about **contraception**. Adults over 50 are five times more likely than younger people to have unprotected sex because they think of **condoms** as a method of birth control rather than a means of preventing disease transmission. In addition, older women have thinner and more fragile tissues lining the walls of the vagina; these tissues are more likely to be bruised or damaged during unprotected intercourse, making it easier for the virus to enter the underlying tissues. Several studies done in 2006 and 2007 reported that older women are less likely than their younger counterparts to take precautions against HIV infection, in part because they are less sexually active than older men, and partly because they do not perceive themselves as being at risk for HIV infection.

According to the *Merck Manual of Geriatrics*, "Practically no prevention information on AIDS is targeted at elderly persons, although most elderly persons are sexually active." According to statistics compiled by the Centers for Disease Control and Prevention, about 2100 men between the ages of 55 and 59 are diagnosed with HIV infection each year, and 800 over the age of 65. Since the epidemic began in 1981, 15,000 adults over age 65 have been diagnosed with HIV in the United States.

## Description

### Background

AIDS is now considered a pandemic because it has spread to every country in the world. According to

the World Health Organization (WHO), 34 million people around the world were living with HIV infection in 2009; 2.1 million people died in 2008 from the disease, 330,000 of them children. Scientists think that the virus that causes AIDS originated somewhere in the African rainforest as an infection of chimpanzees and Old World monkeys. At some point in the twentieth century the virus jumped the species barrier from monkeys into humans, most likely somewhere in western Africa. The earliest known case of HIV infection was found in a blood sample collected from a man in Kinshasa in the Congo in 1959. AIDS was first defined as an epidemic human disease in June 1981 by the Centers for Disease Control and Prevention (CDC). The virus that causes AIDS was identified by two teams of French and American scientists in 1983–1984.

The first cases of AIDS in the United States were not diagnosed until 1981, when the CDC reported a cluster of five cases of an opportunistic lung infection among homosexual men in Los Angeles. In the first 15 years of the epidemic, there were no effective treatments for HIV infection (there is still no cure as of 2009). In 1996, a team of researchers in California introduced a form of treatment known as highly active antiretroviral therapy or HAART. While drug therapy is not a cure for AIDS, it can slow the progress of the disease and improve the patient's quality of life.

## Course

HIV infection progresses in stages as the virus gradually weakens the body's immune system. It takes an average of 11 years for HIV infection to progress to AIDS, although the disease progresses faster in children and the elderly. AIDS is diagnosed when the count of certain white blood cells in the patient's blood drops to a critical level or the patient develops life-threatening tumors or opportunistic infections.

In the early stage of HIV infection, the patient may have no symptoms at all or a mild flu-like illness with **fever** and **headache** within a few days or weeks of getting infected. These symptoms usually go away without treatment and the person feels normal, even though they are a carrier and can transmit the infection to others. The infected person may continue to feel well for a period ranging from a few months to several years.

## Risk factors

AIDS can be transmitted in several ways. The risk factors for HIV transmission vary according to the method of transmission.

- Sexual contact. People at greatest risk are those who do not practice safer sex by always using a condom, those who have multiple sexual partners, those who participate in anal intercourse, and those who have sex with a partner who has HIV infection and/or other sexually transmitted diseases (STDs). In the United States and Europe, most cases of sexually transmitted HIV infection result from homosexual contact, whereas in Africa, the disease is spread primarily through sexual intercourse among heterosexuals. Most people with AIDS in the United States are between 25 and 44 years of age.
- Transmission in pregnancy. High-risk mothers include women sexually active with bisexual men, intravenous drug users, and women living in neighborhoods with a high rate of HIV infection among heterosexuals. The chances of transmitting the disease to the child are higher in women in advanced stages of the disease. Breast feeding increases the risk of HIV transmission as HIV passes into breast milk. The rate of pediatric HIV transmission in the United States had decreased substantially because of HIV testing and improved drug treatment for infected mothers, so fewer than 1% of AIDS cases now occur in children under age 15. In the developing world, mother to infant transmission remains epidemic. In 2006, AIDS was the single most common cause of death in children under age 5 in South Africa, while worldwide children account for about 10% of all AIDS cases.
- Exposure to contaminated blood. Risk of HIV transmission among intravenous drug users increases with the frequency and duration of intravenous use, frequency of needle sharing, number of people sharing a needle, and the rate of HIV infection in the local population. In 2006, about 19% of men with AIDS and 25% of women with AIDS contracted the disease through sharing needles during intravenous drug injection. With the introduction of new blood product screening in the mid-1980s, HIV transmission through blood transfusions became rare in the developed world. However, contaminated blood is still a significant source of infection in the developing world.
- Transmission via improperly sterilized tattooing or body piercing needles.
- Needle sticks or body fluid splashes among health care professionals. Transmission through these sources accounts for fewer than 0.3% of all HIV infections in the United States. This rate reflects the emphasis on universal safety precautions (e.g., use of gloves, face shields, proper disposal of needles)

among health care professionals and first responders.

Some older adults are at higher risk than others of HIV infection. In order to determine whether HIV testing should be a personal priority, an adult 55 years of age or older should use the following checklist of high-risk behaviors for 1978 and later:

- Shared needles for injecting drugs or steroids
- If a male, had unprotected sex with other males
- Had unprotected sex with someone known or suspected to be infected with HIV
- Had a blood transfusion between 1978 and 1985
- Had another sexually transmitted disease
- Had unprotected sex with anyone with any of the five previous risk factors

## Causes and symptoms

### Causes

The cause of AIDS is infection with human immunodeficiency virus or HIV. HIV is a retrovirus that reproduces by inserting its own genetic material into a type of white blood cell called a CD4 lymphocyte. When the virus copies break out of the infected white blood cell, they attack other CD4 cells and the cycle repeats. The virus has a short life cycle, needing as little as 1.5 days to enter a cell, replicate, and release new copies of itself to infect other cells. Eventually so many of the white blood cells have been destroyed that the body's immune system is weakened and the person can no longer fight off opportunistic infections. The patient may also develop certain cancers associated with a weakened immune system.

### Symptoms

**STAGES.** The symptoms of HIV infection vary according to the progress of the infection. As mentioned above, about 30% of patients develop an acute syndrome resembling flu within a month of exposure to HIV. The patient typically has a fever, headache, swollen lymph nodes, and **fatigue**. This illness is called acute retroviral syndrome or ARS. The symptoms then disappear; however, the infected person is highly contagious in this early phase and can readily pass on the virus to others. The patient may or may not have developed antibodies to HIV (a process known as seroconversion) at this point; thus a test for HIV infection in this early period may not yield positive results even though the patient is in fact infected.

In the second phase, the virus may be silent, but more commonly it produces complications. Patients in

this stage of infection may have the following symptoms:

- Swelling of the lymph nodes that lasts three months or longer
- Fevers and night sweats
- Loss of energy
- Weight loss
- Frequent yeast infections of the vagina or mouth and throat. Yeast infections of the mouth are sometimes called thrush
- Skin rashes or flaky skin that does not go away
- Short-term memory loss. This symptom helps to explain why HIV infection in seniors is often misdiagnosed as early-stage Alzheimer's

In full-blown AIDS, the person develops one or more of the following opportunistic infections. Death usually results from one of these infections or from an AIDS-related **cancer**.

- Lung infections: these include a type of pneumonia caused by an organism known as *Pneumocystis jirovecii*, a yeast-like fungus; and tuberculosis.
- Mouth infections: these include oral candidiasis, or thrush.
- Infections of the digestive tract: these include parasitic as well as bacterial infections, and are often marked by severe diarrhea.
- Infections of the central nervous system: these include meningitis and toxoplasmosis. AIDS dementia complex (ADC), which is often misdiagnosed as Alzheimer's disease, is caused by destruction of brain tissue by toxins secreted by HIV. AIDS dementia complex affects between 10 and 20% of AIDS patients in the United States and is often the first symptom of full-blown AIDS. Like Alzheimer's, ADC is characterized by memory loss, inability to concentrate, loss of motor ability, poor balance, and mood changes.

AIDS-related cancers include **Kaposi's sarcoma**, a skin cancer occasionally found in older men who do not have HIV infection; and cervical cancers in women. AIDS patients are also at increased risk of developing Hodgkin's disease, Burkitt's lymphoma, and cancers of the anus or rectum.

## Diagnosis

The diagnosis of HIV infection and AIDS is complicated by the fact that many people are afraid to be tested for the disease. They may fear that a positive test will lead to the loss of housing, jobs, relationships, or the chance to complete their education. Because many infected persons put off getting tested and telling their

partners, the disease continues to spread. In 2006, the CDC recommended routine HIV screening for all adults, adolescents, and pregnant women within health care settings, not just those considered to be high-risk. As of 2009, the CDC recommends that people engaging in high-risk behaviors be tested for HIV infection every year.

## Examination

The patient's history is often the most important single diagnostic clue to HIV infection, particularly if he or she admits to unsafe sexual practices or intravenous drug use. If the doctor suspects HIV infection on the basis of the flu-like symptoms of acute retroviral syndrome, or if the patient requests HIV testing, the doctor will usually order appropriate blood or oral fluid tests.

AIDS-related **dementia** is the first symptom to appear in 4–15% of patients with AIDS in the United States. In those cases the doctor will include a neurologic examination and a **mental status examination** as part of the office physical. The patient may be referred to a psychiatrist for further evaluation if he or she appears to be suicidal or homicidal.

## Tests

**LABORATORY TESTS.** Testing for HIV is a two-step process. The first test is a screening test, which usually involves taking a sample of the patient's blood. There are also newer screening tests that can use a sample of the person's urine or saliva. These rapid screening tests look for antibodies to the HIV virus and give results in about 20 minutes. If the person tests positive for HIV infection, a second test, called a Western blot test, is performed. This test uses a technique for separating out proteins in a blood sample to identify antibodies against HIV.

In 1996 the Food and Drug Administration (FDA) approved a test kit that people can use at home called the Home Access HIV-1 Test. The person pricks their finger on a special blotting card and mails it back to the company. The sample is identified only by a code number, which allows the person to remain completely anonymous. The test costs about \$45 and results are available in seven days.

An important point to keep in mind is that it may take the body several weeks to three months after a person is infected to produce enough antibodies to HIV to be detected by a blood test. This period of time is called the window period. A person who tests negative for HIV infection after high-risk behaviors

should wait three months and have another blood test to make sure they are not infected.

The doctor may also order a **complete blood count** and a stool test if the patient is suspected of having intestinal parasites.

**IMAGING TESTS.** The doctor may order a chest x-ray if opportunistic infections of the lung are suspected, or a **magnetic resonance imaging** (MRI) study of the brain if the patient has signs of AIDS dementia complex (ADC).

### *Diagnosis in children*

The CDC recommends HIV testing as a part of standard prenatal care for all pregnant women. When a pregnant woman tests positive for HIV, testing of her infant ideally begins within 48 hours of birth. Testing is repeated at between one and two months of age and again at age 3–6 months. Testing of infants uses a different technique to detect the presence of HIV virus. Infants can be diagnosed by direct culture of the HIV virus, PCR testing, and p24 antigen testing. By one month of age, results are highly accurate. Diagnostic blood testing in children older than 18 months is similar to adult testing, with ELISA screening confirmed by Western blot.

In terms of symptoms, children are less likely than adults to have an early acute syndrome. They are, however, likely to have delayed growth, a history of frequent illness, recurrent ear infections, a low **white blood cell count**, failure to gain weight, and unexplained fevers. Children with AIDS are more likely to develop bacterial infections, inflammation of the lungs, and AIDS-related brain disorders than are HIV-positive adults.

### *Procedures*

If the patient appears to have an opportunistic infection of the nervous system, the doctor may order a **lumbar puncture** in order to test a sample of spinal fluid. In some cases the doctor may take a sample of nerve, skin, or muscle tissue for a biopsy.

### *Treatment*

Because there is no cure for AIDS, all forms of HIV/AIDS therapy are focused on improving the quality and length of life for people who are infected by slowing or halting the replication of the virus and treating or preventing infections and cancers that often develop in people with AIDS.

#### *Traditional*

##### *Drugs*

Medications are the mainstay of AIDS treatment. Drug treatment guidelines for HIV/AIDS change

frequently as new drugs are approved and new drug regimens developed. Two principles currently guide doctors in developing drug regimens for AIDS patients: using combinations of drugs rather than one medication alone; and basing treatment decisions on the results of the patient's viral load tests. Current information on United States Food and Drug Administration-(FDA) approved drugs by class can be found at the United States Department of Health and Human Services AIDS Info Website at <http://www.aidsinfo.nih.gov/DrugsNew/Default.aspx?MenuItem=Drugs>. Individuals interested in participating in a trial of new HIV/AIDS drugs under development can find a list of clinical trials currently accepting volunteers at <http://www.clinicaltrial.gov>. There is no cost to volunteers to participate and some medical care and testing is provided.

**POST-EXPOSURE PROPHYLAXIS (PEP).** Post-exposure prophylaxis (PEP) is a four- to eight-week course of **antiretroviral drugs** given to persons immediately after exposure (through **rape**, unprotected sex, or needlestick injuries) to HIV to prevent them from being infected by the virus. To be effective, PEP must be started within 48 hours of exposure. It has some unpleasant side effects, including severe **nausea** and headaches.

**TREATMENT OF OPPORTUNISTIC INFECTIONS AND MALIGNANCIES.** Most AIDS patients require complex long-term treatment with medications for infectious diseases. This treatment is often complicated further by the development of resistance in the disease organisms. AIDS-related malignancies in the central nervous system are usually treated with **radiation therapy**. Cancers elsewhere in the body are treated with **chemotherapy**.

**PROPHYLACTIC TREATMENT FOR OPPORTUNISTIC INFECTIONS.** Prophylactic treatment is treatment that is given to prevent disease. AIDS patients with a history of *Pneumocystis pneumonia*, with CD4+ counts below 200 cells/mm<sup>3</sup> or 14% of lymphocytes, weight loss, or thrush should be given prophylactic medications. Drugs that may be given include **antibiotics** such as trimethoprim-sulfamethoxazole (Bactrim) or pentamidine (Pentam-300, Pentacarinat) and anti-fungals such as amphotericin B (AmBisome), flucytosine (Ancobon), and clotrimazole (Lotrim AF, Mycelex, Femizole-7). All these drugs can have undesirable side effects.

**ANTIVIRAL TREATMENTS.** When a person tests positive for HIV infection, the doctor will measure the amount of virus in the patient's blood. This level is called the viral load. The viral load helps the doctor to

## KEY TERMS

**Acquired immune deficiency syndrome (AIDS)**—HIV infection that has led to certain opportunistic infections, cancers, or a CD4+ T-lymphocyte (helper cell) blood cell count lower than 200/mL.

**Acute retroviral syndrome (ARS)**—A syndrome that develops in about 30% of HIV patients within a few weeks of infection. ARS is characterized by nausea, vomiting, fever, headache, general tiredness, and muscle cramps.

**AIDS dementia complex**—A type of brain dysfunction caused by HIV infection that causes difficulty thinking, confusion, and loss of muscular coordination.

**Carrier**—A person who bears or carries a disease agent in or on their body and can transmit the disease to others, but is immune to the disease or has no symptoms of it.

**CD4**—A type of protein molecule in human blood. The HIV virus infects cells with CD4 surface proteins and, as a result, depletes the number of T cells, B cells, natural killer cells, and monocytes in the patient's blood.

**Dietitian**—A health care professional who specializes in individual or group nutritional planning, public education in nutrition, or research in food science.

To be licensed as a registered dietitian (RD) in the United States, a person must complete a bachelor's degree in a nutrition-related field and pass a state licensing examination. Dietitians are also called nutritionists.

**Highly active antiretroviral therapy (HAART)**—An individualized combination of three or more antiretroviral drugs used to treat patients with HIV infection. It is sometimes called a drug cocktail.

**Kaposi's sarcoma**—A cancer of the connective tissue that produces painless purplish red (in people with light skin) or brown (in people with dark skin) blotches on the skin. It is a major diagnostic marker of AIDS.

**Lipodystrophy**—The medical term for redistribution of body fat in response to HAART, insulin injections in diabetics, or rare hereditary disorders.

**Lymphoma**—A cancerous tumor in the lymphatic system that is associated with a poor prognosis in AIDS patients.

**Malabsorption syndrome**—A condition characterized by indigestion, bloating, diarrhea, loss of appetite, and weakness, caused by poor absorption of nutrients from food as a result of HIV infection itself, giardiasis or other opportunistic infections of the

decide when to start drug treatment for HIV. The current method of treatment is called highly active antiretroviral therapy or HAART. Introduced in 1996, HAART consists of combinations of three or more different drugs from two or more of the seven classes of antiretroviral drugs presently available. HAART is not a cure for AIDS, but it reduces the viral load, improves the patient's overall quality of life, and extends life expectancy by four to 12 years.

**Antiviral drugs** suppress HIV replication, as distinct from treating its effects on the body. These drugs fall into several classes:

- Nucleotide reverse transcriptase inhibitors (also called nucleoside analogues). These drugs work by interfering with the action of HIV reverse transcriptase inside infected cells, thus ending the virus's replication process. These drugs include zidovudine (Retrovir), lamivudine (Epivir), and abacavir (Ziagen) and many others. They are often used in used in multi-drug combinations.

- Non-nucleoside reverse transcriptase inhibitors. This class of drugs binds to an enzyme that is necessary for the HIV virus to reproduce. Examples of drugs in this class are viramune, delavirdine (Rescriptor), and efavirenz (Sustiva) and others.
- Protease inhibitors. Protease inhibitors work by disabling protease, an enzyme necessary for HIV reproduction. Protease inhibitors include saquinavir (Invirase), ritonavir (Norvire), indinavir (Crixivan), nelfinavir (Viracept), amprenavir (Agenerase), kaletra, and many others.
- Integrase inhibitors. Integrase inhibitors prevent the virus from inserting its own genetic material into the DNA of the infected cell. This stops the virus from replicating. Integrase was the only FDA-approved drug in this class as of early 2009. Several investigational drugs in this category were in clinical trials at that time.
- Fusion inhibitors and entry inhibitors. Fusion inhibitors block specific proteins on the surface of the virus or the CD4+ cell. These proteins help the

digestive tract, or certain surgical procedures involving the stomach or intestines.

**Non-nucleoside reverse transcriptase inhibitors—**

The newest class of antiretroviral drugs that work by inhibiting the reverse transcriptase enzyme necessary for HIV replication.

**Nucleoside analogues—**The first group of effective anti-retroviral medications. They work by interfering with the AIDS virus' synthesis of DNA.

**Opportunistic infection—**An infection caused by an organism that does not cause disease in a person with a healthy immune system.

**Pandemic—**An infectious disease that spreads across a large region or even worldwide.

**Post-exposure prophylaxis (PEP)—**A four-week course of antiretroviral drugs given to people immediately following exposure to HIV infection from rape, unprotected sex, needlestick injuries, or sharing needles.

**Protease inhibitors—**The second major category of drug used to treat AIDS that works by suppressing the replication of the HIV virus.

**Retrovirus—**A virus that uses its RNA to produce DNA and add that DNA to the genetic material of infected cells.

virus gain entry into the cell. The only FDA-approved fusion inhibitor as of early 2009 was enfuvirtide (Fuzeon). Entry inhibitors block HIV from entering cells. The only FDA-approved fusion inhibitor as of early 2009 was maraviroc (Selzentry). Several drugs in this class are, in pre-approval clinical trials.

HAART has several drawbacks. First, it is a very expensive form of treatment. In addition, many of the drugs used in HAART have troublesome side effects; as a result, some AIDS patients simply stop taking their medications. Last, some patients develop resistance to the antiretroviral drugs and no longer respond to treatment. The doctor can sometimes switch one of the drugs in the patient's combination to another drug within the same class.

Another problem with HAART is the complicated dosing schedules of the different drugs prescribed for an individual patient. To encourage adherence to treatment schedules (which must be at least 98 percent complete to protect the patient from developing a strain of the virus

**Seroconversion—**The development of detectable specific antibodies in a patient's blood serum as a result of infection or immunization.

**T-lymphocyte—**A type of white blood cell, also known as a T-helper cell, a  $T_h$  cell, an effector T cell, or a CD4+ T cell, whose numbers in a blood sample can be used to monitor the progression of HIV infection.

**Viral load—**A measure of the severity of HIV infection, calculated by estimating the number of copies of the virus in a milliliter of blood.

**Wasting syndrome—**A combination of weight loss and change in composition of body tissues that occurs in patients with HIV infection. Typically, the patient's body loses lean muscle tissue and replaces it with fat as well as losing weight overall.

**Western blot—**A procedure that uses electrical current passed through a gel containing a sample of tissue extract in order to break down the proteins in the sample and detect the presence of antibodies for a specific disease. The Western blot method is used in HIV testing to confirm the results of an initial screening test.

**Window period—**The period of time between a person's getting infected with HIV and the point at which antibodies against the virus can be detected in a blood sample.

resistant to HAART), some pharmaceutical companies have developed fixed-dose combinations—medications in which several antiretroviral drugs that are known to work well together are combined in a single pill.

**STIMULATION OF BLOOD CELL PRODUCTION.** Because many patients with AIDS have abnormally low levels of both red and white blood cells, they may be given medications to stimulate blood cell production. Epoetin alfa (erythropoietin) may be given to anemic patients. Patients with low white blood cell counts may be given filgrastim or sargramostim.

### *Alternative*

AIDS patients turn to alternative medicine when conventional treatments are ineffective and to supplement conventional treatment, reduce disease symptoms, counteract drug effects, and improve quality of life. Because alternative medicines may interact with conventional medicines, it is important for patients with HIV infection to inform their doctors of all treatments being used.

CAM treatments that have been recommended for AIDS patients include multivitamin therapy, **acupuncture, yoga, massage therapy**, and the use of relaxation techniques to improve mood and relieve depression. Some studies indicate that naturopathic treatments slow the progression of HIV infection even though they cannot cure it. Interestingly, a study published in 2007 reported that seniors with AIDS are just as likely to use complementary therapies since the introduction of HAART as they were before 1996. The study also reported that men who used CAM were more likely to be college-educated, to have contracted HIV through intravenous drug use rather than through sex with other men, and to be African American rather than Caucasian.

The National Center for Complementary and Alternative Medicine (NCCAM) announced plans in 2007 to conduct a three-year study of CAM therapies used by adults diagnosed with HIV. According to the center, between 47 and 74% of HIV-positive persons in the United States have used some type of CAM approach—most often to relieve the side effects of HAART as well as to improve overall well-being. The study is scheduled to run from 2009 through 2011.

### Prognosis

There was no cure for AIDS as of 2010. Without treatment, HIV infection progresses to AIDS in an average of 11 years. After diagnosis with AIDS, the patient has a life expectancy of 9.2 months without treatment. A person diagnosed with HIV infection who begins treatment with HAART has a life expectancy of about 20 years as of 2010. Unfortunately, about half of patients who begin treatment with HAART fail to benefit from it as much as they had hoped and discontinue it.

About 37% of patients with AIDS eventually develop AIDS dementia complex, with another 30% showing milder symptoms of dementia. Women with AIDS are at slightly higher risk than men of developing ADC.

Older adults generally have a worse prognosis than younger adults diagnosed with AIDS. The earlier stages of HIV infection progress more rapidly to AIDS in seniors, the initial CD4+ T cell counts are lower, and the survival period is shorter. Whereas 80 percent of younger adults survive for a year after being diagnosed with AIDS, only 40% of seniors survive that long.

The reasons for the poorer prognosis in older adults were not fully understood as of 2010. Various explanations include delayed diagnosis due to the fact

that the early symptoms of HIV infection are easily confused with those of other diseases commonly found in older persons; inadequate treatment; the high rate of other diseases and disorders in the elderly that can further weaken the immune system; a lower rate of compliance with treatment regimens; and age-related changes in the immune system itself. It is thought that the immune system in older adults is less efficient in replacing T helper cells and so is more easily overwhelmed by HIV infection.

### Prevention

There was no vaccine against HIV infection as of 2010; moreover, it is unlikely that an effective vaccine will be developed in the foreseeable future because the retrovirus that causes AIDS mutates so rapidly. Although various vaccines against HIV have been tested by the National Institutes of Health since 1996, none have so far been approved for use outside clinical trials.

Researchers are, however, actively working on producing preventative and therapeutic vaccines for HIV. Preventative vaccines immunize an individual against a disease, so that he or she does not become infected. A therapeutic vaccine, also called a treatment vaccine, does not keep someone from getting a disease the way a preventative vaccine does. Instead, therapeutic vaccines are used to boost the body's immune system in order to help control infection. The potential exists to prolong life indefinitely using these and other drug therapies to boost the immune system, keep the virus from replicating, and ward off opportunistic infections and malignancies.

People can lower their risk of HIV infection by taking the following precautions recommended by the CDC:

- Limit sexual activity to a single partner who is known to be uninfected and is faithful
- Use a condom when having sex with anyone whose HIV status is unknown
- Do not share needles or inject illegal drugs
- Do not exchange sex for drugs
- Health care workers should follow guidelines for protecting against needle sticks and other accidental exposures to body fluids that may be contaminated with HIV
- Get tested for HIV infection after engaging in high-risk activities; if the test results are positive, inform all current sexual partners

## Diet and nutritional concerns

Diet and **nutrition** are a major part of managing HIV infection and AIDS. While there is no standard “HIV diet” or “AIDS diet” because patients’ symptoms, medication regimens, and corresponding nutritional needs vary so widely, there are general practices followed by registered dietitians who work with doctors and other health care professionals to care for these patients.

The function of nutritional education and dietary management in patients with HIV infection and AIDS is to maintain the patient’s energy level and ability to carry out normal activities of daily life; lower the risk of opportunistic infections of the digestive system; and minimize the side effects of HAART on the patient’s ability to eat and enjoy food.

### *Dietetics consultation and follow-up*

Patients with HIV infection should consult a registered dietitian (RD) as soon as possible after diagnosis, because good nutrition is essential to maintaining a normal level of activity and self-care as well as supporting the patient’s immune system. RDs use several screening questionnaires to evaluate patients for potential nutritional problems. On the patient’s first visit, he or she is given a quick nutrition screen or QNS to fill out. The QNS identifies such problems as unintentional weight loss, nausea, difficulty swallowing, and **diarrhea**. The dietitian then measures the patient’s height, weight, skinfold thickness, and the circumference of the muscles on the patient’s midarm. These last two measurements are needed in order to monitor changes in body fat distribution and muscle wasting that often accompany HIV infection.

The next step in the initial assessment is the patient’s completion of a food intake record (FIR). The patient is asked to record everything he or she eats or drinks in a 24-hour period, including snacks and alcoholic beverages. If possible, the patient will fill out two FIRs, one for a working day and one for a weekend day or holiday. The FIR allows the dietitian to evaluate the patient’s usual eating habits, portion sizes, food preferences, and average calorie intake. It also establishes a baseline for the individual patient, so that loss of appetite later on or other nutritional problems can be detected as quickly as possible.

Follow-up visits to the dietitian are scheduled according to the degree of the patient’s nutritional risk. The American Dietetic Association and the Los Angeles County Commission on HIV Health Services

use the following timelines for HIV patients at nutritional risk:

- Low risk: The patient’s weight is stable, with a balanced and adequate food intake; normal blood levels of cholesterol, triglycerides, and glucose; no evidence of kidney or liver disorders; regular physical exercise; and low levels of psychosocial stress. Low-risk patients are evaluated by the RD as needed, but at least once a year.
- Moderate risk: The patient is obese or suffers from changing patterns of body fat distribution; has high blood cholesterol levels or high blood pressure; has developed an eating disorder, nausea, vomiting, or diarrhea; has been recently diagnosed with type 2 diabetes or food allergies; is in recovery from substance abuse; or is under psychosocial stress. Moderate-risk patients should be seen by the RD within a month.
- High risk: The patient is pregnant; suffers from poorly controlled diabetes; has lost 10% of body weight over the previous 4–6 months; has lost 5% of body weight in the previous 4 weeks; has dental problems, involvement of the central nervous system, severe nausea or vomiting, severe pain on swallowing, or chronic diarrhea; has one or more opportunistic infections; or is under severe psychosocial stress. These patients should be seen by an RD within one week.

In addition to assessment of the patient’s nutritional needs, RDs also evaluate his or her living situation and other issues that may affect receiving adequate nutrition.

### *Specific issues in nutritional care of HIV patients*

**NAUSEA, VOMITING, AND DIARRHEA.** **Nausea** and **vomiting** are common symptoms of HIV infection as well as side effects of HAART. They can lead to long-term damage to the esophagus and dental problems as well as weight loss and inability to take needed medications. About 30% of patients develop nausea and **vomiting** within one to four weeks following infection as part of a condition called acute retroviral syndrome or ARS, which resembles **influenza** or mononucleosis. Most patients, however, develop nausea, **vomiting**, and diarrhea later on in the course of the disease as side effects of HAART or from opportunistic infections of the gastrointestinal system. Patients with HIV infection are highly susceptible to such diseases as **giardiasis**, **cryptosporidiosis**, **listeriosis**, *Campylobacter* infections, and *Salmonella* infections.

Treatment of nausea, vomiting, and diarrhea in patients with HIV infections may require a number of diagnostic tests and imaging studies as well as evaluation of the patient's medications in order to determine the cause(s) of the symptoms.

**LIPODYSTROPHY.** Lipodystrophy is the medical term for the redistribution of body fat that sometimes occurs in patients with HIV infection as a result of HAART, genetic factors, the length of time a person has been HIV-positive, and the severity of the disease. It is not completely understood why antiretroviral drugs and other factors have this effect. The patient may notice new deposits of fat at the back of the neck (sometimes called "buffalo humps") and around the abdomen. Conversely, fat may be lost under the skin of the face, resulting in sunken cheeks, or lost under the skin of the buttocks, arms, or legs. Lipodystrophy is not necessarily associated with weight loss.

Lipodystrophy may be accompanied by other changes in the patient's metabolism, particularly **insulin resistance** and higher levels of blood cholesterol and **triglycerides**. One recommendation nutritionists often give to patients with lipodystrophy and metabolic changes is to follow the **Mediterranean diet**, which is high in fiber-rich whole grains and vegetables and low in saturated fats. Another recommendation is to maintain a schedule of regular physical **exercise** (particularly weight training), which has been shown to lower insulin resistance and decrease abdominal fat deposits.

**WASTING.** Wasting refers to rapid unintentional weight loss (usually defined as 5% of body weight over a period of six months) combined with changes in the composition of body tissue. Specifically, the patient is losing lean muscle tissue and replacing it with fat. The patient's outward appearance may not be a reliable guide to wasting, particularly if he or she also has lipodystrophy. Weight loss associated with wasting may result from nausea and vomiting related to opportunistic infections of the digestive tract as well as from reactions to medication.

Nutrition is the first line of defense against wasting. To help the patient maintain weight, nutritionists recommend raising the daily calorie intake from 17–20 calories per pound of body weight (a guideline used for patients whose weight has been stable) to 25 calories per pound. Patients with wasting syndrome may require as much as 3500 calories per day to maintain their weight. Nutrient ratios should be 15–20% protein, 50–60% carbohydrates, and 25% fats to protect the body's muscle tissue. Patients who need more calories or protein may benefit from adding such

supplements as Ensure or Instant Breakfast to their daily diet. In addition, weight training or other forms of regular exercise help to maintain muscle tissue.

Other treatments for wasting include the use of appetite stimulants to increase food intake and hormonal treatments to build lean muscle tissue, particularly in male patients.

**MEDICATION INTERACTIONS.** Most medications used in HAART have the potential to cause nausea and vomiting. Some antiretroviral medications should be taken with food to minimize these side effects. Digestive disturbances are the single most common reason given by patients for discontinuing antiretroviral therapy. In some cases, switching to a different combination of drugs helps to relieve nausea, vomiting, or diarrhea.

**FOOD SAFETY ISSUES.** Food safety is an important concern for patients with HIV infection because their immune systems have difficulty fighting off food or water-borne disease organisms. While most people can get **food poisoning** or parasitic infections of the digestive tract if they drink contaminated water or do not prepare food properly, patients with HIV infection can get severely ill as a result of these diseases. Food-borne illnesses are also much more difficult to treat in persons with AIDS or HIV infection, and may lead to **malabsorption syndrome**, a condition in which the body cannot absorb and make use of needed nutrients in food.

The CDC and NIH have brochures with detailed instructions for patients about safety issues in purchasing and preparing foods, particularly when traveling abroad. Basic safeguards include the following:

- Wash hands repeatedly in warm soapy water before and after preparing or eating food; instant hand sanitizers should be used when away from home
- Cook all meats, fish, and poultry to the well-done stage; do not eat sushi, raw oysters, or raw meat in any form
- Do not use unpasteurized milk or dairy products
- Do not eat raw, soft-boiled, or "wet" scrambled eggs, or Caesar salad made with raw egg in the dressing; hard-boiled or hard-scrambled eggs are safe
- Rinse all fruits and vegetables carefully in clean, safe water, and clean all cutting boards and knives that touch chicken and meat with soap and hot water before using these utensils with other food items
- Keep all refrigerated foods below 40°F; check expiration dates on food packaging

- Completely reheat leftovers before eating, and do not eat leftovers that have been stored in the refrigerator for longer than 3 days
- Do not drink water that comes directly from lakes, streams, rivers, or springs, and ask for drinks without ice in restaurants

### **Caregiver concerns**

A caregiver for an older adult with AIDS should be concerned with the following:

- Complete compliance with the senior's HAART regimen. Failure to take the medications exactly as directed can lead to resistant forms of HIV and eventual treatment failure. A handout for patients on how to take antiretroviral medications is available on the American Academy of Family Physicians website at <http://www.aafp.org/afp/20030815/689ph.html>
- Nausea, vomiting, and weight loss, or signs of lipodystrophy or wasting syndrome; the doctor may recommend a consultation with a professional dietitian
- Signs of dementia; AIDS-related dementia in seniors is often misdiagnosed as Alzheimer's disease
- Signs of drug interactions between the senior's anti-retroviral therapy and medications he or she may be taking for other diseases
- Signs of upper respiratory infections, particularly pneumonia or thrush
- Skin disorders, including changes in the skin that may indicate cancer

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- Public Broadcasting System (PBS) Frontline. *The Age of AIDS*. <http://www.pbs.org/wgbh/pages/frontline/aids>

## ORGANIZATIONS

- Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333 800-232-4636, [cdclinfo@cdc.gov](mailto:cdclinfo@cdc.gov), <http://www.cdc.gov>.
- Food and Drug Administration (FDA), 10903 New Hampshire Ave., Silver Spring, MD, 20993 888-INFO-FDA, <http://www.fda.gov/>.
- Gay Men's Health Crisis (GMHC), Tisch Building, 119 West 24th Street, New York, NY, 10011 212-367-1000, <http://www.gmhc.org/>.
- Infectious Diseases Society of America (IDSA), 1300 Wilson Blvd, Suite 300, Arlington, VA, 22209 703-299-0200 703-299-0204, <http://www.idsociety.org/>.
- National Institute of Allergy and Infectious Diseases (NIAID), 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612 301-496-5717 866-284-4107 301-402-3573, <http://www3.niaid.nih.gov>.
- International AIDS Society (IAS), Ave. Louis Casai 71, P. O. Box 28, Geneva, Switzerland, CH - 1216 Cointrin + 41-(0)22-7 100 800 + 41-(0)22-7 100 899, [info@iasociety.org](mailto:info@iasociety.org), <http://www.iasociety.org/>.
- World Health Organization (WHO), Avenue Appia 20, 1211 Geneva 27, Switzerland + 41 22 791 21 11 + 41 22 791 31 11, [info@who.int](mailto:info@who.int), <http://www.who.int/en/>.

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AIDS serology see **AIDS tests**

## AIDS tests

### Definition

**AIDS** tests, short for acquired **immunodeficiency** syndrome tests, cover a number of different procedures used in the diagnosis and treatment of HIV patients. These tests sometimes are called AIDS

serology tests. Serology is the branch of immunology that deals with the contents and characteristics of blood serum. Serum is the clear light yellow part of blood that remains liquid when blood cells form a clot. AIDS serology evaluates the presence of human immunodeficiency virus (HIV) infection in blood serum and its effects on each patient's immune system.

### Purpose

AIDS serology serves several different purposes. Some AIDS tests are used to diagnose patients or confirm a diagnosis; others are used to measure the progression of the disease or the effectiveness of specific treatment regimens. Some AIDS tests also can be used to screen blood donations for safe use in transfusions.

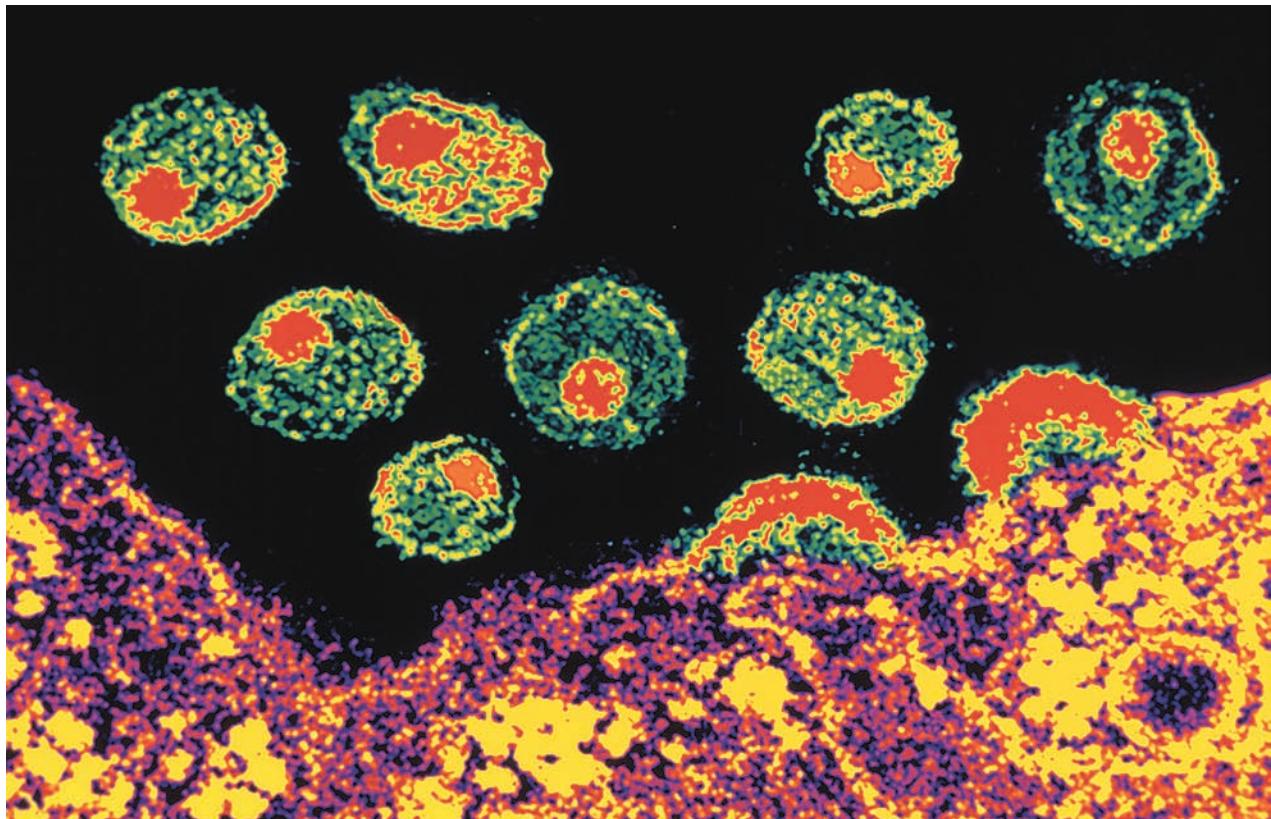
In order to understand the different purposes of the blood tests used with AIDS patients, it is helpful to understand how HIV infection affects human blood and the immune system. HIV is a retrovirus that enters the blood stream of a new host in the following ways:

- by sexual contact
- by contact with infected body fluids (such as blood and urine)
- by transmission during pregnancy, or
- through transfusion of infected blood products

A retrovirus is a virus that contains a unique enzyme called reverse transcriptase that allows it to replicate within new host cells. The virus binds to a protein called CD4, which is found on the surface of certain subtypes of white blood cells, including helper T cells, macrophages, and monocytes. Once HIV enters the cell, it can replicate and kill the cell in ways that are still not completely understood. In addition to killing some lymphocytes directly, the AIDS virus disrupts the functioning of the remaining CD4 cells. CD4 cells ordinarily produce a substance called interleukin-2 (IL-2), which stimulates other cells (T cells and B cells) in the human immune system to respond to infections. Without the IL-2, T cells do not reproduce as they normally would in response to the HIV virus, and B cells are not stimulated to respond to the infection.

### Precautions

In some states such as New York, a signed consent form is needed in order to administer an AIDS test. As with all blood tests, healthcare professionals should always wear latex gloves and avoid being pricked by the needle used in drawing blood for the tests. It may



**Mature HIV-1 viruses (above) and the lymphocyte from which they emerged (below). Two immature viruses can be seen budding on the surface of the lymphocyte (right of center).** (Scott Camazir/Photo Researchers, Inc.)

be difficult to get blood from a habitual intravenous drug user due to collapsed veins.

## Description

### Diagnostic tests

Diagnostic blood tests for AIDS usually are given to persons in high-risk populations who may have been exposed to HIV or who have the early symptoms of AIDS. Most persons infected with HIV will develop a detectable level of antibody within three months of infection. The condition of testing positive for HIV antibody in the blood is called seroconversion, and persons who have become HIV-positive are called seroconverters.

It is possible to diagnose HIV infection by isolating the virus itself from a blood sample or by demonstrating the presence of HIV antigen in the blood. Viral culture, however, is expensive, not widely available, and slow—it takes 28 days to complete the viral culture test. More common are blood tests that work by detecting the presence of antibodies to the HIV virus. These tests are inexpensive, widely available, and accurate in

detecting 99.9% of AIDS infections when used in combination to screen patients and confirm diagnoses.

### ENZYME-LINKED IMMUNOSORBENT ASSAY (ELISA).

This type of blood test is used to screen blood for transfusions as well as diagnose patients. An ELISA test for HIV works by attaching HIV antigens to a plastic well or beads. A sample of the patient's blood serum is added, and excess proteins are removed. A second antibody coupled to an enzyme is added, followed by addition of a substance that will cause the enzyme to react by forming a color. An instrument called a spectrophotometer can measure the color. The name of the test is derived from the use of the enzyme that is coupled or linked to the second antibody.

The latest generation of ELISA tests are 99.5% sensitive to HIV. Occasionally, the ELISA test will be positive for a patient without symptoms of AIDS from a low-risk group. Because this result is likely to be a false-positive, the ELISA must be repeated *on the same sample of the patient's blood*. If the second ELISA is positive, the result should be confirmed by the Western blot test.

**WESTERN BLOT (IMMUNOBLOTT).** The Western blot or immunoblot test is used as a reference procedure to

confirm the diagnosis of AIDS. In Western blot testing, HIV antigen is purified by electrophoresis (large protein molecules are suspended in a gel and separated from one another by running an electric current through the gel). The HIV antigens are attached by blotting to a nylon or nitrocellulose filter. The patient's serum is reacted against the filter, followed by treatment with developing chemicals that allow HIV antibody to show up as a colored patch or blot. A commercially produced Western blot test for HIV-1 is now available. It consists of a prefabricated strip that is incubated with a sample of the patient's blood serum and the developing chemicals. About nine different HIV-1 proteins can be detected in the blots.

When used in combination with ELISA testing, Western blot testing is 99.9% specific. It can, however, yield false negatives in patients with very early HIV infection and in those infected by HIV-2. In some patients the Western blot yields indeterminate results.

**IMMUNOFLUORESCENCE ASSAY (IFA).** This method is sometimes used to confirm ELISA results instead of Western blotting. An IFA test detects the presence of HIV antibody in a sample of the patient's serum by mixing HIV antigen with a fluorescent chemical, adding the blood sample, and observing the reaction under a microscope with ultraviolet light.

**POLYMERASE CHAIN REACTION (PCR).** This test is used to evaluate the very small number of AIDS patients with false-negative ELISA and Western blot tests. These patients are sometimes called antibody-negative asymptomatic (without symptoms) carriers, because they do not have any symptoms of AIDS and there is no detectable quantity of antibody in the blood serum. Antibody-negative asymptomatic carriers may be responsible for the very low ongoing risk of HIV infection transmitted by blood transfusions. It is estimated that the risk is between one in 10,000 and one in 100,000 units of transfused blood.

The polymerase chain reaction (PCR) test can measure the presence of viral nucleic acids in the patient's blood even when there is no detectable antibody to HIV. This test works by amplifying the presence of HIV nucleic acids in a blood sample. Numerous copies of a gene are made by separating the two strands of DNA containing the gene segment, marking its location, using DNA polymerase to make a copy, and then continuously replicating the copies. It is questionable whether PCR will replace Western blotting as the method of confirming AIDS diagnoses. Although PCR can detect the low number of persons (1%) with HIV infections that have not yet generated an antibody response to the virus, the overwhelming

majority of infected persons will be detected by ELISA screening within one to three months of infection. In addition, PCR testing is based on present knowledge of the genetic sequences in HIV. Since the virus is continually generating new variants, PCR testing could yield a false negative in patients with these new variants. In 2004, researchers reported on a new test that was more sensitive to HIV, detecting the infection in as little as 12 days after infection. However, the manufacturer was still seeking FDA approval for the test, which would cost about the same as PCR testing.

In 1999, the U.S. Food and Drug Administration (FDA) approved an HIV home testing kit. The kit contained multiple components, including material for specimen collection, a mailing envelope to send the specimen to a laboratory for analysis, and provides pre- and post-test counseling. It uses a finger prick process for blood collection. Other tests have been in development that would allow patients to monitor their own therapy in the home without sending out for results.

### *Prognostic tests*

Blood tests to evaluate patients already diagnosed with HIV infection are as important as the diagnostic tests. Because AIDS has a long latency period, some persons may be infected with the virus for 10 years or longer before they develop symptoms of AIDS. These patients are sometimes called antibody-positive asymptomatic carriers. Prognostic tests also help drug researchers evaluate the usefulness of new medications in treating AIDS.

**BLOOD CELL COUNTS.** Doctors can measure the number or proportion of certain types of cells in an AIDS patient's blood to see whether and how rapidly the disease is progressing, or whether certain treatments are helping the patient. These cell count tests include:

- **Complete blood count (CBC).** A CBC is a routine analysis performed on a sample of blood taken from the patient's vein with a needle and vacuum tube. The measurements taken in a CBC include a white blood cell count (WBC), a red blood cell count (RBC), the red cell distribution width, the hematocrit (ratio of the volume of the red blood cells to the blood volume), and the amount of hemoglobin (the blood protein that carries oxygen). Although CBCs are used on more than just AIDS patients, they can help the doctor determine if an AIDS patient has an advanced form of the disease. Specific AIDS-related signs in a CBC include a low hematocrit, a sharp decrease in the number of blood platelets, and a low level of a certain type of white blood cell called neutrophils.

- Absolute CD4+ lymphocytes. A lymphocyte is a type of white blood cell that is important in the formation of an immune response. Because HIV targets CD4+ lymphocytes, their number in the patient's blood can be used to track the course of the infection. This blood cell count is considered the most accurate indicator for the presence of an opportunistic infection in an AIDS patient. The absolute CD4+ lymphocyte count is obtained by multiplying the patient's white blood cell count (WBC) by the percentage of lymphocytes among the white blood cells, and multiplying the result by the percentage of lymphocytes bearing the CD4+ marker. An absolute count below 200-300 CD+4 lymphocytes in 1 cubic millimeter ( $\text{mm}^3$ ) of blood indicates that the patient is vulnerable to some opportunistic infections.
- CD4+ lymphocyte percentage. Some doctors think that this is a more accurate test than the absolute count because the percentage does not depend on a manual calculation of the number of types of different white blood cells. A white blood cell count that is broken down into categories in this way is called a WBC differential.

It is important for doctors treating AIDS patients to measure the lymphocyte count on a regular basis. Experts consulted by the United States Public Health Service recommend the following frequency of serum testing based on the patient's CD4+ level:

- CD4+ count more than 600 cells/ $\text{mm}^3$ : Every six months
- CD4+ count between 200-600 cells/ $\text{mm}^3$ : Every three months
- CD4+ count less than 200 cells/ $\text{mm}^3$ : Every three months

When the CD4+ count falls below 200 cells/ $\text{mm}^3$ , the doctor will put the patient on a medication regimen to protect him or her against opportunistic infections.

**HIV VIRAL LOAD TESTS.** Another type of blood test for monitoring AIDS patients is the viral load test. It supplements the CD4+ count, which can tell the doctor the extent of the patient's loss of immune function, but not the speed of HIV replication in the body. The viral load test is based on PCR techniques and can measure the number of copies of HIV nucleic acids. Successive test results for a given patient's viral load are calculated on a base 10 logarithmic scale.

**ORAL HIV TESTS.** Scientists have developed oral HIV tests that can be conducted with saliva samples. One of the unintended effects of these tests is the misperception that HIV can be transmitted through

saliva. Still, they present an excellent alternative to blood sample testing.

**RAPID HIV TESTS.** Researchers constantly work on more rapid tests for HIV that can be done in physician offices or by less skilled people and more convenient locations in developing countries. A finger-stick test that can be read quickly from a whole blood sample had shown promising results in the fall of 2003. Another test, called the VScan test kit, requires no refrigeration or electricity and can safely be stored at room temperature. Even if the positive results must be confirmed by ELISA or Western blotting, an accurate initial rapid test can help screen populations for HIV antibodies.

In 2004, a new three-minute test for HIV was launched in the United States under FDA approval. The hope of this test is that health care providers such as family practice physician offices can quickly test a patient in the office and provide results while the patient waits, rather than sending results to a lab.

**BETA<sub>2</sub>-MICROGLOBULIN (BETA<sub>2M</sub>).** Beta-microglobulin is a protein found on the surface of all human cells with a nucleus. It is released into the blood when a cell dies. Although rising blood levels of  $\beta_{2M}$  are found in patients with **cancer** and other serious diseases, a rising  $\beta_{2M}$  blood level can be used to measure the progression of AIDS.

**P24 ANTIGEN CAPTURE ASSAY.** Found in the viral core of HIV, p24 is a protein that can be measured by the ELISA technique. Doctors can use p24 assays to measure the antiviral activity of the patient's medications. In addition, the p24 assay is sometimes useful in detecting HIV infection before seroconversion. However, p24 is consistently present in only 25% of persons infected with HIV.

**GENOTYPIC DRUG RESISTANCE TEST.** Genotypic testing can help determine whether specific gene mutations, common in people with HIV, are causing drug resistance and drug failure. The test looks for specific genetic mutations within the virus that are known to cause resistance to certain drugs used in HIV treatment. For example the drug 3TC, also known as lamivudine (Epivir), is not effective against strains of HIV that have a mutation at a particular position on the reverse transcriptase protein—amino acid 184—known as M184V (M→V, methionine to valine). So if the genotypic resistance test shows a mutation at position M184V, it is likely the person is resistant to 3TC and not likely to respond to 3TC treatment. Genotypic tests are only effective if the person is already taking antiviral medication and if the viral

## KEY TERMS

**Antibody**—A protein in the blood that identifies and helps remove disease organisms or their toxins. Antibodies are secreted by B cells. AIDS diagnostic tests work by demonstrating the presence of HIV antibody in the patient’s blood.

**Antigen**—Any substance that stimulates the body to produce antibodies.

**B cell**—A type of white blood cell derived from bone marrow. B cells are sometimes called B lymphocytes. They secrete antibody and have a number of other complex functions within the human immune system.

**CD4**—A type of protein molecule in human blood that is present on the surface of 65% of human T cells. CD4 is a receptor for the HIV virus. When the HIV virus infects cells with CD4 surface proteins, it depletes the number of T cells, B cells, natural killer cells, and monocytes in the patient’s blood. Most of the damage to an AIDS patient’s immune system is done by the virus’ destruction of CD4+ lymphocytes. CD4 is sometimes called the T4 antigen.

**Complete blood count (CBC)**—A routine analysis performed on a sample of blood taken from the patient’s vein with a needle and vacuum tube. The measurements taken in a CBC include a white blood cell count, a red blood cell count, the red cell distribution width, the hematocrit (ratio of the volume of the red blood cells to the blood volume), and the amount of hemoglobin (the blood protein that carries oxygen). CBCs are a routine

blood test used for many medical reasons, not only for AIDS patients. They can help the doctor determine if a patient is in advanced stages of the disease.

**Electrophoresis**—A method of separating complex protein molecules suspended in a gel by running an electric current through the gel.

**Enzyme-linked immunosorbent assay (ELISA)**—A diagnostic blood test used to screen patients for AIDS or other viruses. The patient’s blood is mixed with antigen attached to a plastic tube or bead surface. A sample of the patient’s blood serum is added, and excess proteins are removed. A second antibody coupled to an enzyme is added, followed by a chemical that will cause a color reaction that can be measured by a special instrument.

**Human immunodeficiency virus (HIV)**—A transmissible retrovirus that causes AIDS in humans. Two forms of HIV are now recognized: HIV-1, which causes most cases of AIDS in Europe, North and South America, and most parts of Africa; and HIV-2, which is chiefly found in West African patients. HIV-2, discovered in 1986, appears to be less virulent than HIV-1, but also may have a longer latency period.

**Immunofluorescent assay (IFA)**—A blood test sometimes used to confirm ELISA results instead of using the Western blotting. In an IFA test, HIV antigen is mixed with a fluorescent compound and then with a sample of the patient’s blood. If HIV antibody

load is greater than 1,000 copies per milliliter (mL) of blood. The cost of the test, usually between \$300 and \$500, is now covered by many insurance plans.

**PHENOTYPIC DRUG RESISTANCE TESTING.** Phenotypic testing directly measures the sensitivity of a patient’s HIV to particular drugs and drug combinations. To do this, it measures the concentration of a drug required to inhibit viral replication in the test tube. This is the same method used by researchers to determine whether a drug might be effective against HIV before using it in human clinical trials. Phenotypic testing is a more direct measurement of resistance than genotypic testing. Also, unlike genotypic testing, phenotypic testing does not require a high viral load but it is recommended that persons already be taking **antiretroviral drugs**. The cost is between \$700 and \$900 and is now covered by many insurance plans.

### AIDS serology in children

Children born to HIV-infected mothers may acquire the infection through the mother’s placenta or during the birth process. Public health experts recommend the testing and monitoring of all children born to mothers with HIV. Diagnostic testing in children older than 18 months is similar to adult testing, with ELISA screening confirmed by Western blot. Younger infants can be diagnosed by direct culture of the HIV virus, PCR testing, and p24 antigen testing. These techniques allow a pediatrician to identify 50% of infected children at or near birth, and 95% of cases in infants three to six months of age.

### Preparation

Preparation and aftercare are important parts of AIDS diagnostic testing. Doctors are now advised to

is present, the mixture will fluoresce when examined under ultraviolet light.

**Lymphocyte**—A type of white blood cell that is important in the formation of antibodies. Doctors can monitor the health of AIDS patients by measuring the number or proportion of certain types of lymphocytes in the patient's blood.

**Macrophage**—A large white blood cell, found primarily in the bloodstream and connective tissue, that helps the body fight off infections by ingesting the disease organism. HIV can infect and kill macrophages.

**Monocyte**—A large white blood cell that is formed in the bone marrow and spleen. About 4% of the white blood cells in normal adults are monocytes.

**Opportunistic infection**—An infection that develops only when a person's immune system is weakened, as happens to AIDS patients.

**Polymerase chain reaction (PCR)**—A test performed to evaluate false-negative results to the ELISA and Western blot tests. In PCR testing, numerous copies of a gene are made by separating the two strands of DNA containing the gene segment, marking its location, using DNA polymerase to make a copy, and then continuously replicating the copies. The amplification of gene sequences that are associated with HIV allows for detection of the virus by this method.

**Retrovirus**—A virus that contains a unique enzyme called reverse transcriptase that allows it to replicate within new host cells.

take the patient's emotional, social, economic, and other circumstances into account and to provide counseling before and after testing. Patients are generally better able to cope with the results if the doctor has spent some time with them before the blood test explaining the basic facts about HIV infection and testing. Many doctors now offer this type of informational counseling before performing the tests.

## Aftercare

If the test results indicate that the patient is HIV-positive, he or she will need counseling, information, referral for treatment, and support. Doctors can either counsel the patient themselves or invite an experienced HIV counselor to discuss the results of the blood tests with the patient. They also will assess the patient's

**Seroconversion**—The change from HIV- negative to HIV-positive status during blood testing. Persons who are HIV-positive are called seroconverters.

**Serology**—The analysis of the contents and properties of blood serum.

**Serum**—The part of human blood that remains liquid when blood cells form a clot. Human blood serum is clear light yellow in color.

**T cells**—Lymphocytes that originate in the thymus gland. T cells regulate the immune system's response to infections, including HIV. CD4 lymphocytes are a subset of T lymphocytes.

**Viral load test**—A new blood test for monitoring the speed of HIV replication in AIDS patients. The viral load test is based on PCR techniques and supplements the CD4+ cell count tests.

**Western blot**—A technique developed in 1979 that is used to confirm ELISA results. HIV antigen is purified by electrophoresis and attached by blotting to a nylon or nitrocellulose filter. The patient's serum is reacted against the filter, followed by treatment with developing chemicals that allow HIV antibody to show up as a colored patch or blot. If the patient is HIV-positive, there will be stripes at specific locations for two or more viral proteins. A negative result is blank.

**WBC differential**—A white blood cell count in which the technician classifies the different white blood cells by type as well as calculating the number of each type. A WBC differential is necessary to calculate the absolute CD4+ lymphocyte count.

emotional and psychological status, including the possibility of violent behavior and the availability of a support network.

## Risks

The risks of AIDS testing are primarily related to disclosure of the patient's HIV status rather than to any physical risks connected with blood testing. Some patients are better prepared to cope with a positive diagnosis than others, depending on their age, sex, health, resources, belief system, and similar factors.

## Normal results

Normal results for ELISA, Western blot, IFA, and PCR testing are negative for HIV antibody.

Normal results for blood cell counts:

- WBC differential: Total lymphocytes 24–44% of the white blood cells
- Hematocrit: 40–54% in men; 37–47% in women
- T cell lymphocytes:  $644\text{--}2200/\text{mm}^3$ , 60–88% of all lymphocytes
- B cell lymphocytes:  $82\text{--}392/\text{mm}^3$ , 3–20% of all lymphocytes
- CD4+ lymphocytes:  $500\text{--}1200/\text{mm}^3$ , 34–67% of all lymphocytes

### Abnormal results

The following results in AIDS tests indicate progression of the disease:

- Percentage of CD4+ lymphocytes: less than 20% of all lymphocytes.
- CD4+ lymphocyte count: less than 200 cells/ $\text{mm}^3$
- Viral load test: Levels more than 5000 copies/mL
- $\beta$ -2-microglobulin: Levels more than 3.5 mg/dL
- P24 antigen: Measurable amounts in blood serum

### Resources

#### BOOKS

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- “Researchers Report New Ultra-sensitive AIDS Test.” *Bio-tech Week* (July 14, 2004): 246.

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Air embolism see **Gas embolism**

## Alagille syndrome

### Definition

Alagille syndrome (ALGS) is a rare genetic condition that affects the bile ducts of the liver primarily. It can also affect the heart, kidneys, skeleton, and

other parts of the body. ALGS is usually caused by a defect in the JAG1 gene and is known as Alagille syndrome 1 or ALGS1. Rarely it is caused by a defect in the NOTCH2 gene and is known as Alagille syndrome 2 or ALGS2. Other names for ALGS include:

- Alagille’s syndrome
- Alagille-Watson syndrome
- arteriohepatic dysplasia (AHD)
- cardiovertebral syndrome
- cholestasis with peripheral pulmonary stenosis
- hepatic ductular hypoplasia
- hepatofacionurocardiovertebral syndrome
- JAG1-related Alagille syndrome
- NOTCH2-related Alagille Syndrome
- paucity of interlobular bile ducts
- syndromatic hepatic ductular hypoplasia
- syndromic bile duct paucity
- Watson-Miller syndrome

### Demographics

Alagille syndrome is very rare, occurring in only one out of 70,000–100,000 live births. However since symptoms of the disorder are often extremely mild, the true incidence may be closer to one in 20,000. The condition affects males and females equally.

### Description

Liver damage caused by narrowed, malformed, and a reduced number of bile ducts is a major feature of Alagille syndrome. Bile, which helps digest fats, is carried from the liver to the gallbladder and small intestine by ducts. During their first year or two, children with AGS usually lose bile ducts in the liver and have a narrowing of the ducts outside the liver. Bile builds up in the liver causing scarring, which leads to **cirrhosis** in about 30–50% of children with AGS. In addition to **liver disease** AGS can cause:

- characteristic facial features
- heart murmur or other heart defects
- ophthalmologic (eye) problems
- abnormalities in blood vessels in the brain, kidneys, and spinal cord
- an unusual “butterfly” shape in the bones of the spinal cord
- a variety of rarer symptoms

Most cases of ALGS are caused by changes or mutations in the JAG1 gene on the short arm of chromosome 20. The JAG1 gene encodes a cell-surface

## KEY TERMS

**Amniocentesis**—The insertion of a needle through the abdomen into the uterus at 16–18 weeks of gestation to withdraw a small sample of the amniotic fluid surrounding the fetus to test for genetic disorders and other medical conditions.

**Bile**—A liquid secreted by the liver and passed through ducts to the small intestine where it aids in the digestion and absorption of fats.

**Bilirubin**—A red-yellow pigment in the bile and blood; excessive accumulation of bilirubin results in jaundice.

**Chorionic villus sampling (CVS)**—The insertion of a needle through the abdomen or cervix at 10–12 weeks of gestation and the removal of cells from around the embryo to test for chromosome abnormalities or other genetic disorders.

**Cirrhosis**—Disruption of liver function due to damage from chronic progressive disease.

**Jaundice**—Yellowing of the eyes and skin due to the buildup of bilirubin in the blood.

**Xanthomas**—Fatty yellow patches or nodules on the skin or internal tissues.

protein that is active in many cell types. The JAG1 protein interacts with the protein encoded by the NOTCH2 gene to trigger interactions between neighboring cells called Notch signaling. This process directs cells to their proper place in the developing embryo. However ALGS is characterized by variable expressivity. This means that the symptoms and severity of ALGS vary greatly. In some cases this is probably because different mutations in the JAG1 gene result in different symptoms or manifestations. However the symptoms and severity of ALGS in family members with the same JAG1 mutation can differ considerably. In addition, ALGS is not fully penetrant, meaning that some people with an inherited JAG1 mutation have no features or symptoms of the disorder.

### Risk factors

Alagille syndrome is an autosomal dominant trait, meaning that it can affect either gender and that a single copy of the defective or deleted gene is sufficient to cause the disorder. In 30–50% of cases ALGS is inherited from a parent; however it occurs sporadically as a result of random mutations in 50–70% of cases. In these cases neither parent has the gene mutation; rather the change or mutation occurs for the first time either in the egg or sperm or in the developing embryo. Regardless of whether the genetic defect is inherited or spontaneous, individuals with ALGS have a 50% chance of passing on the altered gene to each of their children. Since the disorder is dominant, passing on one copy of the gene can cause ALGS.

### Causes and symptoms

More than 90% of cases of Alagille syndrome are caused by mutations in the JAG1 gene on

chromosome 20. An additional seven percent of cases are caused by small deletions on chromosome 20 that include the JAG1 gene. A variety of different mutations, duplications, and deletions in the JAG1 gene can cause ALGS. Less than one percent of individuals with ALGS have mutations in the NOTCH2 gene.

Alagille syndrome is usually identified within the first months of life by symptoms of liver damage including:

- jaundice (yellowing of the skin and whites of the eyes)
- an enlarged liver
- pale, loose stools
- severe skin itching called pruritus, due to a buildup of bilirubin in the blood
- harmless fatty deposits from high cholesterol levels in the blood, appearing as yellow bumps on the skin called xanthomas
- stunted growth

Although symptoms often stabilize or improve between the ages of four and 10, complications of ALGS may persist:

- Narrowing of the pulmonary arteries carrying blood from the heart to the lungs can cause a heart murmur, the most common sign of ALGS other than liver disease. The murmur rarely affects cardiac function, although a small number of patients have more serious defects in the heart walls or valves.
- Facial features that are characteristic of ALGS include a broad, prominent forehead, deep-set eyes, and a small pointed chin.
- More than 90% of children with ALGS have an unusual eye abnormality.

- The bones of the spinal cord may have the shape of butterfly wings, although this condition almost never affects nerve function or causes other spinal problems.
- Malabsorption of fats and fat-soluble vitamins due to a lack of bile can cause diarrhea, failure to thrive in infancy, poor growth and delayed puberty, learning delays, blood-clotting problems, and bone fractures.
- ALGS can cause undersized kidneys, cysts in the kidneys, decreased kidney function, or other kidney disease.
- Advanced liver disease can cause the spleen to enlarge.
- Abnormalities in the carotid arteries of the head and neck can lead to internal bleeding or stroke.
- Various blood vessels in the body can narrow or bulge.

## Diagnosis

### *Examination*

A diagnosis of Alagille syndrome is based on clinical features—usually a combination of liver disease and at least two other symptoms such as:

- heart abnormalities or murmurs
- skeletal abnormalities
- ophthalmologic abnormalities
- facial features typical of ALGS

A single symptom of ALGS may be sufficient for a diagnosis if a relative is also affected. However other affected family members may have such mild or variable symptoms that their condition is not apparent. Once a patient is diagnosed with ALGS, the parents or other family members may be evaluated for subtle features of the condition. Diagnosis is very important since other genetic syndromes can cause similar liver disease and heart and eye defects and are inherited differently.

### *Tests*

In addition to blood tests to measure liver and kidney function and nutritional status, genetic tests may be performed, sometimes prenatally, to check for gene-related abnormalities. A JAG1 gene mutation may be sufficient for ALGS diagnosis even in the absence of major symptoms. Tests include:

- DNA sequence analysis of the entire JAG1 coding region
- scanning for mutations in the JAG1 coding region
- fluorescence in situ hybridization (FISH) to detect the deletion of the entire JAG1 gene
- tests for duplications of the JAG1 gene

- linkage analysis of the JAG1 gene
- sequence analysis of the entire NOTCH2 coding region
- deletion/duplication analysis of the NOTCH2 gene

## *Procedures*

Procedures for the diagnosis of Alagille syndrome include:

- abdominal ultrasound to detect liver enlargement and to rule out other conditions
- liver biopsy or surgery for direct examination of the bile duct system
- an echocardiogram to detect heart problems
- x rays of the spine
- examinations of the blood vessels and kidneys

## Treatment

### *Traditional*

Treatment of Alagille syndrome varies greatly depending on the symptoms and severity of the disorder. However it usually requires multidisciplinary treatment including medical genetics, gastroenterology, cardiology, ophthalmology, and **nutrition**. Treatment usually focuses on increasing the flow of bile from the liver, maintaining normal growth and development, and correcting nutritional deficiencies. Infants receive special formula containing high levels of medium-chain **triglycerides** (MCTs) for improved fat absorption by the small intestine. Breastfed infants may receive supplemental MCT oil. A child may receive additional calories through a tiny tube passed through the nose into the stomach or through a **gastrostomy** tube placed directly into the stomach through a small opening in the abdomen.

Other treatments may be necessary:

- Approximately 15–20% of ALGS patients require a liver transplant
- Severe pruritus is sometimes treated by partial external biliary diversion (PEBD), in which one end of the small intestine is surgically connected to the gallbladder and the other end to an opening in the abdomen for the collection of bile outside of the body
- Heart surgery may be required to repair defects

## *Drugs*

Drugs used to treat Alagille syndrome include:

- ursodiol (Actigall, Ursod) to increase bile flow
- large oral doses or injections of fat-soluble vitamins (A, D, E, and K) to treat deficiencies

- cholestyramine (Questran, Prevalite), rifampin (Rifadin), naltrexone (ReVia, Depade), or antihistamines to relieve pruritus

### **Home remedies**

Infants, children, and adults with Alagille syndrome can benefit from a high-calorie diet that includes **calcium** and the fat-soluble **vitamins**. Pruritus can be treated with moisturizers to hydrate the skin. Fingernails should be trimmed to prevent damage from scratching.

### **Prognosis**

The prognosis for Alagille syndrome varies greatly depending on the degree of liver, heart, and **kidney disease** and the presence of intracranial bleeding. About 75% of children with ALGS survive to at least 20 years of age. Although there is no way to predict which patients will reach end-stage liver disease, the survival rate for patients undergoing **liver transplantation** is 60–80%. ALGS patients most often die from liver disease, heart disease, or blood vessel abnormalities.

### **Prevention**

Prenatal testing via **chorionic villus sampling** or **amniocentesis** is available if a parent has been diagnosed with Alagille syndrome. However the variability of clinical symptoms, even within a single family, limits the interpretation of test results, since the same genetic mutation can result in a wide range of medical problems with varying degrees of severity.

## **Resources**

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## **ORGANIZATIONS**

- American Liver Foundation (ALF), 75 Maiden Ln., Suite 603, New York, NY, 10038 (212) 668-1000 (212) 483-8179, <http://www.liverfoundation.org>.
- Children’s Liver Association for Support Services (CLASS), 25379 Wayne Mills Pl., Suite 143, Valencia, CA, 91355 (661) 263-9099 (877) 679-9099 (661) 263-9099, [admin@classkids.org](mailto:admin@classkids.org), <http://www.classkids.org>.
- Madisons Foundation (MF), PO Box 241956, Los Angeles, CA, 90024 (310) 264-0826 (310) 264-4766, [getinfo@madisonsfoundation.org](mailto:getinfo@madisonsfoundation.org), <http://www.madisonsfoundation.org>.

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## **Alanine aminotransferase test**

### **Definition**

The alanine aminotransferase test, also known as ALT, is one of a group of tests known as **liver function tests** (or LFTs) and is used to monitor damage to the liver.

### **Purpose**

ALT levels are used to detect liver abnormalities. Since the alanine aminotransferase enzyme is also found in muscle, tests indicating elevated AST levels might also indicate muscle damage. However, other tests, such as the levels of the MB fraction of creatine kinase should indicate whether the abnormal test levels are because of muscle or liver damage.

### **Description**

The alanine aminotransferase test (ALT) can reveal liver damage. It is probably the most specific test for liver damage. However, the severity of the liver damage is not necessarily shown by the ALT test, since the amount of dead liver tissue does not correspond to higher ALT levels. Also, patients with normal, or declining, ALT levels may experience serious liver damage without an increase in ALT.

Nevertheless, ALT is widely used, and useful, because ALT levels are elevated in most patients with **liver disease**. Although ALT levels do not necessarily indicate the severity of the damage to the liver, they may indicate how much of the liver has been damaged. ALT levels, when compared to the levels of a similar enzyme, aspartate aminotransferase (AST), may provide important clues to the nature of the liver disease. For example, within a certain range of values, a ratio of 2:1 or greater

for AST: ALT might indicate that a patient suffers from alcoholic liver disease. Other diagnostic data may be gleaned from ALT tests to indicate abnormal results.

## Preparation

No special preparations are necessary for this test.

## Aftercare

This test involves blood being drawn, probably from a vein in the patient's elbow. The patient should keep the wound from the needle puncture covered (with a bandage) until the bleeding stops. Patients should report any unusual symptoms to their physician.

## Normal results

Normal values vary from laboratory to laboratory, and should be available to your physician at the time of the test. An informal survey of some laboratories indicates many laboratories find values from approximately seven to 50 IU/L to be normal.

## Abnormal results

Low levels of ALT (generally below 300 IU/L) may indicate any kind of liver disease. Levels above 1,000 IU/L generally indicate extensive liver damage from toxins or drugs, viral hepatitis, or a lack of oxygen (usually resulting from very low blood pressure or a **heart attack**). A briefly elevated ALT above 1,000 IU/L that resolves in 24–48 hours may indicate a blockage of the bile duct. More moderate levels of ALT (300–1,000IU/L) may support a diagnosis of acute or chronic hepatitis.

It is important to note that persons with normal livers may have slightly elevated levels of ALT. This is a normal finding.

Michael V. Zuck PhD

Albers-Schönberg disease see **Osteopetroses**



**A man with albinism stands with his normally pigmented father.** (Norman Lightfoot/Photo Researchers, Inc.)

races, may be accompanied by eye problems and may lead to skin **cancer** later in life.

## Description

Albinism is a rare disorder found in fewer than five people per 100,000 in the United States and Europe. Other parts of the world have a much higher rate; for example, albinism is found in about 20 out of every 100,000 people in southern Nigeria.

There are 10 types of the most common form of the condition, known as "oculocutaneous albinism," which affects the eyes, hair, and skin. In its most severe form, hair and skin remain pure white throughout life. People with a less severe form are born with white hair and skin, which turn slightly darker as they age. Everyone with oculocutaneous albinism experiences abnormal flickering eye movements (**nystagmus**) and sensitivity to bright light. There may be other eye problems as well, including poor vision and crossed or "lazy" eyes (**strabismus**).

The second most common type of the condition is known as "ocular" albinism, in which only the eyes lack color; skin and hair are normal. There are five forms of ocular albinism; some types cause more problems, especially eye problems, than others.

## Causes and symptoms

Every cell in the body contains a matched pair of genes, one inherited from each parent. These genes act as a sort of "blueprint" that guides the development of a fetus.

## Albinism

### Definition

Albinism is an inherited condition present at birth, characterized by a lack of pigment that normally gives color to the skin, hair, and eyes. Many types of albinism exist, all of which involve lack of pigment in varying degrees. The condition, which is found in all

## KEY TERMS

**Amino acids**—Natural substances that are the building blocks of protein. The body breaks down the protein in food into amino acids, and then uses these amino acids to create other proteins. The body also changes amino acids into melanin pigment.

**Astigmatism**—An eye condition in which the lens doesn't focus light evenly on the retina, leading to problems with visual sharpness.

**Carrier**—A person with one normal gene and one faulty gene, who can pass on a condition to others without actually having symptoms.

**DNA**—The abbreviation for “deoxyribonucleic acid,” the primary carrier of genetic information found in the chromosomes of almost all organisms. The entwined double structure allows the chromosomes to be copied exactly during cell division.

**DOPA**—The common name for a natural chemical (3, 4-dihydroxyphenylalanine) made by the body during the process of making melanin.

**Enzyme**—A protein that helps the body convert one chemical substance to another.

**Gene**—The basic unit of genetic material carried in a particular place on a chromosome. Genes are passed on from parents to child when the sperm and egg unite during conception.

**Hairbulb**—The root of a strand of hair from which the color develops.

**Hermansky-Pudlak Syndrome (HPS)**—A rare type of albinism characterized by a problem with blood clotting and a buildup of waxy material in lungs and intestines.

**Melanin**—Pigment made in the hair, skin and eyes.

**Nystagmus**—An involuntary back-and-forth movement of the eyes that is often found in albinism.

**Strabismus**—Crossed or “lazy” eyes, often found in albinism.

**Tyrosine**—A protein building block found in a wide variety of foods that is used by the body to make melanin.

**Tyrosinase**—An enzyme in a pigment cell which helps change tyrosine to DOPA during the process of making melanin.

Albinism is an inherited problem caused by a flaw in one or more of the genes that are responsible for directing the eyes and skin to make melanin (pigment). As a result, little or no pigment is made, and the child's skin and hair may be colorless.

In most types of albinism, a recessive trait, the child inherits flawed genes for making melanin from both parents. Because the task of making melanin is complex, there are many different types of albinism, involving a number of different genes.

It's also possible to inherit one normal gene and one albinism gene. In this case, the one normal gene provides enough information in its cellular blueprint to make some pigment, and the child will have normal skin and eye color. They “carry” one gene for albinism. About one in 70 people are albinism carriers, with one flawed gene but no symptoms; they have a 50% chance of passing the albinism gene to their child. However, if both parents are carriers with one flawed gene each, they have a one in four chance of passing on both copies of the flawed gene to the child, who will have albinism. (There is also a type of ocular albinism that is carried on the X chromosome and occurs almost exclusively in males

because they have only one X chromosome and, therefore, no other gene for the trait to override the flawed one.)

Symptoms of albinism can involve the skin, hair, and eyes. The skin, because it contains little pigment, appears very light, as does the hair.

Although people with albinism may experience a variety of eye problems, one of the myths about albinism is that it causes people to have pink or red eyes. In fact, people with albinism can have irises varying from light gray or blue to brown. (The iris is the colored portion of the eye that controls the size of the pupil, the opening that lets light into the eye.) If people with albinism seem to have reddish eyes, it's because light is being reflected from the back of the eye (retina) in much the same way as happens when people are photographed with an electronic flash.

People with albinism may have one or more of the following eye problems:

- They may be very far-sighted or near-sighted, and may have other defects in the curvature of the lens of the eye (astigmatism) that cause images to appear unfocused

- They may have a constant, involuntary movement of the eyeball called nystagmus
- They may have problems in coordinating the eyes in fixing and tracking objects (strabismus), which may lead to an appearance of having “crossed eyes” at times. Strabismus may cause some problems with depth perception, especially at close distances
- They may be very sensitive to light (photophobia) because their irises allow “stray” light to enter their eyes. It’s a common misconception that people with albinism shouldn’t go out on sunny days, but wearing sunglasses can make it possible to go outside quite comfortably

In addition to the characteristically light skin and eye problems, people with a rare form of albinism called Hermansky-Pudlak Syndrome (HPS) also have a greater tendency to have bleeding disorders, inflammation of the large bowel (**colitis**), lung (pulmonary) disease, and kidney (renal) problems.

## Diagnosis

It’s not always easy to diagnose the exact type of albinism a person has; there are two tests available that can identify only two types of the condition. Recently, a blood test has been developed that can identify carriers of the gene for some types of albinism; a similar test during **amniocentesis** can diagnose some types of albinism in an unborn child. A **chorionic villus sampling** test during the fifth week of **pregnancy** may also reveal some types of albinism.

The specific type of albinism a person has can be determined by taking a good family history and examining the patient and several close relatives.

The “hairbulb pigmentation test” is used to identify carriers by incubating a piece of the person’s hair in a solution of tyrosine, a substance in food which the body uses to make melanin. If the hair turns dark, it means the hair is making melanin (a “positive” test); light hair means there is no melanin. This test is the source of the names of two types of albinism: “ty-pos” and “ty-neg.”

The tyrosinase test is more precise than the hairbulb pigmentation test. It measures the rate at which hair converts tyrosine into another chemical (DOPA), which is then made into pigment. The hair converts tyrosine with the help of a substance called “tyrosinase.” In some types of albinism, tyrosinase doesn’t do its job, and melanin production breaks down.

## Treatment

There is no treatment that can replace the lack of melanin that causes the symptoms of albinism. Doctors can only treat, not cure, the eye problems that often accompany the lack of skin color. Glasses are usually needed and can be tinted to ease **pain** from too much sunlight. There is no cure for involuntary eye movements (nystagmus), and treatments for focusing problems (surgery or **contact lenses**) are not effective in all cases.

Crossed eyes (strabismus) can be treated during infancy, using eye patches, surgery or medicine injections. Treatment may improve the appearance of the eye, but it can do nothing to cure the underlying condition.

Patients with albinism should avoid excessive exposure to the sun, especially between 10 a.m. and 2 p.m. If exposure can’t be avoided, they should use UVA-UVB sunblocks with an SPF of at least 20. Taking beta-carotene may help provide some skin color, although it doesn’t protect against sun exposure.

## Prognosis

In the United States, people with this condition can expect to have a normal lifespan. People with albinism may experience some social problems because of a lack of understanding on the part of others. When a member of a normally dark-skinned ethnic group has albinism, he or she may face some very complex social challenges.

One of the greatest health hazards for people with albinism is excessive exposure to sun without protection, which could lead to skin cancer. Wearing opaque clothes and sunscreen rated SPF 20, people with albinism can safely work and play outdoors safely even during the summer.

## Prevention

**Genetic counseling** is very important to prevent further occurrences of the condition.

## Resources

### BOOKS

National Organization for Albinism and Hypopigmentation (NOAH). *Raising a Child with Albinism: A Guide to the Early Years*. East Hampstead, NH: National Organization for Albinism and Hypopigmentation (NOAH), 2008.

## ORGANIZATIONS

Albinism World Alliance, PO Box 959, East Hampstead, NH, 03826-0959, (603) 887-2310, (800) 473-2310, <http://www.albinism.org>.

American Foundation for the Blind, 2 Penn Plaza, Suite 1102, New York, NY, 10121, (212) 502-7600, (888) 545-8381, (800) AFB-LIND (232-5463), <http://www.afb.org/>.

Hermansky-Pudlak Syndrome Network, Inc., One South Road, Oyster Bay, NY, 11771-1905, (516) 922-4022, (800) 780-9477, <http://www.hpsnetwork.org>.

National Organization for Albinism and Hypopigmentation (NOAH), PO Box 959, East Hampstead, NH, 03826-0959, (603) 887-2310, (800) 648-2310, (800) 473-2310, <http://www.albinism.org/>.

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Albuterol see **Bronchodilators**

## Alcohol-related neurologic disease

### Definition

Alcohol, or ethanol, is a poison with direct toxic effects on nerve and muscle cells. Depending on which nerve and muscle pathways are involved, alcohol can have far-reaching effects on different parts of the brain, peripheral nerves, and muscles, with symptoms of **memory loss**, incoordination, seizures, weakness, and sensory deficits. These different effects can be grouped into three main categories: (1) intoxication due to the acute effects of ethanol, (2) withdrawal syndrome from suddenly stopping drinking, and (3) disorders related to long-term or chronic alcohol abuse. Alcohol-related neurologic disease includes Wernicke-Korsakoff disease, alcoholic cerebellar degeneration, alcoholic myopathy, alcoholic neuropathy, alcohol withdrawal syndrome with seizures and **delirium tremens**, and **fetal alcohol syndrome**.

### Description

Acute excess intake of alcohol can cause drunkenness (intoxication) or even **death**, and chronic or long-term abuse leads to potentially irreversible damage to virtually any level of the nervous system. Any given patient with long-term alcohol abuse may have no neurologic complications, a single alcohol-related disease, or multiple conditions, depending on the genes they have inherited, how well nourished they

are, and other environmental factors, such as exposure to other drugs or toxins.

Neurologic complications of alcohol abuse may also result from nutritional deficiency, because alcoholics tend to eat poorly and may become depleted of thiamine or other **vitamins** important for nervous system function. Persons who are intoxicated are also at higher risk for **head injury** or for compression injuries of the peripheral nerves. Sudden changes in blood chemistry, especially **sodium**, related to alcohol abuse may cause central pontine myelinolysis, a condition of the brainstem in which nerves lose their myelin coating. **Liver disease** complicating alcoholic **cirrhosis** may cause **dementia**, delirium, and movement disorder.

### Causes and symptoms

When a person drinks alcohol, it is absorbed by blood vessels in the stomach lining and flows rapidly throughout the body and brain, as ethanol freely crosses the blood-brain barrier that ordinarily keeps large molecules from escaping from the blood vessel to the brain tissue. Drunkenness, or intoxication, may occur at blood ethanol concentrations of as low as 50–150 mg per dL in people who don't drink. Sleepiness, stupor, **coma**, or even death from respiratory depression and low blood pressure occur at progressively higher concentrations.

Although alcohol is broken down by the liver, the toxic effects from a high dose of alcohol are most likely a direct result of alcohol itself rather than of its breakdown products. The fatal dose varies widely because people who drink heavily develop a tolerance to the effects of alcohol with repeated use. In addition, alcohol tolerance results in the need for higher levels of blood alcohol to achieve intoxicating effects, which increases the likelihood that habitual drinkers will be exposed to high and potentially toxic levels of ethanol. This is particularly true when binge drinkers fail to eat, because **fasting** decreases the rate of alcohol clearance and causes even higher blood alcohol levels.

When a chronic alcoholic suddenly stops drinking, withdrawal of alcohol leads to a syndrome of increased excitability of the central nervous system, called delirium tremens or "DTs." Symptoms begin six to eight hours after abstinence, and are most pronounced 24–72 hours after abstinence. They include body shaking (tremulousness), **insomnia**, agitation, confusion, hearing voices or seeing images that are not really there (such as crawling bugs), seizures, rapid heart beat, profuse sweating, high blood pressure, and **fever**. Alcohol-related seizures may also occur without

## KEY TERMS

**Abstinence**—Refraining from the use of alcoholic beverages.

**Atrophy**—A wasting or decrease in size of a muscle or other tissue.

**Cerebellum**—The part of the brain involved in coordination of movement, walking, and balance.

**Degeneration**—Gradual, progressive loss of nerve cells.

**Delirium**—Sudden confusion with decreased or fluctuating level of consciousness.

**Delirium tremens**—A complication that may accompany alcohol withdrawal. The symptoms include body shaking (tremulousness), insomnia, agitation, confusion, hearing voices or seeing images that are not really there (hallucinations), seizures, rapid heart beat, profuse sweating, high blood pressure, and fever.

**Dementia**—Loss of memory and other higher functions, such as thinking or speech, lasting six months or more.

**Myoglobinuria**—Reddish urine caused by excretion of myoglobin, a breakdown product of muscle.

**Myopathy**—A disorder that causes weakening of muscles.

**Neuropathy**—A condition affecting the nerves supplying the arms and legs. Typically, the feet and hands are involved first. If sensory nerves are involved, numbness, tingling, and pain are prominent, and if motor nerves are involved, the patient experiences weakness.

**Thiamine**—A B vitamin essential for the body to process carbohydrates and fats. Alcoholics may suffer complications (including Wernike-Korsakoff syndrome) from a deficiency of this vitamin.

**Wernicke-Korsakoff syndrome**—A combination of symptoms, including eye-movement problems, tremors, and confusion, that is caused by a lack of the B vitamin thiamine and may be seen in alcoholics.

withdrawal, such as during active heavy drinking or after more than a week without alcohol.

Wernicke-Korsakoff syndrome is caused by deficiency of the B-vitamin thiamine, and can also be seen in people who don't drink but have some other cause of thiamine deficiency, such as chronic **vomiting** that prevents the absorption of this vitamin. A 2004 study demonstrated that alcohol-dependent patients admitted to a **detoxification** facility had consumed significantly less thiamine than a comparison group of healthy volunteers. Patients with this condition have the sudden onset of Wernicke encephalopathy; the symptoms include marked confusion, delirium, disorientation, inattention, memory loss, and drowsiness. Examination reveals abnormalities of eye movement, including jerking of the eyes (**nystagmus**) and double vision. Problems with balance make walking difficult. People may have trouble coordinating their leg movements, but usually not their arms. If thiamine is not given promptly, Wernicke encephalopathy may progress to stupor, coma, and death.

If thiamine is given and death averted, **Korsakoff's syndrome** may develop in some patients who suffer from memory impairment that leaves them unable to remember events for a period of a few years before the onset of illness (**retrograde amnesia**) and unable to learn new information (**anterograde amnesia**).

Most patients have very limited insight into their memory dysfunction and have a tendency to make up explanations for events they have forgotten (confabulation).

Severe **alcoholism** can cause cerebellar degeneration, a slowly progressive condition affecting portions of the brain called the anterior and superior cerebellar vermis, causing a wide-based gait, leg incoordination, and an inability to walk heel-to-toe in tightrope fashion. The gait disturbance usually develops over several weeks, but may be relatively mild for some time, and then suddenly worsen after binge drinking or an unrelated illness.

Fetal alcohol syndrome occurs in infants born to alcoholic mothers when prenatal exposure to ethanol retards fetal growth and development. Affected infants often have a distinctive appearance with a thin upper lip, flat nose and mid-face, short stature and small head size. Almost half are mentally retarded, and most others are mildly impaired intellectually or have problems with speech, learning, and behavior. Fetal alcohol syndrome is the leading cause of **mental retardation** and many physicians warn that there is no safe level of alcohol for a pregnant mother to consume.

Alcoholic myopathy, or weakness secondary to breakdown of muscle tissue, is also known as alcoholic

rhabdomyolysis or alcoholic myoglobinuria. Males are affected by acute (sudden onset) alcoholic myopathy four times as often as females. Breakdown of muscle tissue (myonecrosis), can come on suddenly during binge drinking or in the first days of alcohol withdrawal. In its mildest form, this breakdown may cause no noticeable symptoms, but may be detected by a temporary elevation in blood levels of an enzyme found predominantly in muscle, the MM fraction of creatine kinase.

The severe form of acute alcoholic myopathy is associated with the sudden onset of muscle **pain**, swelling, and weakness; a reddish tinge in the urine caused by myoglobin, a breakdown product of muscle excreted in the urine; and a rapid rise in muscle enzymes in the blood. Symptoms usually worsen over hours to a few days, and then improve over the next week to 10 days as the patient is withdrawn from alcohol. Muscle symptoms are usually generalized, but pain and swelling may selectively involve the calves or other muscle groups. The muscle breakdown of acute alcoholic myopathy may be worsened by crush injuries, which may occur when people drink so much that they compress a muscle group with their body weight for a long time without moving, or by withdrawal seizures with generalized muscle activity.

In patients who abuse alcohol over many years, chronic alcoholic myopathy may develop. Males and females are equally affected. Symptoms include painless weakness of the limb muscles closest to the trunk and the girdle muscles, including the thighs, hips, shoulders, and upper arms. This weakness develops gradually, over weeks or months, without symptoms of acute muscle injury. Muscle atrophy, or decreased bulk, may be striking. The nerves of the extremities may also begin to break down, a condition known as alcoholic **peripheral neuropathy**, which can add to the person's difficulty in moving.

The way in which alcohol destroys muscle tissue is still not well understood. Proposed mechanisms include muscle membrane changes affecting the transport of **calcium**, potassium, or other **minerals**; impaired muscle energy metabolism; and impaired protein synthesis. Alcohol is metabolized or broken down primarily by the liver, with a series of chemical reactions in which ethanol is converted to acetate. Acetate is metabolized by skeletal muscle, and alcohol-related changes in liver function may affect skeletal muscle metabolism, decreasing the amount of blood sugar available to muscles during prolonged activity. Because not enough sugar is available to supply needed energy, muscle protein may be broken down as an alternate energy source. However, toxic

effects on muscle may be a direct result of alcohol itself rather than of its breakdown products.

Although alcoholic peripheral neuropathy may contribute to muscle weakness and atrophy by injuring the motor nerves controlling muscle movement, alcoholic neuropathy more commonly affects sensory fibers. Injury to these fibers can cause **tingling** or burning pain in the feet, which may be severe enough to interfere with walking. As the condition worsens, pain decreases but **numbness** increases.

## Diagnosis

The diagnosis of alcohol-related neurologic disease depends largely on finding characteristic symptoms and signs in patients who abuse alcohol. Other possible causes should be excluded by the appropriate tests, which may include blood chemistry, **thyroid function tests**, brain MRI (**magnetic resonance imaging**) or CT (computed tomography scan), and/or **cerbrospinal fluid analysis**.

Acute alcoholic myopathy can be diagnosed by finding myoglobin in the urine and increased creatine kinase and other blood enzymes released from injured muscle. The surgical removal of a small piece of muscle for microscopic analysis (muscle biopsy) shows the scattered breakdown and repair of muscle fibers. Doctors must rule out other acquired causes of muscle breakdown, which include the abuse of drugs such as heroin, **cocaine**, or amphetamines; trauma with crush injury; the depletion of phosphate or potassium; or an underlying defect in the metabolism of carbohydrates or lipids. In chronic alcoholic myopathy, serum creatine kinase often is normal, and muscle biopsy shows atrophy, or loss of muscle fibers. **Electromyography** (EMG) may show features characteristic of alcoholic myopathy or neuropathy.

## Treatment

Acute management of alcohol intoxication, delirium tremens, and withdrawal is primarily supportive, to monitor and treat any cardiovascular or **respiratory failure** that may develop. In delirium tremens, fever and sweating may necessitate treatment of fluid loss and secondary low blood pressure. Agitation may be treated with **benzodiazepines** such as chlordiazepoxide, beta-adrenergic antagonists such as atenolol, or alpha 2-adrenergic agonists such as clonidine. Because Wernicke's syndrome is rapidly reversible with thiamine, and because death may intervene if thiamine is not given promptly, all patients admitted for acute complications of alcohol, as well as all patients with

unexplained encephalopathy, should be given intravenous thiamine.

Withdrawal seizures typically resolve without specific anti-epileptic drug treatment, although status epilepticus (continual seizures occurring without specific) should be treated vigorously. Acute alcoholic myopathy with myoglobinuria requires monitoring and maintenance of kidney function, and correction of imbalances in blood chemistry including potassium, phosphate, and magnesium levels.

Chronic alcoholic myopathy and other chronic conditions are treated by correcting associated nutritional deficiencies and maintaining a diet adequate in protein and carbohydrate. The key to treating any alcohol-related disease is helping the patient overcome alcohol **addiction**. Behavioral measures and social supports may be needed in patients who develop broad problems in their thinking abilities (dementia) or remain in a state of confusion and disorientation (delirium). People with walking problems may benefit from **physical therapy** and assistive devices. Doctors may also prescribe drugs to treat the pain associated with peripheral neuropathy.

## Prognosis

Complete recovery from Wernicke's syndrome may follow prompt administration of thiamine. However, repeated episodes of encephalopathy or prolonged alcohol abuse may cause persistent dementia or Korsakoff **psychosis**. Most patients recover fully from acute alcoholic myopathy within days to weeks, but severe cases may be fatal from **acute kidney failure** and disturbances in heart rhythm secondary to increased potassium levels. Recovery from chronic alcoholic myopathy may occur over weeks to months of abstinence from alcohol and correction of **malnutrition**. Cerebellar degeneration and alcoholic neuropathy may also improve to some extent with abstinence and balanced diet, depending on the severity and duration of the condition.

## Prevention

Prevention requires abstinence from alcohol. Persons who consume small or moderate amounts of alcohol might theoretically help prevent nutritional complications of alcohol use with dietary supplements including B vitamins. However, proper **nutrition** cannot protect against the direct toxic effect of alcohol or of its breakdown products. Patients with any alcohol-related symptoms or conditions, pregnant women, and patients with liver or neurologic disease should abstain completely. Persons with family

history of alcoholism or alcohol-related conditions may also be at increased risk for neurologic complications of alcohol use.

## Resources

### PERIODICALS

"Missouri Clinics Will Diagnose and Treat Fetal Alcohol Syndrome." *Mental Health Weekly Digest* (June 7, 2004): 33.

Stacey, Philip S. "Preliminary Investigation of Thiamine and Alcohol Intake in Clinical and Healthy Samples." *Psychological Reports* (June 2004): 845–849.

### ORGANIZATIONS

National Institute on Alcohol Abuse and Alcoholism (NIAAA), 5635 Fishers Lane, MSC 9304, Bethesda, MD, 20892-9304, (301) 443-3860, <http://www.niaaa.nih.gov/>.

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Alcohol abuse see **Alcoholism**

Alcohol dependence see **Alcoholism**

Alcohol withdrawal see **Withdrawal syndromes**

Alcoholic cerebellar disease see **Alcohol-related neurologic disease**

Alcoholic hepatitis see **Hepatitis, alcoholic**

Alcoholic rose gardener's disease see **Sporotrichosis**

## Alcoholism

### Definition

Alcoholism is a chronic physical, psychological, and behavioral disorder characterized by excessive use of alcoholic beverages; emotional and physical dependence on them; increased tolerance over time of the effects of alcohol; and withdrawal symptoms if the person stops drinking.

### Demographics

The World Health Organization (WHO) estimates that some 2 billion people worldwide consume alcoholic beverages, which can have immediate and long term consequences on health and social life. More than 76 million people are currently affected by alcohol dependence and abuse. Alcohol causes 1.8 million

## Risk factors for alcoholism

- **Age:** Beginning drinking at a young age increases the risk of alcohol dependence.
- **Family history:** Children of alcohol-dependent parents are at greater risk of developing alcoholism.
- **Gender:** Males are more likely to become alcohol dependent than females, but women are at an increased risk of developing complications associated with alcoholism, such as liver disease.
- **Length of use:** Regular binge drinking over an extended period of time may result in alcohol dependence.
- **Mental health:** Persons afflicted by mental health disorders such as depression may be more likely to misuse alcohol or other substances.
- **Social and cultural factors:** Being surrounded by friends who routinely drink may increase a person's level of alcohol use. Alcohol consumption in the media may also influence personal drinking habits.

**SOURCE:** Mayo Clinic, "Alcoholism." Available online at: <http://www.mayoclinic.com/health/alcoholism/DS00340> (accessed August 17, 2010).

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deaths a year, which represents 3.2% of all deaths worldwide. According to a 2007 report from the Task Force on Community Preventive Services of the Centers for Disease Control, excessive alcohol consumption in the United States is responsible for approximately 75,000 deaths per year, making it the third leading cause of preventable death. Moreover, nearly 47% of homicides, 23% of suicides, and 40% of fatal motor vehicle crashes are directly caused by alcohol abuse. According to the 2009 report of the National Survey on Drug Use and Health, 7.8% of Americans aged 12 or older (an estimated 19.3 million people) needed treatment for an alcohol problem in the past year. Of those who needed alcohol treatment, 8.1% received treatment at a specialty substance use treatment facility, 4.5% did not receive treatment but felt they needed it, and 87.4% did not receive treatment and did not perceive a need for it.

According to 2008 Center for Disease Control data, the percentage of adults who drank alcohol in 2007 was 61%. The percentage of drinkers who had five or more drinks on at least one day during that year was 21%.

Alcohol use by persons under age 21 is an important public health concern. In the United States, alcohol is the most commonly used and abused drug among youth. Although drinking under the age of 21 is against the law, people aged 12 to 20 years drink nearly 20% of all alcohol consumed in the United States. More than 90% of this alcohol is consumed in the form of binge drinking.

According to the NIAAA, 60% of American women were having at least one drink a year in 2005. Among women who drank, 13% had more than seven drinks per week with an estimated 5.3 million women drinking in a way that threatened their health, safety, and general well-being. Studies of women alcoholics indicate that women are at higher risk than men for serious health problems related to alcoholism. Because women tend to metabolize alcohol more slowly, have a lower percentage of body water and a higher percentage of body fat than men, they develop higher blood alcohol levels than men at a given amount of alcohol per pound of body weight. Thus, even though women typically begin to drink heavily at a later age than men, they often become dependent on alcohol much more rapidly. This relatively speedy progression of alcoholism in women is called telescoping.

At the other end of the age distribution, alcoholism among the elderly appears to be underrecognized. One third of older alcoholic persons develop a problem with alcohol in later life, while the other two thirds grow older with the medical and psychosocial consequences of early onset alcoholism. Confusion and other signs of intoxication in an elderly person are also often misinterpreted as side effects of other medications. In addition, the effects of alcohol may be increased in elderly patients because of physiologic changes associated with **aging**. The elderly are at higher risk for becoming dependent on alcohol than younger people because their bodies do not absorb alcohol as efficiently; a 90-year-old who drinks the same amount of alcohol as a 20-year-old (of the same sex) will have a blood alcohol level 50% higher.

## Description

Alcoholism is a complex behavioral as well as medical disorder. It often involves the criminal justice system as well as medicine and other helping professions. Its emergence in an individual's life is affected by a number of variables ranging from age, weight, sex, and ethnic background to his or her family history, peer group, occupation, religious preference, and many other categories. Moreover, persons diagnosed with alcoholism may demonstrate considerable variety in their drinking patterns, age at onset of the disorder, and the speed of its progression.

The *Diagnostic and Statistical Manual of Mental Disorders*, 4th edition (DSM-IV), distinguishes between Alcohol Dependence and Alcohol Abuse largely on the basis of a compulsive element in Alcohol Dependence that is not present in Alcohol Abuse. Some psychiatrists differentiate between so-called primary alcoholism, in which the patient has no other

major psychiatric diagnosis; and secondary alcoholism, in which the problem drinking is the patient's preferred way of medicating symptoms of another psychiatric disorder, such as depression, **schizophrenia**, **post-traumatic stress disorder**, or one of the **dissociative disorders**. Experts in other branches of medicine tend to emphasize patterns of and attitudes toward drinking in order to distinguish between non-problematic use of alcohol and alcohol abuse or dependence. Classification is typically based on the following five categories:

- Social drinkers. Individuals who use alcohol in minimal to moderate amounts to enhance meals or other social activities. They do not drink alone
- Situational drinkers. These people rarely or never drink except during periods of stress. They are far more likely to drink alone than social drinkers
- Problem drinkers. These individuals drink heavily, even when they are not under overwhelming stress. Their drinking causes some problems in their lives (e.g., DUI arrests), but they are capable of responding to warnings or advice from others
- Binge drinkers. This type of drinker uses alcohol in an out-of-control fashion at regular intervals. The binges may be planned in advance. This pattern is a growing problem on many college campuses
- Alcoholic drinkers. These are drinkers who have no control of any kind over their intake, and find that their lives are unmanageable

Other factors have complicated definitions of alcoholism in the United States, including: 1) the increasing tendency to combine alcohol with other drugs of abuse, sometimes called cross-addiction; and 2) the rising rates of alcohol abuse and dependence among children under 12 years of age.

### Risk factors

According to the NIAAA, the risk for developing alcoholism seems to run in families. Genetics and lifestyle are both factors. Socializing patterns, the amount of **stress** in a person's life, and the availability of alcohol are all factors that may increase the risk for alcoholism. In general, more men than women are alcohol dependent. Alcohol problems are highest in the 18–29 age group and lowest among adults aged 65 and older. People who start drinking in their teens are also at much higher risk of developing alcohol problems compared to people who start drinking at age 21 or older.

### Causes and symptoms

The symptoms of alcohol intoxication often include talkativeness and a positive mood while the drinker's

blood alcohol level is rising, with depression and mental impairment when it is falling. Blood alcohol concentration (BAC) produces the following symptoms of central nervous system (CNS) depression at specific levels:

- 50 mg/dL: feelings of calm or mild drowsiness
- 50–150 mg/dL: loss of physical coordination. The legal BAC for drivers in most states is 100 mg/dL or lower.
- 150–200 mg/dL: loss of mental faculties
- 300–400 mg/dL: unconsciousness
- Over 400 mg/dL: may be fatal.

The symptoms of long-term heavy consumption of alcohol may take a variety of different forms. In spite of a long history of use for "medicinal" purposes, alcohol is increasingly recognized to be toxic to the human body. It is basically a CNS depressant that is absorbed into the bloodstream, primarily from the small intestine. Regular consumption of large amounts of alcohol can cause irreversible damage to a number of the body's organ systems, including the cardiovascular system, the digestive tract, the central nervous system, and the peripheral nervous system. Heavy drinkers are at high risk of developing stomach or duodenal ulcers, **cirrhosis** of the liver, and cancers of the digestive tract. Many alcoholics do not eat properly, and often develop nutritional deficiency diseases as well as organ damage.

In addition to physical symptoms, most alcoholics have a history of psychiatric, occupational, financial, legal, or interpersonal problems as well. Alcohol misuse is the single most important predictor of violence between domestic partners as well as intergenerational violence within families. In 1994 (the latest year for which statistics are available), 79% of drivers over age 25 involved in fatal automobile accidents were intoxicated. In the states that provided data in 1994 for arrests for driving while impaired (DWI) by alcohol, about one-third of the arrested drivers had previous DWI citations. Since the early 1990s, most states have passed stricter laws against alcohol-impaired driving. These laws include such provisions as immediate license suspension for the first DWI arrest and lowering the legal blood alcohol limit to 0.08 g/dL for adults and 0.02 g/dL for drivers under 21. Penalties for repeated DWI citations include prison sentences; house arrest with electronic monitoring; license plates that identify offending drivers; automobile confiscation; and putting a special ignition interlock on the offender's car.

### Diagnosis

The diagnosis of alcoholism is usually based on the patient's drinking history, a thorough **physical**

## KEY TERMS

**Acamprosate**—An anti-craving medication used in Europe to reduce the craving for alcohol. It is presently undergoing tests for approval in the United States.

**Alcohol Use Disorders Inventory Test (AUDIT)**—A test for alcohol use developed by the World Health Organization (WHO). Its ten questions address three specific areas of drinking over a 12-month period: the amount and frequency of drinking, dependence upon alcohol, and problems that have been encountered due to drinking alcohol.

**Behavioral therapy**—Form of psychotherapy used to treat depression, anxiety disorders, phobias, and other forms of psychopathology.

**Binge drinking**—Consumption of five or more alcoholic drinks in a row on a single occasion.

**CAGE**—A four-question assessment for the presence of alcoholism in both adults and children.

**Disulfiram**—A medication that has been used since the late 1940s as part of a treatment plan for alcohol abuse. Disulfiram, which is sold under the trade name Antabuse, produces changes in the body's metabolism of alcohol that cause headaches, vomiting, and other unpleasant symptoms if the patient drinks even small amounts of alcohol.

**Ethanol**—The chemical name for beverage alcohol. It is also sometimes called ethyl alcohol or grain alcohol to distinguish it from isopropyl or rubbing alcohol.

**Naltrexone**—A medication originally developed to treat addiction to heroin or morphine that is also used to treat alcoholism. It works by reducing the craving for alcohol rather than by producing vomiting or other unpleasant reactions.

**Withdrawal**—The characteristic withdrawal syndrome for alcohol includes feelings of irritability or anxiety, elevated blood pressure and pulse, tremors, and clammy skin.

**examination**, laboratory findings, and the results of psychodiagnostic assessment.

### *Examination*

A physician who suspects that a patient is abusing or is dependent on alcohol should give him or her a complete physical examination with appropriate laboratory tests, paying particular attention to liver function and the nervous system. Physical findings that suggest alcoholism include head injuries after age 18; broken bones after age 18; other evidence of blackouts, frequent accidents, or falls; puffy eyelids; flushed face; alcohol odor on the breath; shaky hands; slurred speech or tongue tremor; rapid involuntary eye movements (**nystagmus**); enlargement of the liver (hepatomegaly); **hypertension**; **insomnia**; and problems with **impotence** (in males). Severe **memory loss** may point to advanced alcoholic damage to the CNS.

### *Tests*

Several laboratory tests can be used to diagnose alcohol abuse and evaluate the presence of medical problems related to drinking. These tests include:

- Full blood cell count. This test indicates the presence of anemia, which is common in alcoholics. In addition, the mean corpuscular volume (MCV) is usually

high in heavy drinkers. An MCV higher than 100 fL suggests alcohol abuse.

- Liver function tests. Tests for serum glutamine oxaloacetic transaminase (SGOT) and alkaline phosphatase can indicate alcohol-related injury to the liver. A high level (30 units) of gamma-glutamyltransferase (GGT) is a useful marker because it is found in 70% of heavy drinkers
- Blood alcohol levels
- Carbohydrate deficient transferrin (CDT) tests. This test should not be used as a screener, but is useful in monitoring alcohol consumption in heavy drinkers (those who consume 60 grams of alcohol per day) When CDT is present, it indicates regular daily consumption of alcohol.

The results of these tests may not be accurate if the patient is abusing or dependent on other substances.

### *Procedures*

Since some of the physical signs and symptoms of alcoholism can be produced by other drugs or disorders, screening tests can also help to determine the existence of a drinking problem. There are several assessment instruments for alcoholism that can be either self-administered or administered by a clinician. The so-called CAGE test is a brief screener consisting of four questions:

- Have you ever felt the need to *cut down* on drinking?
- Have you ever felt *annoyed* by criticism of your drinking?
- Have you ever felt *guilty* about your drinking?
- Have you ever taken a morning *eye opener*? One “yes” answer should raise a suspicion of alcohol abuse; two “yes” answers are considered a positive screen.

Other brief screeners include the Alcohol Use Disorder Identification Test, or AUDIT, which also highlights some of the physical symptoms of alcohol abuse that doctors look for during a physical examination of the patient. The Michigan Alcoholism Screening Test, or MAST, is considered the diagnostic standard. It consists of 25 questions; a score of five or higher is considered to indicate alcohol dependency. A newer screener, the **Substance Abuse** Subtle Screening Inventory, or SASSI, was introduced in 1988. It can be given in either group or individual settings in a paper and pencil or computerized format. The SASSI is available in an adolescent as well as an adult version from the SASSI Institute.

According to one 1998 study, some brief screeners may be inappropriate for widespread use in some subpopulations because of ethnic and sex bias. The CAGE questionnaire often yielded inaccurate results when administered to African American men and Mexican American women. The AUDIT does not appear to be affected by ethnic or gender biases. Another study of the use of alcohol screening questionnaires in women found that the AUDIT was preferable to the CAGE questionnaire for both African American and Caucasian women.

## Treatment

Because alcoholism is a complex disorder with social and occupational as well as medical implications, treatment plans usually include a mix of several different approaches. The following key issues are usually considered in determining which treatment option is appropriate:

- severity of the problem and evidence to suggest other mental health problems (e.g. depression, suicide attempts)
- staff credentials of those treating the child or teen, and what forms of therapy (e.g., family, group, medications) are to be used
- nature of family involvement
- how education is to be continued during treatment
- if an in-patient program is necessary, what length it should be

- what aftercare is to be provided following discharge
- what portion of treatment is to be covered by health insurance and what needs to be paid out of pocket

### *Traditional*

Most alcoholics are treated with a variety of psychosocial approaches, including regular attendance at Alcoholics Anonymous (AA) meetings, **group therapy**, marital or **family therapy**, community-based approaches, social skills training, relapse prevention, and stress management techniques. Insight-oriented individual **psychotherapy** by itself is ineffective with the majority of alcoholics.

The most effective psychosocial treatments of alcohol dependence incorporate a cognitive-behavioral approach. Relapse prevention utilizes cognitive-behavioral approaches to identifying high-risk situations for each patient and restructuring his or her perceptions of the effects of alcohol as well as of the relapse process. Network therapy, which combines individual cognitive-behavioral psychotherapy with the involvement of the patient's family and peers as a group support network, is a newer approach to alcohol dependence. One recent study found that while cognitive-behavioral therapy is effective in treating alcohol dependence, the reasons that are usually offered to explain its effectiveness should be reexamined.

### *Drugs*

Most drugs that are now being used to treat alcoholism fall into one of two groups: those that restrain the desire to drink by producing painful physical symptoms if the patient does drink; and those that appear to reduce the craving for alcohol directly. Several medications in the second category were originally developed to treat **addiction** to opioid substances (e.g., heroin and morphine).

**ALCOHOL-SENSITIZING MEDICATIONS.** The most commonly used alcohol-sensitizing agent is disulfiram (Antabuse), which has been used since the 1950s to deter alcoholics from drinking by the threat of a very unpleasant physical reaction if they do consume alcohol. The severity of the disulfiram/ethanol reaction, or DER, depends on the amount of alcohol and disulfiram in the blood. The symptoms of the reaction include facial flushing, rapid heart beat, **palpitations**, difficult breathing, lowered blood pressure, headaches, **nausea**, and **vomiting**.

A DER results when the drinker consumes alcohol because disulfiram inhibits the functioning of an enzyme called aldehyde dehydrogenase. This enzyme

is needed to convert acetaldehyde, which is produced when the body begins to oxidize the alcohol. Without the aldehyde dehydrogenase, the patient's blood level of acetaldehyde rises, causing the symptoms associated with DER.

Another alcohol-sensitizing agent is **calcium carbimide**, which is marketed under the brand name Temposil. Calcium carbimide produces physiological reactions with alcohol similar to those produced by disulfiram, but the onset of action is far more rapid and the duration of action is much shorter.

**ANTI-CRAVING MEDICATIONS.** Another medication approved for the treatment of alcoholism is naltrexone, which appears to reduce the craving for alcohol. In addition, an injectable, long-acting form of naltrexone (Vivitrol) is also available.

An anti-craving drug that is presently approved for use in the European Community, acamprosate (calcium acetyl-homotaurinate), has no psychotropic side effects nor any potential for abuse or dependence. Acamprosate is also approved in the United States to treat alcohol dependence. It appears to reduce the frequency of drinking, but its effects on enhancing abstinence from alcohol are no greater than those of naltrexone. In addition, acamprosate does not appear to enhance the effectiveness of naltrexone if the drugs are given in combination.

Other medications are available to treat the symptoms of alcohol withdrawal, such as shakiness, nausea, and sweating that occur after someone with alcohol dependence stops drinking.

### *Alternative*

Many clinical trials for the treatment or prevention of alcoholism are currently sponsored by the National Institutes of Health (NIH) and other agencies. In 2008, NIH reported 335 on-going or recently completed studies, including 123 in the recruitment stage.

A few examples include:

- The evaluation of whether long-term chronic alcoholism is associated with changes in emotional functioning and brain structure and function. (NCT00300638)
- The study of serotonin transporter proteins in people with alcoholism and healthy volunteers to examine how these proteins may be related to the inability of people with alcoholism to appropriately regulate their alcohol consumption. Serotonin transporters are substances that regulate levels of the brain chemical serotonin. Problems in this regulation have been implicated in alcoholism. (NCT00085865)
- The use of combined motivational enhancement therapy and cognitive behavioral therapy to test the benefits of continued/discontinued treatment with naltrexone. (NCT00115037)
- The evaluation of the safety and effectiveness of a combination of study medications (ondansetron, topiramate) in the treatment of alcohol dependence. (NCT00006205)

Clinical trial information is constantly updated by NIH and the most recent information on alcoholism trials can be found at: <http://clinicaltrials.gov/ct2/results?term=alcoholism>.

### Prognosis

The prognosis for recovery from alcoholism varies widely. The usual course of the disorder is one of episodes of intoxication beginning in adolescence, with full-blown dependence by the mid-20s to mid-30s. The most common pattern is one of periodic attempts at abstinence alternating with relapses into uncontrolled drinking. On the other hand, it is thought that as many as 20% of persons diagnosed as alcohol-dependent achieve long-term sobriety even without medical treatment. It is difficult to compare the outcomes of the various treatment approaches to alcoholism, in part because their definitions of "success" vary. Some researchers count only total abstinence from alcohol as a successful outcome, while others regard curtailed drinking and better social adjustment as indicators of success. The role of genetic factors in the prognosis is still disputed. Available evidence suggests that such factors as the presence of a spouse, partner, or close friend in the alcoholic's life, or religious commitment, can outweigh genetic vulnerability to the disorder.

### Prevention

It is widely recognized that the best prevention measure for children is strong parenting. This requires good communication between parents and their kids, so that they may be advised about the dangers of alcoholism and addiction. Prevention initiatives in schools, churches and the community have also been widely implemented. However, alcoholism prevention remains a difficult issue because the potential for a problem condition is often not recognized at its onset.

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- "Faces of Change: Do I Have a Problem with Alcohol or Drugs?" *Substance Abuse and Mental Health Services Administration*. Information Page. <http://www.kap.samhsa.gov/products/brochures/pdfs/TIP35.pdf> (accessed October 10, 2009)

#### ORGANIZATIONS

- Al-Anon/Alateen, 1600 Corporate Landing Parkway, Virginia Beach, VA, 23454-5617 (757) 563-1600 (757) 563-1655, [wso@al-anon.org](mailto:wso@al-anon.org), <http://www.al-anon.alateen.org>.
- Alcoholics Anonymous World Services, Inc., 475 Riverside Drive at West 120th St., New York, NY, 10115 (212) 870-3400, <http://www.aa.org>.
- National Council on Alcoholism and Drug Dependence (NCADD), 244 East 58th Street, 4th Floor, New York, NY, 10022 (212) 269-7797 (212) 269-7510, [national@ncadd.org](mailto:national@ncadd.org), <http://www.ncadd.org>.
- National Institute on Alcohol Abuse and Alcoholism (NIAAA), 5635 Fishers Lane, Room 2015, Bethesda, MD, 20892-9304 (301) 443-2238 (866) 503-SKIN, <http://www.niaaa.nih.gov>.

Rebecca J. Frey PhD  
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ALD see **Adrenoleukodystrophy**

## Aldolase test

### Definition

Aldolase is an enzyme found throughout the body, particularly in muscles. Like all enzymes, it is needed to trigger specific chemical reactions. Aldolase helps muscle turn sugar into energy. Testing for aldolase is done to diagnose and monitor skeletal muscle diseases.

## KEY TERMS

**Aldolase**—An enzyme, found primarily in the muscle, that helps convert sugar into energy.

**Enzyme**—A substance needed to trigger specific chemical reactions.

**Neurologic**—Having to do with the nervous system.

**Skeletal muscle**—Muscle connected to, and necessary for, the movement of bones.

## Purpose

Skeletal muscle diseases increase the aldolase level found in a person's blood. Skeletal muscles are those muscles attached to bones and whose contractions make those bones move. When the muscles are diseased or damaged, such as in **muscular dystrophy**, the cells deteriorate and break open. The contents of the cells, including aldolase, spill into the bloodstream. Measuring the amount of aldolase in the blood indicates the degree of muscle damage.

As muscles continue to deteriorate, aldolase levels decrease and eventually fall below normal. Less muscle means fewer cells and less aldolase.

Muscle weakness may be caused by neurologic as well as muscular problems. The measurement of aldolase levels can help pinpoint the cause. Aldolase levels will be normal where muscle weakness is caused by neurological disease, such as poliomyelitis or **multiple sclerosis**, but aldolase levels will be elevated in cases of muscular disease, such as muscular dystrophy.

Aldolase is also found in the liver and cardiac muscle of the heart. Damage or disease to these organs, such as chronic hepatitis or a **heart attack**, will also increase aldolase levels in the blood, but to a lesser degree.

## Description

Aldolase is measured by mixing a person's serum with a substance with which aldolase is known to trigger a reaction. The end product of this reaction is measured, and, from that measurement, the amount of aldolase in the person's serum is determined.

The test is covered by insurance when medically necessary. Results are usually available the next day.

## Preparation

To collect the 5–10 mL of blood needed for this test, a healthcare worker ties a tourniquet on the patient's upper arm, locates a vein in the inner elbow region, and

inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

The patient should avoid strenuous **exercise** and have nothing to eat or drink, except water, for eight to ten hours before this test.

## Aftercare

Discomfort or bruising may occur at the puncture site and the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops will reduce bruising. Warm packs to the puncture site will relieve discomfort.

## Normal results

Newborns have the highest normal aldolase levels and adults the lowest. Normal values will vary based on the laboratory and the method used.

## Abnormal results

As noted, aldolase is elevated in skeletal muscle diseases, such as muscular dystrophies. Duchenne's muscular dystrophy, the most common type of muscular dystrophy, will increase the aldolase level more than any other disease.

Nondisease conditions that affect the muscle, such as injury, **gangrene**, or an infection, can also increase the aldolase level. Also, strenuous exercise can temporarily increase a person's aldolase level.

Certain medications can increase the aldolase level, while others can decrease it. To interpret what the results of the aldolase test mean, a physician will evaluate the result, the person's clinical symptoms, and other tests that are more specific for muscle damage and disease.

## Resources

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Chernecky, Cynthia C. and Barbara J. Berger. *Laboratory Tests and Diagnostic Procedures*. 5th ed. Philadelphia: Saunders, 2007.

Nancy J. Nordenson

## Aldosterone assay

### Definition

This test measures the levels of aldosterone, a hormone produced by the outer part (cortex) of the two adrenal glands, organs which sit one on top of

## KEY TERMS

**Aldosteronism**—A condition in which the adrenal glands secrete excessive levels of the hormone aldosterone.

**Renin**—An enzyme produced in the kidneys that controls the activation of the hormone angiotensin, which stimulates the adrenal glands to produce aldosterone.

each of the kidneys. Aldosterone regulates the amounts of **sodium** and potassium in the blood. This helps maintain water balance and blood volume, which, in turn, affects blood pressure.

### Purpose

Aldosterone measurement is useful in detecting a condition called aldosteronism, which is caused by excess secretion of the hormone from the adrenal glands. There are two types of aldosteronism: primary and secondary. Primary aldosteronism is most commonly caused by an adrenal tumor, as in Conn's syndrome. Idiopathic (of unknown cause) **hyperaldosteronism** is another type of primary aldosteronism. Secondary aldosteronism is more common and may occur with congestive **heart failure**, **cirrhosis** with fluid in the abdominal cavity (**ascites**), certain kidney diseases, excess potassium, sodium-depleted diet, and toxemia of **pregnancy**.

To differentiate primary aldosteronism from secondary aldosteronism, a plasma renin test should be performed at the same time as the aldosterone assay. Renin, an enzyme produced in the kidneys, is high in secondary aldosteronism and low in primary aldosteronism.

### Description

Aldosterone testing can be performed on a blood sample or on a 24-hour urine specimen. Several factors, including diet, posture (upright or lying down), and time of day that the sample is obtained can cause aldosterone levels to fluctuate. Blood samples are affected by short-term fluctuations. A urine specimen collected over an entire 24-hour period lessens the effects of those interfering factors and provides a more reliable aldosterone measurement.

### Preparation

**Fasting** is not required for either the blood sample or urine collection, but the patient should maintain a normal sodium diet (approximately 0.1 oz [3g]/day)

for at least two weeks before either test. The doctor should decide if drugs that alter sodium, potassium, and fluid balance (e.g., **diuretics**, antihypertensives, **steroids**, **oral contraceptives**) should be withheld. The test will be more accurate if these are suspended at least two weeks before the test. Renin inhibitors (e.g., propranolol) should not be taken one week before the test, unless permitted by the physician. The patient should avoid licorice for at least two weeks before the test, because of its aldosterone-like effect. Strenuous **exercise** and **stress** can increase aldosterone levels as well. Because the test is usually performed by a method called radioimmunoassay, recently administered radioactive medications will affect test results.

Since posture and body position affect aldosterone, hospitalized patients should remain in an upright position (at least sitting) for two hours before blood is drawn. Occasionally blood will be drawn again before the patient gets out of bed. Nonhospitalized patients should arrive at the laboratory in time to maintain an upright position for at least two hours.

### Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or **hematoma** (blood accumulating under the puncture site).

### Normal results

Normal results are laboratory-specific and also vary with sodium intake, with time of day, source of specimen (e.g., peripheral vein, adrenal vein, 24-hour urine), age, sex, and posture.

Reference ranges for blood include:

- supine (lying down): 3–10 ng/dL
- upright (sitting for at least two hours): Female: 5–30 ng/dL; Male: 6–22 ng/dL.

Reference ranges for urine: 2–80 mg/24 hr.

### Abnormal results

Increased levels of aldosterone are found in Conn's disease (aldosterone-producing adrenal tumor), and in cases of Bartter's syndrome (a condition in which the kidneys overexcrete potassium, sodium and chloride, resulting in low blood levels of potassium and high blood levels of aldosterone and renin). Among other conditions, elevated levels are also seen in secondary aldosteronism, stress, and malignant **hypertension**.

Decreased levels of aldosterone are found in aldosterone deficiency, steroid therapy, high-sodium diets, certain antihypertensive therapies, and **Addison's disease** (an autoimmune disorder).

## Resources

### BOOKS

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Janis O. Flores

## Alemtuzumab

### Definition

Alemtuzumab is sold as Campath in the United States. Alemtuzumab is a humanized monoclonal antibody that selectively binds to CD52, a protein found on the surface of normal and malignant B and T cells, that is used to reduce the numbers of circulating malignant cells of patients who have B-cell chronic lymphocytic leukemia (B-CLL).

### Purpose

Alemtuzumab is a monoclonal antibody used to treat B-CLL, one of the most prevalent forms of adult chronic leukemia. It specifically binds CD52, a protein found on the surface of essentially all B and T cells of the immune system. By binding the CD52 protein on the malignant B cells, the antibody targets it for removal from the circulation. Scientists believe that alemtuzumab triggers antibody-mediated lysis of the B cells, a method that the immune system uses to eliminate foreign cells.

Alemtuzumab has been approved by the FDA for treatment of refractory B-CLL. For a patient's disease to be classified as refractory, both alkylating agents and fludarabine treatment must have been tried and failed. Thus, this drug gives patients who have tried all approved treatments for B-CLL another option. As most patients with B-CLL are in stage III or IV by the time both alkylating agents and fludarabine have been tried, the experience with alemtuzumab treatment are primarily with those stages of the disease. In clinical trials, about 30% of patients had a partial response to the drug, with 2% of these being complete responses.

This antibody has been tested with limited success in the treatment of non-Hodgkin's lymphoma (NHL)

## KEY TERMS

**Alkylating agent**—A chemical that alters the composition of the genetic material of rapidly dividing cells, such as cancer cells, causing selective cell death; used as a chemotherapeutic agent to treat B-CLL.

**Antibody**—A protective protein made by the immune system in response to an antigen, also called an immunoglobulin.

**Autoimmune**—An immune reaction of a patient against their own cells.

**Humanization**—Fusing the constant and variable framework region of one or more human immunoglobulins with the binding region of an animal immunoglobulin, done to reduce human reaction against the fusion antibody.

**Monoclonal**—Genetically engineered antibodies specific for one antigen.

**Tumor lysis syndrome**—A side effect of some immunotherapies, like monoclonal antibodies, that lyse the tumor cells, due to the toxicity of flooding the bloodstream with such a quantity of cellular contents.

and for the preparation of patients with various immune cell malignancies for **bone marrow transplantation**. There is also a clinical trial ongoing to test the ability of this antibody to prevent rejection in **kidney transplantation**.

### Description

Alemtuzumab is produced in the laboratory using genetically engineered single clones of B-cells. Like all antibodies, it is a Y-shaped molecule can bind one particular substance, the antigen for that monoclonal antibody. For alemtuzumab, the antigen is CD52, a protein found on the surface of normal and malignant B and T cells as well as other cells of the immune and male reproductive systems. Alemtuzumab is a humanized antibody, meaning that the regions that bind CD52, located on the tips of the Y branches, are derived from rat antibodies, but the rest of the antibody is human sequence. The presence of the human sequences helps to reduce the immune response by the patient against the antibody itself, a problem seen when complete mouse antibodies are used for **cancer** therapies. The human sequences also help to ensure that the various cell-destroying mechanisms of the human immune

system are properly triggered with binding of the antibody.

Alemtuzumab was approved in May of 2001 for the treatment of refractory B-CLL. It is approved for use alone but clinical trials have tested the ability of the antibody to be used in combination with the purine analogs pentostatin, fludarabine, and cladribine, and rituximab, a monoclonal antibody specific for the CD20 antigen, another protein found on the surface of B cells.

### Recommended dosage

This antibody should be administered in a gradually escalating pattern at the start of treatment and any time administration is interrupted for seven or more days. The recommended beginning dosage for B-CLL patients is a daily dose of 3 mg of Campath administered as a two-hour IV infusion. Once this amount is tolerated, the dose is increased to 10 mg per day. After tolerating this dose, it can be increased to 30 mg, administered three days a week. Acetaminophen and diphenhydramine hydrochloride are given thirty to sixty minutes before the infusion to help reduce side effects.

Additionally, patients generally receive anti-infective medication before treatment to help minimize the serious opportunistic infections that can result from this treatment. Specifically, trimethoprim/sulfamethoxazole (to prevent bacterial infections) and famciclovir (to prevent viral infections) were used during the clinical trial to decrease infections, although they were not eliminated.

### Precautions

Blood studies should be done on a weekly basis while patients are receiving the alemtuzumab treatment. **Vaccination** during the treatment session is not recommended, given the T cell depletion that occurs during treatment. Furthermore, given that antibodies like alumtuzumab can pass through the placenta to the developing fetus and in breast milk, use during **pregnancy** and **breastfeeding** is not recommended unless clearly needed.

### Side effects

A severe side effect of alemtuzumab treatment is the possible depletion of one or more types of blood cells. Because CD52 is expressed on a patient's normal B and T cells, as well as on the surface of the abnormal B cells, the treatment eliminates both normal and cancerous cells. The treatment also seems to trigger autoimmune reactions against various other blood cells. This results

in severe reduction of the many circulating blood cells including red blood cells (anemia), white blood cells (**neutropenia**), and clotting cells (thrombopenia). These conditions are treated with blood transfusions. The great majority of patients treated exhibit some type of blood cell depletion.

A second serious side effect of this drug is the prevalence of opportunistic infections that occurs during the treatment. Serious, and sometimes fatal bacterial, viral, fungal, and protozoan infections have been reported. Treatments to prevent **pneumonia** and herpes infections reduce, but do not eliminate these infections.

The majority of other side effects occur after or during the first infusion of the drug. Some common side effects of this drug include **fever** and chills, **nausea and vomiting**, **diarrhea**, **shortness of breath**, skin rash, and unusual **fatigue**. This drug can also cause low blood pressure (**hypotension**).

In patients with high tumor burden (a large number of circulating malignant B cells) this drug can cause a side effect called tumor lysis syndrome. Thought to be due to the release of the lysed cells' contents into the blood stream, it can cause a misbalance of urea, uric acid, phosphate, potassium, and **calcium** in the urine and blood. Patients at risk for this side effect must keep hydrated and can be given allopurinol before infusion.

### Interactions

There have been no formal drug interaction studies done for alemtuzumab.

Michelle Johnson MS, JD

Alendronate see **Bone disorder drugs**

## Alexander technique

### Definition

The Alexander technique is a somatic method for improving physical and mental functioning. Excessive tension, which Frederick Alexander, the originator, recognized as both physical and mental, restricts movement and creates pressure in the joints, the spine, the breathing mechanism, and other organs. The goal of the technique is to restore freedom and expression to the body and clear thinking to the mind.

## Purpose

Because the Alexander technique helps students improve overall functioning, both mental and physical, it offers a wide range of benefits. Nikolaas Tinbergen, in his 1973 Nobel lecture, hailed the “striking improvements in such diverse things as high blood pressure, breathing, depth of sleep, overall cheerfulness and mental alertness, resilience against outside pressures, and the refined skill of playing a musical instrument.” He went on to quote a list of other conditions helped by the Alexander technique: “rheumatism, including various forms of arthritis, then respiratory troubles, and even potentially lethal **asthma**; following in their wake, circulation defects, which may lead to high blood pressure and also to some dangerous heart conditions; gastrointestinal disorders of many types, various gynecological conditions, sexual failures, migraines and depressive states.”

Literature in the 1980s and 1990s went on to include improvements in back **pain**, chronic pain, postural problems, repetitive strain injury, benefits during **pregnancy** and **childbirth**, help in applying **physical therapy** and rehabilitative exercises, improvements in strain caused by computer use, improvements in the posture and performance of school children, and improvements in vocal and dramatic performance among the benefits offered by the technique.

## Description

### *Origins*

Frederick Matthias Alexander was born in 1869 in Tasmania, Australia. He became an actor and Shakespearean reciter, and early in his career he began to suffer from strain on his vocal chords. He sought medical attention for chronic hoarseness, but after treatment with a recommended prescription and extensive periods of rest, his problem persisted.

Alexander realized that his hoarseness began about an hour into a dramatic performance and reasoned that it was something he did in the process of reciting that caused him to lose his voice. Returning to his medical doctor, Alexander told him of his observation. When the doctor admitted that he didn’t know what Alexander was doing to injure his vocal chords, Alexander decided to try and find out for himself.

Thus began a decade of self-observation and discovery. Using as many as three mirrors to observe himself in the act of reciting, normal speaking, and later standing, walking, and sitting, Alexander managed to improve his coordination and to overcome his vocal problems. One of his most startling discoveries

## KEY TERMS

**Direction**—Bringing about the free balance of the head on the spine and the resulting release of the erector muscles of the back and legs which establish improved coordination.

**Habit**—Referring to the particular set of physical and mental tensions present in any individual.

**Inhibition**—Referring to the moment in an Alexander lesson when the student refrains from beginning a movement in order to avoid tensing of the muscles.

**Sensory awareness**—Bringing attention to the sensations of tension and/or release in the muscles.

was that in order to change the way he used his body he had to change the way he was thinking, redirecting his thoughts in such a way that he did not produce unnecessary tension when he attempted speech or movement. After making this discovery at the end of the nineteenth century, Alexander became a pioneer in body-mind medicine.

At first, performers and dancers sought guidance from Alexander to overcome physical complaints and to improve the expression and spontaneity of their performances. Soon a great number of people sought help from his teaching for a variety of physical and mental disorders.

The Alexander technique is primarily taught one-on-one in private lessons. Introductory workshops or workshops for special applications of the technique (e.g., workshops for musicians) are also common. Private lessons range from a half-hour to an hour in length, and are taught in a series. The number of lessons varies according to the severity of the student’s difficulties with coordination or to the extent of the student’s interest in pursuing the improvements made possible by continued study. The cost of lessons ranges from \$40–80 per hour. Insurance coverage is not widely available, but discounts are available for participants in some complementary care insurance plans. Pre-tax Flexible Spending Accounts for health care cover Alexander technique lessons if they are prescribed by a physician.

In lessons teachers guide students through simple movements (while students are dressed in comfortable clothing) and use their hands to help students identify and stop destructive patterns of tension. Tensing arises from mental processes as well as physical, so discussions of personal reactions or behavior are likely to arise in the course of a lesson.

The technique helps students move with ease and improved coordination. At the beginning of a movement (the lessons are a series of movements), most people pull back their heads, raise their shoulders toward their ears, over-arch their lower backs, tighten their legs, and otherwise produce excessive tension in their bodies. Alexander referred to this as misuse of the body.

At any point in a movement, proper use can be established. If the neck muscles are not over-tensed, the head will carry slightly forward of the spine, simply because it is heavier in the front. When the head is out of balance in the forward direction, it sets off a series of stretch reflexes in the extensor muscles of the back. It is skillful use of these reflexes, along with reflex activity in the feet and legs, the arms and hands, the breathing mechanism, and other parts of the body, that lessons in the technique aim to develop.

Alexander found that optimal functioning of the body was very hard to maintain, even for the short period of time it took to complete a single movement. People, especially adults, have very strong tension habits associated with movement. Chronic misuse of the muscles is common. It may be caused by slouching in front of televisions or video monitors, too much sitting or driving and too little walking, or by tension associated with past traumas and injuries. Stiffening the neck after a **whiplash** injury or favoring a broken or sprained leg long after it has healed are examples of habitual tension caused by injury.

The first thing a teacher of the Alexander technique does is to increase a student's sensory awareness of this excessive habitual tension, particularly that in the neck and spine. Next the student is taught to inhibit the tension. If the student prepares to sit down, for example, he will tense his muscles in his habitual way. If he is asked to put aside the intention to sit and instead to free his neck and allow less constriction in his muscles, he can begin to change his tense habitual response to sitting.

By leaving the head resting on the spine in its natural free balance, by keeping eyes open and focused, not held in a tense stare, by allowing the shoulders to release, the knees to unlock and the back to lengthen and widen, a student greatly reduces strain. In Alexander lessons students learn to direct themselves this way in activity and become skilled in fluid, coordinated movement.

## Precautions

### Side effects

The focus of the Alexander technique is educational. Teachers use their hands simply to gently

guide students in movement. Therefore, both contraindications and potential physiological side effects are kept to a minimum. No forceful treatment of soft tissue or bony structure is attempted, so damage to tissues, even in the case of errors in teaching, is unlikely.

As students' sensory awareness develops in the course of Alexander lessons, they become more acutely aware of chronic tension patterns. As students learn to release excessive tension in their muscles and to sustain this release in daily activity, they may experience tightness or soreness in the connective tissue. This is caused by the connective tissue adapting to the lengthened and released muscles and the expanded range of movement in the joints.

Occasionally students may get light-headed during a lesson as contracted muscles release and effect the circulatory or respiratory functioning.

Forceful contraction of muscles and rigid postures often indicate suppression of emotion. As muscles release during or after an Alexander lesson, students may experience strong surges of emotion or sudden changes in mood. In some cases, somatic memories surface, bringing to consciousness past injury or trauma. This can cause extreme **anxiety**, and referrals may be made by the teacher for counseling.

## Research and general acceptance

Alexander became well known among the intellectual, artistic, and medical communities in London, England, during the first half of the twentieth century. Among Alexander's supporters were John Dewey, Aldous Huxley, Bernard Shaw, and renowned scientists Raymond Dart, G.E. Coghill, Charles Sherrington, and Nikolaas Tinbergen.

Researchers continue to study the effects and applications of the technique in the fields of education, preventive medicine, and **rehabilitation**. The Alexander technique has proven an effective treatment for reducing **stress**, for improving posture and performance in schoolchildren, for relieving chronic pain, and for improving psychological functioning. The technique has been found to be as effective as beta-blocker medications in controlling stress responses in professional musicians, to enhance respiratory function in normal adults, and to mediate the effects of **scoliosis** in adolescents and adults.

## Resources

### BOOKS

Vineyard, Missy. *How You Stand, How You Move, How You Live: Learning the Alexander Technique to Explore Your*

*Mind–Body Connection and Achieve Self–Mastery.*  
Cambridge, MA: Da Capo, 2007.

#### OTHER

*Alexander Technique Resource Guide.* (Includes list of teachers) AmSAT Books. (800) 473-0620 or (804) 295-2840.

#### ORGANIZATIONS

Alexander Technique International, 1692 Massachusetts Ave., 3rd Floor, Cambridge, MA, 02138, (617) 497-5151, (617) 497-2615, (888) 668-8996, alexandertechnique@verizon.net, <http://www.ati-net.com>.

Sandra Bain Cushman

Alkali-resistant hemoglobin test see **Fetal hemoglobin test**

## KEY TERMS

**Alkaline phosphatase**—An enzyme found throughout the body, primarily in liver, bone, placenta, and intestine.

**Cholestasis**—Stoppage or suppression of the flow of bile.

**Enzyme**—A substance needed to trigger specific chemical reactions.

**Hepatocellular**—Of or pertaining to liver cells.

**Hepatocyte**—A liver cell.

**Isoenzyme**—A variation of an enzyme.

childhood growth spurt or the healing of a broken bone; or the condition may be a disease, such as bone **cancer**, Paget's disease, or **rickets**.

During **pregnancy**, alkaline phosphatase is made by the placenta and leaks into the mother's bloodstream. This is normal. Some tumors, however, start production of the same kind of alkaline phosphatase produced by the placenta. These tumors are called **germ cell tumors** and include **testicular cancer** and certain brain tumors.

Alkaline phosphatase from the intestine is increased in a person with inflammatory bowel disease, such as **ulcerative colitis**.

#### Description

Alkaline phosphatase is measured by combining the person's serum with specific substances with which alkaline phosphatase is known to react. The end product of this reaction is measured; and from that measurement, the amount of alkaline phosphatase in the person's serum is determined.

Each tissue-liver, bone, placenta, and intestine—produces a slightly different alkaline phosphatase. These variations are called isoenzymes. In the laboratory, alkaline phosphatase is measured as the total amount or the amount of each of the four isoenzymes. The isoenzymes react differently to heat, certain chemicals, and other processes in the laboratory. Methods to measure them separately are based on these differences.

The test is covered by insurance when medically necessary. Results are usually available the next day.

#### Preparation

To collect the 5–10 mL blood needed for this test, a healthcare worker ties a tourniquet on the person's

upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

A person being tested for alkaline phosphatase should not have anything to eat or drink, except water, for eight to ten hours before the test. Some people release alkaline phosphatase from the intestine into the bloodstream after eating. This will temporarily increase the result of the test.

### Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops will reduce bruising. Warm packs to the puncture site will relieve discomfort.

### Normal results

Normal results vary by age and by sex. They also vary based on the laboratory and the method used.

### Abnormal results

Bone and liver disease increase alkaline phosphatase more than any other disease, up to five times the normal level. Irritable bowel disease, germ cell tumors, and infections involving the liver, such as viral hepatitis and **infectious mononucleosis**, increase the enzyme also, but to a lesser degree. Healing bones, pregnancy, and normal growth in children also increase levels.

### Resources

#### BOOKS

Dehn, Richard W., and David P. Asprey. *Essential Clinical Procedures*. 2nd ed. Philadelphia: Saunders, 2006.

Nancy J. Nordenson

**Alkalosis** see **Metabolic alkalosis; Respiratory alkalosis**

Allergic alveolitis see **Hypersensitivity pneumonitis**

hypersensitivity reaction that occurs in **asthma** patients who are allergic to this specific fungus.

### Description

ABPA is an allergic reaction to a species of *Aspergillus* called *Aspergillus fumigatus*. It is sometimes grouped together with other lung disorders characterized by eosinophilia—an abnormal increase of a certain type of white blood cell in the blood—under the heading of **eosinophilic pneumonia**. These disorders are also called hypersensitivity lung diseases.

ABPA appears to be increasing in frequency in the United States, although the reasons for the increase are not clear. The disorder is most likely to occur in adult asthmatics aged 20-40. It affects males and females equally.

### Causes and symptoms

ABPA develops when the patient breathes air containing *Aspergillus* spores. These spores are found worldwide, especially around riverbanks, marshes, bogs, forests, and wherever there is wet or decaying vegetation. They are also found on wet paint, construction materials, and in air conditioning systems. ABPA is a nosocomial infection, which means that a patient can get it in a hospital. When *Aspergillus* spores reach the bronchi, which are the branches of the windpipe that lead into the lungs, the bronchi react by contracting spasmodically. So the patient has difficulty breathing and usually wheezes or coughs. Many patients with ABPA also run a low-grade **fever** and lose their appetites.

### Complications

Patients with ABPA sometimes **cough** up large amounts of blood, a condition that is called **hemoptysis**. They may also develop a serious long-term form of **bronchiectasis**, the formation of fibrous tissue in the lungs. Bronchiectasis is a chronic bronchial disorder caused by repeated inflammation of the airway, and marked by the abnormal enlargement of, or damage to, the bronchial walls. ABPA sometimes occurs as a complication of **cystic fibrosis**.

### Diagnosis

The diagnosis of ABPA is based on a combination of the patient's history and the results of blood tests, sputum tests, skin tests, and diagnostic imaging. The doctor will be concerned to distinguish between ABPA and a worsening of the patient's asthma, cystic fibrosis, or other lung disorders. There are seven major

## Allergic bronchopulmonary aspergillosis

### Definition

Allergic bronchopulmonary **aspergillosis**, or ABPA, is one of four major types of infections in humans caused by *Aspergillus* fungi. ABPA is a

## KEY TERMS

**Antifungal**—A medicine used to treat infections caused by a fungus.

**Antigen**—A substance that stimulates the production of antibodies.

**Bronchiectasis**—A disorder of the bronchial tubes marked by abnormal stretching, enlargement, or destruction of the walls. Bronchiectasis is usually caused by recurrent inflammation of the airway and is a diagnostic criterion of ABPA.

**Bronchodilator**—A medicine used to open up the bronchial tubes (air passages) of the lungs.

**Eosinophil**—A type of white blood cell containing granules that can be stained by eosin (a chemical that produces a red stain).

**Eosinophilia**—An abnormal increase in the number of eosinophils in the blood.

**Hemoptysis**—The coughing up of large amounts of blood. Hemoptysis can occur as a complication of ABPA.

**Hypersensitivity**—An excessive response by the body to a foreign substance.

**Immunoglobulin E (IgE)**—A type of protein in blood plasma that acts as an antibody to activate allergic reactions. About 50% of patients with allergic disorders have increased IgE levels in their blood serum.

**Nosocomial infection**—An infection that can be acquired in a hospital. ABPA is a nosocomial infection.

**Precipitin**—An antibody in blood that combines with an antigen to form a solid that separates from the rest of the blood.

**Spirometer**—An instrument used to test a patient's lung capacity.

**"Wheal and flare" reaction**—A rapid response to a skin allergy test characterized by the development of a red, itching spot in the area where the allergen was injected.

**Wheezing**—A whistling or musical sound caused by tightening of the air passages inside the patient's chest.

criteria for a diagnosis of allergic bronchopulmonary aspergillosis:

- a history of asthma
- an accumulation of fluid in the lung that is visible on a chest x-ray
- bronchiectasis (abnormal stretching, enlarging, or destruction of the walls of the bronchial tubes)
- skin reaction to *Aspergillus* antigen
- eosinophilia in the patient's blood and sputum
- *Aspergillus* precipitins in the patient's blood. Precipitins are antibodies that react with the antigen to form a solid that separates from the rest of the solution in the test tube
- a high level of IgE in the patient's blood. IgE refers to a class of antibodies in blood plasma that activate allergic reactions to foreign particles

Other criteria that may be used to support the diagnosis include the presence of *Aspergillus* in samples of the patient's sputum, the coughing up of plugs of brown mucus, or a late skin reaction to the *Aspergillus* antigen.

### Laboratory tests

The laboratory tests that are done to obtain this information include a **complete blood count** (CBC), a **sputum culture**, a blood serum test of IgE levels, and a

skin test for the *Aspergillus* antigen. In the skin test, a small amount of antigen is injected into the upper layer of skin on the patient's forearm about four inches below the elbow. If the patient has a high level of IgE antibodies in the tissue, he or she will develop what is called a "wheal and flare" reaction in about 15–20 minutes. A "wheal and flare" reaction is characterized by the eruption of a reddened, **itching** spot on the skin. Some patients with ABPA will develop the so-called late reaction to the skin test, in which a red, sore, swollen area develops about six to eight hours after the initial reaction.

### Diagnostic imaging

Chest x-rays and CT scans are used to check for the presence of fluid accumulation in the lungs and signs of bronchiectasis.

### Treatment

ABPA is usually treated with prednisone (Meticorten) or other **corticosteroids** taken by mouth, and with **bronchodilators**.

Antifungal drugs are *not* used to treat ABPA because it is caused by an allergic reaction to *Aspergillus* rather than by direct infection of tissue.

### Follow-up care

Patients with ABPA should be given periodic checkups with chest x-rays and a spirometer test. A spirometer is an instrument that evaluates the patient's lung capacity.

### Prognosis

Most patients with ABPA respond well to corticosteroid treatment. Others have a chronic course with gradual improvement over time. The best indicator of a good prognosis is a long-term fall in the patient's IgE level. Patients with lung complications from ABPA may develop severe airway obstruction.

### Prevention

ABPA is difficult to prevent because *Aspergillus* is a common fungus; it can be found in the saliva and sputum of most healthy individuals. Patients with ABPA can protect themselves somewhat by avoiding haystacks, compost piles, bogs, marshes, and other locations with wet or rotting vegetation; by avoiding construction sites or newly painted surfaces; and by having their air conditioners cleaned regularly. Some patients may be helped by air filtration systems for their bedrooms or offices.

### Resources

#### BOOKS

Stauffer, John L. "Lung." In McPhee, Stephen, and Maxine Papadakis. *Current Medical Diagnosis and Treatment*, 2010, 49th ed. New York: McGraw-Hill Medical, 2009.

#### ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, <http://www.cdc.gov>.

National Institute of Allergies and Infectious Diseases, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (301) 402-3573, (866) 284-4107, ocpostoffice@niaid.nih.gov, <http://www.niaid.nih.gov>.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, <http://www.rarediseases.org>.

Rebecca J. Frey PhD

## Allergic purpura

### Definition

Allergic purpura (AP) is an allergic reaction of unknown origin causing red patches on the skin and other symptoms. AP is also called Henoch–Schönlein

### KEY TERMS

**Glomeruli**—Knots of capillaries in the kidneys responsible for filtering the blood (singular, glomerulus).

purpura, named after the two German doctors who first described the condition in the 1860s.

### Demographics

AP affects mostly children but it can occur at any age. Approximately 20 per 100,000 children each year have a reaction. Most cases are children between the ages of two and seven years. Boys are affected more often than girls.

### Description

"Purpura" is a bleeding disorder that occurs when blood vessels inflame and capillaries rupture, allowing small amounts of blood to accumulate in the surrounding tissues. In AP, this occurs because the capillaries are blocked by protein complexes formed during an abnormal immune reaction. The skin is the most obvious site of reaction, but the joints, gastrointestinal tract, and kidneys are also often affected.

### Causes and symptoms

#### Causes

AP is caused by a reaction involving antibodies, special proteins of the immune system. Antibodies are designed to bind with foreign proteins, called antigens. In some situations, antigen–antibody complexes can become too large to remain suspended in the bloodstream. When this occurs, they precipitate out and become lodged in the capillaries. This change can cause the capillary to burst, allowing a local hemorrhage.

The source of the antigen causing AP is unknown. Antigens may be introduced by bacterial or viral infection. More than 75% of patients report having had an infection of the throat, upper respiratory tract, or gastrointestinal system several weeks before the onset of AP. Medical researchers find that AP often occurs after the immune system has had an unusual reaction. Other complex molecules can act as antigens as well, including drugs such as **antibiotics** or vaccines. Otherwise harmless substances that stimulate an immune reaction are known as allergens. Drug allergens that may cause AP include penicillin, ampicillin, erythromycin, and quinine. Vaccines possibly linked to AP include those for typhoid,

**measles, cholera, and yellow fever.** Cold weather can also be a contributing factor in its cause.

### Symptoms

The onset of AP may be preceded by a **headache, fever**, and loss of appetite. Most patients first develop an itchy skin rash. The rash is red, either flat or raised, and may be small and freckle-like. The rash may also be larger, resembling a bruise. **Rashes** become purple and then rust colored over the course of a day, and fade after several weeks. Rashes are most common on the buttocks, abdomen, and lower extremities. Rashes higher on the body may also occur, especially in younger children.

Joint **pain** and swelling is common, especially in the knees and ankles. **Hives, nausea, vomiting**, and **diarrhea** can also be present. Abdominal pain occurs in almost all patients, along with blood in the body waste (feces). About half of all patients show blood in the urine, low urine volume, or other signs of kidney involvement. Kidney failure may occur due to widespread obstruction of the capillaries in the filtering structures called glomeruli. Kidney failure develops in about five percent of all patients, and in 15% of those with elevated blood or protein in the urine.

Less common symptoms include prolonged headache, fever, and pain and swelling of the scrotum. Involvement of other organ systems may lead to **heart attack** (myocardial infarction), inflammation of the pancreas (**pancreatitis**), intestinal obstruction, or bowel perforation.

### Diagnosis

Diagnosis of AP is based on the symptoms and their development, a careful medical history, and blood and urine tests. A **physical examination** will indicate lesions of the skin and tenderness of joints. A **skin biopsy** may be used, along with **urinalysis**. X rays or computed tomography (CT) scans may be performed to assess complications in the bowel or other internal organs.

### Treatment

Most cases of AP resolve completely without treatment, often within one month. Nonetheless, a hospital stay is required because of the possibility of serious complications, such as internal bleeding. Non-aspirin pain relievers may be given for joint pain. **Corticosteroids** (like prednisone) are sometimes used, although not all specialists agree on their utility. Kidney involvement requires monitoring and correction of blood fluids and electrolytes.

Patients with severe kidney complications may require a **kidney biopsy** so that tissue can be analyzed. Even after all other symptoms subside, elevated levels of blood or protein in the urine may persist for months and require regular monitoring. **Hypertension** or kidney failure may develop months or even years after the acute phase of the disease. Kidney failure requires dialysis or transplantation.

### Prognosis

Most people who develop AP become better on their own after several weeks. About half of all patients have at least one recurrence. Cases that do not have kidney complications, or where those complications are minor, usually have the best prognosis.

### Prevention

All necessary and proper action should be taken to ensure exposure of the foreign substance (source) causing allergic purpura does not occur.

### Resources

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Richard Robinson

## Allergic rhinitis

### Definition

Allergic **rhinitis**, more commonly referred to as hay **fever**, is an inflammation of the nasal passages caused by allergic reaction to airborne substances such as dander, dust, or pollen.



This illustration depicts excessive mucus production in the nose after inhalation of airborne pollen. (© John Bavosi/SPL/Photo Researchers, Inc.)

## Demographics

Allergic rhinitis affect approximately 60 million people in the United States, and its prevalence is increasing. In 2008, there were more than 12 million doctor visits because of it, which affects about 20% of all adults and as many as 40% of children in the United States, and is responsible for 2.5% of all doctor visits. Allergic rhinitis (AR) is the most common allergic condition and one of the most common of all minor afflictions. **Antihistamines** and other drugs used to treat allergic rhinitis make up a significant fraction of both prescription and over-the-counter drug sales each year.

From 2000 to 2005, the cost of treating allergic rhinitis almost doubled from \$6.1 billion to \$11.2 billion, with more than half the cost spent on prescription medications. Immunotherapy helps reduce hay fever symptoms in about 85% of people with allergic rhinitis.

## Description

There are two types of allergic rhinitis: seasonal and perennial. Seasonal AR occurs in the spring, summer, and early fall, when airborne plant pollens are at their highest levels. In fact, the term hay fever is really a misnomer, since allergy to grass pollen is only one cause of symptoms for most people. Perennial AR occurs all year and is usually caused by home or workplace airborne pollutants. A person can be affected by one or both types. Symptoms of seasonal AR are worst after being outdoors, while symptoms of perennial AR are worst after spending time indoors.

Both types of **allergies** can develop at any age, although onset in childhood through early adulthood is most common. Although allergy to a particular substance is not inherited, increased allergic sensitivity may “run in the family.” While allergies can improve on their own over time, they can also become worse over time.

## Causes and symptoms

### Causes

Allergic rhinitis is a type of immune reaction. Normally, the immune system responds to foreign microorganisms, or particles, like pollen or dust, by producing specific proteins, called antibodies, that are capable of binding to identifying molecules, or antigens, on the foreign particle. This reaction between antibody and antigen sets off a series of reactions designed to protect the body from infection. Sometimes, this same series of reactions is triggered by harmless, everyday substances. This is the condition known as allergy, and the offending substance is called an allergen.

Like all allergic reactions, AR involves a special set of cells in the immune system known as mast cells. Mast cells, found in the lining of the nasal passages and eyelids, display a special type of antibody, called immunoglobulin type E (IgE), on their surface. Inside, mast cells store reactive chemicals in small packets, called granules. When the antibodies encounter allergens, they trigger release of the granules, which spill out their chemicals onto neighboring cells, including blood vessels and nerve cells. One of these chemicals, histamine, binds to the surfaces of these other cells, through special proteins called histamine receptors. Interaction of histamine with receptors on blood vessels causes neighboring cells to become leaky, leading to the fluid collection, swelling, and increased redness characteristic of a runny nose and red, irritated eyes. Histamine also stimulates **pain** receptors, causing the

## KEY TERMS

**Allergen**—A substance that provokes an allergic response.

**Anaphylaxis**—Increased sensitivity caused by previous exposure to an allergen that can result in blood vessel dilation (swelling) and smooth muscle contraction. Anaphylaxis can result in sharp blood pressure drops and difficulty breathing.

**Antibody**—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

**Antigen**—A foreign protein to which the body reacts by making antibodies.

**Granules**—Small packets of reactive chemicals stored within cells.

**Histamine**—A chemical released by mast cells that activates pain receptors and causes cells to become leaky.

**Mast cells**—A type of immune system cell that is found in the lining of the nasal passages and eyelids, displays a type of antibody called immunoglobulin type E (IgE) on its cell surface, and participates in the allergic response by releasing histamine from intracellular granules.

itchy, scratchy nose, eyes, and throat common in allergic rhinitis.

The number of possible airborne allergens is enormous. Seasonal AR is most commonly caused by grass and tree pollens, since their pollen is produced in large amounts and is dispersed by the wind. Showy flowers, like roses or lilacs, that attract insects produce a sticky pollen that is less likely to become airborne. Different plants release their pollen at different times of the year, so seasonal AR sufferers may be most affected in spring, summer, or fall, depending on which plants provoke a response. The amount of pollen in the air is reflected in the pollen count, often broadcast on the daily news during allergy season. Pollen counts tend to be lower after a good rain that washes the pollen out of the air and higher on warm, dry, windy days.

Virtually any type of tree or grass may cause AR. A few types of weeds that tend to cause the most trouble for people include the following:

- ragweed
- sagebrush
- lamb's-quarters
- plantain
- pigweed
- dock/sorrel
- tumbleweed

Perennial AR is often triggered by house dust, a complicated mixture of airborne particles, many of which are potent allergens. House dust contains some or all of the following:

- house mite body parts. All houses contain large numbers of microscopic insects called house mites. These harmless insects feed on fibers, fur, and skin shed by

the house's larger occupants. Their tiny body parts easily become airborne.

- animal dander. Animals constantly shed fur, skin flakes, and dried saliva. Carried in the air, or transferred from pet to owner by direct contact, dander can cause allergy in many sensitive people.
- mold spores. Molds live in damp spots throughout the house, including basements, bathrooms, air ducts, air conditioners, refrigerator drains, damp windowsills, mattresses, and stuffed furniture. Mildew and other molds release airborne spores that circulate throughout the house.

Other potential causes of perennial allergic rhinitis include the following:

- cigarette smoke
- perfume
- cosmetics
- cleansers
- copier chemicals
- industrial chemicals
- construction material gases

### **Symptoms**

Inflammation of the nose, or rhinitis, is the major symptom of AR. Inflammation causes **itching**, sneezing, runny nose, redness, and tenderness. Sinus swelling can constrict the eustachian tube that connects the inner ear to the throat, causing a congested feeling and "ear popping." The drip of mucus from the sinuses down the back of the throat, combined with increased sensitivity, can also lead to throat irritation and redness. AR usually also causes redness, itching, and watery eyes. **Fatigue** and **headache** are also common.

## Diagnosis

Diagnosing seasonal AR is usually easy and can often be done without a medical specialist. When symptoms appear in spring or summer and disappear with the onset of cold weather, seasonal AR is almost certainly the culprit. Other causes of rhinitis, including infection, can usually be ruled out by a **physical examination** and a nasal smear, in which a sample of mucus is taken on a swab for examination.

**Allergy tests**, including skin testing and provocation testing, can help identify the precise culprit, but may not be done unless a single source is suspected and subsequent avoidance is possible. Skin testing involves placing a small amount of liquid containing a specific allergen on the skin and then either poking, scratching, or injecting it into the skin surface to observe whether redness and swelling occurs. Provocation testing involves challenging an individual with either a small amount of an inhalable or ingestible allergen to see if a response is elicited.

Perennial AR can also usually be diagnosed by careful questioning about the timing of exposure and the onset of symptoms. Specific allergens can be identified through allergy skin testing.

## Treatment

Avoidance of the allergens is the best treatment, but this is often not possible. When it is not possible to avoid one or more allergens, there are two major forms of medical treatment, drugs and immunotherapy.

### Drugs

**ANTIHISTAMINES.** Antihistamines block the histamine receptors on nasal tissue, decreasing the effect of histamine release by mast cells. They may be used after symptoms appear, though they may be even more effective when used preventively, before symptoms appear. A wide variety of antihistamines are available.

Older antihistamines often produce drowsiness as a major side effect. Such antihistamines include the following:

- diphenhydramine (Benadryl and generics)
- chlorpheniramine (Chlor-Trimeton and generics)
- brompheniramine (Dimetane and generics)
- clemastine (Tavist and generics).

Newer antihistamines that do not cause drowsiness are available by prescription and include the following:

- astemizole (Hismanal)
- fexofenadine (Allegra)

- cetirizine (Zyrtec)
- azelastine HCl (Astelin)

Loratadine (Claritin) was available only by prescription but was released to over-the-counter status by the FDA.

Hismanal has the potential to cause serious heart **arrhythmias** when taken with the antibiotic erythromycin, the antifungal drugs ketoconazole and itraconazole, or the antimalarial drug quinine. Taking more than the recommended dose of Hismanal can also cause arrhythmias. Seldane (terfenadine), the original non-drowsy antihistamine, was voluntarily withdrawn from the market by its manufacturers in early 1998 because of this potential and because of the availability of an equally effective, safer alternative drug, fexofenadine.

**LEUKOTRIENE RECEPTOR ANTAGONISTS.** Leukotriene receptor antagonists (montelukast or Singulair and zafirlukast or Accolate) are a newer class of drugs used daily to help prevent **asthma**. They've also become approved in the United States to treat allergic rhinitis.

**DECONGESTANTS.** Decongestants constrict blood vessels to counteract the effects of histamine. This decreases the amount of blood in the nasopharyngeal and sinus mucosa and reduces swelling. Nasal sprays are available that can be applied directly to the nasal lining and oral systemic preparations are available. Decongestants are stimulants and may cause increased heart rate and blood pressure, headaches, insomnia, agitation and difficulty emptying the bladder. Use of topical decongestants for longer than several days can cause loss of effectiveness and rebound congestion, in which nasal passages become more severely swollen than before treatment.

**TOPICAL CORTICOSTEROIDS.** Topical **corticosteroids** reduce mucous membrane inflammation and are available by prescription. Allergies tend to become worse as the season progresses because the immune system becomes sensitized to particular antigens and can produce a faster, stronger response. Topical corticosteroids are especially effective at reducing this seasonal sensitization because they work more slowly and last longer than most other medication types. As a result, they are best started before allergy season begins. Side effects are usually mild, but may include headaches, nosebleeds, and unpleasant taste sensations.

**MAST CELL STABILIZERS.** Cromolyn **sodium** prevents the release of mast cell granules, thereby preventing release of histamine and the other chemicals contained in them. It acts as a preventive treatment if

it is begun several weeks before the onset of the allergy season. It can be used for perennial AR as well.

### **Immunotherapy**

Immunotherapy, also known as desensitization or allergy shots, alters the balance of antibody types in the body, thereby reducing the ability of IgE to cause allergic reactions. Immunotherapy is preceded by allergy testing to determine the precise allergens responsible. Injections involve very small but gradually increasing amounts of allergen, over several weeks or months, with periodic boosters. Full benefits may take up to several years to achieve and are not seen at all in about one in five patients. Individuals receiving all shots will be monitored closely following each shot because of the small risk of **anaphylaxis**, a condition that can result in difficulty breathing and a sharp drop in blood pressure.

### **Alternative treatment**

Alternative treatments for AR often focus on modulation of the body's immune response, and frequently center around diet and lifestyle adjustments. Chinese herbal medicine can help rebalance a person's system, as can both acute and constitutional homeopathic treatment. Vitamin C in substantial amounts can help stabilize the mucous membrane response. For symptom relief, western herbal remedies including eyebright (*Euphrasia officinalis*) and nettle (*Urtica dioica*) may be helpful. Bee pollen may also be effective in alleviating or eliminating AR symptoms. A 2004 report said that **phototherapy** (treatment with a combination of ultraviolet and visible light) decreased the symptoms of allergic rhinitis in a majority of patients who did not respond well to traditional drug treatment.

### **Prognosis**

Most people with AR can achieve adequate relief with a combination of preventive strategies and treatment. While allergies may improve over time, they may also get worse or expand to include new allergens. Early treatment can help prevent an increased sensitization to other allergens.

### **Prevention**

Reducing exposure to pollen may improve symptoms of seasonal AR. Strategies include the following:

- stay indoors with windows closed during the morning hours, when pollen levels are highest
- keep car windows up while driving

- use a surgical face mask when outside
- avoid uncut fields
- learn which trees are producing pollen in which seasons, and avoid forests at the height of pollen season
- wash clothes and hair after being outside
- clean air conditioner filters in the home regularly
- use electrostatic filters for central air conditioning

Moving to a region with lower pollen levels is rarely effective, since new allergies often develop

Preventing perennial AR requires identification of the responsible allergens.

#### Mold spores:

- keep the house dry through ventilation and use of dehumidifiers
- use a disinfectant such as dilute bleach to clean surfaces such as bathroom floors and walls
- have ducts cleaned and disinfected
- clean and disinfect air conditioners and coolers
- throw out moldy or mildewed books, shoes, pillows, or furniture

#### House dust:

- vacuum frequently, and change the bag regularly. Use a bag with small pores to catch extra-fine particles
- clean floors and walls with a damp mop
- install electrostatic filters in heating and cooling ducts, and change all filters regularly

#### Animal dander:

- avoid contact if possible
- wash hands after contact
- vacuum frequently
- keep pets out of the bedroom, and off furniture, rugs, and other dander-catching surfaces
- have your pets bathed and groomed frequently

### **Resources**

#### **BOOKS**

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Richard Robinson  
Karl Finley

## Allergies

### Definition

Allergies are hypersensitive responses by the immune system to otherwise harmless foreign substances.

### Demographics

Allergies are among the most common medical disorders. It is estimated that 60 million Americans, or more than one in every five, suffer from some form of allergy that is pronounced enough to cause symptoms. More than half of all Americans test positive for one or more allergens. Allergies are the third leading cause of chronic disease among American children and the single largest reason for school absences. Allergies are the fifth leading cause of chronic disease among all Americans, accounting for one in nine physician visits and a major source of lost workplace productivity. There are similar proportions of allergy sufferers throughout much of the world.

Among Americans:

- Approximately 36 million suffer from seasonal allergies, with seasonal allergic rhinitis—or hay fever—ffecting 20% of all adults and up to 40% of children. Pollen allergies generally develop between the ages of 6 and 13. Other respiratory allergies, such as those to dust, animal dander, and molds, may occur in children as young as two or three.
- Approximately 12 million have food allergies, including 4% of adults and 6-8% of children four years-of-age and under. Approximately 6.9 million Americans are allergic to seafood and 0.4-0.6% are allergic to peanuts and other nuts—the most severe of food allergies.
- Allergic drug reactions account for 5-10% of all adverse drug reactions, with skin reactions being the most common. About one-fifth of all children are allergic to some type of medication, often penicillin, sulfa drugs, or aspirin.

- Although about 15% of adults have mild, localized allergic reactions to insect bites and stings, approximately 3% have serious allergies to the venom of stinging insects, such as honeybees, wasps, hornets, yellow jackets, and fire ants (which are found only in the South). Children rarely experience the severe reactions to venom that sometimes occur in adults.
- Hives affect up to 20% of the population at some point in their lives.
- Skin allergies or allergic contact dermatitis is the most common skin condition in children under age 11.
- Estimates of the prevalence of latex allergy vary from less than 1% to 6%. Healthcare workers are particularly at risk for contact dermatitis from latex gloves.

Almost nine million American children suffer from **asthma**, a chronic disease that causes inflammation of the airways, making it difficult to breathe. Many different allergens can trigger asthma attacks and it is estimated that 50% of adults and more than 80% of children with asthma have associated allergies, especially **allergic rhinitis**. It is believed that asthma is both under-diagnosed and under-treated in the elderly.

**Anaphylaxis** or anaphylactic shock is a rare, severe, and potentially fatal allergic reaction that causes blood pressure to drop severely and the airways to swell shut. Among Americans:

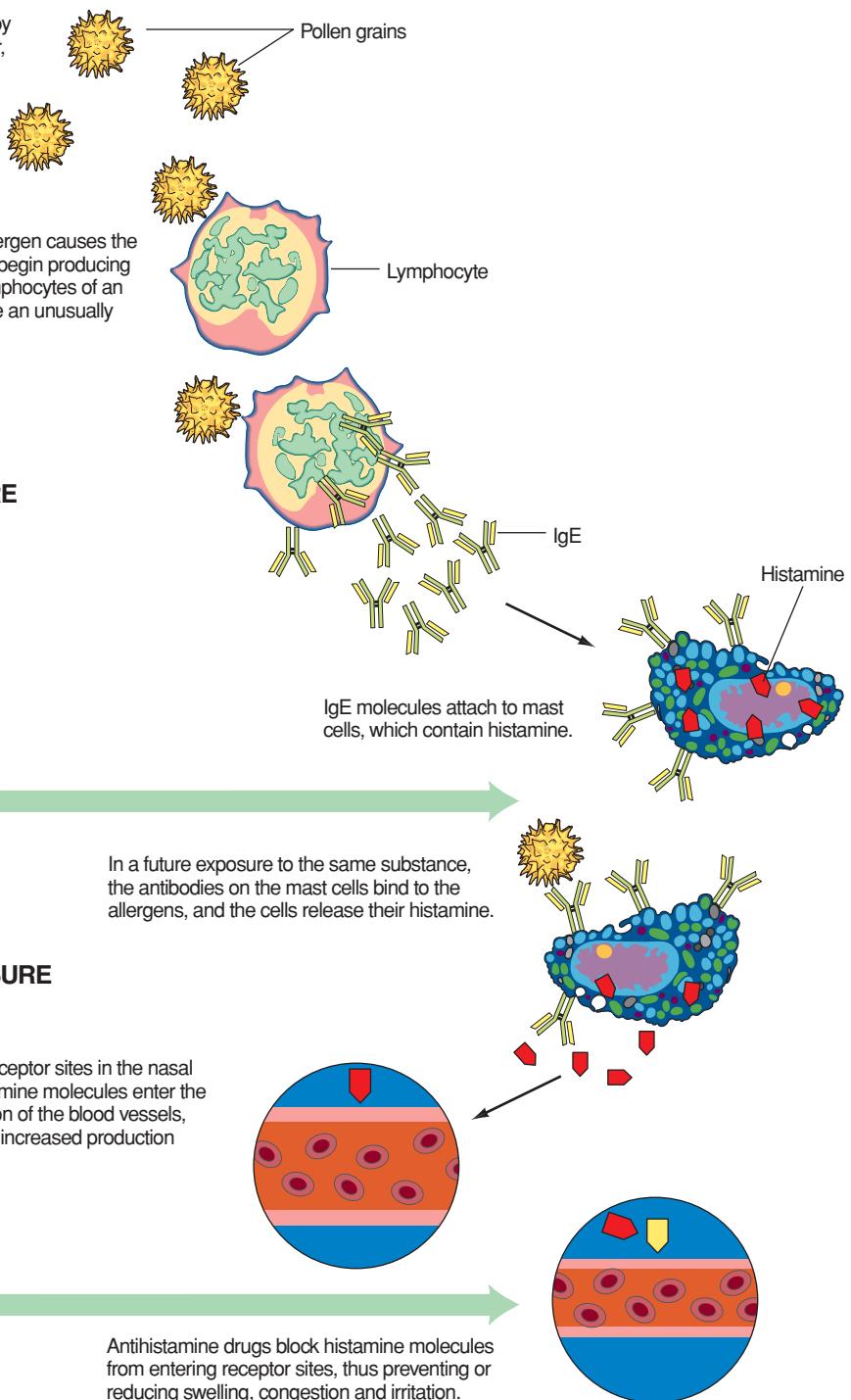
- More than 700 die each year from anaphylaxis brought on by an allergic reaction
- Approximately 150–200 die from food-induced anaphylaxis
- Penicillin in its various forms results in about 400 deaths per year in the United States. Worldwide, 32 out of every 100,000 patients exposed to penicillin have an anaphylactic reaction
- Each year 40–100 Americans die from an anaphylactic reaction to insect bites or stings
- There are about 220 cases of anaphylaxis and three deaths annually from latex allergy

The incidence of allergies and asthma is increasing in industrialized countries by about 5% per year and as many as half of all those affected are children. Some of this increase can be attributed to better diagnosis and reporting. However much of it may be due to lifestyle and environmental factors.

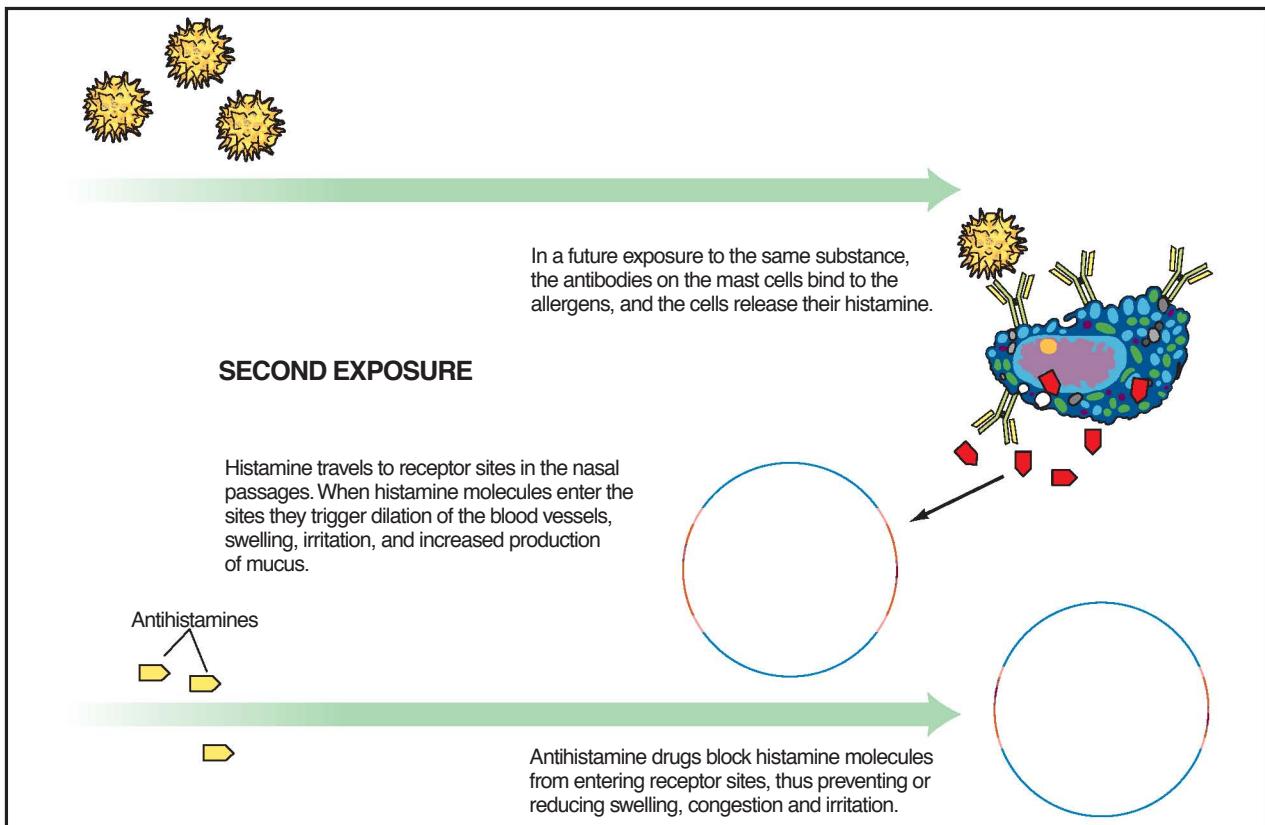
### Description

An allergy is a type of immune response. The immune system normally responds to microorganisms, such as bacteria or viruses, or foreign particles by producing specific proteins called antibodies. These

Allergic rhinitis is commonly triggered by exposure to household dust, animal fur, or pollen. The foreign substance that triggers an allergic reaction is called an allergen.



**The allergic response.** (Illustration by Hans & Cassady, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)



**Second and subsequent exposure to allergen.** (Illustration by Hans & Cassady, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)

antibodies identify and bind to a specific foreign molecule—known as the antigen. The reaction between the antibody and its antigen sets off a series of chemical reactions designed to protect the body from infection. However with allergies, this immune response is triggered by harmless common substances called allergens. Allergens may be inhaled into the lungs (pollen, dust, animal dander, mold, pollutants), swallowed (food, drugs), injected (drugs, insect venom), or touched (poisonous plants, latex).

There are two main types of allergic reactions. Immediate hypersensitivity reactions are mediated predominately by a type of immune-system cell called a mast cell and occur within minutes of contact with the allergen. Delayed hypersensitivity reactions are mediated by T cells, a type of white blood cell, and occur hours to days after exposure to the allergen.

In immediate sensitivity reactions allergens bind to a type of antibody called immunoglobulin E or IgE on the surface of mast cells. Mast cells are filled with granules that contain a variety of potent chemicals including histamine. When the IgE on a mast cell binds its specific allergen, the contents of the granules

spill out onto neighboring cells. Histamine binds to proteins called histamine receptors on the surfaces of these other cells, causing a chain of reactions that lead to allergy symptoms. Histamine binding to receptors on blood vessels increases leakage, leading to the fluid accumulation, swelling, and redness. In the nasal passages histamine causes swelling, congestion, and increased mucus production. Histamine also stimulates **pain** receptors on nerve cells, causing sensitivity and irritation. These symptoms last from one to several hours following contact with the allergen.

In delayed hypersensitivity reactions roving T cells contact the allergen, setting in motion a more prolonged immune response. This type of allergic response may develop over several days following contact with the allergen and symptoms may persist for a week or more.

Allergens enter the body through four main routes: the airways, the gastrointestinal tract, the circulatory system, and the skin. Inhaled or ingested allergens usually cause immediate hypersensitivity reactions. Allergens on the skin usually cause delayed hypersensitivity reactions.

People are sensitive to different allergens. For example, some people have severe allergic **rhinitis** but no **food allergies**, whereas others are extremely sensitive to nuts but not to any other food. Allergies may worsen over time. For example, allergic rhinitis can be either seasonal or chronic and a childhood ragweed allergy may progress to year-round dust and pollen allergies. Conversely, people can lose allergies. Infant or childhood **atopic dermatitis**, for example, almost always disappears with advancing age. However most often, an apparent loss of sensitivity is due to reduced exposure to the allergen or increased tolerance for the allergy symptoms.

### Risk factors

Although allergies to specific allergens are not inherited, the propensity for developing allergies is frequently inherited.

- If neither parent has allergies, the chances of a child developing allergies are approximately 10–20%.
- A child with one allergic parent has a 30–50% chance of developing allergies.
- The likelihood of developing allergies rises to 40–75% if both parents have allergies. However children are not necessarily sensitive to the same allergens as their parents. Since people with allergies tend to produce more IgE than those without allergies, it may be that the tendency to produce more IgE is inherited. High levels of IgE also increase the likelihood of having allergies to multiple allergens.

Other risk factors for the development of childhood allergies include:

- low birth weight
- being born during a high-pollen season
- not being breastfed
- growing up in a home with tobacco smoke
- having a family pet
- having a lower socioeconomic status
- repeated exposure to an allergen or prolonged exposure to a strong allergen

### Causes and symptoms

The most common airborne allergens are:

- plant pollens
- animal fur and dander
- body parts from house mites (microscopic creatures found in all houses)
- house dust
- mold spores

- feathers
- cigarette smoke
- chemicals
- solvents
- cleansers

Pollen can cause both seasonal and chronic rhinitis. Seasonal rhinitis occurs at the same time every year and is caused by the pollen of specific plants, especially grasses and trees in the spring and ragweed in the late summer and fall. Allergies tend to worsen as the season progresses because the immune system becomes sensitized to particular antigens and produces a faster, stronger response. Chronic rhinitis can be caused by food as well as airborne allergens.

Airborne allergens cause immediate hypersensitivity reactions in the upper airways and eyes. These include sneezing, runny nose, itchy, watery, and bloodshot eyes, nasal congestion, and scratchy or irritated throat due to postnasal drip. Airborne allergens can also cause inflammation of the thin membrane (conjunctiva) covering the eye, resulting in the redness, irritation, and increased tearing of allergic **conjunctivitis** or pink eye. Asthma causes **wheezing**, coughing, and **shortness of breath** and is associated with exposure to numerous allergens including cockroach allergens.

Common food allergens include:

- cow's milk
- eggs
- grains such as wheat or corn
- nuts, especially peanuts, walnuts, and Brazil nuts
- fish, mollusks, and shellfish
- soy products
- some fruits, especially raw seeded fruit
- some vegetables, especially tomatoes or legumes such as peas or beans
- chocolate
- certain spices
- food additives and preservatives

True food allergies are often confused with intolerance to certain foods. Food allergies, like other types of allergies, are caused by an antibody response, whereas intolerance is due a deficiency in the enzymes needed to digest a certain food. For example, a milk allergy is caused by sensitivity to an allergen (often the protein lactalbumin) in the milk itself. In contrast, people who lack the enzyme lactase have lactose intolerance—the inability to digest one of the sugars in milk—and suffer from gastrointestinal problems when they consume milk or certain milk products.

Symptoms of food allergies depend on the tissues that are most sensitive to the allergen and whether the allergen has spread systemically through the circulatory system. Allergens in food can cause immediate hypersensitivity reactions that include **itching**, swelling, and/or **rashes** of the eyes, lips, mouth, and throat. Food allergies can also cause respiratory symptoms. Swelling and irritation of the intestinal lining can cause **nausea**, **vomiting**, cramping, **diarrhea**, and gas. When food allergens enter the bloodstream from the gastrointestinal tract, they can cause **hives**, atopic **dermatitis**, or more severe reactions such as angioedema. Some food allergens may cause anaphylaxis, a potentially life-threatening condition marked by tissue swelling, airway constriction, and drop in blood pressure. Reactions to peanuts and other nuts can be so dangerous that physicians recommend caution in giving these foods to infants and children with a family history of allergy. Some school systems are restricting the use of peanuts and peanut butter in lunchrooms or banning them altogether, since even smelling or touching them can cause an allergic reaction in some children.

Drugs that often cause allergic reactions include:

- penicillin and other antibiotics
- flu vaccines
- tetanus toxoid vaccine
- gamma globulin

Insects and other arthropods whose **bites** or **stings** may cause an allergic reaction include:

- bees, wasps, and hornets
- mosquitoes
- fleas
- scabies

Injected allergens from drugs or insect **bites and stings** are introduced directly into the circulation where they can cause both local reactions, such as swelling and irritation at the injection site, and system-wide (systemic) reactions, including anaphylaxis. Symptoms of an allergy to insect venom include:

- hives
- itchy eyes
- a dry cough
- constriction of the throat and chest
- nausea
- dizziness
- abdominal pain

There are three main types of allergic skin reactions:

- atopic dermatitis or eczema
- hives (urticaria)
- contact dermatitis

Atopic dermatitis and **eczema** are skin reactions to allergens introduced through the airways or gastrointestinal tract. Eczema commonly occurs in infants and children with a family history of allergies and is usually outgrown by the age of six. It generally occurs in cycles, beginning with dry, itchy skin that becomes inflamed when scratched, followed by weeping sores that subsequently crust over. In the chronic stage the affected skin becomes thickened, leathery, and scaly. Eczema appears most often on the cheeks, ears, and neck and the inner folds of elbows and knees, but it may affect other parts of the body as well.

Whole-body or systemic reactions can occur with any type of allergen, but are more common following ingestion or injection of an allergen. Hives are a systemic skin reaction characterized by raised, red, itchy blotches of varying sizes anywhere on the body, but especially on the stomach, chest, arms, hands, and face. Angioedema is a deeper, more extensive, and painful reaction in which fluid accumulation causes recurrent, non-inflammatory swelling of the skin, eyelids, lips, mucous membranes, genitals, other organs, and brain. However it most often occurs on the extremities, fingers, toes, and parts of the head, neck, and face. Hives and angioedema are usually acute conditions, although they can sometimes persist for weeks.

Skin contact with allergens can cause reddening, itching, and blistering, known as **contact dermatitis**. The dermatitis sometimes has an identifying pattern, such as the outline of an earring or latex glove. Common causes include:

- poison ivy, oak, and sumac
- nickel or nickel alloys
- chemicals
- cosmetics
- latex

Dermatitis can also be caused by non-allergic damage to skin cells arising from irritants such as cold, soap, or chemical agents.

Asthma is a chronic, reversible respiratory disorder caused by obstruction and swelling of the airways to the lungs. An asthma attack begins when the muscles surrounding the bronchial tubes spasm and the tubes narrow. This stimulates increased mucus production, further blocking the airways, and inflammation and swelling, which cause even more congestion and discomfort. Symptoms of asthma include

coughing, wheezing, shortness of breath, **fatigue**, **anxiety**, and tightness in the chest. Asthma can be triggered by allergens—including pollen, animal dander, dust, and certain foods—and by non-allergenic irritants.

Anaphylaxis is an IgE-mediated hypersensitivity reaction brought about by mediators released by mast cells in the tissues and by immune system cells called basophils in the blood. These can cause airway constriction, blood pressure drop, widespread tissue swelling, heart rhythm abnormalities, and sometimes loss of consciousness. Other symptoms may include **dizziness**, weakness, seizures, coughing, flushing, or cramping. Symptoms can begin within five minutes after exposure to the allergen or up to an hour or more later. Anaphylaxis is most often associated with allergies to foods, medications, and insect venoms.

### *Genetic profile*

The genetic predisposition toward the development of hypersensitivity reactions upon exposure to specific antigens is called atopy. After birth the immune system switches to become either non-allergy prone (TH1) or allergy prone (TH2), depending on an interplay of heredity and environment. TH stands for T-helper white blood cells. TH1 cells fight bacteria and viruses and protect against allergies. TH2 cells fight parasitic infections and promote the production of excessive IgE, increasing the likelihood of developing allergies. TH2 immunity is much more likely to be switched on in children with a family history of allergies.

Over the past four decades atopy has increased significantly, for reasons that are not well understood. In addition to genetic factors, it has been suggested that our environment contains more allergy-inducing substances and that protective factors may have been removed from the environment. There is also some evidence suggesting that the worldwide fight against **infectious disease** and increased personal cleanliness may be interfering with immune system function. Global warming—and the accompanying changes in natural vegetation patterns and increased pollen production—may also be affecting atopy.

## **Diagnosis**

### *Examination*

Allergies can often be diagnosed by a careful medical history that matches the onset of symptoms with exposure to possible allergens. Allergy is suspected if the symptoms are characteristic of an allergic reaction and occur repeatedly upon exposure to the suspected

allergen, at a certain time of year, or in a particular environment. Although **allergy tests** can be used to identify potential allergens, their results must be supported by evidence of an allergic response.

### *Tests*

With allergy skin tests a tiny dose of an aqueous extract of the suspected allergen is pricked, scratched, punctured, or patched on the skin. The initial test is usually a prick or patch test on the back, forearm, or top of the thigh. Reactions are usually evaluated about 15 minutes after exposure. An allergen may produce a classic immune wheal-and-flare response—a skin lesion with a raised, white, compressible area surrounded by a red flare. A positive skin reaction will occur even if the allergen is normally encountered in the airways or in food. Skin testing can produce false positives and, occasionally, serious allergic reactions. Intradermal skin tests involve injection of the allergen into the dermis of the skin. These are more sensitive and use smaller amounts of allergen, so they can be used with potentially fatal allergens such as **antibiotics**.

Provocation tests administer the allergen directly through its normal route under medically controlled conditions. Food allergen provocation tests involve the ingestion of a measured amount of the suspected allergen in an opaque capsule after abstinence from the suspected allergen for two weeks or more. The results are compared to the response to ingestion of a placebo. Diagnosis of delayed allergic contact dermatitis involves the application of a skin patch containing the allergen. Provocation tests are never used when a patient's medical history suggests the possibility of anaphylaxis.

Since people with allergies may have a higher level of total IgE in their serum (the portion of the blood that contains antibodies) than those without allergies, total IgE can be measured with a two-site immunometric assay. However there is considerable overlap in serum IgE levels among people with and without allergies. Furthermore other non-allergic conditions—including **smoking**, HIV/AIDS, parasitic infections, and IgE myeloma—can raise IgE levels. However a total serum IgE test is useful for diagnosing some conditions.

With allergen-specific IgE measurements, the suspected allergen is bound to a solid support, such as a cellulose sponge, microtiter plate, or paper disk. A patient's serum is incubated with the allergen. Allergen-specific IgE antibodies will bind to the solid phase and remain there when the serum is washed off. A second labeled antibody that binds to any IgE is added to determine the level of the allergen-specific

## KEY TERMS

**Allergen**—Any substance that provokes an allergic response.

**Allergenic**—Acting as an allergen or inducing an allergic response.

**Allergic rhinitis**—Inflammation of the mucous membranes of the nose and eyes in response to an allergen. Hay fever is seasonal allergic rhinitis.

**Anaphylaxis**—Severe, potentially fatal hypersensitivity caused by previous exposure to an allergen that can result in blood vessel dilation and a sharp drop in blood pressure, smooth muscle contraction, and difficulty breathing.

**Angioedema**—Severe non-inflammatory swelling of the skin, organs, and brain, possibly accompanied by fever and muscle pain.

**Antibody**—A specific immunoglobulin protein produced by the immune system in response to a specific antigen.

**Antigen**—A foreign protein or particle that causes the body to produce specific antibodies that bind to it.

**Asthma**—A lung condition, usually of allergic origin, in which the airways become narrow due to smooth muscle contraction, causing wheezing, coughing, and shortness of breath.

**Atopic dermatitis**—A skin condition resulting from exposure to airborne or food allergens.

**Atopy**—Genetic predisposition toward the development of allergies.

**Conjunctivitis**—Inflammation of the conjunctiva, the membrane covering the white part of the eye.

**Contact dermatitis**—Skin inflammation resulting from contact with an allergen or other substance.

**Delayed hypersensitivity reactions**—Allergic reactions mediated by T cells that occur hours to days after exposure to the antigen.

**Eczema**—An inflammatory skin condition characterized by redness, itching, and oozing lesions, which become crusty, scaly, or hardened.

**Epinephrine**—Adrenalin; a hormone released into the bloodstream in response to stress. Its many effects include stimulating the heart and increasing blood pressure, metabolic rate, and blood glucose concentration.

**Granules**—Small packets of reactive chemicals stored within cells.

**Histamine**—A chemical released by mast cells during an allergic reaction and which has a variety of effects on other cells.

**Hives**—A raised, itchy area of skin that is usually a sign of an allergic reaction.

**Immediate hypersensitivity reactions**—Allergic reactions that are mediated by mast cells and occur within minutes of allergen contact.

**Immunoglobulin E (IgE)**—Antibodies produced in the lungs, skin, and mucous membranes that are responsible for allergic reactions.

**Mast cells**—A type of immune system cell that displays immunoglobulin E (IgE) on its cell surface and participates in allergic reactions by releasing histamine and other chemicals from intracellular granules. The lining of the nasal passages and eyelids are particularly rich in mast cells.

**T cells**—Immune system white blood cells that have highly specific antigen receptors on their surfaces. Some T cells stimulate other immune system cells to produce and release antibodies.

IgE. The radioallergosorbent test (RAST) uses radioactive anti-IgE antibodies. A newer test called an enzyme-linked immunosorbent assay (ELISA) uses anti-IgE antibodies that are linked to an enzyme. A test called the CAP-RAST measures the amount of IgE in the blood that is specific for a given food.

Attempts are being made to directly measure immune system mediators such as histamine, eosinophil cationic protein (ECP), and mast cell tryptase.

Electrodermal testing or electro-acupuncture allergy testing has been used in Europe, but is

somewhat controversial and has not been approved by the U.S. Food and Drug Administration (FDA). An electric potential is applied to the skin and changes in the electrical resistance are measured upon exposure to the suspected allergen.

### **Procedures**

Elimination diets are often used to diagnose food allergies. Suspect foods may be sequentially eliminated from the diet. Alternatively, after several weeks on a diet lacking any of the suspected allergenic foods, each

suspected food is reintroduced one at a time and the patient is observed for signs of allergic reaction.

## Treatment

### Traditional

The most effective allergy treatment is avoiding all allergen exposure. This is usually possible with food allergens but can be very difficult with other types of allergens. Therefore immediate hypersensitivity reactions are usually treated with drugs.

Immunotherapy, usually called allergy shots or desensitization, alters the balance of antibody types in the body. Immunotherapy is generally used when medications cannot relieve symptoms. Extracts of the allergen are injected into the skin in gradually increasing amounts over a period of weeks, months, or years, with occasional booster shots. The amounts of allergen are too small to trigger an allergic response; however patients are monitored closely after each injection because of the small risk of anaphylaxis. Immunotherapy is most effective for hay **fever** and insect sting allergies, particularly in patients who cannot avoid allergens in the environment and who do not respond to medications. It may also reduce or eliminate the need for medications. While many rhinitis sufferers have been helped by allergy shots, they are costly and time-consuming and are not always effective. It may take up to several years of treatment to fully benefit from immunotherapy and about one in five patients do not respond at all. However some experts recommend preventative immunotherapy for children who have severe reactions to insect stings.

### Drugs

There are a large number of prescription and over-the-counter medications for treating immediate hypersensitivity reactions. Most of these work by decreasing the ability of histamine to provoke symptoms. Other drugs counteract the effects of histamine by stimulating other systems or by reducing the general immune response. Medications are available as pills, liquids, nasal sprays, eye drops, and skin creams. The appropriate medication depends on the symptoms and the patient's overall health. A physician may recommend trying a few different medications to determine which ones are most effective with the fewest side effects.

**Antihistamines** are the most common treatment for rhinitis. They block the histamine receptors in nasal tissue, thereby decreasing the effects of histamine released by mast cells. Antihistamines can be used after symptoms appear, although they may be even more effective when used preventively, before

symptoms appear. They help reduce sneezing, itching, and runny nose (rhinorrhea). Antihistamines can also be used to treat other types of allergies.

There are a wide variety of antihistamines available. Older first-generation antihistamines often cause drowsiness as a major side effect. They can also cause dizziness, **dry mouth**, tachycardia, blurred vision, **constipation**, and a lowered threshold for seizures. Their effects can be similar to those of alcohol and care should be taken when operating motor vehicles, since individuals may not be aware that they are impaired. These antihistamines include:

- diphenhydramine (Benadryl and generics)
- chlorpheniramine (Chlor-trimeton and generics)
- brompheniramine (Dimetane and generics)
- clemastine (Tavist and generics)

Newer antihistamines that do not cause drowsiness or cross the blood-brain barrier include:

- loratadine (Claritin)
- cetirizine (Zyrtec)
- fexofenadine (Allegra)
- desloratadine (Clarinetex)
- azelastine HCl (Astelin)
- astemizole (Hismanal)

Seldane (terfenadine), the original non-drowsy antihistamine, was voluntarily withdrawn from the market by its manufacturer in early 1998 because of its potential for causing serious heart **arrhythmias** and the availability of the equally effective but safer drug fexofenadine. Hismanal also has the potential for causing heart arrhythmias when taking more than the recommended dose or taking it along with the antibiotic erythromycin, the antifungal drugs ketocconazole or itraconazole, or the antimalarial drug quinine.

**Decongestants** constrict the blood vessels in the nasopharyngeal and sinus mucosa, reducing swelling and relieving nasal and sinus congestion. Both oral systemic preparations and nasal sprays—which are applied directly to the nasal lining—are available. Decongestants are stimulants and may cause increased heart rate and blood pressure, headaches, **insomnia**, agitation, and difficulty emptying the bladder. Use of nasal decongestants for longer than several days can result in loss of effectiveness and rebound congestion in which nasal passages become even more swollen.

Cromolyn **sodium** is a nonsteroidal mast cell stabilizer that prevents the release of mast cell granules and thus the release of histamine and other chemicals. It can be started several weeks before the onset of the

allergy season as a preventive treatment. It can also be used for year-round allergy prevention. Cromolyn sodium is available as a nasal spray that coats the nasal membranes to treat allergic rhinitis and in aerosol form (a suspension of particles in gas) for asthma.

Newer types of allergy medications include:

- the IgE modifier omalizumab (Xolair), which interferes with the action of mast cells
- leukotriene modifiers or antileukotrienes, which block the action of leukotrienes—Inflammatory substances released by the immune system during an allergic reaction—and include zafirlukast (Accolate), montelukast (Singulair), and zileuton (Zyflo)
- immunomodulatory topical ointments—which interfere with cell mechanisms that produce inflammatory responses—and include pimecrolimus (Elidel cream) and tacrolimus (Protopic ointment)

**Corticosteroids** help to prevent and treat the inflammation associated with allergic conditions by reducing the recruitment of inflammatory cells and the synthesis of immune-system chemicals called cytokines. Studies have shown that steroid nasal sprays are more effective on an as-needed basis for seasonal allergies than antihistamines. Although hives and angioedema are usually treated with antihistamines, cromolyn, or epinephrine, intractable cases may be treated with oral cortisone; however it should be used sparingly and only as a last recourse because of its side effects. Corticosteroids are also used to prevent and control asthma attacks.

Topical corticosteroids reduce mucous membrane and skin inflammations by decreasing the amount of fluid that moves from the vascular spaces into the tissues. Topical corticosteroid creams are effective for contact dermatitis, although overuse can lead to dry and scaly skin. Moderately strong corticosteroids can be applied as a wrap for 24 hours. Short-term oral corticosteroid therapy also may be appropriate for acute contact dermatitis. Side effects are usually mild, but may include headaches, nosebleeds, and unpleasant taste sensations.

Because allergic reactions involving the lungs cause the airways or bronchial tubes to narrow, bronchodilators—which open or dilate the smooth muscle lining the airways—can be very effective for treating asthma attacks. **Bronchodilators** include:

- adrenaline (epinephrine)
- albuterol (Proventil)
- pirbuterol (Maxair)
- theophylline
- other adrenergic stimulants

Most bronchodilators are administered as aerosols. Theophylline, naturally present in coffee and tea, is usually taken orally, but in a severe asthma attack it may be administered intravenously.

Bronchodilators are often administered via metered-dose inhalers (MDIs):

- The inhaler is shaken and the patient exhales air from the lungs
- The inhaler is placed at least two fingerbreadths in front of the mouth and aimed at the back of the throat
- The inhaler is activated while breathing in slowly for three to four seconds
- The breath is held for at least ten seconds and then expelled
- There should be at least 30–60 seconds before the inhaler is used again
- The mouth should be washed out and the teeth brushed to remove residual medication

Other drugs, including **steroids**, are used in the long-term management of asthma and to prevent asthma attacks. The anticholinergics ipratropium bromide (Atrovent) and atropine sulfate are also used to treat asthma. Ipratropium is used in emergency situations with a nebulizer.

An anaphylaxis emergency is treated by injection of adrenaline, which relaxes muscles and helps open the airways. People who are susceptible to anaphylaxis because of food or insect allergies often carry an EpiPen—adrenaline in a hypodermic needle. Prompt injection into the thigh can prevent a more serious reaction. The patient should be placed in a recumbent position and vital signs—especially the airway status—determined. If the reaction is the result of an insect sting or injection, a tourniquet may need to be placed proximal to the penetrated area and released for one to two minutes at 10-minute intervals. If the individual does not respond to these interventions, emergency treatment is essential.

### *Alternative*

Any alternative treatment for allergies starts with identifying the allergen and avoiding or eliminating it, although this is not always possible. A physician should be consulted before initiating any alternative therapy. Although alternative remedies may be derived from natural sources, they are still drugs and can have potentially harmful effects.

The following treatments may help relieve symptoms of allergic rhinitis from airborne allergens:

- Traditional Chinese medicine treats allergic rhinitis with various herbs. The patent combination medicines Bu Zhong Yi Qi Wan (Tonify the Middle and Augment the Qi) and Yu Ping Feng San (Jade Wind-screen) are used for preventing allergies. Bi Yan Pian (Rhinitis Infusion) is often prescribed for symptoms affecting the nose.
- Acupuncture may be as effective as antihistamine drugs in treating allergic rhinitis. It is also may strengthen the immune system.
- Vitamins A and E are antioxidants and help to promote normal functioning of the immune system.
- Coenzyme Q10 may help promote normal functioning of the immune system.
- Zinc may boost the immune system.
- Echinacea* spp. may have anti-inflammatory activity and may boost the immune system.
- Astragalus membranaceus* (milk-vetch root) may help strengthen the immune system.
- Vitamin C has antihistamine and decongestive activities.
- Stinging nettle (*Urtica dioica*) has antihistamine and anti-inflammatory properties. The usual dose is 300 milligrams (mg) four times daily.
- Grape (*Vitis vinifera*) seed extract has antihistamine and anti-inflammatory properties. The usual dose is 50 mg three times daily.
- The bioflavonoid hesperidin may act as a natural antihistamine.
- The dietary supplement N-acetylcysteine may have decongestive activity.
- The homeopathic remedies *Rhus toxicodendron*, *Apis mellifica*, *Nux vomica*, and *Ferrum phosphoricum* alternating with *Kali muriaticum* have decongestant activities when taken internally.
- Licorice (*Glycyrrhiza glabra*) has cortisone-like anti-inflammatory activity, stimulating the adrenals and relieving allergy symptoms. It can be taken as a tea or in 100–300 mg capsules. Long-term use can result in sodium retention or potassium loss.
- Chinese skullcap (*Scutellaria baicalensis*) has bronchodilating activity, is an anti-inflammatory, and can help prevent allergic reactions. It is taken in combination with other herbs.
- The herbal remedies khellin (*Ammi visnaga*) and cramp (*Viburnum opulus*) bark have bronchodilating activity.
- Ginkgo biloba* seeds are used in Chinese medicine for relief from wheezing and coughing.
- The bioflavonoids quercetin and hesperidin may help stabilize mast cells.

- Although *Ephedra sinica* (ma huang in traditional Chinese medicine) has anti-inflammatory activity and has proven effective in treating allergies, ephedra should not be used because it can raise blood pressure, cause rapid heartbeat, and interfere with adrenal gland function. The supplement ephedra was banned from sale in the United States in April of 2004 because of severe health risks.

The following homeopathic remedies are taken internally:

- Marsh tea (*Ledum*) for itching insect bites
- Apis mellifica* for bee stings and hives that are relieved by cold
- Poison ivy (*Rhus toxicodendron*) for hives that are relieved with heat and for poison ivy, oak, or sumac rashes
- Stinging nettle (*Urtica urens*) for hives
- Croton tiglium* oil for poison ivy, oak, or sumac rashes
- Anacardium* A qualified homeopathic practitioner should be consulted to match symptoms with the correct remedy.

Various Chinese herbal remedies may be effective in treating atopic dermatitis. A poultice (crushed herbs applied directly to the affected area) made of jewelweed (*Impatiens* spp.) or chickweed (*Stellaria media*) may soothe the skin. A topical cream or wash containing *Calendula officinalis*, a natural antiseptic and anti-inflammatory agent, may help heal rash.

### Home remedies

The basic home remedy for allergies is to avoid or eliminate the allergen. This may involve keeping dust under control by cleaning or using air filters, making adjustments in pet ownership, removing items such as feather pillows, and eliminating allergenic foods from the diet. Children with allergies to milk, eggs, fish, or apples who follow an oral desensitization procedure—in which they are exposed to allergenic foods in controlled, but increasing, doses—may develop resistance to the allergen.

Eczema is treated by keeping the skin lubricated with hypoallergenic lotions and gentle soaps. For extremely dry, sensitive skin, Cetaphil lotion may be used as a cleanser instead of soap.

Cold-water compresses and calamine lotion may help reduce the irritation of contact dermatitis. Hydrocortisone ointment or cream or similar preparations can help alleviate itching. Side effects of topical agents may include excessive drying of the skin.

## Prognosis

There is no cure for allergies. Although most allergy symptoms can be successfully treated with medications, these cannot prevent future allergic reactions. Some allergies improve over time, but often they worsen. Although severe asthma and anaphylaxis can be life-threatening, learning to recognize and avoid allergy-provoking situations enables most people with allergies to lead normal lives.

Some children outgrow their allergies, meaning that the allergen no longer causes obvious symptoms. Children younger than three who are in danger of anaphylaxis from foods such as milk, eggs, wheat, or soybeans often outgrow their food allergies after several years. Children who develop food sensitivities after three years-of-age are less likely to outgrow them. Allergies to foods such as tree nuts, fish, and seafood are generally lifelong.

More than half of all asthmatic children outgrow the condition completely and another 10% improve to the point where they have only occasional asthma attacks as adults.

## Prevention

Avoiding allergens is the first line of defense. By identifying allergens, most people can learn to avoid allergic reactions from food, drugs, and contact allergens such as **poison ivy** or latex. Many allergenic foods, such as peanuts, eggs, and milk, are used as ingredients in other foodstuffs. Since 2006 food manufacturers in the United States have been required to clearly state if a product contains any of the eight major food allergens that are responsible for more than 90% of allergic food reactions: milk, eggs, peanuts, tree nuts, fish, shellfish, wheat, and soy.

Airborne allergens are more difficult to avoid. Recommendations include:

- avoiding environmental irritants such as tobacco smoke, perfumes, household cleaning agents, paints, glues, air fresheners, and potpourri
- controlling dust mites with allergen-impermeable covers on mattresses and pillows, frequent washing of bedding in hot water, and removal of items that collect dust such as stuffed toys
- vacuuming often
- keeping windows and doors closed to prevent pollen from entering the home
- reducing growth of mold by lowering indoor humidity, repairing foundations to reduce indoor leakage and seepage, and installing exhaust systems to

ventilate areas where steam is generated, such as the bathroom and kitchen

- reducing pet dander, avoiding pet allergens including those in saliva, body excretions, pelts, urine, and feces, and restricting pets to only specific areas of the home
- repairing poorly vented gas and wood-burning stoves and artificial fireplaces because nitrogen dioxide from these has been linked to poor asthma control

Infants appear to be most sensitive to allergens during the first six months of life. Some physicians believe babies are especially vulnerable to allergies because their immune systems are still developing. **Breastfeeding** is recommended to reduce the likelihood of allergic reactions, since infants are never allergic to their mother's milk. However traces of whatever the mother consumes pass into breast milk, so it is important to be alert to possible connections between a baby's allergic symptoms and foods, medication, or even **vitamins** ingested by the mother.

Rashes in infants under one year of age are likely caused by a food or drug allergy. Physicians often recommend that solid foods be introduced gradually if there is a family history of allergies. New foods can be introduced one at a time with 7–10 days in between. The later a food item is introduced into the diet, the less likely it is to cause an allergic reaction.

Babies and young children can have allergic reactions to ingredients in lotions, soaps, detergents, and baby wipes. Dye- and fragrance-free baby products can help prevent unnecessary exposure to potential allergens.

Toddlers are old enough to become anxious about allergy symptoms, which can trigger further allergic attacks and create a frustrating cycle. Parents should try to avoid conveying their own anxieties about allergy symptoms to the child.

During the preschool years, controlling a child's diet and environment becomes more difficult. Children may feel stigmatized or left out when provided with special foods and denied others. Children also may begin encountering potential allergens, including pet dander, at school and playmates' homes.

Parents of school-age children with allergies need to educate them about their condition and inform teachers and the school nurse of any restrictions and/or emergency procedures. Children are generally not allowed to carry medication, asthma inhalers, or Epi-Pens in school, so arrangements must be made for the school nurse or other supervising adult to administer emergency medication.

## Health care team roles

Diagnosis and effective management of allergy symptoms involves cooperation and collaboration between the patient and an interdisciplinary team of healthcare professionals. The primary-care physician or pediatrician, allergy and immunology specialists, nurses, laboratory technologists, respiratory therapists, and health educators are involved in helping patients and families learn to prevent and effectively manage symptoms. They teach patients how to distinguish mild allergy symptoms from those requiring immediate medical attention. Pharmacists and pharmacy assistants may offer additional instruction about medication use and the importance of adhering to prescribed treatment.

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- "Tips to Remember: What is an Allergic Reaction?" *AAAAI*. <http://www.aaaai.org/patients/publicedmat/tips/whatisallergicreaction.stm>

### ORGANIZATIONS

- American Academy of Allergy, Asthma & Immunology (AAAAI), 555 East Wells Street, Milwaukee, WI, 53202-3823 (414) 272-6071, <http://www.aaaai.org/>.
- Asthma and Allergy Foundation of America, 8201 Corporate Drive, Suite 1000, Landover, MD, 20785 (800) 7-ASTHMA, [Info@aafa.org](mailto:Info@aafa.org), <http://www.aafp.org>.
- Centers for Disease Control and Prevention, 1600 Clifton Road, Atlanta, GA, 30333 (888) 232-6348 (301) 563-6595, [cdeinfor@cdc.gov](mailto:cdeinfor@cdc.gov), <http://www.cdc.gov>.
- National Institute of Allergy and Infectious Diseases (NIAID), Office of Communications and Public Liaison, 6610 Rockledge Drive, Bethesda, MD, 20892-66123 (866) 284-4107, <http://www3.niaid.nih.gov>.
- U.S. Food and Drug Administration, 10903 New Hampshire Ave., Silver Spring, MD, 20993-0002 (888) INFO-FDA, <http://www.fda.gov>.

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## Allergy tests

### Definition

Allergy tests indicate a person's allergic sensitivity to commonly encountered environmental substances.

### Demographics

Allergy tests are very common. Skin tests are the most common, and the most common method is the



**A close-up of a patient's arm after allergy testing.** (Custom Medical Stock Photo, Inc. Reproduced by permission.)

prick test. It is estimated that 60 million Americans, or more than one in every five people, suffer from some form of allergy, with similar proportions worldwide. Allergy is the single largest reason for school absence and is a major source of lost productivity in the workplace.

### Description

In prick testing, a drop of each allergen to be tested is placed on the skin, usually on the forearm or the back. A typical battery of tests may involve two dozen allergen drops, including a drop of saline solution that should not provoke a reaction (negative control) and a drop of histamine that should provoke a reaction (positive control). A small needle is inserted through the drop, and used to prick the skin below. A new needle is used for each prick. The sites are examined over the next 20 minutes for evidence of swelling and redness, indicating a positive reaction. In some instances, a tracing of the set of reactions may be made by placing paper over the tested area. Similarly, in intradermal testing, separate injections are made for each allergen tested. Observations are made over the next 20 minutes.

In RAST testing, a blood sample is taken for use in the laboratory, where the antibody-containing serum is separated from the blood cells. The serum is then exposed to allergens bound to a solid medium. If a person has antibodies to a particular allergen, those antibodies will bind to the solid medium and remain behind after a rinse. Location of allergen-antibody combinations is done by adding antibody-reactive antibodies, so called anti-antibodies, that are chemically linked with a radioactive dye. By locating radioactive spots on the solid medium, the reactive allergens are discovered.

Provocation testing may be performed to identify airborne or food allergens. Inhalation testing is performed only after a patient's lung capacity and response to the medium used to dilute the allergen has been determined. Once this has been determined, the patient inhales increasingly concentrated samples of a particular allergen, followed each time by measurement of the exhalation capacity. Only one allergen is tested per day. Testing for **food allergies** is usually done by removing the suspect food from the diet for two weeks, followed by eating a single portion of the suspect food and follow-up monitoring.

### Purpose

Allergy is a reaction of the immune system. Normally, the immune system responds to foreign microorganisms and particles, like pollen or dust, by producing specific proteins called antibodies that are capable of binding to identifying molecules, or antigens, on the foreign organisms. This reaction between antibody and antigen sets off a series of reactions designed to protect the body from infection. Sometimes, this same series of reactions is triggered by harmless, everyday substances. This is the condition known as allergy, and the offending substance is called an allergen. Common inhaled allergens include pollen, dust, and insect parts from tiny house mites. Common food allergens include nuts, fish, and milk.

Allergic reactions involve a special set of cells in the immune system known as mast cells. Mast cells serve as guards in the tissues where the body meets the outside world: the skin, the mucous membranes of the eyes and other areas, and the linings of the respiratory and digestive systems. Mast cells display a special type of antibody, called immunoglobulin type E (IgE), on their surface. Inside, mast cells store reactive chemicals in small packets, called granules. When the antibodies encounter allergens, they trigger the release of granules, which spill out their chemicals onto neighboring cells, including blood vessels and nerve cells. One of these chemicals, histamine, binds to the surfaces of these other cells, through special proteins called histamine receptors. Interaction of histamine with receptors on blood vessels causes neighboring cells to become leaky, leading to the fluid collection, swelling, and increased redness characteristic of a runny nose and red, irritated eyes. Histamine also stimulates **pain** receptors, causing the itchy, scratchy nose, eyes, and throat common in **allergic rhinitis**.

The particular allergens to which a person is sensitive can be determined through allergy testing.

## KEY TERMS

**Allergen**—A substance that provokes an allergic response.

**Anaphylaxis**—Increased sensitivity caused by previous exposure to an allergen that can result in blood vessel dilation (swelling) and smooth muscle contraction. Anaphylaxis can result in sharp blood pressure drops and difficulty breathing.

**Antibody**—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

**Antigen**—A foreign protein to which the body reacts by making antibodies.

**Histamine**—A chemical released by mast cells that activates pain receptors and causes cells to become leaky.

**Mast cells**—A type of immune system cell that is found in the lining of the nasal passages and eyelids, displays a type of antibody called immunoglobulin type E (IgE) on its cell surface, and participates in the allergic response by releasing histamine from intracellular granules.

Allergy tests may be performed on the skin or using blood serum in a test tube. During skin tests, potential allergens are placed on the skin and the reaction is observed. In radio-allergosorbent allergy testing (RAST), a patient's blood serum is combined with allergen in a test tube to determine if serum antibodies react with the allergen. Provocation testing involves direct exposure to a likely allergen, either through inhalation or ingestion. Positive reactions from any of these tests may be used to narrow the candidates for the actual allergen causing the allergy.

Identification of the allergenic substance may allow the patient to avoid the substance and reduce allergic reactions. In addition, allergy testing may be done in those with **asthma** that is difficult to manage, **eczema**, or **skin rashes** to determine if an allergy is causing the condition or making it worse. Allergy tests may also be done before allergen desensitization to ensure the safety of more extensive exposure.

Skin testing is the most common type of allergy test. There are two forms: percutaneous and intradermal. In percutaneous or prick testing, allergen solutions are placed on the skin, and the skin is then pricked with a needle, allowing the allergen to enter the skin and become exposed to mast cells. Scratch

testing, in which the skin is scratched instead of punctured, is used less often. Intradermal testing involves directly injecting allergen solutions into the skin. In both tests, a reddened, swollen spot develops at the injection site for each substance to which the person is sensitive. Skin reactivity is seen for allergens regardless of whether they usually affect the skin. In other words, airborne and food allergens cause skin reactions equally well.

The range of allergens used for testing is chosen to reflect possible sources in the environment and may include the following:

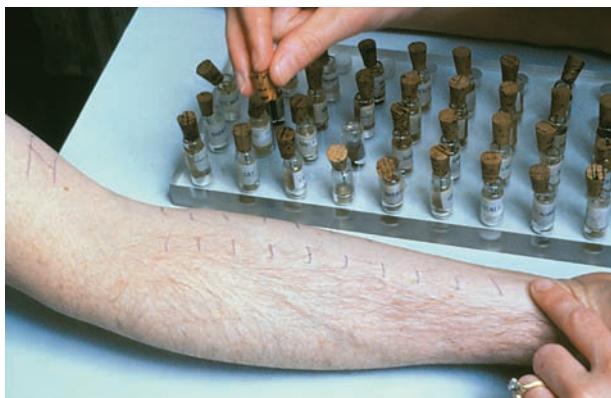
- pollen from a variety of trees, common grasses, and weeds
- mold and fungus spores
- house dust
- house mites
- animal skin cells (dander) and saliva
- food extracts
- antibiotics
- insect venoms

Radio-allergosorbent testing (RAST) is a laboratory test performed when a person may be too sensitive to risk skin testing or when medications or skin conditions prevent it.

Provocation testing is done to positively identify suspected allergens after preliminary skin testing. A purified preparation of the allergen is inhaled or ingested in increasing concentrations to determine if it will provoke a response. In 2004, scientists introduced an optical method to continuously measure the changes in nasal mucosa (lining) changes with an infrared light to help improve the accuracy of provocation testing. Food testing is much more tedious than inhalation testing, since full passage through the digestive system may take a day or more.

## Precautions

While allergy tests are quite safe for most people, the possibility of a condition known as **anaphylaxis** exists. Anaphylaxis is a potentially dangerous condition that can result in difficulty breathing and a sharp drop in blood pressure. People with a known history of anaphylaxis should inform the testing clinician. Skin tests should never include a substance known to cause anaphylaxis in the person being tested.



**Patient is being exposed to certain allergens as part of an allergy test.** (Custom Medical Stock Photo, Inc. Reproduced by permission.)

Provocation tests may cause an allergic reaction. Therefore, treatment medications should be available following the tests, to be administered, if needed.

## Preparation

Skin testing is preceded by a brief examination of the skin. The patient should refrain from using anti-allergy drugs for at least 48 hours before testing. Prior to inhalation testing, patients with asthma who can tolerate it may be asked to stop any asthma medications. Testing for food **allergies** requires the person to avoid all suspect food for at least two weeks before testing.

## Aftercare

Skin testing does not usually require any after-care. A generalized redness and swelling may occur in the test area, but it will usually resolve within a day or two.

Inhalation tests may cause delayed asthma attacks, even if the antigen administered in the test initially produced no response. Severe initial reactions may justify close professional observation for at least 12 hours after testing.

## Risks

Intradermal testing may inadvertently result in the injection of the allergen into the circulation, with an increased risk of adverse reactions. Inhalation tests may provoke an asthma attack. Exposure to new or unsuspected allergens in any test carries the risk of anaphylaxis. Because patients are monitored following allergy testing, an anaphylactic reaction is usually recognized and treated promptly. Occasionally, a

delayed anaphylactic response can occur that will require immediate care. Proper patient education regarding how to recognize anaphylaxis is vital.

## Normal results

Lack of redness or swelling on a skin test indicates no allergic response. In an inhalation test, the exhalation capacity should remain unchanged. In a food challenge, no symptoms should occur.

## Abnormal results

Presence of redness or swelling, especially more than 5 mm (1/4 inch) in diameter, indicates an allergic response. This does not mean the substance actually causes the patient's symptoms, however, since he or she may have no regular exposure to the allergen. In fact, the actual allergen may not have been included in the test array.

Following allergen inhalation, reduction in exhalation capacity of more than 20%, and for at least 10–20 minutes, indicates a positive reaction to the allergen.

Gastrointestinal symptoms within 24 hours following the ingestion of a suspected food allergen indicates a positive response.

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Allogenic transplant see **Bone marrow transplantation**

Allopurino see **Gout drugs**

# Alopecia

## Definition

Alopecia simply means hair loss (baldness).

## Demographics

The most common type of alopecia is androgenetic alopecia, which is an inherited condition. This type of alopecia affects as many as 30-40% of men and women. Androgenetic alopecia is the most common cause of hair loss in adolescents and can begin much earlier than most people think, as early as age 12 in boys and girls. Hair loss accounts for approximately 3% of children's visits to dermatologists.

## Description

Hair loss occurs for a great many reasons, from conditions that make people literally pull it out to complete hair loss caused by the toxicity of **cancer chemotherapy**. Some causes are considered natural, while others signal serious health problems. Some conditions are confined to the scalp. Others reflect disease throughout the body. Being plainly visible,



**Top of balding male's head.** (Kelly A. Quin. Reproduced by permission.)

the skin and its components can provide early signs of disease elsewhere in the body.

Often, conditions affecting the skin of the scalp will result in hair loss. The first clue to the specific cause is the pattern of hair loss, whether it is complete baldness (alopecia totalis), patchy bald spots, thinning, or hair loss confined to certain areas. Another contributing factor is the condition of the hair and the scalp beneath it. Sometimes only the hair is affected; sometimes the skin is visibly diseased as well.

## Causes and symptoms

Alopecia results from a number of causes ranging from hereditary to psychological.

- Male pattern baldness (androgenic alopecia) is considered normal in adult males. It is easily recognized by the distribution of hair loss over the top and front of the head and by the healthy condition of the scalp. Researchers in Taiwan in 2010 reported in the *British Journal of Dermatology* that men with androgenic alopecia are at increased risk for the development of metabolic syndrome (increased risk for the development of a spectrum of cardiovascular diseases and diabetes mellitus Type 2).
- Alopecia areata is a hair loss condition of unknown cause that can be patchy or extend to complete baldness.
- Fungal infections of the scalp usually cause patchy hair loss. The fungus, similar to the ones that cause athlete's foot and ringworm, often glows under ultraviolet light.
- Trichotillomania is the name of a mental disorder that causes a person to pull out his or her own hair.
- Complete hair loss is a common result of cancer chemotherapy, due to the toxicity of the drugs used. Cancer cells reproduce rapidly and so the drugs are designed to attack rapidly reproducing cells in the body. Hair cells also reproduce rapidly and end up being destroyed, causing hair loss.
- Systemic diseases often affect hair growth either selectively or by altering the skin of the scalp. One example is thyroid disorders. Hyperthyroidism (too much thyroid hormone) causes hair to become thin and fine. Hypothyroidism (too little thyroid hormone) thickens both hair and skin.
- Several autoimmune diseases (when protective cells begin to attack self cells within the body) affect the skin, notably lupus erythematosus.
- Alopecia is becoming nearly epidemic among black women as a result of some hairstyles that pull too tightly on the scalp and the use of harsh chemical

## KEY TERMS

**Autoimmune disease**—Certain diseases caused by the body's development of an immune reaction to its own tissues.

**Chemotherapy**—The treatment of diseases, usually cancer, with drugs (chemicals).

**Hair follicles**—Tiny organs in the skin, each one of which grows a single hair.

**Lupus erythematosus**—An autoimmune disease that can damage skin, joints, kidneys, and other organs.

**Systemic**—Affecting all or most parts of the body.

treatments that damage the hair shaft and follicles, according to the American Academy of Dermatology.

### Diagnosis

Dermatologists are skilled in diagnosis by sight alone. For more obscure diseases, a **skin biopsy** may be used to remove a specimen of the skin so that it can be examined under a microscope. Systemic diseases will require a complete evaluation by a physician, including specific tests to identify and characterize the problem.

### Treatment

Successful treatment of underlying causes is most likely to restore hair growth, such as the completion of chemotherapy, effective cure of a scalp fungus, or control of a systemic disease.

#### Traditional

Over the past few decades a multitude of hair replacement methods have been performed by physicians and non-physicians. They range from simply weaving someone else's hair in with the remains of one's own to surgically transplanting thousands of hair follicles one at a time.

**Hair transplantation** is completed by taking tiny plugs of skin, each containing one to several hairs, from the back side of the scalp. The bald sections are then implanted with the plugs. Research has evaluated the technique of hair grafting, and found that micro-grafts (one or two hairs transplanted per follicle) resulted in fewer complications and the best results.

Another surgical procedure used to treat androgenetic alopecia is scalp reduction. By stretching skin, the hairless scalp can be removed and the area of bald

skin decreased by closing the space with hair-covered scalp. Hair-bearing skin can also be folded over an area of bald skin with a technique called a flap.

Stem cell research is generating new hope for baldness. Scientists know that a part of the hair follicle called the bulge contains stem cells that can give rise to new hair and help heal skin **wounds**. Research with mice and humans continues to show promise for identifying the genes that cause baldness and to identify drugs that can reverse the process.

### Drugs

Two drugs—minoxidil (Rogaine) and **finasteride** (Proscar)—promote hair growth in a significant minority of patients, especially those with male pattern baldness and alopecia areata. Both drugs have proved to be safe when used for this purpose. **Minoxidil** is a liquid that is applied directly to the scalp and finasteride is the first and only approved treatment for hair loss available in a pill form. Only minoxidil is used in women.

Minoxidil was approved for over-the-counter sales in 1996. When used continuously for long periods of time, minoxidil produces satisfactory results in about one-fourth of patients with androgenetic alopecia and as many as half the patients with alopecia areata. There is also an over-the-counter extra-strength version of minoxidil (5% concentration) approved for use by men only. The treatment often results in new hair that is thinner and lighter in color. It is important to note that new hair stops growing soon after the use of minoxidil is discontinued.

Women with androgenetic alopecia who do not respond to treatment with minoxidil may be prescribed the drug spironolactone, which blocks the action of the hormone aldosterone.

Results of a small study on 42 patients with alopecia areata reported in 2009 indicated that application of a 1% bexarotene gel applied daily to areas of alopecia areata for up to six months resulted in significant hair regrowth, even in areas of the scalp that had not been treated with the topical solution.

Researchers in 2010 reported in the *British Journal of Clinical Psychiatry* that the drug olanzapine was a safe and effective treatment for alopecia associated with the condition trichotillomania.

### Prognosis

The prognosis of alopecia varies with the cause. It is generally much easier to lose hair than to regrow it. Even when it returns, it is often thin and less attractive than the original.

## Resources

### PERIODICALS

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- Olsen, E.A. "A Multicenter, Randomized, Placebo-controlled, Double-blind Clinical Trial of a Novel Formulation of 5% Minoxidil Topical Foam versus Placebo in the Treatment of Androgenetic Alopecia in Men." *Journal of the American Academy of Dermatology* (2007): 757-67.
- Talpur, R., et al. "Phase I/II Randomized Bilateral Half-Head Comparison of Topical Bexarotene 1% Gel for Alopecia Areata." *Journal of the American Academy of Dermatology* 61 (2009): 592-98.

### ORGANIZATIONS

The American Hair Loss Council, 30 South Main, Shenandoah, PA, 17976, <http://www.ahlc.org>.

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## Alpha-fetoprotein test

### Definition

The alpha-fetoprotein (AFP) test is a blood test that is performed during **pregnancy**.

### Purpose

This screening test measures the level of AFP in the mother's blood and indicates the probability that the fetus has one of several serious **birth defects**. The level of AFP can also be determined by analyzing a sample of amniotic fluid. This screening test cannot diagnose a specific condition; it only indicates increased risk for several birth defects. Outside pregnancy, the AFP test is used to detect **liver disease**, certain cancerous tumors, and to monitor the progress of **cancer** treatment.

### Description

Alpha-fetoprotein is a substance produced by the liver of a fetus. The exact function of this protein is unknown. After birth, the infant's liver stops producing AFP, and an adult liver contains only trace amounts. During pregnancy, the fetus excretes AFP in urine and some of the protein crosses the fetal membranes to enter the mother's blood. The level of AFP can then be determined by analyzing a sample of

the mother's blood. The AFP test is usually performed at weeks 13 to 16 of pregnancy. AFP levels peak in maternal blood at 16 to 18 weeks. Blood is drawn from the patient's (mother's) vein, usually on the inside of the elbow. AFP can also be measured in the sample of amniotic fluid taken at the time of **amniocentesis**. Test results are usually available after about one week.

By analyzing the amount of AFP found in a blood or amniotic fluid sample, doctors can determine the probability that the fetus is at risk for certain birth defects. It is very important that the doctor know precisely how old the fetus is when the test is performed since the AFP level changes over the length of the pregnancy. Alone, AFP screening cannot diagnose a birth defect. The test is used as an indicator of risk and then an appropriate line of testing (such as amniocentesis or ultrasound) follows, based on the results.

### High AFP levels

Abnormally high AFP may indicate that the fetus has an increased risk of a neural tube defect, the most common and severe type of disorder associated with increased AFP. These types of defects include spinal column defects (**spina bifida**) and anencephaly (a severe and usually fatal brain abnormality). If the tube that becomes the brain and spinal cord does not close correctly during fetal development, AFP may leak through this abnormal opening and enter the amniotic fluid. This leakage creates abnormally high levels of AFP in amniotic fluid and in maternal blood. If the screening test indicates abnormally high AFP, ultrasound is used to diagnose the problem.

Other fetal conditions that can raise AFP levels above normal include:

- cysts at the end of the spine
- blockage in the esophagus or intestines
- liver disease causing liver cells to die
- defects in the abdominal wall
- kidney or urinary tract defects or disease
- brittle bone disease

Levels may also be high if there is too little fluid in the amniotic sac around the fetus, more than one developing fetus, or a pregnancy that is farther along than estimated.

### Low AFP levels

For unknown reasons, abnormally low AFP may indicate that the fetus has an increased risk of **Down syndrome**. Down syndrome is a condition that includes **mental retardation** and a distinctive physical

## KEY TERMS

**Amniotic fluid**—Fluid within the uterine sac in which the fetus lives until born.

**Fetus**—The stage in human development from the second month of pregnancy until birth.

appearance linked to an abnormality of chromosome 21 (called trisomy 21). If the screening test indicates an abnormally low AFP, amniocentesis is used to diagnose the problem. Abnormally low levels of AFP can also occur when the fetus has died or when the mother is overweight.

### Additional disorders

AFP is often part of a “triple check” blood test that analyzes three substances as risk indicators of possible birth defects: AFP, estriol, and human chorionic gonadotropin (HCG). When all three substances are measured in the mother’s blood, the accuracy of the test results increases.

In 2004, a study showed that the risk of an infant’s death from **sudden infant death syndrome** (SIDS) increased if levels of AFP were higher during the second trimester of the mother’s pregnancy.

Although AFP in human blood gradually disappears after birth, it never disappears entirely. It may reappear in liver disease, or tumors of the liver, ovaries, or testicles. The AFP test is used to screen people at high risk for these conditions. After a cancerous tumor is removed, an AFP test can monitor the progress of treatment. Continued high AFP levels suggest the cancer is growing.

### Preparation

There is no specific physical preparation for the AFP test.

### Aftercare

There is no specific aftercare involved with this screening test.

### Risks

The risks associated with drawing blood are minimal, but may include bleeding from the puncture site, feeling faint or lightheaded after the blood is drawn, or blood accumulating under the puncture site (hematoma).

## Results

It is very important that the doctor know precisely how old the fetus is when the test is performed since the AFP level considered normal changes over the length of the pregnancy. Errors in determining the age of the fetus lead to errors when interpreting the test results. Since an AFP test is only a screening tool, more specific tests must follow to make an accurate diagnosis. An abnormal test result does not necessarily mean that the fetus has a birth defect. The test has a high rate of abnormal results (either high or low) to prevent missing a fetus that has a serious condition.

Alpha-fetoprotein is measured in nanograms per milliliter (ng/mL) and is expressed as a probability. The probability (1:100, for example) translates into the chance that the fetus has a defect (a one in 100 chance, for example).

When testing for cancer or liver diseases, AFP results are reported as nanograms per milliliter. An AFP level less than or equal to 15 ng/mL for men, non-pregnant women, and children is considered normal.

### Abnormal results

The doctor will inform the woman of her specific increased risk as compared to the “normal” risk of a standard case. If the risk of Down syndrome is greater than the standard risk for women who are 35 years old or older (one in 270), amniocentesis is recommended. Again, the test has a high rate of showing an abnormal AFP level in order to prevent missing a fetus that has Down’s syndrome. This screening test only predicts risk; appropriate diagnostic testing will follow after an abnormal screening result.

In tumor or liver disease testing, an AFP level greater than 15 ng/mL is considered abnormal. A difference of greater than 20% between two different measurements is considered to be medically significant.

### Resources

#### BOOKS

Van Leeuwen, A.M., and D.J. Poelhuis-Leth. *Davis’s Comprehensive Handbook of Laboratory and Diagnostic Tests with Nursing Implications*, 3rd Edition. Philadelphia: F.A. Davis Company, 2009.

#### PERIODICALS

Smith, Gordon C.S., et al. “Second-trimester Maternal Serum Levels of Alpha-fetoprotein and the Subsequent Risk of Sudden Infant Death Syndrome.” *New England Journal of Medicine* (September 2, 2004): 978.

#### ORGANIZATIONS

March of Dimes, 1275 Mamaroneck Ave., White Plains, NY, 10605 (914) 997-4488, <http://www.modimes.org>.

National Cancer Institute, NCI Office of Communications and Education, Public Inquiries Office, 6116 Executive Boulevard, Suite 300, Bethesda, MD, 20892-2580 (800) 422-6237, <http://www.cancer.gov>.

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Alpha-thalassemia see **Thalassemia**

## Alpha<sub>1</sub>-adrenergic blockers

### Definition

Alpha<sub>1</sub>-adrenergic blockers, called alpha blockers for short, are drugs that work by blocking the alpha<sub>1</sub> receptors in smooth muscle. When these receptor sites are blocked, **stress** hormones (catecholamines) cannot act on the smooth muscle cells. The result is relaxation (vasodilatation) and widening of the blood vessels. Blood pressure is lowered and blood flows more easily through the blood vessels.

### Purpose

Alpha blockers are used for two main purposes. They treat high blood pressure (**hypertension**), and they treat benign (non-cancerous) prostatic hyperplasia (BPH), a condition that affects men and is characterized by an **enlarged prostate** gland that often causes reduced urine flow.

### High blood pressure

High blood pressure puts a strain on the heart and the arteries. Over time, hypertension can damage blood vessels to the point of causing **stroke**, **heart failure**, or kidney (renal) failure. People with high blood pressure may also be at higher risk for **heart attack** (myocardial infarction). Controlling high blood pressure makes these problems less likely. Alpha blockers help lower blood pressure by causing vasodilatation, meaning that they increase the diameter of the blood vessels, which reduces the amount of work the heart must do to maintain adequate blood flow. Alpha<sub>1</sub>-adrenergic blockers have also been shown to increase the amount of HDL ("good") cholesterol and reduce the level of LDL ("bad") cholesterol. They also increase the body's sensitivity to insulin and in this way may help to prevent type 2 diabetes.

### **Benign prostatic hyperplasia (BPH)**

BPH primarily affects older men. Over time, the prostate, a donut-shaped gland below the bladder, enlarges. When this happens, it may restrict the flow of urine from the bladder out of the body. Men who are diagnosed with BPH may have to urinate more often, or they may feel that they can not completely empty their bladders. Alpha blockers inhibit the contraction of prostatic smooth muscle and thus relax the prostate and the bladder, allowing urine to flow more freely.

### Other conditions

Alpha blockers also can be used to treat other problems resulting from reduced blood circulation. These include **Raynaud's disease**, a painful constriction of the blood vessels in the hands and feet, phlebitis, an inflammation of the veins that can lead to **blood clots**, diabetic **gangrene**, a condition in which tissue dies as the result of poor circulation to the legs and feet, **acrocyanosis**, a disorder of very small arteries in the hands and feet, and acute blockage of an artery.

### Description

Alpha blockers are not the first choice treatment for controlling high blood pressure because of their significant side effects. **Diuretics** (water pills) and a low-salt diet are the preferred first treatment for hypertension. Commonly prescribed alpha blockers for hypertension and BPH include doxazosin (Cardura), prazosin (Minipress), terazosin (Hytrin), tamsulosin (Flomax) and alfuzosin (Uroxatral) and many others. Prazosin is also used in the treatment of heart failure. All are available only with a physician's prescription and are sold in tablet form.

### Recommended dosage

The recommended dose depends on the patient and the type of alpha blocker and may change over the course of treatment. The prescribing physician will gradually increase the dosage, if necessary. Some patients may need as much as 15–20 mg per day of terazosin, 16 mg per day of doxazosin, or as much as 40 mg per day of prazosin, but most people benefit from lower dosages. As the dosage increases, so does the possibility of unwanted side effects.

Alpha blockers should be taken exactly as directed, even if the medication does not seem to be working at first. It should not be stopped even if symptoms improve. These drugs need to be taken regularly to be effective. Patients should avoid missing any doses, and should not take larger or more frequent doses to make up for missed doses.

## KEY TERMS

**Adrenergic**—Refers to neurons (nerve cells) that use catecholamines as neurotransmitters at a synapse.

**Adrenergic receptor**—There are three families of adrenergic receptors, alpha<sub>1</sub>, alpha<sub>2</sub> and beta, and each family contains three distinct subtypes. Each of the nine subtypes are coded by separate genes, and display specific drug specificities and regulatory properties.

**Alpha blockers**—Medications that bind alpha adrenergic receptors and decrease the workload of the heart and lower blood pressure. They are commonly used to treat hypertension, peripheral vascular disease, and hyperplasia.

**Arteries**—Blood vessels that carry oxygenated blood away from the heart to the cells, tissues, and organs of the body.

**Catecholamines**—Family of neurotransmitters containing dopamine, norepinephrine and epinephrine, produced and secreted by cells of the adrenal medulla and the brain. Catecholamines have excitatory effects on smooth muscle cells of the vessels that supply blood to the skin and mucous membranes and have inhibitory effects on smooth muscle cells located in the wall of the gut, the bronchial tree of the lungs, and the vessels that supply blood to skeletal muscle. There are two different main types of

receptors for these neurotransmitters, called alpha and beta adrenergic receptors. The catecholamines are therefore also known as adrenergic neurotransmitters.

**Hyperplasia**—The abnormal increase in the number of normal cells in a given tissue.

**Hypertension**—Persistently high arterial blood pressure.

**Neurotransmitter**—Substance released from neurons of the peripheral nervous system that travels across the synaptic clefts (gaps) of other neurons to excite or inhibit the target cell.

**Palpitation**—Rapid, forceful, throbbing, or fluttering heartbeat.

**Receptor**—A molecular structure in a cell or on the surface of a cell that allows binding of a specific substance that causes a specific physiologic response.

**Synapse**—A connection between nerve cells, by which nervous excitation is transferred from one cell to the other.

**Vasodilatation**—The increase in the internal diameter of a blood vessel that results from relaxation of smooth muscle within the wall of the vessel thus causing an increase in blood flow.

### Precautions

Alpha blockers may lower blood pressure to a greater extent than desired, especially in the elderly. This can cause **dizziness**, lightheadedness, heart **palpitations**, and **fainting**. Activities such as driving, using machinery, or doing anything else that might be dangerous should be avoided for at least 24 hours after taking the first dose. Patients should be especially careful when getting up in the middle of the night because of the increased risk of dizziness and falling. The same precautions are recommended if the dosage is increased or if the drug has been stopped and then started again. Anyone whose safety on the job could be affected by taking alpha blockers should inform his or her physician, so that the physician can take this factor into account when increasing dosage.

Some people may feel drowsy or less alert when using these drugs. They should accordingly avoid driving or performing activities that require full attention.

People diagnosed with **kidney disease** or **liver disease** may also be more sensitive to alpha blockers.

They should inform their physicians about these conditions if alpha blockers are prescribed. Older people may also be more sensitive and may be more likely to have unwanted side effects, such as fainting, dizziness, and lightheadedness.

It should be noted that alpha blockers do not cure high blood pressure. They simply help to keep the condition under control. Similarly, these drugs will not shrink an enlarged prostate gland. Although they will help relieve the symptoms of prostate enlargement, the prostate may continue to grow, and it eventually may be necessary to have prostate surgery.

Alpha blockers may lower blood counts. Patients may need to have their blood checked regularly while taking this medicine.

Anyone who has had unusual reactions to alpha blockers in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

The effects of taking alpha blockers during **pregnancy** are not fully known. Women who are pregnant or planning to become pregnant should inform their physicians. **Breastfeeding** mothers who need to take alpha blockers should also talk to their physicians. These drugs pass into breast milk and may affect nursing babies. It may be necessary to stop breastfeeding while being treated with alpha blockers. The safety of alpha blockers in children remains unproven.

## Side effects

The most serious side effect of alpha blockers is an increased risk of heart attack when these drugs are taken for an extended period. The link between increased risk of heart attack and alpha blockers emerged from the 42,000-patient Antihypertensive and Lipid-Lowering Treatment to Prevent Heart Attack (ALLHAT) study. For this reason, these drugs are not usually prescribed until other treatments have failed to control symptoms.

Common side effects are dizziness, drowsiness, tiredness, **headache**, nervousness, irritability, stuffy or runny nose, **nausea**, **pain** in the arms and legs, and weakness. These problems usually appear after only a few days on the drug and gradually go away as the body adjusts to the drug. Most do not require medical treatment. If side effects do not subside or if they interfere with normal activities, the physician should be informed.

If any of the following side effects occur, the prescribing physician should be notified as soon as possible:

- fainting
- shortness of breath or difficulty breathing
- fast, pounding, or irregular heartbeat
- swollen feet, ankles, wrists

Other side effects may occur. Anyone who has unusual symptoms after taking alpha blockers should contact his or her physician. Patients who smoke, use alcohol, or **exercise** strenuously tend to have more severe side effects.

## Interactions

At high doses, alpha blockers may interact with other antihypertensive (blood-pressure lowering) drugs to cause unsafe low blood pressure. Excessive low blood pressure may also occur in men taking alpha blockers and **impotence** drugs. They may also interact with drugs used to treat heart rhythm abnormalities (**arrhythmias**). People taking alpha blockers should also avoid taking over-the-counter drugs that make blood vessels constrict (narrow). Drugs that cause blood vessel

constriction are often found in cold, **cough**, **asthma**, and allergy medications and in diet pills.

Other **drug interactions** are possible. Anyone taking alpha blockers should discuss with their physician and pharmacist all prescription, over-the-counter, and herbal remedies being taken to avoid unwanted side effects or dangerous interactions.

## Resources

### OTHER

"Alpha Blockers." *MayoClinic.com*. December 22, 2006  
<http://www.mayoclinic.com/health/alpha-blockers/HI00055>.

"Alpha Blockers." *Your Total Health*. undated [accessed May 30, 2008]. <http://yourtotalhealth.ivillage.com/alpha-blockers.html>.

### ORGANIZATIONS

American College of Cardiology, Heart House, 2400 N Street, NW, Washington, DC, 20037 (202) 375-6000 (800) 253-4636 x8603 (202) 375-7000, resource @acc.org, <http://www.acc.org>.

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231 (800) 242-8721, <http://www.americanheart.org>.

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## Alport syndrome

### Definition

Alport syndrome is a hereditary disease of the kidneys that primarily affects men, causing blood in the urine, **hearing loss**, and eye problems. Eventually, **kidney dialysis** or transplant may be necessary.

### Demographics

Alport syndrome affects about one in 5,000 Americans, striking men more often and more severely than women. There are several varieties of the syndrome, some occurring in childhood and others not causing symptoms until men reach their 20s or 30s.

### Description

All varieties of Alport syndrome are characterized by **kidney disease** that usually progresses to **chronic kidney failure** and by uremia (the presence of excessive amounts of urea and other waste products in the blood).

## KEY TERMS

**Albumin**—A protein that is important in maintaining blood volume.

**Dialysis**—A technique of removing waste material from the blood. It is used with patients whose kidneys have stopped functioning and can no longer cleanse the blood on their own.

**Diuretic**—A drug that increases the amount of urine a person produces.

**Hematuria**—Blood in the urine.

**Pulmonary edema**—Excess fluid in the air spaces of the lungs.

**Uremia**—The presence of excessive amounts of urea and other waste products in the blood.

## Tests

Blood tests are performed to evaluate platelet levels. Low platelet levels are another indication of Alport syndrome.

Tests for the Alport gene are now available. Although testing is fairly expensive, it is covered by many types of health insurance. DNA tests can diagnose affected children even before birth, and genetic linkage tests tracing all family members at risk for Alport syndrome are available.

## Treatment

There is no specific treatment that can cure Alport syndrome. Instead, care is aimed at easing the problems related to kidney failure, such as the presence of too many waste products in the blood (uremia).

To control kidney inflammation (**nephritis**), patients should:

- restrict fluids
- control high blood pressure
- manage pulmonary edema
- control high blood levels of potassium

Rarely patients with Alport syndrome may develop **nephrotic syndrome**, a group of symptoms including too much protein in the urine, low albumin levels, and swelling. To ease these symptoms, patients should:

- drink less
- eat a salt-free diet
- use diuretics
- have albumin transfusions

The treatment for chronic kidney failure is dialysis or a kidney transplant.

## Prognosis

Women with this condition can lead a normal life, although they may have slight hearing loss. An affected woman may notice blood in her urine only when under **stress** or pregnant.

Men generally have a much more serious problem with the disease. Most will experience kidney disease in their 20s or 30s, which may eventually require dialysis or transplantation, and many develop significant hearing loss. Men with Alport syndrome often die of complications by middle age.

## Diagnosis

Alport syndrome is diagnosed with a medical evaluation and family history, together with a **kidney biopsy** that can detect changes in the kidney typical of the condition. **Urinalysis** may reveal blood or protein in the urine.

## Prevention

Alport syndrome is a genetic disease and prevention efforts are aimed at providing affected individuals and their families with information concerning the genetic mechanisms responsible for the disease. Since it is possible to determine if a woman is a carrier, or if an unborn child has the condition, **genetic counseling** can provide helpful information and support for the decisions that affected individuals and their families may have to make.

## Resources

### BOOKS

Bennett, Robin L. *The Practical Guide to the Genetic Family History*. 2nd ed. New York: Wiley-Blackwell, 2010.

### OTHER

Alport Syndrome Home Page. <http://www.cc.utah.edu/~cla6202/ASHP.htm> (accessed August 1, 2010).

"Alport Syndrome." MedlinePlus. November 24, 2009. <http://www.nlm.nih.gov/medlineplus/ency/article/000504.htm> (accessed August 1, 2010).

### ORGANIZATIONS

American Association of Kidney Patients, 3505 E. Frontage Rd., Suite 315, Tampa, FL, 33607 (800) 749-2257 (813) 636-8122, [info@aakp.org](mailto:info@aakp.org), <http://www.aakp.org>.

American Kidney Fund (AKF), Suite 1010, 6110 Executive Boulevard, Rockville, MD, 20852 (800) 638-8299, <http://www.kidneyfund.org>.

National Kidney and Urologic Disease Information Clearinghouse, 3 Information Way, Bethesda, MD, 20892 (301) 654-4415, <http://www.niddk.nih.gov>.

National Kidney Foundation, 30 East 33rd St., New York, NY, 10016 (800) 622-9010, <http://www.kidney.org>.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923 (800) 999-6673, <http://www.rarediseases.org>.

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**Alprazolam** see **Benzodiazepines**

**ALS** see **Amyotrophic lateral sclerosis**

**Alteplase** see **Thrombolytic therapy**

is important to understand the range of the different altitudes that may be involved. High altitude is defined as height greater than 8,000 feet (2,438 m); medium altitude is defined as height between 5,000 and 8,000 feet (1,524–2,438 m); and extreme altitude is defined as height greater than 19,000 feet (5,791 m). The majority of healthy individuals suffer from altitude sickness when they reach very high altitudes. In addition, about 20% of people ascending above 9,000 feet (2,743 m) in one day will develop altitude sickness. Children under six years and women in the premenstrual part of their cycles may be more vulnerable. Individuals with preexisting medical conditions—even a minor respiratory infection—may become sick at more moderate altitudes.

## Description

There are three major clinical syndromes that fall under the heading of altitude sickness: acute mountain sickness (AMS), high-altitude **pulmonary edema** (HAPE), and high-altitude cerebral **edema** (HACE). These syndromes are not separate, individual syndromes as much as they are a continuum of severity, all resulting from a decrease in oxygen in the air. AMS is the mildest, and the other two represent severe, life-threatening forms of altitude sickness.

Altitude sickness occurs because the partial pressure of oxygen decreases with altitude. (Partial pressure is a term applied to gases that is similar to the way the term concentration is applied to liquid solutions.) For instance, at 18,000 feet (5,486 m) the partial pressure of oxygen drops to one-half its value at sea level and, therefore, there is a substantially lower amount of oxygen available for the individual to inhale. This is known as hypoxia. Furthermore, since there is less oxygen to inhale, less oxygen reaches the blood. This is known as hypoxemia. These two conditions are the major factors that form the basis for all the medical problems associated with altitude sickness.

As a person becomes hypoxic, his natural response is to breathe more rapidly (hyperventilate). This is the body's attempt to bring in more oxygen at a rapid rate. This attempt at alleviating the effects of the hypoxia at higher altitudes is known as acclimatization, and it occurs during the first few days. Acclimatization is a response that occurs in individuals who travel from lower to higher altitudes. There are groups of people who have lived at high altitudes (for example, in the Himalayan and Andes mountains) for generations, and they are simply accustomed to living at such altitudes, perhaps through a genetic ability.

## Altitude sickness

### Definition

Altitude sickness is a general term encompassing a spectrum of disorders that occur at higher altitudes. Since the severity of symptoms varies with altitude, it

## KEY TERMS

**Cerebral**—Pertaining to the brain.

**Edema**—Accumulation of excess fluid in the tissues of the body.

**Hypoxemia**—Insufficient oxygenation of the blood.

**Hypoxia**—A deficiency in the amount of oxygen required for effective ventilation.

**Pulmonary**—Pertaining to the lungs.

### Causes and symptoms

Acute mountain sickness (AMS) is a mild form of altitude sickness that results from ascent to altitudes higher than 8,000 feet (2,438 m)—even 6,500 feet (1,981 m) in some susceptible individuals. Although hypoxia is associated with the development of AMS, the exact mechanism by which this condition develops has yet to be confirmed. It is important to realize that some individuals acclimatize to higher altitudes more efficiently than others. As a result, under similar conditions some will suffer from AMS while others will not. At present, the susceptibility of otherwise healthy individuals to contracting AMS cannot be accurately predicted. Of those who do suffer from AMS, the condition tends to be most severe on the second or third day after reaching the high altitude, and it usually abates after three to five days if they remain at the same altitude. However, it can recur if the individuals travel to an even higher altitude. Symptoms usually appear a few hours to a few days following ascent, and they include **dizziness**, **headache**, **shortness of breath**, **nausea**, **vomiting**, loss of appetite, and **insomnia**.

High-altitude pulmonary edema (HAPE) is a life-threatening condition that afflicts a small percentage of those who suffer from AMS. In this condition, fluid leaks from within the pulmonary blood vessels into the lung tissue. As this fluid begins to accumulate within the lung tissue (pulmonary edema), the individual begins to become more and more short of breath. HAPE is known to afflict all types of individuals, regardless of their level of physical fitness.

Typically, the individual who suffers from HAPE ascends quickly to a high altitude and almost immediately develops shortness of breath, a rapid heart rate, a **cough** productive of a large amount of sometimes bloody sputum, and a rapid rate of breathing. If no medical assistance is provided by this point, the patient goes into a **coma** and dies within a few hours.

High-altitude cerebral edema (HACE), the rarest and most severe form of altitude sickness, involves cerebral edema, and its mechanism of development is also poorly understood. The symptoms often begin with those of AMS, but neurologic symptoms such as an altered level of consciousness, speech abnormalities, severe headache, loss of coordination, **hallucinations**, and even seizures. If no intervention is implemented, **death** is the result.

### Diagnosis

The diagnosis for altitude sickness may be made from the observation of the individual's symptoms during travel to higher altitudes.

### Treatment

Mild AMS requires no treatment other than an **aspirin** or ibuprofen for headache, and avoidance of further ascent. **Narcotics** should be avoided because they may blunt the respiratory response, making it even more difficult for the person to breathe deeply and rapidly enough to compensate for the lower levels of oxygen in the environment. Oxygen may also be used to alleviate symptoms of mild AMS.

As for HAPE and HACE, the most important course of action is descent to a lower altitude as soon as possible. Even a 1,000–2,000 foot (305–610 m) descent can dramatically improve one's symptoms. If descent is not possible, **oxygen therapy** should be started. In addition, dexamethasone (a steroid) has been suggested in order to reduce cerebral edema.

### Prognosis

The prognosis for mild AMS is good, if appropriate measures are taken. As for HAPE and HACE, the prognosis depends upon the rapidity and distance of descent and the availability of medical intervention. Descent often leads to improvement of symptoms, however, recovery times vary among individuals.

### Prevention

When individuals ascend from sea level, it is recommended that they spend at least one night at an intermediate altitude prior to ascending to higher elevations. In general, climbers should take at least two days to go from sea level to 8,000 feet (2,438m). After reaching that point, healthy climbers should generally allow one day for each additional 2,000 feet (610m), and one day of rest should be taken every two or three days. Should mild symptoms begin to surface, further ascent should be avoided. If the symptoms are severe,

the individual should return to a lower altitude. Some reports indicate that acetazolamide (a diuretic) may be taken before ascent as a preventative measure for AMS.

Paying attention to diet can also help prevent altitude sickness. Water loss is a problem at higher altitudes, so climbers should drink ample water (enough to produce copious amounts of relatively light-colored or clear urine). Alcohol and large amounts of salt should be avoided. Eating frequent small, high-carbohydrate snacks (for example, fruits, jams and starchy foods) can help, especially in the first few days of climbing.

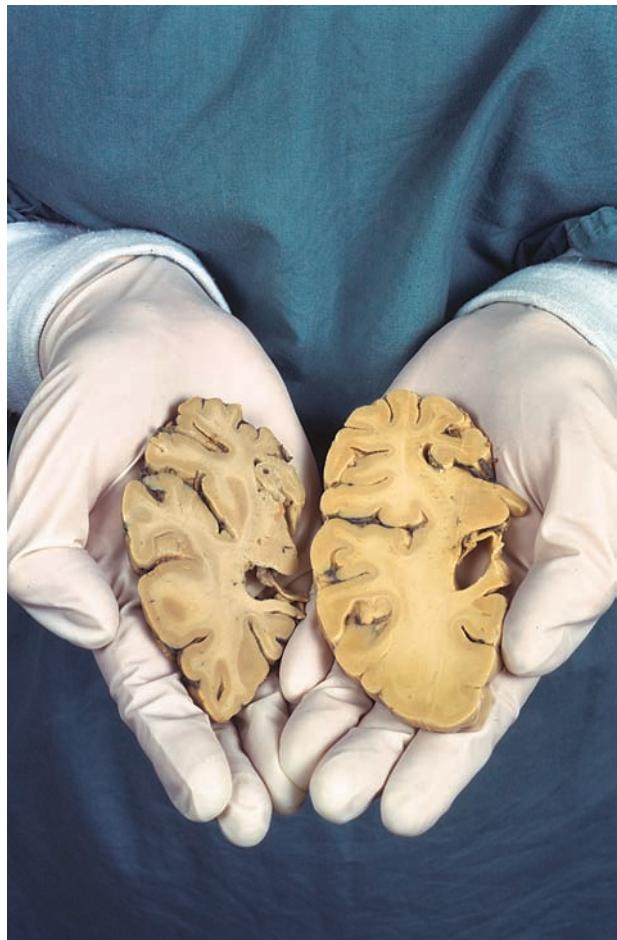
## Resources

### BOOKS

West, John B., Robert B. Schoene, and James S. Milledge. *High Altitude Medicine and Physiology*. 4th ed. Oxford, UK: Hodder Arnold, 2007.

Kapil Gupta MD

Aluminum hydroxide see **Antacids**



**A brain segment affected by Alzheimer's disease on the right compared with a healthy brain segment (left). The diseased brain appears shrunken, and the fissures are noticeably larger.** (Simon Fraser/MRC Unit, Newcastle General Hospital/Science Photo Library/Photo Researchers, Inc.)

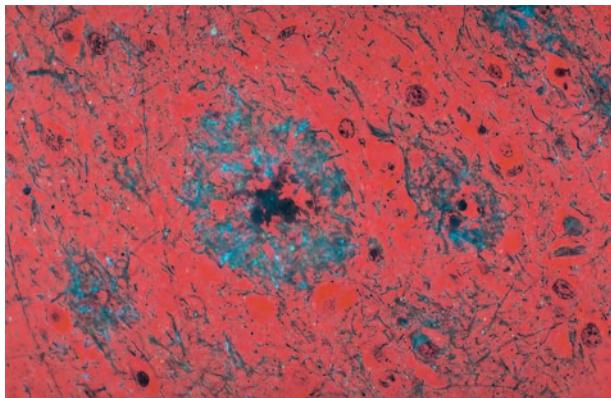
fourth leading cause of death in American adults after heart disease, **cancer**, and **stroke**.

Alzheimer's rarely occurs before the age of 60. Early-onset AD, affecting people in their 30s, 40s, and 50s, accounts for only about 5% of total cases. About 3–5% of men and women aged 65–74 have AD. About 19–20% of those between 75 and 84 and nearly half of those over 85 have the disease. Slightly more women than men develop AD, but this may be because women tend to live longer. About half of all nursing home patients in the United States have AD.

Alzheimer's disease appears to be more prevalent among African Americans, with estimates ranging from 14% to almost 100% higher than among Caucasian Americans. One study reported that the onset of AD in Hispanics occurs at an age that is, on average, five years younger than its onset in Caucasians.

## Demographics

Alzheimer's disease is the most common degenerative brain disorder. It accounts for 50–70% of all cases of dementia in the United States and for about 75% of all dementias in people over age 65. An estimated 5.1 million Americans have AD. The exact number is difficult to determine since AD is often misdiagnosed or not diagnosed until the disease is in its later stages. About 350,000 new cases of Alzheimer's disease are diagnosed each year in the United States and approximately 65,800 people die from AD each year. It is the



**Diseased tissue from the brain of an Alzheimer's patient showing senile plaques within the brain's gray matter.** (*Cecil Fox/Photo Researchers, Inc.*)

The incidence of Alzheimer's in other developed countries is about the same as in the United States. In countries such as Japan that have a rapidly **aging** population with a higher percentage of people over 65, the incidence of AD is even higher than in the United States. In developing countries the percentage of the population with AD is lower because fewer people live to age 65. However more than 50% of people with AD live in developing countries and by 2025 this is expected to be above 70%.

The number of people afflicted with Alzheimer's is expected to more than triple by 2050, as the population ages and more people live longer. The number may be even higher than predicted, since recent research suggests that mild cognitive impairment observed in many elderly people may be early-stage Alzheimer's disease.

## Description

In 1906 Alois Alzheimer (1864–1915), a German psychiatrist and neuroanatomist, was studying slides prepared from the brain of a 51-year-old woman, known as Frau D., who had died after suffering from dementia for several years. Her symptoms did not fit those of any brain disorder known at the time. Alzheimer found abnormal clumps of material—now called beta-amyloid plaques—and tangled bundles of fibers—neurofibrillary tangles—in Frau D.'s brain tissue. These plaques and tangles, found upon brain **autopsy**, constitute the diagnostic signature of Alzheimer's disease. The plaques, sometimes called senile plaques, are sticky clumps or clusters of dead and dying neurons and other cellular debris surrounding insoluble deposits of beta-amyloid. The latter are fragments of a larger protein called amyloid precursor

protein (APP) that was not processed properly. These plaques are located in between neurons. They are believed to interfere with normal communication between neurons, eventually causing the nerve cells to die. The tangles are accumulations of twisted fragments of tau proteins inside neurons. Tau proteins normally bind and stabilize neurons. When tau proteins are damaged by the addition of phosphorus, a process called hyperphosphorylation, they form filaments that twist around each other to form neurofibrillary tangles that can no longer stabilize the neurons. Increased beta-amyloid may cause the formation of neurofibrillary tangles. However it is not known whether the plaques and tangles cause AD or are the result of it. Plaques and tangles occur as part of the normal aging process, but are far less prevalent in normal brains than in the brains of AD patients. Because dementia had been associated with the elderly and Frau D. had been middle-aged, her disease was named presenile dementia and was thought to be a very rare disorder. It was not until the early 1950s that researchers at St. Elizabeth's Hospital in Washington, D.C. came to realize that Alzheimer's disease is the single most common cause of dementia.

Scientists have since found other changes in the brains of AD patients. Connections between nerve cells are disrupted and nerve cells die in areas of the brain that are vital for memory and learning, including the hippocampus, which is a structure deep in the brain that controls short-term memory. Later, AD affects the cerebral cortex, particularly the areas responsible for language and reasoning. Eventually many areas of the brain become involved and atrophied (shrunken and dysfunctional).

The levels of the brain neurotransmitters serotonin, norepinephrine, and acetylcholine are also lower in AD. These chemicals transmit signals across the synapses or gaps between nerve cells. Many of the behavioral and psychiatric problems associated with AD are thought to result from low levels of these neurotransmitters. Acetylcholine and norepinephrine are important for many processes in the body including digestion, blood vessel dilation and constriction, and regulation of heartbeat.

Public awareness of AD increased significantly when Ronald Reagan (1911–2004), the 40th president of the United States (1981–1989), was diagnosed with the disease in 1994. He died from complications of AD at the age of 93. Because of the growing numbers of people who are affected by AD, their increasing life expectancy, and the direct and indirect costs of their care, Alzheimer's disease is now considered to be a major public health concern.

Alzheimer's disease places severe emotional and financial burdens on patients and their families. In 2007 the annual cost of caring for a patient with AD was estimated at \$18,400 for mild or early-stage conditions and at \$36,100 for a patient with severe AD. The total annual cost of caring for AD patients in the United States was estimated to be at least \$100 billion, including both direct patient costs and indirect costs, such as time lost from work by caregivers. On average, Medicare pays more than three times as much for the healthcare of a beneficiary with AD compared to a beneficiary without AD.

### **Risk factors**

The most significant risk factor for Alzheimer's disease is advancing age. The risk of developing AD begins to rise after age 65 and rises sharply after age 75. There are various other possible risk factors:

- About 25% of AD cases are considered to be familial (FAD), defined as having symptoms of Alzheimer's disease in at least three generations of a single family. About 2–5% of all AD cases are familial early-onset FAD of one of three types (AD1, AD3, and AD4), in which the disease develops before the age of 60, usually between the ages of 40 and 50, but sometimes as early as age 30. First-degree relatives of AD patients may have as much as a 20% lifetime risk of being affected by the disease. The risk to immediate relatives increases as more family members develop the disease. The remaining 75% of cases are sporadic Alzheimer's disease (SAD) with no clear family history.
- African American and Caribbean Hispanics who have mutations in a particular gene are at a higher than normal risk for AD, particularly if they have a family history of the disease.
- A family history of Parkinson's disease is a risk factor for AD.
- There is some evidence that neuronal damage from small strokes may be linked to AD.
- Studies have found a clear correlation between low educational and occupational attainment (employment in jobs that are not mentally challenging) and an increased risk for AD. Taking on less challenging rather than more challenging jobs as one grows older is also associated with a higher risk for AD.
- Studies on special breeds of genetically engineered (transgenic) mice have suggested high blood cholesterol levels may increase the rate of plaque deposition.
- Researchers suspect that a high-cholesterol, high-fat diet may increase the risk of AD. However, studies

have not found cholesterol-lowering drugs to have any affect on AD onset.

- High systolic blood pressure combined with high blood cholesterol levels increases the risk of AD by three-four fold.
- Obesity is a risk factor for AD.
- Mild cognitive impairment (MCI), which is characterized primarily by memory loss while other cognitive functions remain intact, increases the risk of AD. About 12% of people with MCI develop Alzheimer's disease each year. About 40% of people diagnosed with MCI have clear symptoms of AD after four years.
- High levels of an amino acid called homocysteine may be a risk factor for late-onset AD.
- Symptoms of AD may develop faster in people who have had a head trauma or hypothyroidism.
- Down syndrome patients over the age of 40 all develop the brain cell changes that are characteristic of Alzheimer's disease. Down syndrome-associated AD accounts for less than 1% of Alzheimer's cases.

Various environmental factors have been suspected of contributing to the development of AD. However, epidemiological studies have not borne out any links between AD and factors such as pollutants in drinking water, aluminum from commercial products, and metal **dental fillings**. Although higher-than-average levels of aluminum have been found in the brains of patients with AD, it now appears that this a result rather than a cause of the disease.

### **Causes and symptoms**

In most cases the cause of AD is unknown. It is most likely caused by a combination of genetic and environmental factors. Viral, immunological, and/or biochemical etiologies have also been proposed. Genetics almost certainly plays a role, even in sporadic AD. Brain inflammation and restriction of blood flow to the brain may play a role in the development of beta-amyloid plaques and neurofibrillary tangles. Highly reactive molecules called free radicals damage all types of cells through oxidative processes, especially brain cells, which have lower levels of protective **antioxidants**.

AD symptoms can be grouped into three categories: cognitive deficits or losses in brain function related to memory and learning; behavioral and psychiatric symptoms of dementia or BPSD; difficulties with activities of daily life or ADL. For most of the twentieth century studies of AD patients focused on cognitive symptoms. It was not until the 1980s and

1990s that researchers began to examine behavioral and psychiatric symptoms more closely.

There are four major cognitive deficits associated with AD:

- Amnesia or memory impairment, including a loss of the sense of time.
- Aphasia or loss of language. Patients may not remember the names of objects and use words like “thing” or “it” instead. They may echo what other people say or repeat a word or phrase over and over. Sometimes patients lose all language except curses.
- Apraxia—the inability to perform voluntary movements. Patients with apraxia may have trouble putting on a hospital gown or brushing their teeth.
- Agnosia—the inability to recognize familiar people and places. *Agnosia* comes from the Greek word meaning “to not know.” Patients with agnosia may even fail to recognize their own face in a mirror.

Symptoms associated with BPSD (behavioral and psychiatric symptoms of dementia) include:

- Depression. Depression in AD is believed to result, at least in part, from lowered production of serotonin.
- Delusions, or a false belief that is maintained even in the presence of evidence to the contrary. For example, AD patients may believe that someone is stealing from them when they cannot remember where they put something.
- Wandering. This behavior may result from becoming disoriented or lost, but sometimes AD patients wander for no apparent reason.
- Hallucinations, or sensory experiences that seem real. Although hallucinations can affect any of the senses, most are visual or auditory. For example, AD patients may say that they see Martians in the corner of the room or hear the voices of their long-dead parents. Like delusions, hallucinations are believed to be related to the deterioration of brain tissue. However sometimes they are caused by medications.
- Aggression—hitting, shoving, pushing, or threatening behavior.
- Agitation. Emotionally excited behavior (screaming, shouting, cursing, pacing, fidgeting, etc.) that is disruptive or unsafe may result from brain tissue damage or be a symptom of depression. It is thought that the emotional overreactions of AD patients are related to destruction of neurons in the amygdala of the brain.

ADL (activities of daily life) or personal-care symptoms include difficulties with:

- eating, including simple cooking and washing dishes
- shopping for groceries and other necessities

- bathing, showering, or shaving
- grooming and dressing in clothing appropriate for the weather and activity
- toileting
- other aspects of personal hygiene such as teeth brushing, denture cleaning, or washing hair

Although the rate of AD progression and specific symptoms vary with the individual, the general course of the progression is fairly consistent. Early-onset AD often progresses faster than the more common late-onset type. AD is generally considered to have seven stages:

- Stage 1: no decline in function yet noted. This includes individuals who may carry predictive gene mutations but have no symptoms and those who will develop AD by other mechanisms.
- Stage 2: generally normal functioning. The individual is aware of a subtle cognitive decline.
- Stage 3: early Alzheimer's disease. Patients have difficulty performing complex tasks that require cognitive skills.
- Stage 4: mild Alzheimer's disease. Patients require assistance with tasks such as paying bills or balancing a checkbook.
- Stage 5: moderate Alzheimer's disease. Patients require assistance in making everyday personal decisions such as choosing appropriate clothing or ordering from a restaurant menu.
- Stage 6: moderately severe Alzheimer's disease. Patients require assistance dressing, bathing, and using the toilet and may have urinary and/or bowel incontinence.
- Stage 7: severe Alzheimer's disease. Vocabulary shrinks to a few words, followed by little or no verbal communication. The ability to walk is lost, followed by an inability to maintain a sitting posture in a chair. Eventually the patient experiences a profound lack of purposeful muscle control, is totally dependent for care, and cannot smile or hold up his or her head.

AD usually starts slowly with a very gradual decline that is termed “insidious.” Some people are unaware of any impairment, blaming their forgetfulness on old age or “senior moments.” Often the earliest symptoms are recognized only in hindsight by a friend or family member. Furthermore, since the present generation at risk for AD is the first in history to understand the implications of the disease, there are very powerful emotional reasons for attributing early signs of AD to normal aging, job **stress**, adjusting to retirement, and other less troubling factors.

However the insidious nature of AD onset is a characteristic that helps physicians to distinguish it from other causes of dementia, including vascular dementia.

Key warning signs of early-stage AD include:

- repeatedly asking the same question
- repeatedly telling the same story, word for word
- memory loss that affects job performance
- loss of initiative
- inability to pay bills or balance a checkbook
- misplacing commonly used personal or household objects
- difficulty performing familiar tasks such as cooking, making repairs, or playing games like cards or checkers
- poor or decreased judgment
- problems with abstract thinking
- getting lost in familiar surroundings
- relying on others to make decisions or answer questions
- disorientation of time and place
- problems with language
- mood or behavior changes
- personality changes
- neglecting personal hygiene—not bathing or changing clothes regularly

The first symptoms of early-stage AD usually include forgetfulness, short-term memory loss, temporary episodes of spatial disorientation, groping for words, minor problems with arithmetic, and small errors in judgment, often accompanied by some **anxiety**, agitation, mild depression, and withdrawal. The patient may light the stove under a saucepan while forgetting to add the food or water, but most ADL are unaffected. Some patients can continue to operate a motor vehicle safely, although many people with early-stage AD voluntarily give up driving.

Everyone has occasional memory lapses that do not signify any change in cognitive function. Early-stage AD may begin with routine memory lapses—forgetting where one left the car keys—but progresses to more profound or disturbing lapses, such as forgetting that one has a car. Some AD patients are unaware that their memory is failing. Other patients are keenly aware of their memory loss and may become anxious and frustrated. Becoming lost or disoriented on a walk around the neighborhood becomes more likely as the disease progresses. Individuals with AD may forget the names of family members or forget what was said at the beginning of a sentence by the time they

hear the end. Although the progression of memory loss varies, it eventually begins to interfere with daily activities.

Middle-stage Alzheimer's typically begins two to three years after the initial onset. Patients begin to lose awareness of their cognitive deficits. Memory loss, especially of recent events, becomes more severe and is accompanied by moderate spatial and temporal disorientation, loss of ability to concentrate, **aphasia**, and increased anxiety. Severe language problems develop. Patients cannot understand or remember the names of things. Their speech may not flow smoothly. Because of individual variation in disease progression, some patients may still be able to carry out routine behaviors and engage in generalized conversation. However they can no longer drive a car, cook a meal, or read a newspaper. They are unable to work, plan and execute familiar tasks, and reason and exercise judgment. They may get lost easily and find simple things confusing. The loss of cognitive functioning becomes impossible to ignore. Mood and personality are affected. Some people become angry or violent. Behavioral and psychiatric symptoms include agitation, wandering, temper tantrums, depression, and disorientation. Patients begin to lose their basic sense of personal identity. They may be at high risk for falls and other accidents. A small number of AD patients have vision problems. Although they frequently deny that they cannot see, autopsies confirm destruction in areas of the brain that process visual images.

Eventually spatial and temporal disorientation becomes profound and may be accompanied by **delusions**, **hallucinations**, and **paranoia**. Patients may not recognize a family member or may accuse a spouse of infidelity. They may become uninhibited and confrontational. Some patients exhibit inappropriate sexual behaviors. AD patients may have trouble sleeping and suffer from nighttime confusion or agitation called sunsetting or sundowner's syndrome. Some patients repeat words, thoughts, or movements, a behavior known as perseveration. Eventually they are unable to feed, bathe, dress, or groom themselves and cannot be left unattended.

In end-stage Alzheimer's disease patients undergo general physical decline and lose control of many physical functions. Seizures and hypertonicity (increased muscle movements) are common. Bladder and bowel control is lost and stiffening muscles prevent walking. Patients who can walk often wander aimlessly and must be monitored for night wandering due to altered sleep patterns. Although some patients may use a wheelchair temporarily, eventually they become completely bedridden, unable even to sit up. Many patients are unable to talk. Abnormal jerking

movements may occur for no reason or in response to touch or noises. Reflexes may be exaggerated and some patients experience whole body contractions known as generalized seizures.

Once the disease affects the brain stem, the basic processes of digestion, respiration, and excretion shut down. Patients may be unable to eat or swallow and they sleep most of the time. Their hands and feet feel cold, breathing becomes shallow, and the patient is generally unresponsive. Death often results from infection, **pneumonia**, or **malnutrition**. Otherwise breathing simply stops. From the onset of initial symptoms, disease progression can last up to 25 years, although the typical duration is eight to 10 years.

### ***Genetic profile***

Familial early-onset Alzheimer's disease accounts for fewer than 10% of AD cases. It can be caused by mutations in one of three genes. It is usually an autosomal dominant trait. Autosomal means that it affects males and females with equal frequency. Dominant means that it will affect individuals even if they inherited one copy of the mutated gene from one parent and a normal copy of the gene from the other parent. Individuals who have two copies of the mutant gene will pass on the gene to all of their children. If each parent has one copy of the mutant gene, there is a 75% that any of their children will inherit the gene. If only one parent has one copy of the gene, each of their children has a 50% of inheriting the gene.

Identification of these three genes has led to the subdivision of familial early-onset AD into three categories:

- AD1 is a genetic defect in the amyloid precursor protein (APP) gene located on chromosome 21. Mutations in the APP gene are associated with AD onset between the ages of 55 and 60.
- AD3 is a genetic defect in the presenilin 1 (PSEN1) gene located on chromosome 14. Presenilin 1 may be one of the enzymes that clips APP into beta-amyloid. It also may be important for the functioning of synaptic connections between neurons.
- AD4 is an extremely rare genetic defect in the presenilin 2 (PSEN2) gene located on chromosome 1. Presenilin 2 is also involved in processing APP. Mutations in PSEN1 and PSEN2 are associated with AD onset between the ages of 30 and 50. These three mutations result in the production of abnormal proteins and increased amounts of beta-amyloid. Together they account for approximately 50% of early-onset FAD.

AD2 is familial late-onset Alzheimer's disease, accounting for 15–25% of all AD cases. An association has also been found between AD2 and mutations in the gene encoding apolipoprotein E (APOE), located on chromosome 19. Apolipoprotein E is a major part of a lipoprotein that removes excess cholesterol from the blood. There are at least three forms or alleles of the APOE gene: e2, e3, and e4. Since each person inherits one APOE gene from each parent, it is possible to have two copies of one form of the APOE gene or two different forms of the gene. APOE e3 is the most common allele in the general population and does not appear to affect the development of AD. The relatively rare APOE e2 allele may be associated with a lower risk for AD or a later age of onset. Individuals with one copy of the e4 gene are three times more likely to develop late-onset AD than those without it. Those with two copies of APOE e4 gene are almost four times more likely to develop AD. APOE e4 can also lower the age of onset by as much as 17 years. Although APOE e4 increases the risk of developing AD, it does not cause the disease. Not everyone with e4 develops AD. However about 65% of all people with AD have at least one copy of e4. There are various theories as to why APOE e4 increases the risk of developing AD: it may facilitate beta-amyloid buildup in plaques, thereby lowering the age of AD onset, or it may interact with cholesterol levels and have effects on neuronal death that are independent of its effects on plaque buildup.

Sporadic AD is referred to as a polygenic disorder because it is believed to result from the effects of multiple genes combined with environmental factors. This view is supported by research involving identical twins. Only one-third of identical twins of those with AD develop AD themselves. This suggests that factors other than genetic predisposition affect the development of SAD.

AD researchers are also interested in the SORL1 gene, which encodes a protein that is involved regulating the transport of APP and lipoproteins in cells and may play a role in late-onset AD.

Down syndrome-associated Alzheimer's is another genetically determined form of AD. Normal individuals have two copies of each of the 22 human chromosomes, one copy from each parent. People with **Down syndrome**, also called trisomy 21, have three copies of chromosome 21, which results in brain changes that are similar to those that occur in both familial and sporadic AD. This is thought to be due to the over-production of APP from the extra chromosome 21 APP gene.

## Diagnosis

An early and accurate diagnosis of AD is important for developing strategies for managing symptoms and helping patients and their families plan for treatment, long-term care, and financial concerns while the patient can still be involved in decision making. A diagnosis of AD also may help family members to avoid unnecessary anger and feelings of **impotence** when dealing with the progression of the disease.

A diagnosis of AD is based upon the finding of slowly progressive dementia, exclusion of other possible causes for dementia, and brain-imaging studies that show changes in the structure of the brain, usually in the form of shrinkage. Possible AD is diagnosed when AD is considered to be the primary cause of the symptoms, but the diagnosis is complicated by the presence of another disorder. Probable AD is diagnosed when physicians and psychiatrists have ruled out all other disorders that could produce similar symptoms.

## Examination

Diagnosis of Alzheimer's disease can be quite complex and require consultations with various specialists. It requires a complete **physical examination** and medical and family history, including family members who have had AD and their ages of onset. The results of neurological exams are generally normal in early-stage AD. A complete evaluation of alcohol use and prescription and over-the-counter medication history, including alternative remedies, **vitamins**, herbal supplements, or illicit drugs, is necessary to rule out other causes of dementia, because more than 150 drugs can cause AD-like symptoms. Diagnosis is based upon clinical findings of otherwise unexplained slowly progressing dementia. FAD is diagnosed if there is a family history of the disease. Although AD virtually always develops in Down syndrome patients over age 40, it may be difficult to determine whether further impairment is due to the Down syndrome or the progression of AD.

Other types of dementia, including some that are reversible, can cause symptoms similar to those of AD. Approximately 20% of patients originally suspected of having AD turn out to have some other disorder, about half of which are treatable:

- Multi-infarct vascular dementia is caused by strokes (blood clots in the brain) that lead to stepwise destruction of mental capacities.
- Diffuse white matter disease is a form of vascular dementia that can be diagnosed by magnetic resonance imaging (MRI) that reveals the generalized death of large parts of the brain.

- Parkinson's disease is a neurodegenerative condition that causes movement and functional abnormalities. Most Parkinson's patients have tremors and rigidity in their arms and legs.
- Alcohol-associated dementia is caused by nutritional deficiencies in alcoholics, especially malnutrition and deficiencies in vitamins B1 (thiamine) and B12 (cobalamin) and niacin (nicotinic acid). It is potentially reversible.
- Chronic use of certain drugs such as tranquilizers, sedatives, and pain relievers, as well as drug interactions, can cause potentially reversible dementia.
- Endocrine abnormalities (hormone imbalances), especially thyroid dysfunction, are less common causes of dementia. They can be diagnosed by blood tests.
- Chronic infections of the central nervous system, tertiary syphilis, trauma or injury to the brain, brain tumors, psychiatric conditions such as depression (pseudodementia or dementia of depression), and genetic and degenerative disorders other than AD can also cause dementia.

Evaluations for depression and **delirium** (reduced consciousness or awareness of one's environment) are particularly important components of the diagnostic process because, although they may be symptoms of AD, they can also be mistaken for AD. Depression and memory loss are both common among the elderly and a combination of the two can lead to a mistaken diagnosis of AD. Depression can be treated with drugs, although some antidepressants may worsen dementia, further complicating both diagnosis and treatment.

The clinical evaluation will assess cognitive impairment other than short-term memory loss. A family member or close friend of the patient often will be questioned about the onset and duration of symptoms. A neuropsychiatric examination may be performed to determine the pattern of cognitive impairment and probe the patient's level of functioning. Patients may be asked to write a sample check, describe how they answer the telephone, interpret sample traffic signs, or pick out items on a shopping list from a display.

## Tests

Blood and urine tests are used to help rule out other causes of dementia. Genetic tests are available to detect genes known to cause AD. However the APOE e4 gene is not used for diagnostic purposes, since even two copies of gene do not necessarily predict the development of AD.

Several types of oral and written tests are used to help diagnose AD and track its progression, including

## KEY TERMS

**Acetylcholine**—A neurotransmitter with effects that are generally opposite those of dopamine and norepinephrine. Acetylcholine dilates blood vessels, lowers blood pressure, and slows heartbeat.

**Agitation**—Excessive restlessness or emotional disturbance that is often associated with anxiety or psychosis; common in middle-stage AD.

**Agnosia**—Inability to recognize familiar people, places, and objects.

**Amnesia**—Partial or complete loss of memory or gaps in memory.

**Amygdala**—An almond-shaped brain structure of the limbic system that is activated in stressful situations and triggers fear.

**Antioxidant**—A substance that prevents the destructive effects of oxidative chemicals in the body.

**Aphasia**—Loss of language abilities.

**Apolipoprotein E (APOE)**—A protein that transports cholesterol throughout the body. One form of this protein, APOE e4, is associated with a 60% risk of late-onset AD.

**Apraxia**—An inability to perform purposeful movements that is not caused by paralysis or loss of feeling.

**Autosomal dominant**—A gene located on a chromosome other than the X or Y sex chromosomes, whose expression is dominant over that of a second copy of the same gene.

**Beta-amyloid plaques**—Senile plaques; structures in the brain, composed of dead or dying nerve cells and cell debris surrounding deposits of beta-amyloid protein, that are diagnostic of AD. Beta-amyloid forms when amyloid precursor protein (APP) is not broken down properly.

**Brain stem**—The part of the brain that connects to the spinal cord and controls most basic bodily functions. It is the last part of the brain to be destroyed by AD.

**Cholinesterase inhibitors**—Drugs that may slow the progression of AD by inhibiting the enzymes that break down acetylcholine.

**Computed topography (CT) scan**—A scan that uses x rays and a computer to form detailed images of a part of the body.

**Delirium**—A disturbance of consciousness marked by confusion, inattention, delusions, hallucinations, and agitation. It is distinguished from dementia by its relatively sudden onset and variation in the severity of symptoms.

**Delusion**—A persistent false belief held in the face of strong contradictory evidence.

**Dementia**—A group of symptoms (syndrome) associated with a chronic progressive impairment of memory, reasoning ability, and other intellectual functions, personality changes, deterioration in personal grooming, and disorientation.

**Donepezil hydrochloride (Aricept)**—A drug that increases the levels of acetylcholine in the brain.

**Down syndrome**—A genetic disorder characterized by an extra chromosome 21 (trisomy 21), mental retardation, and susceptibility to early-onset AD.

**Free radicals**—Reactive atoms or molecules with unpaired electrons that damage cells, proteins, and DNA.

**Genetic disease**—A disease caused by genes inherited from one or both parents.

tests of mental status, functional abilities, memory, verbal fluency, and concentration. In early-stage AD the results of these tests are usually within the normal range. The widely used mini-mental status examination (MMSE) is a screening test. It is not particularly sensitive for detecting cognitive impairment in well-educated individuals who have previously functioned at a high level. It may also not yield accurate results for poorly educated individuals or cultural minorities. The clock test asks patients draw the face of a clock, possibly including a specific time such as 3:20. Patients with AD often put the numbers out of order, put them

all in one part of the clock face instead of evenly spaced, or have difficulty drawing in the clock hands.

Occasionally the cerebrospinal fluid is tested for the levels of two proteins, Tau and a specific beta-amyloid protein fragment called A beta 42. Increased Tau protein and decreased A beta 42 in the cerebrospinal fluid are indicative of AD.

### *Procedures*

Brain neuroimaging studies such as **positron emission tomography (PET)**, **MRI**, **single photon**

**Ginkgo**—An herb from *Ginkgo biloba*, a shade tree native to China with fan-shaped leaves and fleshy seeds with edible kernels. Some alternative practitioners recommend ginkgo extract for preventing and treating AD.

**Hallucination**—False sensory perceptions; hearing sounds or seeing people or objects that are not there. Hallucinations can also affect the senses of smell, touch, and taste.

**Hippocampus**—A part of the brain's limbic system that is involved in memory formation and learning.

**Insidious**—Progressing gradually and inconspicuously, but with serious effects.

**Magnetic resonance imaging (MRI)**—An imaging technique that uses electromagnetic radiation and a computer to obtain detailed images of soft tissues such as the brain.

**Mild cognitive impairment (MCI)**—A transitional phase of memory loss in older people that precedes dementia or AD.

**Neurofibrillary tangles**—Accumulations of twisted protein fragments inside nerve cells in the brain that are diagnostic of AD.

**Neuron**—A nerve cell.

**Neurotransmitters**—Chemicals that carry nerve impulses from one nerve cell to another. AD causes a drop in the production of several important neurotransmitters.

**Norepinephrine**—A neurotransmitter and adrenal hormone and the precursor of epinephrine.

**Perseveration**—Continuous involuntary repetition of speech or behavior.

**Polygenic**—A trait or disorder that is determined by several different genes. Most human characteristics, including height, weight, and general body build, are polygenic. Schizophrenia and late-onset AD are considered polygenic disorders.

**Positron emission tomography (PET)**—A method of medical imaging capable of displaying the metabolic activity of organs and useful for investigating brain disorders.

**Presenile dementia**—The original name for Alzheimer's disease.

**Presenilin (PSEN)**—Presenilin 1 and presenilin 2 are proteins that are involved in processing amyloid precursor protein (APP). Mutations in the genes encoding these proteins can cause early-onset AD.

**Pseudodementia**—Depression with symptoms resembling those of dementia. The term "dementia of depression" is now preferred.

**Serotonin**—A neurotransmitter found in the brain and blood. Low levels of serotonin are associated with AD.

**Sunsetting**—Confusion or agitation in the evening.

**Systolic**—Referring to the rhythmic contraction of the heart (systole) as the blood in the chambers is forced out. Systolic blood pressure is blood pressure measured during the systolic phase.

**Tau protein**—A protein involved in maintaining the internal structure of nerve cells. Tau protein is damaged in AD and forms neurofibrillary tangles.

**Tomography**—A technique for producing a focused image of the structures at a specific depth within the body, while blurring details at other depths.

**Emission computed tomography (SPECT)** scans, or computed topography (CT) scans may be used to detect gross cerebral cortex atrophy due to brain cell death. **PET** scans can detect the earliest changes in brain structure. MRI scans are often performed on patients who are having problems with balance or gait. MRIs can detect diffuse atrophy that is often present in the cerebrum of the brain of AD patients. PET and SPECT scans can be used to evaluate patterns of glucose (sugar) metabolism in the brain to differentiate patterns characteristic of AD from those associated with vascular dementia and Pick's disease. PET scans are more precise than SPECT

scans but are more expensive. However imaging alone cannot diagnose AD. MRI and CT scans and electroencephalographs (EEGs), which measure the electrical activity in the brain, can be useful for excluding other causes of dementia such as stroke, **subdural hematoma**, and brain tumors.

Although a skilled physician can diagnose probable AD with 90% accuracy, a definitive diagnosis of Alzheimer's disease requires a brain autopsy after death and examination of the brain tissue by a histopathologist. The presence of a large number of beta-amyloid plaques and intraneuronal neurofibrillary

tangles are considered diagnostic of AD. Antibodies that bind to the specific amyloid proteins are tagged with a fluorescent or colorimetric molecule and visualized in a microscope. In addition, the longer the disease has progressed, the smaller the brain is at death.

A study published in *The Archives of Neurology* in August 2010 found that spinal fluid test can be 100 percent accurate in identifying patients with significant memory loss who are on their way to developing Alzheimer's disease. The test is one of many ways the diagnosis of AD is moving from only being positive after death. Much work lies ahead, researchers say: making sure the tests are reliable if used in doctors' offices, making sure the research findings hold up in real-life situations, getting doctors and patients comfortable with the notion of spinal taps, the method used to get spinal fluid. In addition to spinal fluid tests, new PET scans of the brain that show the telltale amyloid plaques are being developed, which are a unique feature of the disease. And researchers are testing hundreds of new drugs that might change the course of the brain cell death associated with this disease. Breakthroughs in research have been rather stagnant, but as of 2010, this research field had a flurry of new studies.

## Treatment

### *Traditional*

Although there is no cure for Alzheimer's disease, early diagnosis and prompt intervention can slow its progression and enable patients to function independently for a longer period. Healthcare professionals usually assess a patient's ADL to determine what type of care is needed. The mainstay of treatment is the establishment of daily routines, good nursing care and/or home-care strategies, and providing physical and emotional support. In the initial stages, counseling by a psychologist or an AD support group is recommended. The patient and caregiver should establish a relationship with a primary-care provider so that illnesses, such as urinary or respiratory infections, can be properly diagnosed and treated rather than being simply attributed to the inevitable decline of AD. Neurological and behavioral aspects of AD, including anxiety, agitation, defiant behavior, **insomnia**, hallucinations, and seizures are treated on an as-needed basis.

Treatment of AD is a very active area of research and the National Institutes of Health (NIH) and other agencies sponsor numerous clinical trials of new drugs and therapies. A list of current clinical trials enrolling volunteers can be found at <http://clinicaltrials.gov/>

### Drugs

The most common drugs prescribed for AD are inhibitors of acetylcholinesterase and butyrylcholinesterase, enzymes that break down the neurotransmitters acetylcholine and butyrylcholine, respectively. These medications increase levels of acetylcholine in the brain, thereby improving brain function in early-stage mild-to-moderate AD:

- galantamine (Razadyne, formerly known as Reminyl)
- rivastigmine (Exelon)
- donepezil hydrochloride (Aricept)

Memantine (Namenda) is used to treat moderate-to-severe AD. It acts on glutamate, another brain neurotransmitter. It is used alone or in combination with donepezil.

These drugs can modestly increase attention span, concentration, mental acuity, and information processing and improve the ability to perform normal ADL. They slow the progression of symptoms for about six months to one year in one-third to one-half of patients with AD. All have side effects, most often mild **diarrhea, nausea, vomiting, muscle cramps, dizziness, headache, fatigue**, and sleep disturbances. Tacrine (Cognex), the first such drug, is no longer prescribed because of the risk of liver toxicity.

The antioxidant vitamin E may delay AD onset by protecting neurons from free-radical damage. AD patients have lower blood levels of vitamin E than other adults of the same age. One large two-year study of moderately affected AD patients found that taking 2000 IU (international units) of vitamin E daily significantly delayed disease progression as compared with patients taking a placebo. However, high levels of vitamin E can put patients at higher risk for bleeding disorders. Vitamin E therapy, in combination with cholinesterase inhibitors, has become the standard treatment for AD.

Drugs previously used to treat AD—including selegiline (a drug for Parkinson's disease), prednisone, estrogen, and nonsteroidal anti-inflammatory drugs (NSAIDs)—have been found to be ineffective.

Medications can be prescribed to manage the behavioral and psychiatric symptoms of AD, which are often very stressful for caregivers. These medications are usually prescribed for specific symptoms:

- typical antipsychotics—usually haloperidol (Haldol), risperidone (Risperdal), olanzapine, or quetiapine—for anxiety, aggression, delusions, or hallucinations

- short-term antianxiety drugs, usually lorazepam (Ativan) or buspirone (BuSpar), for agitation
- a selective serotonin reuptake inhibitor (SSRI), such as citalopram or sertraline, at half the adult dosage, for depression, which is common in early-stage AD
- acetaminophen or a very low dose of codeine for pain

Patients with AD are more susceptible to the side effects of medications, especially psychoactive drugs, and are usually given lower doses than younger adults. Physicians often recommend first trying to reduce behavioral symptoms with changes to the patient's environment.

### *Alternative*

Antioxidants have shown some degree of effectiveness in treating AD. Antioxidants, in addition to vitamin E, include:

- vitamin C
- selenium
- green tea
- ginkgo biloba extract

Derived from the leaves of the *Gingko biloba* tree, ginkgo also increases blood and oxygen flow to the brain and has anti-inflammatory and neuroprotective effects. It has been used for many years in China, is widely prescribed in Europe for circulatory problems, and is the most common herbal treatment for AD. However a large-scale, well-designed 2008 study found that Ginkgo extract neither prevented nor delayed AD.

Other supplements for treating AD include:

- Huperzine A, from the club moss *Huperzia serrata*, is a natural cholinesterase inhibitor that has been reported to produce greater improvement than synthetic cholinesterase inhibitors at doses of 0.1–0.4 milligrams (mg) daily and has few side effects. Side effects may include nausea, muscle cramps, vomiting, and diarrhea. Like ginkgo biloba, it is an unregulated herb and preparations may have widely varying amounts of active ingredients.
- Thiamine (vitamin B1) in daily doses of 3 grams (g) for two to three months have been shown in small studies to improve mental function and AD assessment scores; however other studies have found no effect. Side effects can include nausea and indigestion.
- Cobalamin (vitamin B12) improved memory and mental function in AD patients in some studies but not in others.

- Acetyl L-carnitine is similar in structure to acetylcholine and some studies have indicated that 2–3 g daily slows the progression of AD in patients who developed the disease before age 66. Patients who developed AD after age 66 worsened with the treatment. Side effects include increased appetite, body odor, and rash.
- DHEA (dehydroepiandrosterone) is a steroid hormone. Although a link between decreased levels of DHEA in the elderly and AD has been suggested, no studies have been performed. Side effects include acne, hair growth, irritability, insomnia, headache, and menstrual irregularities.
- Melatonin is a hormone that helps regulate mood and sleep cycles. The usual dose is 3 mg one to two hours before bed. Side effects are drowsiness, confusion, headache, decreased sex drive, and decreased body temperature.

Naturopathic treatment for AD includes supplementation with antioxidant vitamins (A, C, and E), carotenoids, small amounts of selenium and zinc, and thiamine. Some alternative practitioners advise people with AD to also take supplements of phosphatidylcholine, gotu kola, **ginseng**, **St. John's Wort**, rosemary, saiko-keishi-to-shakuyaku (a Japanese herbal mixture), and **folic acid**. However none of these have met the safety and effectiveness standards of conventional Western medicine.

The incidence of AD is lower in countries with **diets** that are lower in calories and fats. There have been a few reports suggesting that diets rich in fish improve mental function in patients with AD or dementia and AD patients treated with essential fatty acids have shown greater improvement in mood and mental function than patients on placebos. Because of its disease-preventing properties, red wine in moderation may also benefit AD patients. Patients with AD should avoid environmental toxins such as tobacco smoke.

A variety of other therapies may be beneficial in the treatment of psychological symptoms of AD:

- Music therapy has been found to calm agitated AD patients and improve mood, reduce chronic pain, depression, agitation, wandering, and feelings of isolation, and enhance long-term memory. Old familiar songs can be particularly effective in improving recall
- Light therapy in the evening can help alleviate sleep-cycle disturbances
- Supportive therapies include touch, compliments, and displays of affection

- Sensory stimulation through massage and aromatherapy may be beneficial
- Socio-environmental therapies include activities related to the patient's previous interests and favorite foods, as well as pleasant surroundings
- Cognitive therapy can reduce negative perceptions and teach coping strategies
- Insight-oriented psychotherapy addresses patients' awareness of their disease
- Dance therapy, validation therapy, reminiscence therapy, and reality-oriented therapy have also been used with AD patients

### ***Home remedies***

About 70% of AD patients are cared for at home, with the remainder residing in various types of institutions. Creative strategies are necessary to help the patient stay as independent as possible. Caregivers need their own support systems to minimize anger, despair, and burnout. Becoming familiar with likely future scenarios and considering financial and legal issues early on can ease the burden on both the patient and the family.

In the early stages of AD when memory loss is minimal, it is helpful for family and friends to interact with patients as much as possible, reminding them to eat, take their medication, keep their appointments, and help sustain daily living activities. Keeping records is helpful, particularly when there are several caregivers. The household should be organized so that important items can be found easily. The patient will need help in managing finances. Providing neighbors with a house key and setting up a schedule to check in on the patient are recommended. With the help of family, neighbors, and community resources, many people with early AD are able to maintain a successful lifestyle in their home environment for months or years.

Basic safety concerns for AD patients include:

- falls
- ingestion of dangerous substances
- wandering from home and becoming lost
- injuring one's self or others with sharp objects, fire, or burns
- the inability to respond rapidly to crisis situations

Often families have to modify their homes because of safety concerns:

- grab bars in bathrooms, bed rails, and clutter-free passageways
- electrical appliances that are unplugged and put away when not in use

- matches, lighters, knives, or weapons stored out of reach
- lowered hot water heater temperature to avoid accidental scalding
- a list of emergency numbers, including the poison control center and hospital emergency room, posted by the phone

Patients who have been diagnosed with AD should never be allowed to drive because of the danger of accidents or becoming disoriented. Some local chapters of the Alzheimer's Association offer help with transportation.

A calm, structured environment with simple orientation aids such as calendars and clocks can help reduce anxiety and increase safety. Labeling cabinets and drawers can help patients focus their attention. Signs can be posted reminding patients of important phone numbers and to turn off appliances and lock doors. Scheduling meals, bathing, and other activities at regular times and places provides routine and emotional security, since unfamiliar places and activities can be disorienting. Caregivers should develop a daily routine and take advantage of periods during the day when the patient is less confused and more cooperative. The most severe symptoms often occur at night. Sleep disturbances may be minimized by keeping the patient engaged in activities during the day. Daily supervised walks are a good general exercise for people with AD.

A loss of grooming skills—mismatched clothing, unkempt hair, and decreased interest in personal hygiene—is often one of the early symptoms of AD. Caregivers, especially spouses, may find these changes socially embarrassing and difficult to cope with. The caregiver will increasingly assume grooming responsibilities as the disease progresses.

Feeding may require using a colored plate to focus the patient's attention on the food. Finger foods may be preferable to the use of utensils. A nutritionist can give advice on well-balanced, easily prepared meals. Eventually the caregiver may need to feed the patient. As movement and swallowing become difficult, a feeding tube may be placed into the stomach through the abdominal wall.

Incontinence presents the most difficult problem for many caregivers and is a major reason for moving to nursing-home care. In the early stages, limiting fluid intake and increasing the frequency of toileting can help. Careful attention to hygiene is important to prevent skin irritation and infection from soiled clothing.

Family members or other caregivers have a difficult and stressful job, which becomes harder still as the disease progresses. Caring for dementia patients is significantly more demanding and time-consuming than caring for patients with other illnesses. Each day may bring new challenges as the patient's ability levels decrease and new patterns of behavior develop. Many caregivers find the constant but unpredictable demands extremely difficult. The personality changes of AD can be heartbreakingly difficult for family members as a loved one deteriorates, seeming to become a different person. As the disease progresses, the patient's behavior may become increasingly erratic. It may be impossible to leave a patient unattended for even a few minutes because they may wander off. Neighbors should always be informed of the person's condition. However not all AD patients develop negative behaviors: some become gentle, spending increasing amounts of time in dreamlike states.

Caregivers often develop feelings of anger, resentment, guilt, and hopelessness. Depression is common and may need to be treated. Caregivers can become susceptible to illness, especially if they do not receive adequate support from family, friends, and community. Support groups can help caregivers deal with stress. The location and contact numbers for AD caregiver support groups are available from the Alzheimer's Association, local social service agencies, physicians, and pharmaceutical companies that manufacture the drugs used to treat AD.

Most families eventually need outside help to care for the AD patient. Personal-care assistants, either volunteer or paid, may be available through local social service agencies. Adult daycare facilities are becoming increasingly common. Meal delivery, shopping assistance, or respite care may also be available. Special Alzheimer's disease facilities are available for both respite daycare and permanent long-term care.

The decision to move the patient to a nursing home is often one of the most difficult for the family, who may consider that they have failed in their obligations and are abandoning their loved one. Counseling with a physician, clergy, or other trusted adviser can ease this transition. Selecting a nursing home may require a difficult balancing of costs, services, location, and availability. Keeping the entire family involved in the decision may help prevent further stress later.

Social Security Disability, Medicare, Medicaid, or Supplemental Security Income may provide financial assistance, but will not usually cover nursing home care indefinitely. Long-term care insurance, if purchased

prior to diagnosis, reverse mortgages, or other financial devices may be appropriate.

## Prognosis

There is no cure for Alzheimer's disease and once the symptoms develop patients do not recover. The goal is to maintain cognitive and physical function for as long as possible. Although there is considerable variation in the rate of disease progression, symptoms continue to worsen, usually over a period of years. Eventually loss of brain cells and brain damage result in the impairment of autonomic body functions, the failure of various organ systems, **coma**, and death. Most AD patients die within eight to 10 years of diagnosis, although that interval can be as short as one year or as long as 20 years. The life expectancy of AD patients is increasing because the disease is generally being diagnosed at an earlier stage.

The most common cause of death among AD patients is infection. People with AD are often in poor health and may be malnourished, which puts them at increased risk of life-threatening infections such as pneumonia. They are also susceptible to other conditions and diseases of old age. The consequences of cancer, stroke, and heart disease can be more severe in patients with AD than in otherwise healthy people.

## Prevention

There is no known prevention for Alzheimer's disease. Several studies have suggested that high-fat and high-calorie diets may increase the risk of developing AD. Other possible risk factors include alcohol, salt, and refined carbohydrates. Some studies have found that fish consumption reduces the incidence of AD in Europe and North America, possibly due to the omega-3 fatty acids found in fish. It is also possible that staying physically and mentally active throughout life may lower the risk of AD.

Individuals with a history of Alzheimer's disease in their families may want to consider **genetic counseling** to clarify possible risk factors and determine the appropriateness of available genetic tests. Since the APOE e4 gene is merely a risk factor for AD, it is not considered useful for predicting whether a person will develop the disease. The National Institute on Aging does not recommend using the test to screen people because:

- it does not predict whether an individual will develop AD
- there are ethical implications to testing for a disease that is currently incurable

- it may have adverse psychological consequences for patients and their families
- it could lead to discrimination in employment or health insurance for carriers of the gene

Research on the prevention of AD has focused on blocking the production of amyloid protein in the brain and on breaking down beta-amyloid after it is released from cells but before it has a chance to aggregate into insoluble plaques.

## Health care team roles

Treatment of AD is a team effort, involving primary-care physicians, nurses, imaging and laboratory technicians, gerontology specialists, psychiatrists, psychologists, and caregivers. Educating patients and caregivers about the nature of the disease and its progression usually falls on the nursing staff. Nurses are also the first line of access for medical care and support groups. Social workers, counselors, and support group facilitators may provide emotional support, practical advice, and information about community resources. Specialized Alzheimer's disease facilities may be used for either respite daycare or permanent long-term care.

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## ORGANIZATIONS

Alzheimer's Association, 225 N. Michigan Ave., Fl. 17, Chicago, IL, 60601-7633 (312) 335-8700 (800) 272-3900 (866) 699-1246, info@alz.org, http://www.alz.org.  
 Alzheimer's Australia, PO Box 4019, Hawker, ACT, Australia, 2614 61 (2) 6254-4233 (1800) 100-500 (Australia only), http://www.alzheimers.org.au.  
 Alzheimer's Disease Education and Referral Center, National Institute on Aging, PO Box 8250, Silver Spring, MD, 20907-8250 (800) 438-4380, adear@nia.nih.gov, http://www.nia.nih.gov/Alzheimers.  
 Alzheimer's Foundation of America, 322 Eighth Avenue, 7th Floor, New York, NY, 10001 (866) 232-8484 (646) 638-1546, info@alzfdn.org, http://www.alzfdn.org.  
 American Health Assistance Foundation, 22512 Gateway Center Drive, Clarksburg, MD, 20871 (800) 437-2423 (301) 948-4403, info@ahaf.org, http://www.ahaf.org.  
 European Alzheimer's Disease Consortium, Dept. of Internal Medicine and Clinical Gerontology, Toulouse University Hospital, 170 Avenue de Casselardit, Toulouse, France, 31300 33-5-6177-7649 33-5-6149-7109, reynish.e@chu-toulouse.fr, http://eadc.alzheimer-europe.org.  
 Fisher Center for Alzheimer's Research Foundation, One Intrepid Square, West 46th Street & 12th Avenue, New York, NY, 10036 (800) ALZINFO (259-4636), http://www.alzinfo.org.  
 National Institute of Neurological Disorders and Stroke (NINDS), NIH Neurological Institute, PO Box 5801, Bethesda, MD, 20824 (301) 496-5751 (800) 352-9424, http://www.ninds.nih.gov/index.htm.

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Ambiguous genitals see **Intersex states**



**Man with a lazy eye.** (Custom Medical Stock Photo, Inc. Reproduced by permission.)

information from the “bad” or amblyopic eye. Lazy eye is a common non medical term used to describe amblyopia because the eye with poorer vision does not seem to be doing its job of seeing.

## Demographics

Amblyopia is the most common cause of impaired vision in children. It affects about three out of every 100 people or two to four percent of the population.

## Description

Vision is a combination of the clarity of the images received from the eyes (visual acuity) and the processing of those images by the brain. If the images produced by the two eyes are substantially different, the brain may not be able to fuse the images. Instead of seeing two different images or double vision (diplopia), the brain suppresses the blurrier image. This suppression can lead to amblyopia.

The critical stage for binocular vision development occurs between the ages of five and seven months with continued development through about age eight years. Amblyopia is most likely to develop early in childhood and leads to poor visual development in the blurrier eye. Amblyopia can also occur in adults if one eye is damaged or vision is reduced by the development of a cataract.

## Risk factors

Children who were premature, who are developmentally delayed, have other eye problems, or who have a family history of amblyopia are at higher risk for developing this disorder.

## Causes and symptoms

Some of the major causes of amblyopia are as follows:

- **Strabismus.** A misalignment of the eyes (strabismus) is the most common cause of functional amblyopia. The two eyes are looking in two different directions at the same time. The brain is sent two different images and this causes confusion. The brain turns off images from the misaligned or “crossed” eye in order to avoid double vision.
- **Anisometropia.** This is another type of functional amblyopia. In this case, there is a difference of refractive states between the two eyes (in other words, a difference of prescriptions between the two eyes). For example, one eye may be more nearsighted than the other eye, or one eye may be farsighted and the other eye nearsighted. Because the brain cannot fuse the two dissimilar images, it will suppress the blurrier image, causing the eye to become amblyopic.
- **Cataract.** Clouding of the lens of the abnormal eye will cause the image to be blurrier than the image from the normal eye. The brain “prefers” the clearer image. The eye with the cataract may become amblyopic.
- **Ptosis.** This is the drooping of the upper eyelid. If light cannot enter the eye because of the drooping lid, the eye is essentially not being used. This condition can lead to amblyopia.
- **Nutrition.** Nutritional deficiencies or chemical toxicity may result in amblyopia. Alcohol, tobacco, or a deficiency in the B vitamins may result in toxic amblyopia.
- **Heredity.** Amblyopia can run in families.

Barring the presence of **strabismus** or **ptosis**, children may or may not show signs of amblyopia. Children may hold their heads at an angle while trying to favor the eye with normal vision. They may have trouble seeing or reaching for things when approached from the side of the amblyopic eye. Parents may notice that one side of approach is preferred by the child or infant. If an infant’s good eye is covered, the child may cry.

## Diagnosis

### *Examination*

Because children with outwardly normal eyes may have amblyopia, regular vision screenings are recommended beginning at a young age. There is some controversy regarding the age at which children should have their first vision examination. Some authorities recommend that children have their vision checked by their pediatrician, family physician, ophthalmologist, or optometrist at or before six months of age. Others recommend testing by at least the child’s fourth

## KEY TERMS

**Anisometropia**—An eye condition in which there is an inequality of vision between the two eyes. There may be unequal amounts of nearsightedness, farsightedness, or astigmatism, so that one eye will be in focus while the other is not.

**Cataract**—Cloudiness of the eye’s natural lens.

**Occlusion therapy**—A type of treatment for amblyopia in which the good eye is patched for a period of time. This forces the weaker eye to be used.

**Strabismus**—A condition in which the eyes are misaligned and point in different directions. One eye may look straight ahead, while the other turns inward, outward, upward, or downward. This is also called crossed-eyes.

**Visual acuity**—Acuity is the acuteness or sharpness of vision.

birthday. In actuality, children’s eyes can be examined at any age, even at one day of life. The earlier amblyopia is found, the better the possible outcome. Most physicians test vision as part of a child’s medical examination. If there is any sign of an eye problem, the child may be referred to an eye specialist.

Generally, a difference of two lines or more (on an eye-chart test of visual acuity) between the two eyes would be defined as amblyopia. For example, if someone has 20/20 vision with the right eye and only 20/40 with the left, and the left eye cannot achieve better vision with corrective lenses, the left eye is said to be amblyopic.

Objective methods such as retinoscopy can measure the refractive status of the eyes. This can help determine anisometropia. In retinoscopy, a hand-held instrument is used to shine a light in the child’s (or infant’s) eyes. Using hand-held lenses, a rough prescription can be obtained. Visual acuity can be determined using a variety of methods. Many different eye charts are available (e.g., tumbling E, pictures, or letters).

In amblyopia, single letters are easier to recognize than when a whole line is shown. This is called the “crowding effect” and helps in diagnosing amblyopia. Neutral density filters also may be held over the eye to aid in the diagnosis. Sometimes visual fields to determine defects in the area of vision will be performed. Color vision testing also may be performed. Amblyopia is a diagnosis of exclusion, so many tests may be performed to rule out visual or health problems that also can cause a decrease in vision.

## Treatment

The treatment plan should be discussed with the doctor to fully understand the purpose of the treatment, its length, and expected results.

### Traditional

Treatment should be begun as early as possible in a child's life. The primary treatment is occlusion therapy, which is performed by a child's wearing a patch over the good eye. This forces the amblyopic eye to work and the brain to process information from this eye. Clinical trials sponsored by the United States National Institutes of Health (NIH) have shown that for many children, wearing a patch over the good eye for two hours daily effectively treats mild to moderate amblyopia; patching for six hours daily generally improves severe amblyopia. Limited patching time allows the child to wear the patch at home, avoiding the stigma of looking different in public. Initially it was thought that if patching were not done by age seven, it would be ineffective, but research as of 2010 has shown that the effective period for reversing or reducing amblyopia can extend through age 17 years in some individuals; information on reversing amblyopia in older adults is limited.

When patched, eye exercises may be prescribed to force the amblyopic eye to focus and work. This is called vision therapy or **vision training**. Even after vision has been improved in the weak eye, part-time patching may be recommended to maintain the improvement.

### Drugs

An alternative to patching is treatment with the drug atropine. Atropine eyedrops are applied to the "good" (stronger) eye. Atropine dilates the pupil and causes vision in the good eye to become blurry. This forces the brain to process information from the "bad" or amblyopic eye.

While patching or atropine treatment is necessary to get the amblyopic eye/brain processing to work, it is just as important to correct any underlying reason for the amblyopia. Glasses may also be worn if there are errors in refraction. Surgery or vision training may be necessary in the case of strabismus. Better **nutrition** is indicated in some toxic amblyopias.

### Prognosis

It is important to diagnose and treat amblyopia early because significant vision loss can occur if left untreated. The best outcomes result from early diagnosis

and treatment. However, treatment may be successful in older children. Success in the treatment of amblyopia also depends upon how severe the amblyopia is, the specific type of amblyopia, and patient compliance.

## Prevention

To protect their child's vision, parents must be aware of amblyopia as a potential problem. Parents should be encouraged to take young children for vision exams early on in life and certainly before they begin school. Proper nutrition is important in the avoidance of toxic amblyopia.

### ORGANIZATIONS

American Academy of Ophthalmology (AAO), P. O. Box 7424, San Francisco, CA, 94120-7424, (415) 561-8500, (415) 561-8500, <http://www.aoa.org>.

American Optometric Association, 243 North Lindbergh Blvd., St. Louis, MO, 63141, (314) 991-4100, (314) 991-4101, (800) 365-2219, <http://www.aoa.org>.

American Academy of Optometry, 6110 Executive Blvd., Suite 506, Rockville, MD, 20852 (301) 984-1441 (301) 984-4737, [aaopt@aaopt.org](mailto:aaopt@aaopt.org), <http://www.aaopt.org>.

EyeCare America Foundation of the American Academy of Ophthalmology, PO Box 429098, San Francisco, CA, 94142-9098 (877) 887-6327 (800) 324-EYES (3937) (415) 561-8567, [pubserv@aao.org](mailto:pubserv@aao.org), <http://www.eyecareamerica.org>.

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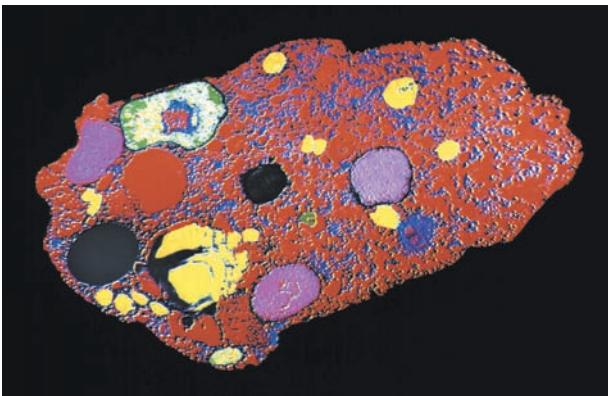
## Amebiasis

### Definition

Amebiasis is an **infectious disease** caused by a parasitic one-celled microorganism (protozoan) called *Entamoeba histolytica*. Persons with amebiasis may experience a wide range of symptoms, including **diarrhea, fever**, and cramps. The disease may also affect the intestines, liver, or other parts of the body.

### Description

Amebiasis, also known as amebic **dysentery**, is one of the most common parasitic diseases occurring in humans, with an estimated 500 million new cases each year. It occurs most frequently in tropical and subtropical areas where living conditions are crowded, with inadequate sanitation. Although most cases of amebiasis occur in persons who carry the disease but do not exhibit any symptoms (asymptomatic), as



**A micrograph of *Entameoba histolytica*, a parasitic amoeba that invades and destroys the tissues of the intestines, causing amebiasis and ulceration to the intestinal wall.** (Photo Researchers, Inc.)

many as 100,000 people die of amebiasis each year. In the United States, between one and 5% of the general population will develop amebiasis in any given year, while male homosexuals, migrant workers, institutionalized people, and recent immigrants develop amebiasis at a higher rate.

Human beings are the only known host of the amebiasis organism, and all groups of people, regardless of age or sex, can become affected. Amebiasis is primarily spread in food and water that has been contaminated by human feces but is also spread by person-to-person contact. The number of cases is typically limited, but regional outbreaks can occur in areas where human feces are used as fertilizer for crops, or in cities with water supplies contaminated with human feces.

### Causes and symptoms

Recently, it has been discovered that persons with symptom-causing amebiasis are infected with *Entamoeba histolytica*, and those individuals who exhibit no symptoms are actually infected with an almost identical-looking ameba called *Entamoeba dispar*. During their life cycles, the amebas exist in two very different forms: the infective cyst or capsule form, which cannot move but can survive outside the human body because of its protective covering, and the disease-producing form, the trophozoite, which although capable of moving, cannot survive once excreted in the feces and, therefore, cannot infect others. The disease is most commonly transmitted when a person eats food or drinks water containing *E. histolytica* cysts from human feces. In the digestive tract the cysts are transported to the intestine where the walls of the cysts are broken open by digestive

secretions, releasing the mobile trophozoites. Once released within the intestine, the trophozoites multiply by feeding on intestinal bacteria or by invading the lining of the large intestine.

Within the lining of the large intestine, the trophozoites secrete a substance that destroys intestinal tissue and creates a distinctive bottle-shaped sore (ulcer). The trophozoites may remain inside the intestine, in the intestinal wall, or may break through the intestinal wall and be carried by the blood to the liver, lungs, brain, or other organs. Trophozoites that remain in the intestines eventually form new cysts that are carried through the digestive tract and excreted in the feces. Under favorable temperature and humidity conditions, the cysts can survive in soil or water for weeks to months, ready to begin the cycle again.

Although 90% of cases of amebiasis in the United States are mild, pregnant women, children under two years of age, the elderly, malnourished individuals, and people whose immune systems may be compressed, such as **cancer** or **AIDS** patients and those individuals taking prescription medications that suppress the immune system, are at a greater risk for developing a severe infection.

The signs and symptoms of amebiasis vary according to the location and severity of the infection and are classified as follows:

#### **Intestinal amebiasis**

Intestinal amebiasis can be subdivided into several categories:

**ASYMPTOMATIC INFECTION.** Most persons with amebiasis have no noticeable symptoms. Even though these individuals may not feel ill, they are still capable of infecting others by person-to-person contact or by contaminating food or water with cysts that others may ingest, for example, by preparing food with unwashed hands.

**CHRONIC NON-DYSENTERIC INFECTION.** Individuals may experience symptoms over a long period of time during a chronic amebiasis infection and experience recurrent episodes of diarrhea that last from one to four weeks and recur over a period of years. These patients may also suffer from abdominal cramps, **fatigue**, and weight loss.

**AMEBIC DYSENTERY.** In severe cases of intestinal amebiasis, the organism invades the lining of the intestine, producing sores (ulcers), bloody diarrhea, severe abdominal cramps, **vomiting**, chills, and fevers as high as 104–105°F (40–40.6°C). In addition, a case of acute amebic dysentery may cause complications, including

## KEY TERMS

**Ameboma**—A mass of tissue that can develop on the wall of the colon in response to amebic infection.

**Antibody**—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

**Appendicitis**—Condition characterized by the rapid inflammation of the appendix, a part of the intestine.

**Asymptomatic**—Persons who carry a disease and are usually capable of transmitting the disease but who do not exhibit symptoms of the disease are said to be asymptomatic.

**Dysentery**—Intestinal infection marked by diarrhea containing blood and mucus.

**Fulminating colitis**—A potentially fatal complication of amebic dysentery marked by sudden and severe inflammation of the intestinal lining, severe bleeding or hemorrhaging, and massive shedding of dead tissue.

**Inflammatory bowel disease (IBD)**—Disease in which the lining of the intestine becomes inflamed.

**Lumen**—The inner cavity or canal of a tube-shaped organ, such as the bowel.

**Protozoan**—A single-celled, usually microscopic organism that is eukaryotic and, therefore, different from bacteria (prokaryotic).

inflammation of the appendix (**appendicitis**), a tear in the intestinal wall (perforation), or a sudden, severe inflammation of the colon (**fulminating colitis**).

**AMEBOMA.** An ameboma is a mass of tissue in the bowel that is formed by the amebiasis organism. It can result from either chronic intestinal infection or acute amebic dysentery. Amebomas may produce symptoms that mimic cancer or other intestinal diseases.

**PERIANAL ULCERS.** Intestinal amebiasis may produce skin infections in the area around the patient's anus (perianal). These ulcerated areas have a "punched-out" appearance and are painful to the touch.

### *Extraintestinal amebiasis*

Extraintestinal amebiasis accounts for approximately 10% of all reported amebiasis cases and includes all forms of the disease that affect other organs.

The most common form of extraintestinal amebiasis is amebic **abscess** of the liver. In the United States, amebic liver abscesses occur most frequently in young Hispanic adults. An amebic liver abscess can result from direct infection of the liver by *E. histolytica* or as a complication of intestinal amebiasis. Patients with an amebic abscess of the liver complain of **pain** in the chest or abdomen, fever, **nausea**, and tenderness on the right side directly above the liver.

Other forms of extraintestinal amebiasis, though rare, include infections of the lungs, chest cavity, brain, or genitals. These are extremely serious and have a relatively high mortality rate.

### **Diagnosis**

Diagnosis of amebiasis is complicated, partly because the disease can affect several areas of the body and can range from exhibiting few, if any, symptoms to being severe, or even life-threatening. In most cases, a physician will consider a diagnosis of amebiasis when a patient has a combination of symptoms, in particular, diarrhea and a possible history of recent exposure to amebiasis through travel, contact with infected persons, or anal intercourse.

It is vital to distinguish between amebiasis and another disease, inflammatory bowel disease (IBD) that produces similar symptoms because, if diagnosed incorrectly, drugs that are given to treat IBD can encourage the growth and spread of the amebiasis organism. Because of the serious consequences of misdiagnosis, potential cases of IBD must be confirmed with multiple stool samples and blood tests, and a procedure involving a visual inspection of the intestinal wall using a thin lighted, tubular instrument (**sigmoidoscopy**) to rule out amebiasis.

A diagnosis of amebiasis may be confirmed by one or more tests, depending on the location of the disease.

### **Stool examination**

This test involves microscopically examining a stool sample for the presence of cysts and/or trophozoites of *E. histolytica* and not one of the many other intestinal amebas that are often found but that do not cause disease. A series of three stool tests is approximately 90% accurate in confirming a diagnosis of amebic dysentery. Unfortunately, however, the stool

test is not useful in diagnosing amebomas or extraintestinal infections.

### Sigmoidoscopy

Sigmoidoscopy is a useful diagnostic procedure in which a thin, flexible, lighted instrument, called a sigmoidoscope, is used to visually examine the lower part of the large intestine for amebic ulcers and take tissue or fluid samples from the intestinal lining.

### Blood tests

Although tests designed to detect a specific protein produced in response to amebiasis infection (antibody) are capable of detecting only about 10% of cases of mild amebiasis, these tests are extremely useful in confirming 95% of dysentery diagnoses and 98% of liver abscess diagnoses. Blood serum will usually test positive for antibody within a week of symptom onset. Blood testing, however, cannot always distinguish between a current or past infection since the antibodies may be detectable in the blood for as long as 10 years following initial infection.

### Imaging studies

A number of sophisticated imaging techniques, such as **computed tomography scans (CT)**, **magnetic resonance imaging (MRI)**, and ultrasound, can be used to determine whether a liver abscess is present. Once located, a physician may then use a fine needle to withdraw a sample of tissue to determine whether the abscess is indeed caused by an amebic infection.

### Treatment

Asymptomatic or mild cases of amebiasis may require no treatment. However, because of the potential for disease spread, amebiasis is generally treated with a medication to kill the disease-causing amebas. More severe cases of amebic dysentery are additionally treated by replacing lost fluid and blood. Patients with an amebic liver abscess will also require hospitalization and bed rest. For those cases of extraintestinal amebiasis, treatment can be complicated because different drugs may be required to eliminate the parasite, based on the location of the infection within the body. Drugs used to treat amebiasis, called amebicides, are divided into two categories:

#### *Luminal amebicides*

These drugs get their name because they act on organisms within the inner cavity (lumen) of the bowel. They include diloxanide furoate, iodoquinol, metronidazole, and paromomycin.

#### *Tissue amebicides*

Tissue amebicides are used to treat infections in the liver and other body tissues and include emetine, dehydroemetine, metronidazole, and chloroquine. Because these drugs have potentially serious side effects, patients given emetine or dehydroemetine require bed rest and heart monitoring. Chloroquine has been found to be the most useful drug for treating amebic liver abscess. Patients taking metronidazole must avoid alcohol because the drug-alcohol combination causes nausea, **vomiting**, and **headache**.

Most patients are given a combination of luminal and tissue amebicides over a treatment period of seven to ten days. Follow-up care includes periodic stool examinations beginning two to four weeks after the end of medication treatment to check the effectiveness of drug therapy.

### Prognosis

The prognosis depends on the location of the infection and the patient's general health prior to infection. The prognosis is generally good, although the mortality rate is higher for patients with ameboma, perforation of the bowel, and liver infection. Patients who develop fulminant colitis have the most serious prognosis, with over 50% mortality.

### Prevention

There are no immunization procedures or medications that can be taken prior to potential exposure to prevent amebiasis. Moreover, people who have had the disease can become reinfected. Prevention requires effective personal and community hygiene.

Specific safeguards include the following:

- Purification of drinking water. Water can be purified by filtering, boiling, or treatment with iodine.
- Proper food handling. Measures include protecting food from contamination by flies, cooking food properly, washing one's hands after using the bathroom and before cooking or eating, and avoiding foods that cannot be cooked or peeled when traveling in countries with high rates of amebiasis.
- Careful disposal of human feces.
- Monitoring the contacts of amebiasis patients. The stools of family members and sexual partners of infected persons should be tested for the presence of cysts or trophozoites.

## Resources

### BOOKS

Friedman, Lawrence S. "Liver, Biliary Tract, & Pancreas." In McPhee, Stephen, and Maxine Papadakis. *Current Medical Diagnosis and Treatment*, 2010, 49th ed. New York: McGraw-Hill Medical, 2009.

Rebecca J. Frey PhD

Amebic dysentery see **Amebiasis**

## KEY TERMS

**Hymen**—Membrane that stretches across the opening of the vagina.

**Hypothyroidism**—Underactive thyroid gland.

**Hysterectomy**—Surgical removal of the uterus.

**Turner's syndrome**—A condition in which one female sex chromosome is missing.

## Amenorrhea

### Definition

The absence of menstrual periods is called amenorrhea. Primary amenorrhea is the failure to start having a period by the age of 16. Secondary amenorrhea is more common and refers to either the temporary or permanent ending of periods in a woman who has menstruated normally in the past. Many women miss a period occasionally. Amenorrhea occurs if a woman misses three or more periods in a row.

### Description

The absence of menstrual periods is a symptom, not a disease. While the average age that menstruation begins is 12, the range varies. The incidence of primary amenorrhea in the United States is just 2.5%.

Some female athletes who participate in rowing, long distance running, and cycling, may notice a few missed periods. Women athletes at a particular risk for developing amenorrhea include ballerinas and gymnasts, who typically **exercise** strenuously and eat poorly.

### Causes and symptoms

Amenorrhea can have many causes. Primary amenorrhea can be the result of hormonal imbalances, psychiatric disorders, **eating disorders**, **malnutrition**, excessive thinness or fatness, rapid weight loss, body fat content too low, and excessive physical conditioning. Intense physical training prior to **puberty** can delay menarche (the onset of menstruation). Every year of training can delay menarche for up to five months. Some medications such as anti-depressants, tranquilizers, **steroids**, and heroin can induce amenorrhea.

### Primary amenorrhea

However, the main cause is a delay in the beginning of puberty either from natural reasons (such as

heredity or poor **nutrition**) or because of a problem in the endocrine system, such as a pituitary tumor or **hypothyroidism**. An obstructed flow tract or inflammation in the uterus may be the presenting indications of an underlying metabolic, endocrine, congenital or gynecological disorder.

Typical causes of primary amenorrhea include:

- excessive physical activity
- drastic weight loss (such as occurs in anorexia or bulimia)
- extreme obesity
- drugs (antidepressants or tranquilizers)
- chronic illness
- Turner's syndrome (a chromosomal problem in place at birth, relevant only in cases of primary amenorrhea)
- the absence of a vagina or a uterus
- imperforate hymen (lack of an opening to allow the menstrual blood through)

### Secondary amenorrhea

Some of the causes of primary amenorrhea can also cause secondary amenorrhea—strenuous physical activity, excessive weight loss, use of antidepressants or tranquilizers, in particular. In adolescents, **pregnancy** and **stress** are two major causes. Missed periods are usually caused in adolescents by stress and changes in environment. Adolescents are especially prone to irregular periods with fevers, weight loss, changes in environment, or increased physical or athletic activity. However, any cessation of periods for four months should be evaluated.

The most common cause of secondary amenorrhea is pregnancy. Also, a woman's periods may halt temporarily after she stops taking birth control pills. This temporary halt usually lasts only for a month or two, though in some cases it can last for a year or more. Secondary amenorrhea may also be related to hormonal problems related to stress, depression,

**anorexia nervosa** or drugs, or it may be caused by any condition affecting the ovaries, such as a tumor. The cessation of menstruation also occurs permanently after **menopause** or a **hysterectomy**.

## Diagnosis

It may be difficult to find the cause of amenorrhea, but the exam should start with a pregnancy test; pregnancy needs to be ruled out whenever a woman's period is two to three weeks overdue. Androgen excess, estrogen deficiency, or other problems with the endocrine system need to be checked. Prolactin in the blood and the thyroid stimulating hormone (TSH) should also be checked.

The diagnosis usually includes a patient history and a physical exam (including a **pelvic exam**). If a woman has missed three or more periods in a row, a physician may recommend blood tests to measure hormone levels, a scan of the skull to rule out the possibility of a pituitary tumor, and ultrasound scans of the abdomen and pelvis to rule out a tumor of the adrenal gland or ovary.

## Treatment

Treatment of amenorrhea depends on the cause. Primary amenorrhea often requires no treatment, but it's always important to discover the cause of the problem in any case. Not all conditions can be treated, but any underlying condition that is treatable should be treated.

If a hormonal imbalance is the problem, progesterone for one to two weeks every month or two may correct the problem. With **polycystic ovary syndrome**, birth control pills are often prescribed. A pituitary tumor is treated with bromocriptine, a drug that reduces certain hormone (prolactin) secretions. Weight loss may bring on a period in an obese woman. Easing up on excessive exercise and eating a proper diet may bring on periods in teen athletes. In very rare cases, surgery may be needed for women with ovarian or uterine cysts.

## Prognosis

Prolonged amenorrhea can lead to **infertility** and other medical problems such as **osteoporosis** (thinning of the bones). If the halt in the normal period is caused by stress or illness, periods should begin again when the stress passes or the illness is treated. Amenorrhea that occurs with discontinuing birth control pills usually go away within six to eight weeks, although it may take up to a year.

The prognosis for polycystic ovary disease depends on the severity of the symptoms and the treatment plan. Spironolactone, a drug that blocks the production of male hormones, can help in reducing body hair. If a woman wishes to become pregnant, treatment with clomiphene may be required or, on rare occasions, surgery on the ovaries.

## Prevention

Primary amenorrhea caused by a congenital condition cannot be prevented. In general, however, women should maintain a healthy diet, with plenty of exercise, rest, and not too much stress, avoiding **smoking** and **substance abuse**. Female athletes should be sure to eat a balanced diet and rest and exercise normally. However, many cases of amenorrhea cannot be prevented.

## ORGANIZATIONS

American College of Obstetricians and Gynecologists (ACOG), PO Box 96920, Washington, DC, 20090-6920, (202) 638-5577, <http://www.acog.org>.

American College of Obstetricians and Gynecologists, PO Box 96920, Washington, DC, 20090-6920, (202) 638-5577, <http://www.acog.org>.

Feminist Women's Health Center, 106 East E Street, Yakima, WA, 98901, (800) 572-4223, <http://www.fwhc.org>.

Carol A. Turkington

Amikacin see **Aminoglycosides**

Amiloride see **Diuretics**

## Amino acid disorders screening

### Definition

Amino acid disorder screening checks for inherited disorders in amino acid metabolism. Tests are most commonly done on newborns. Two tests are available, one using a blood sample and the other a urine sample.

### Purpose

Amino acid disorder screening is done in newborns, and sometimes children and adults, to detect inborn errors in metabolism of amino acids. 20 of the 100 known amino acids are the main building blocks for human proteins. Proteins regulate every aspect of cellular function. Of these 20 amino acids, ten are not

## KEY TERMS

**Amino acid**—An organic compound composed of both an amino group and an acidic carboxyl group; amino acids are the basic building blocks of proteins.

**Aminoaciduria**—The abnormal presence of amino acids in the urine.

**Chromatography**—A family of laboratory techniques that separate mixtures of chemicals into their individual components.

**Enzyme**—A biological catalyst that increases the rate of a chemical reaction without being used up in the reaction.

**Metabolism**—The sum of all the chemical and energy reactions that take place in the human body.

made by the body and must be acquired through diet. Congenital (present at birth) enzyme deficiencies that affect amino acid metabolism or congenital abnormalities in the amino acid transport system of the kidneys creates a condition called aminoaciduria.

Screening is especially important in newborns. Some congenital amino acid metabolic defects cause **mental retardation** that can be prevented with prompt treatment of the newborn. One of the best known examples of this is **phenylketonuria** (PKU). This is a genetic error in metabolism of phenylalanine, an amino acid found in milk. Individuals with PKU do not produce the enzyme necessary to break down phenylalanine.

PKU occurs in about one out of 16,000 live births in the United States, but is more prevalent in Caucasians and less prevalent in Ashkenazi Jews and African Americans. Newborns in the United States are routinely screened for PKU by a blood test.

There are two types of aminoacidurias. Primary or overflow aminoaciduria results from deficiencies in the enzymes necessary to metabolize amino acids. Overflow aminoaciduria is best detected by a blood plasma test.

Secondary or renal aminoaciduria occurs because of a congenital defect in the amino acid transport system in the tubules of the kidneys. This produces increased amino acids in the urine. Blood and urine test in combination are used to determine if the aminoaciduria is of the overflow or renal type. Urine tests are also used to monitor specific amino acid disorders.

Newborns are screened for amino acid disorders. Young children with acidosis (accumulation of acid in the body), severe **vomiting** and **diarrhea**, or urine with an abnormal color or odor, are also screened with a urine test for specific amino acid levels.

## Precautions

Both blood and urine tests are simple tests that can be done in a doctor's office or clinic. These tests can be done on even the youngest patients.

## Description

Two types of amino acid screening tests are used together to diagnose amino acid disorders.

### Blood plasma screening

In the blood test, a medical technician draws a small amount of blood from a baby's heel. The procedure is rapid and relatively painless. Total time for the test is less than ten minutes. The blood is sent to a laboratory where results will be available in about two days.

### Urine test

In the urine test, the patient is asked to urinate into a collecting cup. For an infant, the urine is collected in a pediatric urine collector. The process is painless. The length of time the test takes is determined by how long it takes the patient to urinate. Results also take about two days.

Both these tests use thin layer chromatography to separate the amino acids present. Using this technique, the amino acids form a characteristic patterns on a glass plate coated with a thin layer of silica gel. This pattern is then compared to the normal pattern to determine if there are abnormalities.

## Preparation

Before the blood test, the patient must not eat or drink for four hours. Failure to fast will alter the results of the test.

The patient should eat and drink normally before the urine test. Some drugs may affect the results of the urine test. The technician handling the urine sample should be informed of any medications the patient is taking. Mothers of **breastfeeding** infants should report any medications they are taking, since these can pass from mother to child in breast milk.

## Aftercare

The blood screening is normally done first. Depending on the results, it is followed by the urine test. It takes both tests to distinguish between overflow and renal aminoaciduria. Also, if the results are abnormal, a 24-hour urine test is performed along with other tests to determine the levels of specific amino acids. In the event of abnormal results, there are many other tests that will be performed to determine the specific amino acid involved in the abnormality.

## Risks

There are no particular risks associated with either of these tests. Occasionally minor bruising may occur at the site where the blood was taken.

## Normal results

The pattern of amino acid banding on the thin layer chromatography plates will be normal.

## Abnormal results

The blood plasma amino acid pattern is abnormal in overflow aminoaciduria and is normal in renal aminoaciduria. The pattern is abnormal in the urine test, suggesting additional tests need to be done to determine which amino acids are involved. In addition to PKU, a variety of other amino acid metabolism disorders can be detected by these tests, including tyrosinosis, histidinemia, maple syrup urine disease, hypervaline-mia, hyperprolinemia, and homocystinuria.

## ORGANIZATIONS

Association for Neuro-Metabolic Disorders, 5223 Brookfield Lane, Sylvania, OH, 43560-1809, (419) 885-1809.  
Children's PKU Network (CPN), 3790 Via De La Valle, Ste 120, Del Mar, CA, 92014, (858) 509-0767, (858) 509-0768, (800) 377-6677, pkunetwork@aol.com, <http://www.pkunetwork.org/>.

National Society for Phenylketonuria, PO Box 26642, London, England, N14 4ZF, 440208 364 3010, [info@nspku.org](mailto:info@nspku.org), <http://www.nspku.org/>.

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# Aminoglycosides

## Definition

Aminoglycosides are a group of **antibiotics** that are used alone or in combination with other antibiotics to treat bacterial infections. This group of antibiotics

includes at least eight drugs: amikacin, gentamicin, kanamycin, neomycin, netilmicin, paromomycin, streptomycin, and tobramycin. All of these drugs have the same basic chemical structure.

## Purpose

Aminoglycosides are primarily used to combat infections due to aerobic, Gram-negative bacteria. These bacteria can be identified by their reaction to Gram's stain. In Gram's staining, a film of material containing the possible bacteria is placed on a glass slide and dried. The slide is stained with crystal violet for one minute, cleaned off with water and then placed into a solution of Gram's iodine solution for one minute. The iodine solution is rinsed off and the slide is immersed in 95% ethyl alcohol. The slide is then stained again with reddish carbolfuchsin or safranine for 30 seconds, rinsed in water, dried and examined. Gram-positive bacteria retain the violet purple stain. Gram-negative bacteria accept the red stain. Bacteria that can successfully be combated with aminoglycosides include *Pseudomonas*, *Acinetobacter*, and *Enterobacter* species, among others. Streptomycin is also effective against mycobacteria, the bacteria responsible for **tuberculosis**.

Although the aminoglycosides can be used against certain Gram-positive bacteria, they are not typically employed as a first-line treatment because other antibiotics are more effective with fewer side effects. Aminoglycosides are relatively ineffective against anaerobic bacteria (bacteria that grow in the absence of oxygen) and fungi. Only one aminoglycoside, paromomycin, is used to treat parasitic infection. Like all other antibiotics, aminoglycosides are not effective against **influenza**, the **common cold**, or other viral infections.

## Description

### U.S. brand names

Aminoglycosides are manufactured under many brand names. Some U.S. brand names are as follows:

- tobramycin—AkTob, TOBI, Tobirex
- gentamycin—Gentak, Gentalol
- amikacin—Amikin
- neomycin—NeoFradin, Neo-Rx
- kanamycin—Kantrex

### Canadian brand names

Some Canadian brand names for aminoglycoside drugs include:

## KEY TERMS

**Aerobic bacteria**—Bacteria that require oxygen in order to grow and survive.

**Anaerobic bacteria**—Bacteria that cannot grow or reproduce in the presence of oxygen.

**Eighth cranial nerve disease**—A disorder affecting the eighth cranial nerve, characterized by a loss of hearing and/or balance.

**Gram-negative**—Referring to bacteria that take on a pink color when exposed to Gram's stain.

**Gram-positive**—Referring to bacteria that takes on a purplish-black color when exposed to Gram's stain.

**Gram's stain**—A stain used in microbiology to classify bacteria and help identify the species to which

they belong. This identification aids in determining treatment.

**Kidney (renal) disease**—Any disorder that impairs the kidney's ability to remove waste and toxins from the body.

**Myasthenis gravis**—A neuromuscular disease characterized by muscle weakness in the limbs and face.

**Parkinson's disease**—A neurological disorder caused by deficiency of dopamine, a neurotransmitter, which is a chemical that assists in transmitting messages between the nerves within the brain. It is characterized by muscle tremor or palsy and rigid movements.

- tobramycin—PMS-Tobramycin, Sandoz-Tobramycin, TOBI, Tobrex
- gentamycin—Alomicin, Diogent, Garamycin, Garamycin Injectable
- amikacin—Amikin, Amikacin Sulfate Injectable

Streptomycin, the first aminoglycoside, was isolated from *Streptomyces griseus* in the mid-1940s. This antibiotic proved to be very effective against tuberculosis. One of the main drawbacks to streptomycin is its toxicity, especially to cells in the inner and middle ear and the kidney. Furthermore, some strains of tuberculosis are resistant to treatment with streptomycin. Therefore, medical researchers have put considerable effort into identifying other antibiotics with streptomycin's effectiveness, but without its toxicity.

Aminoglycosides are absorbed very poorly from the gastrointestinal tract; in fact, aminoglycosides taken by mouth are excreted virtually unchanged and undiminished in quantity. The route of drug administration depends on the type and location of the infection being treated. The typical routes of administration are by intramuscular (injection into a muscle) or intravenous injection (injection into a vein), irrigation, topical skin application, or inhalation. If the infection being treated involves the central nervous system, the drug can be injected directly into the fluid of the spinal canal.

The way in which aminoglycosides stop bacterial growth has not been fully explained. It is known that the drug attaches to a bacterial cell wall and is drawn into the cell via channels made up of the protein porin. Once inside the cell, the aminoglycoside attaches to the

cell's ribosomes. Ribosomes are the intracellular structures responsible for manufacturing proteins. This attachment either shuts down protein production or causes the cell to produce abnormal, ineffective proteins. The bacterial cell cannot survive with this impediment.

Antibiotic treatment using aminoglycosides may pair the drug with a second type of antibiotic, usually a beta-lactam or vancomycin, administered separately. Beta-lactams disrupt the integrity of the bacteria cell wall, making it more porous. The increased porosity allows more of the aminoglycoside into the bacteria cell.

### Recommended dosage

Dosage depends on the patient's age, weight, gender, and general health. Since the drug is removed from the body by the kidneys, it is important to assess any underlying problems with kidney function. Kidney function is assessed by measuring the blood levels of creatinine, a protein normally found in the body. If these levels are high, it is an indication that the kidneys may not be functioning at an optimal rate and dosage will be lowered accordingly.

Traditionally, aminoglycosides were administered at even doses given frequently throughout the day. It was thought that a steady concentration of the drug in the blood was necessary to combat infection. However, this administration schedule is time and labor intensive. Furthermore, administering doses 8-12 hours apart can be as effective.

## Precautions

All pre-existing medical conditions, especially **kidney disease, liver disease, eighth cranial nerve disease, myasthenia gravis**, and Parkinson's diseases, should be discussed with the prescribing physician before taking any aminoglycosides.

### Pregnant or breastfeeding

Pregnant women are usually advised against taking aminoglycosides, because it may cause damage to the fetus's hearing, kidneys, or sense of balance. However, those risks need to be considered alongside the threat to the mother's health and life in cases of serious infection. Aminoglycosides do not pass into breast milk to any great extent, so nursing mothers may be prescribed aminoglycosides without harming their infant.

### Pediatric

Children are more likely to experience side effects from aminoglycosides. These medications should only be prescribed when the benefits outweigh the risks.

### Geriatric

The elderly are especially sensitive to the side effects of aminoglycosides. These patients need to pay close attention to any new symptoms and should discuss them with a physician.

## Side effects

Aminoglycosides have been shown to be toxic to certain cells in the ears and in the kidneys. Approximately 5–10% of people who are treated with aminoglycosides experience some side effect impairing their hearing, sense of balance, or kidneys. In most cases the damage is minor and reversible once medication is stopped.

If cells in the inner ear are damaged or destroyed, an individual may experience a loss of balance and feelings of **dizziness**. Damage to the middle ear may result in **hearing loss** or **tinnitus**. Neomycin, kanamycin, and amikacin are the most likely to cause problems with hearing, and streptomycin and gentamicin carry the greatest risk of causing vertigo and loss of balance. Kidney damage, apparent with changes in urination frequency or urine production, is most likely precipitated by neomycin, tobramycin, and gentamicin.

Young children and the elderly are at the greatest risk of experiencing side effects. Excessive dosage or

poor clearance of the drug from the body can be injurious at any age.

Less common side effects include skin **rashes** and **itching**. Very rarely, certain aminoglycosides may cause difficulty in breathing, weakness, or drowsiness. Gentamicin, when injected, may cause leg cramps, skin rash, **fever**, or seizures.

If side effects linger or become worse after medication is stopped, it is advisable to seek medical advice. Side effects that may be of concern include tinnitus or loss of hearing, dizziness or loss of balance, changes in urination frequency or urine production, increased thirst, appetite loss, and **nausea** or **vomiting**.

## Interactions

Individual aminoglycoside drugs can have multiple interactions with other drugs. Patients who are prescribed aminoglycosides should ask their health care provider for a list of interactions specific to the aminoglycoside preparation they are taking.

## Resources

### BOOKS

Fauci, Anthony, et al., eds. *Harrison's Principles of Internal Medicine*, 17th ed. New York, NY: McGraw-Hill, 2008.  
Goldman, Lee, and Dennis Ausiello, eds. *Cecil Textbook of Medicine*, 23rd edition. Philadelphia Saunders Elsevier, 2008.

### OTHER

"Aminoglycosides (Systemic)." *Drugs.com* May 18, 2010. <http://www.drugs.com/cons/aminoglycoside-inhalation-irrigation-parenteral.html> accessed July 22, 2010.  
Levison, Matthew E. "Aminoglycosides." *Merck Manuals Online Medical Library*. July 2009. <http://www.merck.com/mmpc/sec14/ch170/ch170b.html> accessed July 22, 2010.

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**Amitriptyline** see **Antidepressant drugs, tricyclic**

**Amlodipine** see **Calcium channel blockers**

## Amnesia

### Definition

Amnesia refers to the loss of memory. **Memory loss** may result from two-sided (bilateral) damage to parts of the brain vital for memory storage,

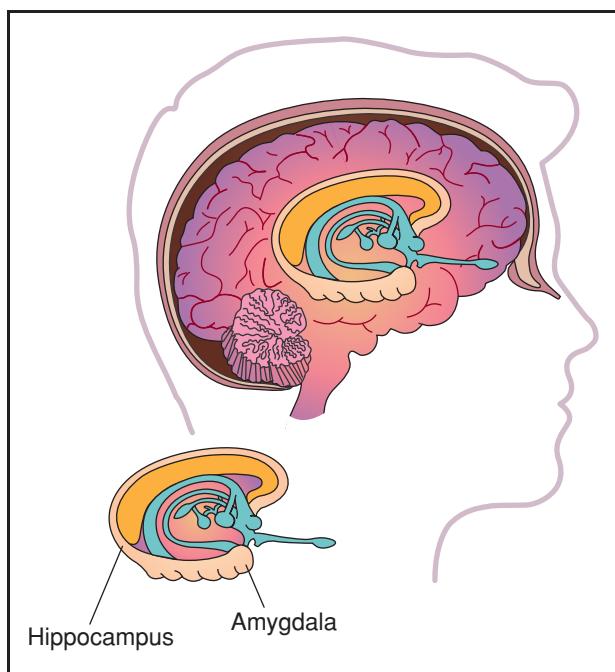
processing, or recall (the limbic system, including the hippocampus in the medial temporal lobe).

## Description

Amnesia can be a symptom of several neurodegenerative diseases; however, people whose primary symptom is memory loss (amnesiacs), typically remain lucid and retain their sense of self. They may even be aware that they suffer from a memory disorder.

People who experience amnesia have been instrumental in helping brain researchers determine how the brain processes memory. Until the early 1970s, researchers viewed memory as a single entity. Memory of new experiences, motor skills, past events, and previous conditioning were grouped together in one system that relied on a specific area of the brain.

If all memory were stored in the same way, it would be reasonable to deduce that damage to the specific brain area would cause complete memory loss. However, studies of amnesiacs counter that theory. Such research demonstrates that the brain has multiple systems for processing, storing, and drawing on memory.



**Memory loss may result from bilateral damage to the limbic system of the brain responsible for memory storage, processing, and recall.** (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

## Causes and symptoms

Amnesia has several root causes. Most are traceable to brain injury related to physical trauma, disease, infection, drug and alcohol abuse, or reduced blood flow to the brain (vascular insufficiency). In Wernicke-Korsakoff syndrome, for example, damage to the memory centers of the brain results from the use of alcohol or malnutrition. Infections that damage brain tissue, including encephalitis and herpes, can also cause amnesia. If the amnesia is thought to be of psychological origin, it is termed psychogenic.

There are at least three general types of amnesia:

- Anterograde. This form of amnesia follows brain trauma and is characterized by the inability to remember new information. Recent experiences and short-term memory disappear, but victims can recall events prior to the trauma with clarity.
- Retrograde. In some ways, this form of amnesia is the opposite of anterograde amnesia: the victim can recall events that occurred after a trauma, but cannot remember previously familiar information or the events preceding the trauma.
- Transient global amnesia. This type of amnesia has no consistently identifiable cause, but researchers have suggested that migraines or transient ischemic attacks may be the trigger. (A transient ischemic attack, sometimes called “a small stroke,” occurs when a blockage in an artery temporarily blocks off blood supply to part of the brain.) A victim experiences sudden confusion and forgetfulness. Attacks can be as brief as 30–60 minutes or can last up to 24 hours. In severe attacks, a person is completely disoriented and may experience retrograde amnesia that extends back several years. While very frightening for the patient, transient global amnesia generally has an excellent prognosis for recovery.

## Diagnosis

In diagnosing amnesia and its cause, doctors look at several factors. During a **physical examination**, the doctor inquires about recent traumas or illnesses, drug and medication history, and checks the patient's general health. Psychological exams may be ordered to determine the extent of amnesia and the memory system affected. The doctor may also order imaging tests such as **magnetic resonance imaging (MRI)** to reveal whether the brain has been damaged, and blood work to exclude treatable metabolic causes or chemical imbalances.

## KEY TERMS

**Classical conditioning**—The memory system that links perceptual information to the proper motor response. For example, Ivan Pavlov conditioned a dog to salivate when a bell was rung.

**Emotional conditioning**—The memory system that links perceptual information to an emotional response. For example, spotting a friend in a crowd causes a person to feel happy.

**Explicit memory**—Conscious recall of facts and events that is classified into episodic memory (involves time and place) and semantic memory (does not involve time and place). For example, an amnesiac may remember he has a wife (semantic memory), but cannot recall his last conversation with her (episodic memory).

**Limbic system**—The brain structures involved in memory.

**Magnetic resonance imaging (MRI)**—MRI uses a large circular magnet and radio waves to

generate signals from atoms in the body. These signals are used to construct images of internal structures.

**Motor skill learning**—This memory system is associated with physical movement and activity. For example, learning to swim is initially difficult, but once an efficient stroke is learned, it requires little conscious effort.

**Neurodegenerative disease**—A disease in which the nervous system progressively and irreversibly deteriorates.

**Priming memory**—The memory system that joins perceptual and conceptual representations.

**Transient ischemic attack**—A sudden and brief blockage of blood flow in the brain.

**Working memory**—The memory system that relates to the task at hand and coordinates recall of memories necessary to complete it.

### Treatment

Treatment depends on the root cause of amnesia and is handled on an individual basis. Regardless of cause, cognitive **rehabilitation** may be helpful in learning strategies to cope with memory impairment.

### Prognosis

Some types of amnesia, such as transient global amnesia, are completely resolved and there is no permanent loss of memory. Others, such as Korsakoff syndrome, associated with prolonged alcohol abuse or amnesias caused by severe brain injury, may be permanent. Depending on the degree of amnesia and its cause, victims may be able to lead relatively normal lives. Amnesiacs can learn through therapy to rely on other memory systems to compensate for what is lost.

### Prevention

Amnesia is only preventable in so far as brain injury can be prevented or minimized. Common sense approaches include wearing a helmet when bicycling or participating in potentially dangerous sports, using automobile seat belts, and avoiding excessive alcohol or drug use. Brain infections should be treated swiftly and aggressively to minimize the damage due to swelling. Victims of strokes, brain aneurysms, and

transient ischemic attacks should seek immediate medical treatment.

### Resources

#### PERIODICALS

Squire, Larry R., and Stuart M. Zola. "Amnesia, Memory and Brain Systems." *Philosophical Transactions of the Royal Society of London, Series B* 352 (1997): 1663.

Julia Barrett

## Amniocentesis

### Definition

Amniocentesis is a procedure used to diagnose fetal defects in the early second trimester of **pregnancy**. A sample of the amniotic fluid, which surrounds a fetus in the womb, is collected through a pregnant woman's abdomen using a needle and syringe. Tests performed on fetal cells found in the amniotic fluid can reveal the presence of many types of genetic disorders as well as the sex of the fetus. Early diagnosis allows doctors and prospective parents to make important decisions about treatment and intervention prior to birth.



A physician uses an ultrasound monitor (left) to position the needle for insertion into the amnion when performing amniocentesis. (Will & Deni McIntyre/Photo Researchers, Inc.)

## Purpose

Since the mid-1970s, amniocentesis has been used routinely to test for **Down syndrome**, by far the most common, nonhereditary, genetic birth defect, afflicting about one in every 1,000 babies. More than 800 different diagnostic tests are available, most of them for hereditary genetic disorders such as **Tay-Sachs disease**, **sickle cell disease**, **hemophilia**, **muscular dystrophy**, and **cystic fibrosis**. Amniocentesis also can be used to assess lung development in the fetus, detect Rh disease, and detect neural tube defects such as **spina bifida**. Although the test is not used for this purpose, the sex of the baby can be determined.

## Description

Amniocentesis, often called amnio, is recommended for women who will be older than 35 on their due date. It is also recommended for women who have already borne children with **birth defects**, or when either of the parents has a family history of a birth defect for which a diagnostic test

is available. Another reason for the procedure is to confirm indications of Down syndrome and certain other defects (e.g., neural tube defects) that may have shown up previously during routine maternal blood screening.

The risk of bearing a child with a nonhereditary genetic defect such as Down syndrome is directly related to a woman's age—the older the woman, the greater the risk. Thirty-five is the recommended age to begin amniocentesis testing because that is the age at which the risk of carrying a fetus with such a defect roughly equals the risk of **miscarriage** caused by the procedure, which is about one in 200. At age 25, the risk of giving birth to a child with this type of defect is about one in 1,400; by age 45, it increases to about one in 20. All pregnant women over 35 in the United States are encouraged to undergo amniocentesis, and many younger women also decide to have the procedure. Notably, some 75% of all Down syndrome infants born in the United States each year are to women younger than 35. In January 2007, the American College of Obstetricians and Gynecologists issued a

## KEY TERMS

**Alpha-fetoprotein (AFP)**—A protein normally produced by the liver of a fetus and detectable in maternal blood samples. AFP screening measures the amount of alpha-fetoprotein in the blood. Levels outside the norm may indicate fetal defects.

**Chorionic villus sampling (CVS)**—A procedure similar to amniocentesis, except that cells are taken from the chorionic membrane for testing. These cells, called chorionic villus cells, eventually become the placenta. The samples are collected either through the abdomen, as in amniocentesis, or through the vagina. CVS can be done earlier in the pregnancy than amniocentesis, but carries a somewhat higher risk.

**Chromosomes**—Chromosomes are the strands of genetic material in a cell that occur in nearly identical pairs. Normal human cells contain 23 chromosome pairs—one in each pair inherited from the mother, and one from the father.

**Down syndrome**—The most prevalent of a class of genetic defects known as trisomies, in which cells contain three copies of certain chromosomes rather than the usual two. Down syndrome, or trisomy 21, usually results from three copies of chromosome 21.

**Hereditary**—Something that is inherited or passed down from parents to offspring. In biology and medicine, the word pertains to inherited genetic characteristics.

**Maternal blood screening**—Maternal blood screening is normally done early in pregnancy to test for a variety of conditions. Abnormal amounts of certain proteins in a pregnant woman's blood raise the probability of fetal defects. Amniocentesis is recommended if such a probability occurs.

**Rh disease**—The Rh factor is a genetically determined antigen on red blood cells that produce immune responses. If an Rh-negative woman is pregnant with an Rh-positive fetus, her body will produce antibodies against the fetus's blood, causing a disease known as Rh disease. Sensitization to the disease occurs when the women's blood is exposed to the fetus's blood. Rh immune globulin (RhoGAM) is a vaccine that must be given to a woman after an abortion, miscarriage, or prenatal tests in order to prevent sensitization to Rh disease.

**Tay-Sachs disease**—An inherited disease prevalent among the Ashkenazi Jewish population of the United States. Infants with the disease are unable to process a certain type of fat that accumulates in nerve and brain cells, causing mental and physical retardation, and death by age four.

**Ultrasound**—A technique that uses high-frequency sound waves to create a visual image (a sonogram) of soft tissues. The technique is routinely used in prenatal care and diagnosis.

recommendation that all pregnant patients be offered the option of amniocentesis testing, regardless of maternal age.

One of the most common reasons for performing amniocentesis is an abnormal alpha-fetoprotein (AFP) test. Alpha-fetoprotein is a protein produced by the fetus and present in the mother's blood. A simple blood screening, usually conducted around the fifteenth week of pregnancy, can determine the AFP levels in the mother's blood. Levels that are too high or too low may signal possible fetal defects. Because this test has a high false-positive rate, another test such as amniocentesis is recommended whenever the AFP levels fall outside the normal range.

Amniocentesis is generally performed during the sixteenth week of pregnancy, with results usually available within three weeks. It is possible to

perform amniocentesis as early as the eleventh week, but this is not usually recommended because there appears to be an increased risk of miscarriage when done at this time. The advantage of early amniocentesis and speedy results lies in the extra time for decision making if a problem is detected. Potential treatment of the fetus can begin earlier. Important, also, is the fact that elective abortions are safer and less controversial the earlier they are performed.

### Precautions

As an invasive surgical procedure, amniocentesis poses a real, although small, risk to the health of a fetus. Parents must weigh the potential value of the knowledge gained, or indeed the reassurance that all is well, against the small risk of miscarriage. The serious emotional and ethical dilemmas that adverse test

results can bring must also be considered. The decision to undergo amniocentesis is always a matter of personal choice.

## Description

The word amniocentesis literally means “puncture of the amnion,” the thin-walled sac of fluid in which a developing fetus is suspended during pregnancy. During the procedure, the obstetrician inserts a very fine needle through the woman’s abdomen into the uterus and the amniotic sac and withdraws approximately 1 oz (28.3 g) of amniotic fluid for testing. The relatively painless procedure is performed on an outpatient basis, sometimes using **local anesthesia**.

The physician uses ultrasound images to guide needle placement and collect the sample, thereby minimizing the risk of fetal injury and the need for repeated needle insertions. Once the sample is collected, the woman can return home after a brief observation period. She may be instructed to rest for the first 24 hours and to avoid heavy lifting for two days.

The sample of amniotic fluid is sent to a laboratory where fetal cells contained in the fluid are isolated and grown in order to provide enough genetic material for testing. This takes about seven to 14 days. The material is then extracted and treated so that visual examination for defects can be made. For some disorders, like Tay-Sachs, the simple presence of a telltale chemical compound in the amniotic fluid is enough to confirm a diagnosis. Depending on the specific tests ordered, and the skill of the lab conducting them, all the results are available one to four weeks after the sample is taken.

Cost of the procedure depends on the doctor, the lab, and the tests ordered. Most insurers provide coverage for women over 35, as a follow-up to positive maternal blood screening results, and when genetic disorders run in the family.

An alternative to amniocentesis now in general use, is **chorionic villus sampling** (CVS), which can be performed as early as the eighth week of pregnancy. While this allows for the possibility of a first-trimester abortion, if warranted, CVS is apparently also riskier and is more expensive. The most promising area of new research in prenatal testing involves expanding the scope and accuracy of maternal blood screening as this poses no risk to the fetus.

## Preparation

It is important for a woman to fully understand the procedure and to feel confident in the obstetrician

performing it. Evidence suggests that a physician’s experience with the procedure reduces the chance of mishap. Almost all obstetricians are experienced in performing amniocentesis. The patient should feel free to ask questions and seek emotional support before, during, and after amniocentesis is performed.

## Aftercare

Necessary aftercare falls into two categories: physical and emotional.

### *Physical aftercare*

During and immediately following the sampling procedure, a woman may experience **dizziness, nausea**, a rapid heartbeat, and cramping. Once past these immediate hurdles, the physician will send the woman home with instructions to rest and to report any complications requiring immediate treatment, including:

- Vaginal bleeding. The appearance of blood could signal a problem
- Premature labor. Unusual abdominal pain and/or cramping may indicate the onset of premature labor. Mild cramping for the first day or two following the procedure is normal
- Signs of infection. Leaking of amniotic fluid or unusual vaginal discharge, and fever could signal the onset of infection

### *Emotional aftercare*

Once the procedure has been safely completed, the **anxiety** of waiting for the test results can prove to be the worst part of the process. A woman should seek and receive emotional support from family and friends, as well as from her obstetrician and family doctor. Professional counseling may also prove necessary, particularly if a fetal defect is detected.

## Risks

Most of the risks and short-term side effects associated with amniocentesis relate to the sampling procedure. A successful amniocentesis sampling results in no long-term side effects. Risks include:

- Maternal/fetal hemorrhaging. While spotting in pregnancy is fairly common, bleeding following amniocentesis should always be investigated.
- Infection. Infection, although rare, can occur after amniocentesis. An unchecked infection can lead to severe complications.
- Fetal injury. A very slight risk of injury to the fetus resulting from contact with the amniocentesis needle does exist.

- Miscarriage. The rate of miscarriage occurring during standard, second-trimester amniocentesis is approximately 0.5%. This compares to a miscarriage rate of 1% for CVS. Many fetuses with severe genetic defects miscarry naturally during the first trimester.
- The trauma of difficult family-planning decisions. The threat posed to parental and family mental health from the trauma accompanying an abnormal test result can not be underestimated.

### Normal results

Negative results from an amniocentesis analysis indicate that everything about the fetus appears normal and the pregnancy can continue without undue concern. A negative result for Down syndrome means that it is 99% certain that the disease does not exist.

An overall “normal” result does not, however, guarantee that the pregnancy will come to term, or that the fetus does not suffer from some other defect. Laboratory tests are not 100% accurate at detecting targeted conditions, nor can is there a test for every possible fetal condition.

### Abnormal results

Positive results on an amniocentesis analysis indicate the presence of a fetal defect, with an accuracy approaching 100%. With such a diagnosis, prospective parents face emotionally and ethically difficult choices regarding prenatal treatment options, the prospect of treating the defect at birth, and the option of elective abortion. At this point, the parents need expert medical advice and counseling.

### Resources

#### OTHER

Pre-Conception: Genetic Testing for Inherited Diseases.

LabTests Online June 17, 2008. [http://labtestsonline.org/understanding/wellness/pre\\_genetic.html](http://labtestsonline.org/understanding/wellness/pre_genetic.html)

Prenatal Testing. MedlinePlus December 22, 2009. <http://www.nlm.nih.gov/medlineplus/prenataltesting.html>

Routine Tests in Pregnancy. American Congress of Obstetricians and Gynecologists. January 2009. [http://www.acog.org/publications/patient\\_education/bp133.cfm](http://www.acog.org/publications/patient_education/bp133.cfm)

#### ORGANIZATIONS

American College of Obstetricians and Gynecologists, P.O. Box 96920, Washington, DC, 20090-6920 (202) 638-5577, <http://www.acog.org>.

American Pregnancy Association, 431 Greenway Drive, Suite 800, Irving, TX, 75038 (972) 550-0140 (972) 550-0800, [Questions@AmericanPregnancy.org](mailto:Questions@AmericanPregnancy.org), <http://www.americanpregnancy.org>.

March of Dimes Foundation, 1275 Mamaroneck Avenue, White Plains, NY, 10605 (914)997-4488, [askus@marchofdimes.com](mailto:askus@marchofdimes.com), <http://www.marchofdimes.com>. National Society of Genetic Counselors, 401 N. Michigan Avenue, Chicago, IL, 60611 (312) 321-6834 (312) 673-6972, [nsgc@nsgc.org](mailto:nsgc@nsgc.org), <http://www.nsgc.org>.

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Amniotic fluid analysis see **Amniocentesis**

Amoxicillin see **Penicillins**

Amphetamines see **Central nervous system stimulants**

Amphotericin B see **Antifungal drugs, systemic**

## Amputation

### Definition

Amputation is the intentional surgical removal of a limb or body part. It is performed to remove diseased tissue or relieve pain.

### Purpose

Arms, legs, hands, feet, fingers, and toes can be amputated. Most amputations involve small body parts such as a finger, rather than an entire limb. About 65,000 amputations are performed in the United States each year.

Amputation is performed for the following reasons:

- to remove tissue that no longer has an adequate blood supply
- to remove malignant tumors
- because of severe trauma to the body part

The blood supply to an extremity can be cut off because of injury to the blood vessel, hardening of the arteries, **arterial embolism**, impaired circulation as a complication of **diabetes mellitus**, repeated severe infection that leads to **gangrene**, severe **frostbite**, **Raynaud's disease**, or **Buerger's disease**.

More than 90% of amputations performed in the United States are due to circulatory complications of diabetes. Sixty to eighty percent of these operations involve the legs or feet. Although attempts have been

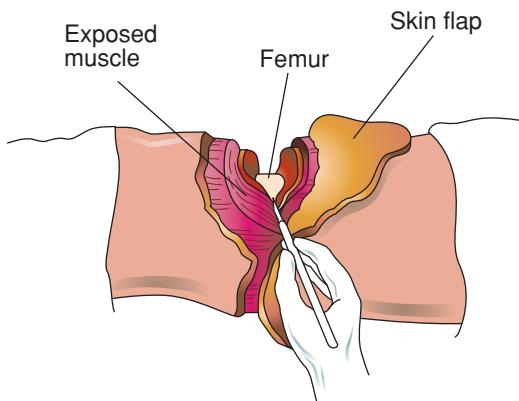


Figure A

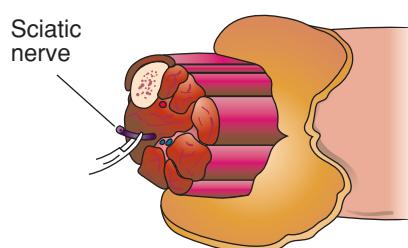


Figure B

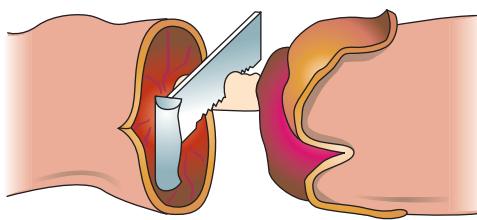


Figure C

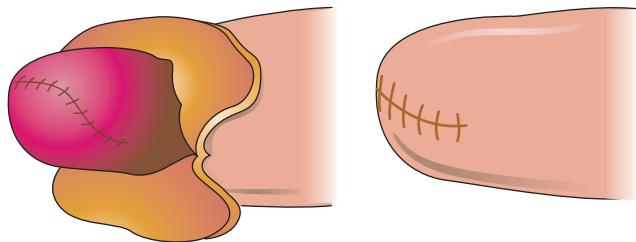


Figure D

**Amputation of leg.** Figure A: After the surgeon creates two flaps of skin and tissue, the muscle is cut and the main artery and veins of the femur bone are exposed. Figure B: The surgeon severs the main artery and veins. New connections are formed between them, restoring blood circulation. The sciatic nerve is then pulled down, clamped and tied, and severed. Figure C: The surgeon saws through the exposed femur bone. Figure D: The muscles are closed and sutured over the bone. The remaining skin flaps are then sutured together, creating a stump. (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

made in the United States to better manage diabetes and the foot ulcers that can be complications of the disease, the number of resulting amputations has not decreased.

### Precautions

Amputations cannot be performed on patients with uncontrolled diabetes mellitus, **heart failure**, or infection. Patients with blood clotting disorders are also not good candidates for amputation.

### Description

Amputations can be either planned or emergency procedures. Injury and arterial embolisms are the main reasons for emergency amputations. The operation is performed under regional or **general anesthesia** by a general or orthopedic surgeon in a hospital operating room.

Details of the operation vary slightly depending on what part is to be removed. The goal of all amputations is twofold: to remove diseased tissue so that the wound will heal cleanly, and to construct a stump that will allow the attachment of a prosthesis or artificial replacement part.

The surgeon makes an incision around the part to be amputated. The part is removed, and the bone is smoothed. A flap is constructed of muscle, connective tissue, and skin to cover the raw end of the bone. The flap is closed over the bone with sutures (surgical stitches) that remain in place for about one month. Often, a rigid dressing or cast is applied that stays in place for about two weeks.

### Preparation

Before an amputation is performed, extensive testing is done to determine the proper level of amputation. The goal of the surgeon is to find the place

## KEY TERMS

**Arterial embolism**—A blood clot arising from another location that blocks an artery.

**Buerger's disease**—An episodic disease that causes inflammation and blockage of the veins and arteries of the limbs. It tends to be present almost exclusively on men under age 40 who smoke, and may require amputation of the hand or foot.

**Diabetes mellitus**—A disease in which insufficient insulin is made by the body to metabolize sugars.

**Raynaud's disease**—A disease found mainly in young women that causes decreased circulation to the hands and feet. Its cause is unknown.

where healing is most likely to be complete, while allowing the maximum amount of limb to remain for effective **rehabilitation**.

The greater the blood flow through an area, the more likely healing is to occur. These tests are designed to measure blood flow through the limb. Several or all of them can be done to help choose the proper level of amputation.

- measurement of blood pressure in different parts of the limb
- xenon 133 studies, which use a radiopharmaceutical to measure blood flow
- oxygen tension measurements in which an oxygen electrode is used to measure oxygen pressure under the skin. If the pressure is 0, the healing will not occur. If the pressure reads higher than 40 mm Hg (40 millimeters of mercury), healing of the area is likely to be satisfactory.
- laser Doppler measurements of the microcirculation of the skin
- skin fluorescent studies that also measure skin microcirculation
- skin perfusion measurements using a blood pressure cuff and photoelectric detector
- infrared measurements of skin temperature

No single test is highly predictive of healing, but taken together, the results give the surgeon an excellent idea of the best place to amputate.

### Aftercare

After amputation, medication is prescribed for pain, and patients are treated with **antibiotics** to discourage infection. The stump is moved often to encourage good circulation. **Physical therapy** and

rehabilitation are started as soon as possible, usually within 48 hours. Studies have shown that there is a positive relationship between early rehabilitation and effective functioning of the stump and prosthesis. Length of stay in the hospital depends on the severity of the amputation and the general health of the amputee, but ranges from several days to two weeks.

Rehabilitation is a long, arduous process, especially for above the knee amputees. Twice daily physical therapy is not uncommon. In addition, psychological counseling is an important part of rehabilitation. Many people feel a sense of loss and grief when they lose a body part. Others are bothered by phantom limb syndrome, where they feel as if the amputated part is still in place. They may even feel pain in the limb that does not exist. Many amputees benefit from joining self-help groups and meeting others who are also living with amputation. Addressing the emotional aspects of amputation often speeds the physical rehabilitation process.

### Risks

Amputation is major surgery. All the risks associated with the administration of anesthesia exist, along with the possibility of heavy blood loss and the development of **blood clots**. Infection is of special concern to amputees. Infection rates in amputations average 15%. If the stump becomes infected, it is necessary to remove the prosthesis and sometimes to amputate a second time at a higher level.

Failure of the stump to heal is another major complication. Nonhealing is usually due to an inadequate blood supply. The rate of nonhealing varies from 5–30% depending on the facility. Centers that specialize in amputation usually have the lowest rates of complication.

Persistent pain in the stump or pain in the phantom limb is experienced by most amputees to some degree. Treatment of phantom limb pain is difficult. Finally, many amputees give up on the rehabilitation process and discard their prosthesis. Better fitting prosthetics and earlier rehabilitation have decreased the incidence of this problem. Researchers and prosthetic manufacturers continue to refine the materials and methods used to try to improve the comfort and function of prosthetic devices for amputees. For example, a 2004 study showed that a technique called the bone bridge amputation technique helped improve comfort and stability for transtibial amputees.

## Normal results

The five-year survival rate for all lower extremity amputees is less than 50%. For diabetic amputees, the rate is less than 40%. Up to 50% of people who have one leg amputated because of diabetes will lose the other within five years. Amputees who walk using a prosthesis have a less stable gait. Three to five percent of these people fall and break bones because of this instability. Although the **fractures** can be treated, about one-half of amputees who suffer them then remain wheelchair bound.

## Resources

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- Edwards, Anthony R. "Study Helps Build Functional Bridges for Amputee Patients." *Biomechanics* (May 1, 2004): 17.
- Jeffcoat, William. "Incidence of Amputation is a Poor Measure of the Quality of Ulcer Care." *The Diabetic Foot* Summer (2004): 70–74.

### OTHER

- Amputation Prevention Global Resource Center Page.  
<http://www.diabetesresource.com>.

### ORGANIZATIONS

- American Diabetes Association, 1701 North Beauregard Street, Alexandria, VA, 22311, (800) 342-2383, Ask ADA@diabetes.org, <http://www.diabetes.org/>.

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## Amylase tests

### Definition

Amylase is a digestive enzyme made primarily by the pancreas and salivary glands. Enzymes are substances made and used by the body to trigger specific chemical reactions. The primary function of the enzyme amylase is to break down starches in food so that they can be used by the body. Amylase testing is usually done to determine the cause of sudden abdominal pain.

### Purpose

Amylase testing is performed to diagnose a number of diseases that elevate amylase levels. **Pancreatitis**, for example, is the most common reason for a high amylase level. When the pancreas is inflamed, amylase escapes from the pancreas into the blood. Within six to

## KEY TERMS

**Amylase**—A digestive enzyme made primarily by the pancreas and salivary glands.

**Enzyme**—A substance made and used by the body to trigger specific chemical reactions.

**Pancreatitis**—Inflammation of the pancreas.

48 hours after the pain begins, amylase levels in the blood start to rise. Levels will stay high for several days before gradually returning to normal.

There are other causes of increased amylase. An ulcer that erodes tissue from the stomach and goes into the pancreas will cause amylase to spill into the blood. During a **mumps** infection, amylase from the inflamed salivary glands increases. Amylase is also found in the liver, fallopian tubes, and small intestine; inflammation of these tissues also increases levels. Gall bladder disease, tumors of the lung or ovaries, alcohol **poisoning**, ruptured **aortic aneurysm**, and intestinal strangulation or perforation can also cause unusually high amylase levels.

### Precautions

This is not a screening test for future pancreatic disease.

### Description

Amylase testing is done on both blood and urine. The laboratory may use any of several testing methods that involve mixing the blood or urine sample with a substance with which amylase is known to react. By measuring the end-product or the reaction time, technicians can calculate the amount of amylase present in the sample. More sophisticated methods separately measure the amylase made by the pancreas and the amylase made by the salivary glands.

Urine testing is a better long-term monitor of amylase levels. The kidneys quickly move extra amylase from the blood into the urine. Urine levels rise six to 10 hours after blood levels and stay high longer. Urine is usually collected throughout a 2- or 24-hour time period. Results are usually available the same day.

### Preparation

In most cases, no special preparation is necessary for a person undergoing an amylase blood test. Patients taking longer term urine amylase tests will

be given a container and instructions for collecting the urine at home. The urine should be refrigerated until it is brought to the laboratory.

### Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Applying warm packs to the puncture site relieves discomfort.

### Normal results

Normal results vary based on the laboratory and the method used.

### Abnormal results

Eight out of ten persons with acute pancreatitis will have high amylase levels, up to four times the normal level. Other causes of increased amylase, such as mumps, kidney failure, **pregnancy** occurring in the abdomen but outside the uterus (**ectopic pregnancy**), certain tumors, a penetrating ulcer, certain complications of diabetes, and advanced pancreatic **cancer**, are further investigated based on the person's symptoms, medical history, and the results of other tests.

In **kidney disease**, the kidneys are not as efficient at removing amylase from the blood. Amylase rises in the blood, but stays at normal levels in the urine.

People with macroamylasias have large clumps of amylase in their blood. These clumps are too large to move through the kidney, so they stay in the blood. Amylase levels in the blood will be high; levels in the urine will be low.

Amylase levels may be low in severe **liver disease** (including hepatitis), conditions in which the pancreas fails to secrete enough enzyme for proper digestions (pancreatic insufficiency), when toxic materials build up in the blood during pregnancy (pre-eclampsia), following **burns**, in thyroid disorders, and in advanced **cystic fibrosis**. Some medications can raise or lower levels.

### Resources

#### BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Nancy J. Nordenson

## Amyloidosis

### Definition

Amyloidosis is a progressive, incurable, metabolic disease characterized by abnormal deposits of protein in one or more organs or body systems.

### Demographics

Amyloidosis is a rare disease, occurring in about eight of every one million people. It affects males and females equally and usually develops after the age of 40.

### Description

Amyloid proteins are manufactured by malfunctioning bone marrow. Amyloidosis, which occurs when accumulated amyloid deposits impair normal body function, can cause organ failure or **death**. At least 15 types of amyloidosis have been identified. Each one is associated with deposits of a different kind of protein.

#### *Types of amyloidosis*

The major forms of this disease are primary systemic, secondary, and familial or hereditary amyloidosis. Another form of amyloidosis is associated with **Alzheimer's disease**.

Primary systemic amyloidosis usually develops between the ages of 50 and 60. With about 2,000 new cases diagnosed annually, primary systemic amyloidosis is the most common form of this disease in the United States. Also known as light-chain-related amyloidosis, it may also occur in association with **multiple myeloma** (bone marrow **cancer**).

Secondary amyloidosis is a result of chronic infection or inflammatory disease. It is often associated with:

- familial Mediterranean fever (a bacterial infection characterized by chills, weakness, headache, and recurring fever)
- granulomatous ileitis (inflammation of the small intestine)
- Hodgkin's disease (cancer of the lymphatic system)
- leprosy
- osteomyelitis (bacterial infection of bone and bone marrow)
- rheumatoid arthritis

Familial or hereditary amyloidosis is the only inherited form of the disease. It occurs in members of

## KEY TERMS

**Amyloid**—A waxy, starch-like protein.

**Peripheral nerves**—Nerves that carry information to and from the spinal cord.

**Stem cells**—Parent cells from which other cells are made.

most ethnic groups, and each family has a distinctive pattern of symptoms and organ involvement. Hereditary amyloidosis is thought to be autosomal dominant, which means that only one copy of the defective gene is necessary to cause the disease. A child of a parent with familial amyloidosis has a 50–50 chance of developing the disease.

Amyloidosis can involve any organ or system in the body. The heart, kidneys, gastrointestinal system, and nervous system are affected most often. Other common sites of amyloid accumulation include the brain, joints, liver, spleen, pancreas, respiratory system, and skin.

### Causes and symptoms

The cause of amyloidosis is unknown. Most patients have gastrointestinal abnormalities, but other symptoms vary according to the organ(s) or system(s) affected by the disease. The affected organs are rubbery, firm, and enlarged.

#### Heart

Because amyloid protein deposits can limit the heart's ability to fill with blood between beats, even the slightest exertion can cause **shortness of breath**. If the heart's electrical system is affected, the heart's rhythm may become erratic. The heart may also be enlarged and **heart murmurs** may be present. Congestive **heart failure** may result.

#### Kidneys

The feet, ankles, and calves swell when amyloidosis damages the kidneys. The kidneys become small and hard, and kidney failure may result. It is not unusual for a patient to lose 20–25 lb (9–11 kg) and develop a distaste for meat, eggs, and other protein-rich foods. Cholesterol elevations that do not respond to medication and protein in the urine (proteinuria) are common.

### Nervous system

Nervous system symptoms often appear in patients with familial amyloidosis. Inflammation and degeneration of the peripheral nerves (**peripheral neuropathy**) may be present. One in four patients with amyloidosis has **carpal tunnel syndrome**, a painful disorder that causes **numbness** or **tingling** in response to pressure on nerves around the wrist. Amyloidosis that affects nerves to the feet can cause burning or numbness in the toes and soles and eventually weaken the legs. If nerves controlling bowel function are involved, bouts of **diarrhea** alternate with periods of **constipation**. If the disease affects nerves that regulate blood pressure, patients may feel dizzy or faint when they stand up suddenly.

### Liver and spleen

The most common symptoms are enlargement of the liver and spleen. Liver function is not usually affected until quite late in the course of the disease. Protein accumulation in the spleen can increase the risk of rupture of this organ due to trauma.

### Gastrointestinal system

When amyloidosis affects the gastrointestinal system, there may be bleeding, abdominal **pain**, constipation, and diarrhea. Intestinal movement (motility) may be reduced, and absorption of food and other nutrients may be impaired (leading to **malnutrition**). The tongue may become inflamed, enlarged, and stiff.

### Skin

Skin symptoms occur in about half of all cases of primary and secondary amyloidosis and in all cases where there is inflammation or degeneration of the peripheral nerves. Waxy-looking raised bumps (papules) appear on the face and neck, in the groin, armpits, or anal area, and on the tongue or in the ear canals. Swelling, hemorrhage beneath the skin (purpura), hair loss, and **dry mouth** may occur.

### Respiratory system

Airways may be obstructed by amyloid deposits in the nasal sinus, larynx and trachea (windpipe).

### Diagnosis

Blood and urine tests can reveal the presence of amyloid protein, but tissue or bone-marrow biopsy is necessary to positively diagnose amyloidosis. Once the diagnosis has been confirmed, additional laboratory

tests and imaging procedures are performed to determine:

- which type of amyloid protein is involved
- which organ(s) or system(s) have been affected
- how far the disease has progressed

## Treatment

### Traditional

The goal of treatment is to slow down or stop production of amyloid protein, eliminate existing amyloid deposits, alleviate underlying disorders (that give rise to secondary amyloidosis), and relieve symptoms caused by heart or kidney damage. Specialists in cardiology, hematology (the study of blood and the tissues that form it), nephrology (the study of kidney function and abnormalities), neurology (the study of the nervous system), and rheumatology (the study of disorders characterized by inflammation or degeneration of connective tissue) work together to assess a patient's medical status and evaluate the effects of amyloidosis on every part of the body.

### Drugs

Colchicine (Colebenemid, Probeneaid), prednisone, (Prednisolone), and other anti-inflammatory drugs can slow or stop disease progression. Bone-marrow and stem-cell transplants can enable patients to tolerate higher and more effective doses of melphalan (Alkeran) and other **chemotherapy** drugs prescribed to combat this non-malignant disease.

Surgery can relieve nerve pressure and may be performed to correct other symptom-producing conditions. Localized amyloid deposits can also be removed surgically. Dialysis or **kidney transplantation** can lengthen and improve the quality of life for patients whose amyloidosis results in kidney failure. Heart transplants are rarely performed.

### Home remedies

Although no link has been established between diet and development of amyloid proteins, a patient whose heart or kidneys have been affected by the disease may be advised to use a diuretic or follow a low-salt diet.

## Prognosis

Most cases of amyloidosis are diagnosed after the disease has reached an advanced stage. The course of each patient's illness is unique, but death resulting from heart disease or kidney failure generally occurs within a few years. Amyloidosis associated by multiple

myeloma usually has a poor prognosis. Most patients with both diseases die within one to two years.

## Prevention

**Genetic counseling** may be helpful for patients with hereditary amyloidosis and their families. Use of Cholchicine in patients with **familial Mediterranean fever** has successfully prevented amyloidosis.

## Resources

### BOOKS

Bashey, Asad, and Rafat Abonour. *100 Questions and Answers About Myeloma*. 2nd ed. Sudbury, MA: Jones & Bartlett Publishers, 2008.

### ORGANIZATIONS

Amyloidosis Foundation, 7151 N. Main St., Suite 2, Clarkston, MI, 48346, <http://www.amyloidosis.org>.

Amyloidosis Network International, 7118 Cole Creek Drive, Houston, TX, 77092-1421 (888) 269-5643.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923 (800) 999-6673, <http://www.rarediseases.org>.

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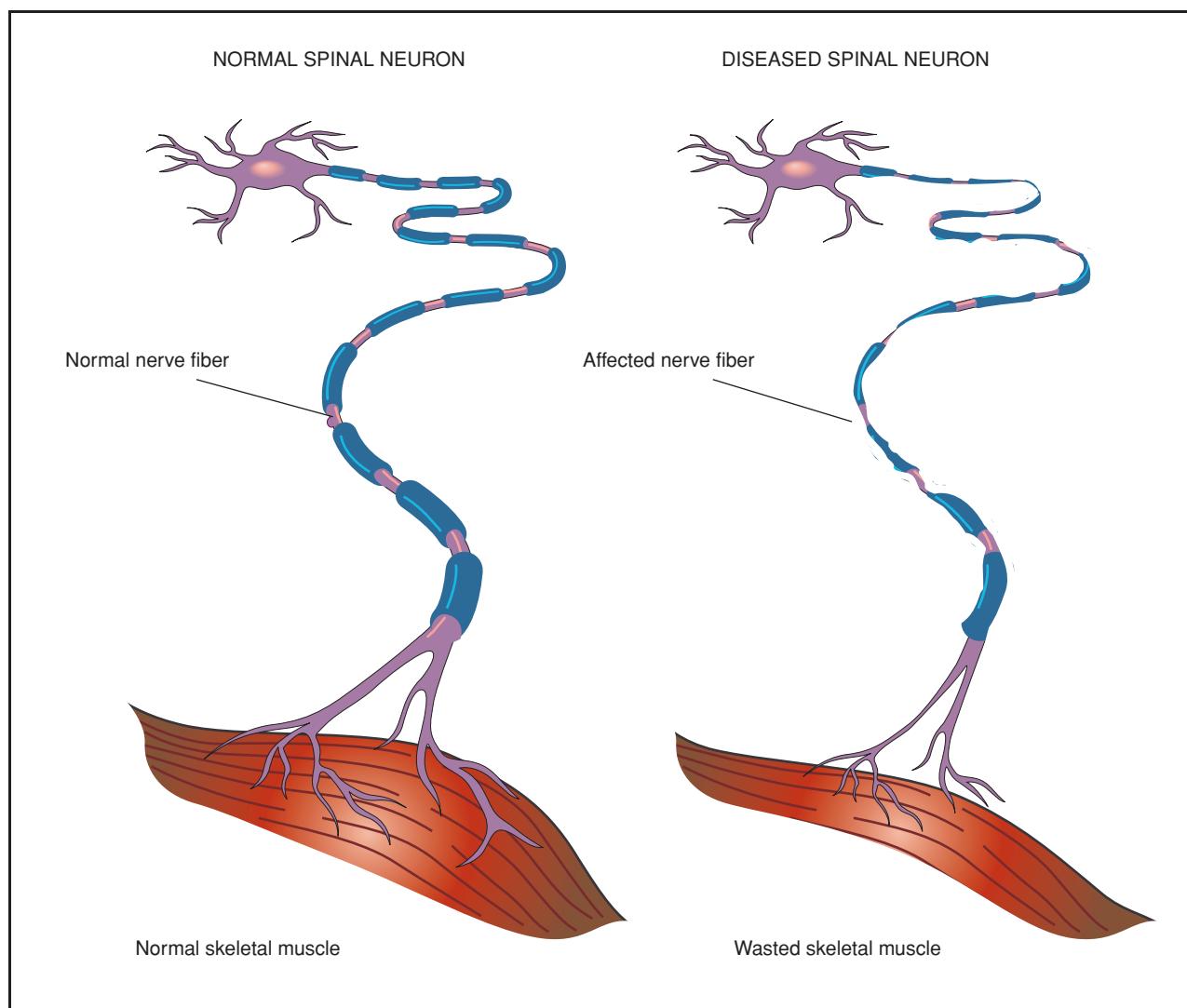
## Amyotrophic lateral sclerosis

### Definition

Amyotrophic lateral sclerosis (ALS) is a disease that breaks down tissues in the nervous system (a neurodegenerative disease) of unknown cause that affects the nerves responsible for movement. It is also known as motor neuron disease and Lou Gehrig's disease, after the baseball player whose career it ended.

## Demographics

According to the National Institute for Neurological Disorders and **Stroke**, an estimated 20,000 Americans had ALS as of 2009, with some 5,000 people diagnosed with the disease each year. Worldwide, ALS is considered one of the most common neuromuscular diseases, affecting people of all races equally. Onset of ALS most commonly occurs between ages 40 and 60, but younger and older people may also develop ALS. Men are affected more often than women.



**Amyotrophic lateral sclerosis (ALS)** is caused by the degeneration and death of motor neurons in the spinal cord and brain. These neurons convey electrical messages from the brain to the muscles to stimulate movement in the arms, legs, trunk, neck, and head. As motor neurons degenerate, the muscles are weakened and cannot move as effectively, leading to muscle wasting. (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

## Description

Amyotrophic lateral sclerosis is a progressive disease of the central nervous system. “A” means “no,” “myo” implies muscle cells, and “trophic” refers to nourishment. The nerve cells that extend from the brain to the spinal cord (upper motor neurons), and from the spinal cord to the peripheral nerves (lower motor neurons), for unexplained reasons, degenerate and die. “Lateral” refers to the areas of the spinal cord that are affected, and “sclerosis” occurs as hard tissue replaces the previously originally healthy nerve.

The parts of the body that are not affected by ALS are those areas not involved in the use of motor neurons. The mind remains very sharp and in control of sight,

hearing, smell, touch and taste. Bowel and bladder functions are generally not affected. Amyotrophic lateral sclerosis rarely causes pain, yet leaves patients dependent on the care of others during advanced stages.

ALS progresses rapidly and paralyzed patients are usually under the intensive care of nursing facilities or loved ones. This can have a devastating psychological effect on the family members and the patient. In most cases ALS is fatal within two to five years, although approximately 10% live eight years or more.

## Risk factors

In most ALS cases, the disease occurs apparently at random with no clearly identified risk factors.

People do not have a family history of ALS are not considered to be at risk for developing ALS.

### Causes and symptoms

The cause of ALS is unknown, nor is it known why ALS strikes some people and not others. The symptoms of ALS are caused by the death of motor neurons in the spinal cord and brain. Normally, these neurons convey electrical messages from the brain to the muscles to stimulate movement in the arms, legs, trunk, neck, and head. As motor neurons die, the muscles they innervate cannot be moved as effectively, and weakness results. In addition, lack of stimulation leads to muscle wasting, or loss of bulk. Involvement of the upper motor neurons causes spasms and increased tone in the limbs, and abnormal reflexes. Involvement of the lower motor neurons causes persistent muscle wasting and twitching (fasciculations).

Although many causes of motor neuron degeneration have been suggested for ALS, none has yet been proven responsible. Results of recent research have implicated toxic molecular fragments known as free radicals. Some evidence suggests that a cascade of events leads to excess free radical production inside motor neurons, leading to their death. Why free radicals should be produced in excess amounts is unclear, as is whether this excess is the cause or the effect of other degenerative processes. Additional agents within this toxic cascade may include excessive levels of a neurotransmitter known as glutamate, which may over-stimulate motor neurons, thereby increasing free-radical production, and a faulty **detoxification** enzyme known as SOD-1, for superoxide dismutase type 1. The actual pathway of destruction is not known, however, nor is the trigger for the rapid degeneration that marks ALS. Further research may show that other pathways are involved, perhaps ones even more important than this one. Autoimmune factors or premature **aging** may play some role, as could viral agents or environmental toxins.

The disease starts slowly, affecting just one limb, such as the hands or feet, and steadily progresses to more limbs and muscles. When muscles lack the proper nourishment they require, they begin to thin and deteriorate. This condition is the hallmark of amyotrophic lateral sclerosis. Muscle wasting is due to the inability of degenerating motor neurons to elicit a signal to the muscles that allow them to function and grow. Common examples of symptoms for ALS are **muscle cramps** and twitching, weakness in the hands, feet, or ankles, speech slurring, and swallowing difficulties. Other early symptoms include arm and leg

### KEY TERMS

**Aspiration**—Inhalation of food or saliva.

**Bulbar muscles**—Muscles that control chewing, swallowing, and speaking.

**Degeneration**—Nerves progressively withering.

**Fasciculations**—Involuntary twitching of patient's muscles.

**Voluntary muscle**—A muscle under conscious control, such as arm and leg muscles.

stiffness, foot drop, weight loss, **fatigue**, and difficulty making facial expressions.

One of the earliest symptoms of ALS is weakness in the bulbar muscles. These muscles in the mouth and throat assist in chewing, swallowing, and speaking. Weakness of these muscle groups usually cause problems such as slurred speech, difficulty with conversation and hoarseness of the voice.

As the disease progresses the respiratory muscles (breathing muscles) weaken, resulting in increased difficulty with breathing, coughing and possibly inhaling food or saliva. The potential for lung infection increases and can cause death. Many patients find it more comfortable and extend their lives when assisted by ventilators at this stage of the disease. Communication becomes very difficult. One way to accomplish feedback with others is to make use of the eyes. Blinking is one mode that patients of amyotrophic lateral sclerosis will be forced to utilize, in order to continue communication.

As the disease progresses, victims gradually lose the use of their feet, hand, leg, and neck muscles, and **paralysis** results in affected muscle groups. They are able to speak and swallow only with great struggle. **Sexual dysfunction** is not affected. Breathing will become increasingly difficult and the patients of ALS may decide to prolong life with the use of assisted ventilation, which may decrease the risks of death from infections such as **pneumonia**.

### Diagnosis

ALS is difficult to diagnose. There is no one set way to test for the disease. A second opinion is frequently recommended if ALS is suspected since it is a fatal neurological disease. To date, there is no one test or procedure to ultimately establish the diagnosis of ALS. It is through a clinical examination and series of

diagnostic tests, often ruling out other diseases that mimic ALS, that a diagnosis can be established.

### Examination

The diagnosis of ALS begins with a complete medical history and physical exam, plus a neurological examination to determine the distribution and extent of weakness. The examinations are repeated at regular intervals to assess whether symptoms are getting progressively worse.

### Tests

A series of diagnostic tests are performed to rule out and exclude other possible causes and diseases that resemble ALS, such as tumors of the skull base or high cervical spinal cord, thyroid disease, spinal arthritis, **lead poisoning**, or severe vitamin deficiency. Other possibilities to rule out include **multiple sclerosis**, spinal cord neoplasm, polyarteritis, syringomyelia, **myasthenia gravis**, and **muscular dystrophy**. Electro diagnostic tests such as **electromyography** (EMG) and nerve conduction velocity (NCV) are used to help diagnose ALS. Blood and urine tests, spinal taps, x rays, and muscle and/or nerve biopsy are performed, as well as **magnetic resonance imaging** (MRI), myelograms of the cervical spine and CT (computed tomography) scans. ALS is rarely misdiagnosed following a careful review of all these tests.

### Treatment

Currently, there is no cure for ALS and no treatment that can significantly alter its course. Management aims to control the symptoms that patients experience. Emotional, psychological and physical support, are provided to ease the difficulty associated with this disorder.

### Traditional

Moderate activities are recommended in the early stages of the disease. **Physical therapy** can help muscles stay active and delay the resulting weakness. ALS patients are encouraged to maintain a healthy diet and **exercise** regularly for as long as possible. Education of ALS is very important in developing an understanding of the disease, and is vital for family members as well as patients.

A physical therapist works with an affected person and family to implement exercise and stretching programs to maintain strength and range of motion, and to promote general health. Swimming may be a good choice for people with ALS, as it provides a low-

impact workout to most muscle groups. One result of chronic inactivity is contracture, or muscle shortening. **Contractures** limit a person's range of motion, and are often painful. Regular stretching can prevent contracture. Several drugs are available to reduce cramping, a common complaint in ALS.

An occupational therapist can help design solutions to movement and coordination problems, and provide advice on adaptive devices and home modifications.

Speech and swallowing difficulties can be minimized or delayed through training provided by a speech-language pathologist. This specialist can also provide advice on communication aids, including computer-assisted devices and simpler word boards.

Nutritional advice can be provided by a nutritionist. A person with ALS often needs softer foods to prevent jaw exhaustion or **choking**. Later in the disease, **nutrition** may be provided by a **gastrostomy** tube inserted into the stomach.

Mechanical ventilation may be used when breathing becomes too difficult. Modern mechanical ventilators are small and portable, allowing a person with ALS to maintain the maximum level of function and mobility. Ventilation may be administered through a mouth or nose piece, or through a tracheostomy tube. This tube is inserted through a small hole made in the windpipe. In addition to providing direct access to the airway, the tube also decreases the risk aspiration. While many people with rapidly progressing ALS choose not to use ventilators for lengthy periods, they are increasingly being used to prolong life for a short time.

The progressive nature of ALS means that most persons will eventually require full-time nursing care. This care is often provided by a spouse or other family member. While the skills involved are not difficult to learn, the physical and emotional burden of care can be overwhelming. Caregivers need to recognize and provide for their own needs as well as those of people with ALS, to prevent depression, burnout, and bitterness.

Throughout the disease, a support group can provide important psychological aid to affected persons and their caregivers as they come to terms with the losses ALS inflicts. Support groups are sponsored by both the ALS Society and the Muscular Dystrophy Association.

### Drugs

Only one drug has been approved by the Food and Drug Administration (FDA) for treatment of

ALS: riluzole (Rilutek). The drug appears to have a positive effect in that it appears to extend the life of ALS patients by about three months when taken regularly early in the disease, and shows a significant slowing of the loss of muscle strength. Riluzole acts by decreasing glutamate release from nerve terminals. Experimental trials of nerve growth factor have not demonstrated any benefit.

Another drug, Myotrophin (somatomedin C), appears to prevent neuron loss and enhance neuron generation in animal studies.

### **Alternative**

Given the serious prognosis and absence of traditional medical treatments, it is not surprising that a large number of alternative treatments have been tried for ALS. Some studies suggested that amino-acid therapies may provide some improvement for some people with ALS. While individual reports claim benefits for megavitamin therapy, herbal medicine, and removal of **dental fillings**, for instance, no evidence suggests that these offer any more than a brief psychological boost, often followed by a more severe letdown when it becomes apparent the disease has continued unabated. However, once the causes of ALS are better understood, alternative therapies may be more intensively studied. For example, if damage by free radicals turns out to be the root of most of the symptoms, antioxidant **vitamins** and supplements may be used more routinely to slow the progression of ALS. Or, if environmental toxins are implicated, alternative therapies with the goal of detoxifying the body may be of some use.

### **Prognosis**

Amyotrophic lateral sclerosis normally progresses rapidly and leads to death from respiratory infection within three to five years. If the person involved is young and the initial symptoms appear in the limbs, the disease tends to develop more slowly. Improved medical care prolongs the lives of ALS patients and shows promise for more effective treatments in the future.

### **Prevention**

There is no known way to prevent ALS or to alter its course.

### **Resources**

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**ORGANIZATIONS**

- ALS Association, 27001 Agoura Road, Suite 250, Calabasas Hills, CA, 91301-5104 (818) 880-9007 (800) 782-4747 (818) 880-9006, advocacy@alsa-national.org, <http://www.alsa.org>.
- ALS Therapy Development Institute, 215 First Street, Cambridge, MA, 02142 (617) 441-7200 (617) 441-7299, info@als.net, <http://www.als.net>.
- Muscular Dystrophy Association, 3300 East Sunrise Drive, Tucson, AZ, 85718-3208 (520) 529-2000 (800) 344-4863 (520) 529-5300, mda@mdausa.org, <http://www.mda.org>.
- Les Turner ALS Foundation, 5550 W. Touhy Avenue, Suite 302, Skokie, IL, 60077-3254 (847) 679-3311 (800) ALS-1107 (847) 679-9109, info@lesturnerals.org, <http://www.lesturnerals.org>.
- Project ALS, 900 Broadway, Suite 901, New York, NY, 10003 (212) 420-7382 (800) 603-0270 (212) 420-7387, info@projectals.org, <http://www.projectals.org>.

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**Description**

Anabolic steroids are more accurately called anabolic-androgenic steroids. This name defines their two principle characteristics. Anabolic means to synthesize or build up; thus anabolic steroids increase skeletal muscle mass. Androgenic means involving male sexual characteristics. Anabolic steroids are related to testosterone and affect the body the many of the same ways as testosterone. Testosterone is the main hormone responsible for male sexual characteristics. It stimulates and maintains the male reproductive organs, stimulates development of bones and muscle, promotes skin and hair growth, and can influence emotions and sex drive. In males, the testes produce testosterone with a small amount also secreted by the adrenal glands. Women have only the small amount of testosterone produced by the adrenal glands.

Several hundred different types of anabolic steroids have been synthesized in attempts to maximize their benefits and minimize side effects. As of 2009, not a single anabolic steroid had been manufactured that was free of negative side effects. In many developing countries, anabolic steroids can be purchased without a prescription. However, in the United States, they have been controlled substances since 1991. Possession of an anabolic steroid without a prescription is illegal and can result in a maximum one-year prison sentence and a minimum fine of \$1,000 fine for the first offense.

***Medical uses***

Anabolic steroids were first developed in the 1930s in Europe in an effort to produce a drug to treat conditions where the testes did not secrete enough testosterone. Physicians tried using these drugs for many other purposes in the 1940s and 1950s with limited success. Disadvantages outweighed benefits for most purposes, and during the later decades of the twentieth century, medical use in North America and Europe was restricted to a few conditions. These include:

- Bone marrow stimulation: During the second half of the twentieth century anabolic steroids were the mainstay of therapy for hypoplastic anemia not due to nutrient deficiency, especially aplastic anemia. In the twenty-first century anabolic steroids have been replaced by synthetic protein hormones that selectively stimulate growth of blood cell precursors with fewer side effects.
- Growth stimulation: From the 1960s through the 1980s, anabolic steroids were used heavily by pediatric endocrinologists to treat children with growth failure. The availability of synthetic growth hormone

**Anabolic steroid use****Definition**

Anabolic **steroids** are a class of man-made drugs that are chemically related to the male hormone testosterone.

## KEY TERMS

**Adrenal gland**—An endocrine gland located above each kidney. The inner part of each gland secretes epinephrine (adrenaline) and the outer part secretes steroid hormones.

**Androgen**—A natural or artificial steroid that acts as a male sex hormone. Androgens are responsible for the development of male sex organs and secondary sexual characteristics.

**Androstenedione**—Also called “andro,” this hormone occurs naturally during the making of testosterone and estrogen.

**Catabolic**—A metabolic process in which energy is released through the breakdown of complex molecules into simpler ones.

**Corticosteroids**—A steroid hormone produced by the adrenal gland and involved in metabolism and immune response.

**Estrogen**—Any of several steroid hormones, produced mainly in the ovaries, that stimulate estrus and the development of female secondary sexual characteristics.

**Hormone**—A chemical messenger that is produced by one type of cell and travels through the bloodstream to change the metabolism of a different type of cell.

**Hypoplastic anemia**—Anemia that is characterized by defective function of the blood-forming organs (such as bone marrow) and is caused by toxic agents such as chemicals or x rays. Anemia is a blood condition in which there are too few red blood cells or the red blood cells are deficient in hemoglobin.

**Progestin**—Female steroid sex hormones.

**Prohormones**—A physiologically inactive precursor of a hormone.

**Prostate gland**—An O-shaped gland in males that secretes a fluid into the semen that acts to improve the movement and viability of sperm.

**Testosterone**—A male steroid hormone produced in the testes and responsible for the development of secondary sex characteristics.

(GH) and increasing social stigmatization of anabolic steroids has significantly reduced their use for this purpose.

- Stimulation of appetite and preservation of muscle mass: Anabolic steroids are given to treat chronic wasting syndrome in people with diseases such as cancer and HIV/AIDS.
- Induction of male puberty: Androgens sometimes are given to boys distressed about extreme delay of puberty. Testosterone is, as of 2009, nearly the only androgen used for this purpose, but synthetic anabolic steroids often were used prior to the 1980s.
- Treatment of breast cancer: Testosterone has been reported to slow the development of some, but not all, breast cancer in some women.
- Treatment of hypogonadism: The average adult male naturally produces 2.5–11 milligrams (mg) of testosterone daily. Testosterone is given as a replacement hormone if the testes either do not produce enough hormone or if the testes are damaged or removed (e.g., in testicular cancer).

### *Abuse of steroids*

Soon after the first anabolic steroids were synthesized, experimenters realized that these compounds caused an increase in muscle mass in laboratory

animals. This soon led to the abuse of these drugs by bodybuilders and weightlifters. Anabolic steroid use spread to elite athletes looking for an edge in strength and speed. By the 1950s some Olympic athletes, primarily from the Soviet Union, East Germany, and other Eastern European countries, were taking large doses of steroids that allowed them to dominate their sports. Many of the male athletes developed such **enlarged prostate** glands (a gland near that surrounds the urethra that aids in semen production) that they needed a tube inserted into their urethra in order to urinate. Some of the female athletes developed so many male physical characteristics (e.g., low voices, facial hair, male musculature) that chromosome tests were necessary to prove that they were female.

Concerns over the growing illicit market and the prevalence of abuse, combined with the possibility of harmful long-term effects of steroid use, led the United States Congress in 1991 to place anabolic steroids in Schedule III of the Controlled Substances Act (CSA). The CSA defines anabolic steroids as any drug or hormonal substance chemically and pharmacologically related to testosterone (other than estrogens, progestins, and **corticosteroids**) that promotes muscle growth.

On January 20, 2005, the Anabolic Steroid Control Act of 2004 took effect, amending and expanding

the Controlled Substance Act by placing both anabolic steroids and prohormones (substances the body can convert into anabolic steroids) on the controlled substance list and making possession of the banned substances a federal crime. Also in 2005, Major League Baseball (MLB), amid long-time rumors of anabolic steroid abuse among players, was rocked by the publication of *Juiced* by former Oakland Athletics outfielder Jose Canseco who alleged steroid abuse was wide spread in professional baseball. In response, Congress held hearings in March 2005 on steroid abuse in the MLB, subpoenaing such baseball superstars as home run champion Mark McGwire, Sammy Sosa, and Curt Schilling to testify. MLB officials promised a crackdown on anabolic steroid use among players. Nevertheless, steroid use continued, and in 2007, Barry Bonds, baseball's all-time home run leader was indicted for illicit steroid use. In that same year, the United States Drug Enforcement Agency, in conjunction with many other federal agencies, broke up 56 illegal laboratories producing steroids and seized 11.4 million steroid dosage units and 242 kilograms of raw Chinese steroid power as part of a two-year investigation known as Operation Raw Deal.

Most illicit anabolic steroids are sold at gyms, bodybuilding competitions, and through the mail and Internet. Many of these substances or the raw materials to make them are smuggled into the United States from countries where their possession without a prescription is legal (e.g., China, Mexico). The drugs are available both as pills and injectable liquids. Anabolic steroids commonly encountered on the illicit market include: boldenone (Equipoise), ethlestrenol (Maxibolin), fluoxymesterone (Halotestin), methandriol, methandrostenolone (Dianabol), methyltestosterone, nandrolone (Durabolin, DecaDurabolin), oxandrolone (Anavar), oxymetholone (Anadrol), stanozolol (Winstrol), testosterone (including sustanon), and trenbolone (Finajet). In addition, new anabolic steroid compounds specifically designed to be undetectable by current drug tests are constantly being developed. Many of these drugs are produced in unsanitary, illicit laboratories with little or no quality control. In addition, many counterfeit products that do not contain any steroids or that are mislabeled relative to the type and dose of steroid they contain are sold over the Internet.

Steroid abuse has spread downward from elite and professional athletes to college and then high school athletes and younger. According to the a survey by the United States Centers for Disease Control and Prevention (CDC), in 2005, 850,000 high school

students in the United States had used anabolic steroid pills or shots without a prescription. A more recent 2007 study found that 1.5% of eighth graders and 2.2% of twelfth graders (2.3% of boys and 0.6% of girls) had at some time used illicit steroids. Anabolic steroid users generally take extremely high doses of steroids that can add up to 100 mg a day or more through "stacking" or combining several different types or brands of steroids. Often athletes take these drugs on a schedule called "cycling," where they take steroids for a period of 12–16 weeks followed by a steroid-free period. Another approach to illicit anabolic steroids use is "pyramiding," in which doses are gradually increased to mid-cycle, then decreased to zero.

## Causes and symptoms

Anabolic steroids do increase muscle mass. While this may seem desirable at first, these drugs have very serious side effects. Anabolic steroids fool the body into thinking that testosterone is being produced in large quantities. Excessive use causes a harmful disturbance of the body's normal hormone levels and body chemistry. Cardiovascular side effects are the most common. They include increased heart rate (tachycardia), **heart attack** (myocardial infarction) even in young athletes, high blood pressure (**hypertension**), an increase in low-density lipoprotein (LDL or "bad" cholesterol and a decrease in high-density lipoprotein (HDL or "good" cholesterol that increases the risk of **stroke**. Other negative side effects may include liver damage, liver tumors (usually not cancerous), and a decrease in blood clotting factors. Young people may develop severe **acne**. Males may experience shrinking testes, falling sperm count, increased risk of **infertility**, enlarged breasts, and an enlarged prostate gland and baldness. In addition, the ends of long bones fuse together and stop growing, resulting in permanently stunted growth and short stature. Women frequently show signs of masculinity including the development of facial hair, lower voice, and male-type musculature. They may stop menstruating, may be at higher risk for certain types of **cancer** and have an increased risk of **birth defects** in their children.

Anabolic steroids also affect mental health. Their use can cause drastic mood swings, inability to sleep, depression, and feelings of hostility. There is some evidence that young men may become more volatile and violent when taking these drugs, a condition know "roid rage." Steroids also may be psychologically and physically addictive to some users. Withdrawal

symptoms may include **insomnia, fatigue**, restlessness, reduced sex drive, depression, and suicidal thoughts.

In addition to these physical and mental side effects, steroid abuse brings other risks, some of which are connected to the way some steroids are manufactured and distributed. The drugs are often made in motel rooms, bathrooms, and warehouses in developing countries and then smuggled into the United States. The potency, purity, and strength of the steroids produced this way are not regulated; therefore, users cannot know how much they are taking. Some users of injectable steroids share needles, increasing the risk of contracting HIV or hepatitis.

Most data on the long-term effects of anabolic steroids on humans come from case reports rather than formal scientific studies. From the case reports, the incidence of life-threatening side effects appears to be low, but serious adverse effects may be under-recognized or under-reported. Data from animal studies seem to support this possibility. One study found that exposing male mice for one-fifth of their lifespan to steroid doses comparable to those taken by human athletes caused a high percentage of premature deaths. Most effects of anabolic steroid use are reversible if the abuser stops taking the drugs, but some, such as short stature, can be permanent.

## Diagnosis

Diagnosis is often difficult, since anyone using anabolic steroids without a prescription and not under the direction of a physician is considered abusing the drug. Many athletes either do not understand what they are taking or strongly resist admitting that they are using performance-enhancing substances. Sudden increase in musculature, as well as the symptoms listed above are clues that anabolic steroid abuse could be occurring. Virtually all major professional sports leagues in the United States test for steroids and other performance-enhancing drugs, as do most intercollegiate athletic leagues. Many steroids are detectable in urine samples, however new compounds are constantly being developed in a deliberate attempt to produce compounds that are undetectable by current tests.

## Treatment

Few studies of treatment for anabolic steroid abuse have been conducted. Knowledge as of 2009 is based largely on the experiences of a small number of physicians who have worked with individuals undergoing steroid withdrawal. The physicians have found that supportive therapy is sufficient in some cases.

Patients are educated about what they may experience during withdrawal and are evaluated for suicidal thoughts. If symptoms are severe or prolonged, medications or hospitalization may be needed. Depression needs to be monitored closely.

Sometimes medications are used to restore hormone balance after its disruption by steroid abuse. Other medications target specific withdrawal symptoms, for example, antidepressants to treat depression, and **analgesics (pain killers)** for headaches, muscle, and joint pains. Some individuals are psychologically addicted to steroids and benefit from behavioral therapies.

## Alternative treatment

There is little data on alternative medicines or treatments for anabolic steroid abuse. However, anabolic steroid manufacturers recommend **saw palmetto** to be taken in conjunction with androstenedione as it can help reduce associated hair loss and is useful in controlling prostate enlargement.

## Prognosis

Anabolic steroid abuse is a treatable condition. Abusers can overcome the problem with the help of family members, support groups, **psychotherapy**, medication, treatment programs, and family counseling. These programs are customized to help teens and adults lead productive and normal lives. However, heavy steroid use—even if it is stopped after a few years—may stunt growth and increase the risk of **liver cancer**. A steroid user who quits may experience severe depression that can lead to suicidal thoughts and **suicide** attempts or completion. The risk of depression and suicide is highest among teenage abusers.

Some physicians recommend that athletes using steroids avoid sudden discontinuance of all steroids simultaneously because their bodies may enter an immediate catabolic (metabolic breakdown of compounds) phase. This can lead to a considerable loss of strength and mass, an increase of fat and water in the body, and breast enlargement in males. Breast enlargement occurs because the suddenly low androgen level shifts the hormone balance in favor of estrogen compounds, which suddenly become the dominant hormone.

## Prevention

Educating young people to the dangers of anabolic steroid abuse is the best way to prevent their misuse. The National Institute on Drug Abuse in conjunction with the Oregon Health & Science University has

developed two programs for use with high school sports teams. The Adolescent Training and Learning to Avoid Steroids (ATLAS) program is aimed at teaching high school football players how to improve performance with training and healthy behaviors. The Athletes Targeting Healthy Exercise and Nutrition Alternatives (ATHENA) has similar goals but is designed for female athletes. Both programs have been shown to reduce steroid abuse and decrease other risky behaviors such as alcohol and **marijuana** use. These programs were awarded the 2006 *Sports Illustrated* magazine Champion Award for improving the safety and healthy of high school athletes.

## Resources

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### ORGANIZATIONS

National Center for Drug Free Sport Inc., 2735 Madison Avenue, Kansas City, MO, 64108, (816) 474-8644, (816) 501-9287, [info@drugfreesport.com](mailto:info@drugfreesport.com), <http://www.drugfreesport.com>.

National Clearinghouse for Alcohol and Drug Information, P.O. Box 2345, Rockville, MD, 20847-2345, (877) 726-4727, <http://store.samhsa.gov/>.

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## Anaerobic infections

### Definition

An anaerobic infection is an infection caused by bacteria (called anaerobes) which cannot grow in the presence of oxygen. Anaerobic bacteria can infect

## KEY TERMS

**Abscess**—A lump filled with pus resulting from an infection.

**Anaerobic**—Living and growing in the absence of oxygen.

**Necrosis**—Tissue death and destruction resulting from infection or disease.

deep **wounds**, deep tissues, and internal organs where there is little oxygen. These infections are characterized by **abscess** formation, foul-smelling pus, and tissue destruction.

### Description

Anaerobic means “life without air.” Anaerobic bacteria grow in places which completely, or almost completely, lack oxygen. They are normally found in the mouth, gastrointestinal tract, and vagina, and on the skin. Commonly known diseases caused by anaerobic bacteria include gas **gangrene**, **tetanus**, and **botulism**. Nearly all dental infections are caused by anaerobic bacteria.

Anaerobic bacteria can cause an infection when a normal barrier (such as skin, gums, or intestinal wall) is damaged due to surgery, injury, or disease. Usually, the immune system kills any invading bacteria, but sometimes the bacteria are able to grow and cause an infection. Body sites that have tissue destruction (necrosis) or a poor blood supply are low in oxygen and favor the growth of anaerobic bacteria. The low oxygen condition can result from blood vessel disease, **shock**, injury, and surgery.

Anaerobic bacteria can cause infection practically anywhere in the body. For example:

- Mouth, head, and neck. Infections can occur in the root canals, gums (gingivitis), jaw, tonsils, throat, sinuses, and ears.
- Lung. Anaerobic bacteria can cause pneumonia, lung abscesses, infection of the lining of the lung (empyema), and dilated lung bronchi (bronchiectasis).
- Intraabdominal. Anaerobic infections within the abdomen include abscess formation, peritonitis, and appendicitis.
- Female genital tract. Anaerobic bacteria can cause pelvic abscesses, pelvic inflammatory disease, inflammation of the uterine lining (endometritis), and pelvic infections following abortion, childbirth, and surgery.

- Skin and soft tissue. Anaerobic bacteria are common causes of diabetic skin ulcers, gangrene, destructive infection of the deep skin and tissues (necrotizing fascitis), and bite wound infections.
- Central nervous system. Anaerobic bacteria can cause brain and spinal cord abscesses.
- Bloodstream. Anaerobic bacteria can be found in the bloodstream of ill patients (a condition called bacteremia).

## Causes and symptoms

People who have experienced shock, injury, or surgery, and those with blood vessel disease or tumors are at an increased risk for infection by anaerobic bacteria. There are many different kinds of anaerobic bacteria which can cause an infection. Indeed, most anaerobic infections are “mixed infections” which means that there is a mixture of different bacteria growing. The anaerobic bacteria that most frequently cause infections are *Bacteroides fragilis*, *Peptostreptococcus*, and *Clostridium* species.

The signs and symptoms of anaerobic infection can vary depending on the location of the infection. In general, anaerobic infections result in tissue destruction, an abscess which drains foul-smelling pus, and possibly **fever**. Symptoms for specific infections are as follows:

- Tooth and gum infections. Swollen, tender bleeding gums, bad breath, and pain. Severe infections may produce oozing sores.
- Throat infection. An extremely sore throat, bad breath, a bad taste in the mouth, fever, and a sense of choking.
- Lung infection. Chest pain, coughing, difficulty breathing, fever, foul-smelling sputum, and weight loss.
- Intraabdominal infection. Pain, fever, and possibly, if following surgery, foul-smelling drainage from the wound.
- Pelvic infection. Foul-smelling pus or blood draining from the uterus, general or localized pelvic pain, fever, and chills.
- Skin and soft tissue infection. Infected wounds are red, painful, swollen, and may drain a foul-smelling pus. Skin infection causes localized swelling, pain, redness, and possibly a painful, open sore (ulcer) which drains foul-smelling pus. Severe skin infections may cause extensive tissue destruction (necrosis).
- Bloodstream. Bloodstream invasion causes high fever (up to 105°F [40.6°C]), chills, a general ill feeling, and is potentially fatal.

## Diagnosis

The diagnosis of anaerobic infection is based primarily on symptoms, the patient’s medical history, and location of the infection. A foul-smelling infection or drainage from an abscess is diagnostic of anaerobic infection. This foul smell is produced by anaerobic bacteria and occurs in one third to one half of patients late in the infection. Other clues to anaerobic infection include tissue necrosis and gas production at the infection site. A sample from the infected site may be obtained, using a swab or a needle and syringe, to determine which bacteria is (are) causing the infection. Because these bacteria can be easily killed by oxygen, they rarely grow in the laboratory cultures of tissue or pus samples.

The recent medical history of the patient is helpful in diagnosing anaerobic infection. A patient who has or recently had surgery, dental work, tumors, blood vessel disease, or injury are susceptible to this infection. The failure to improve following treatment with **antibiotics** that aren’t able to kill anaerobes is another clue that the infection is caused by anaerobes. The location and type of infection also help in the diagnosis.

Diagnostic tests may include blood tests to see if bacteria are in the bloodstream and x rays to look at internal infections.

## Treatment

Serious infections may require hospitalization for treatment. Immediate antibiotic treatment of anaerobic infections is necessary. Laboratory testing may identify the bacteria causing the infection and also which antibiotic will work best. Every antibiotic does not work against all anaerobic bacteria but nearly all anaerobes are killed by chloramphenicol (Chloromycetin), metronidazole (Flagyl or Protostat), and imipenem (Primaxin). Other antibiotics which may be used are clindamycin (Cleocin) or cefoxitin (Mefoxin).

Surgical removal or drainage of the abscess is almost always required. This may involve drainage by needle and syringe to remove the pus from a skin abscess (called “aspiration”). The area would be numbed prior to the aspiration procedure. Also, some internal abscesses can be drained using this procedure with the help of ultrasound (a device which uses sound waves to visualize internal organs). This type of abscess drainage may be performed in the doctor’s office.

## Prognosis

Complete recovery should be achieved with the appropriate surgery and antibiotic treatment.

Untreated or uncontrolled infections can cause severe tissue and bone destruction, which would require **plastic surgery** to repair. Serious infections can be life threatening.

## Prevention

Although anaerobic infections can occur in anyone, good hygiene and general health may help to prevent infections.

## Resources

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Fauci, Anthony S., et al., eds. *Harrison's Principles of Internal Medicine*. 17th ed. New York: McGraw-Hill Professional, 2008.

Belinda Rowland PhD

Anaerobic myositis see **Gangrene**

## KEY TERMS

**Anus**—The canal at the end of the large intestine through which waste is excreted to the outside of the body.

**Bowel obstruction**—Anything that prevents waste from moving normally to the anal opening.

**Colostomy**—An operation where the large intestine is diverted through an opening in the abdomen and waste is excreted.

**Feces**—Bodily waste material that normally passes through the anus.

**Fistula**—An abnormal channel that connects two organs or connects an organ to the skin.

## Causes and symptoms

Anal atresia is a defect in the development of the fetus. The cause is unknown, but genetics seem to play a minor role.

## Diagnosis

Usually a physician can make an obvious visual diagnosis of anal atresia right after birth. Occasionally, however, anal atresia is missed until the baby is fed and signs of intestinal obstruction appear. At the end of the first or second day, the abdomen swells and there is **vomiting** of fecal material. To determine the type of anal atresia and the exact position, x rays will be taken which include injecting opaque dye into the opening. **Magnetic resonance imaging** (MRI) or **computed tomography scans** (CT), as well as ultrasound, are the imaging techniques used to determine the type and size of the anal atresia. Ultrasound uses sound waves, CT scans pass x rays through the body at different angles, and an MRI uses a magnetic field and radio waves.

## Treatment

Surgery is the only treatment for anal atresia. For high anal atresia, immediately after the diagnosis is made, a surgical incision is made in the large intestine to make a temporary opening (**colostomy**) in the abdomen where waste is excreted. Several months later, the intestine is moved into the ring of muscle (sphincter) that is part of the anus and a hole is made in the skin. The colostomy is closed several weeks later. In low anal atresia, immediately after diagnosis, a hole is made in the skin to open the area where the anus should be. If the channel is in the wrong place, the

## Anal atresia

### Definition

The anus is either not present or it is in the wrong place.

### Description

There are basically two kinds of anal atresia. In boys with high anal atresia, there may be a channel (**fistula**) connecting the large intestine to either the urethra (which delivers urine from the bladder) or the bladder itself. In girls, the channel may connect with the vagina. Sixty percent of children with high anal atresia have other defects, including problems with the esophagus, urinary tract, and bones. In low anal atresia, the channel may open in front of the circular mass of muscles that constrict to close the anal opening (anal sphincter) or, in boys, below the scrotum. Occasionally, the intestine ends just under the skin. It is estimated that overall abnormalities of the anus and rectum occur in about one in every 5,000 births and are slightly more common among boys. A mother who has one child with these kind of conditions has a 1% chance of having another child who suffers from this ailment.

intestine is moved into the correct position sometime during the child's first year. After surgery, the pediatric surgeon uses an instrument to dilate or widen the rectum and teaches the parents how to do this daily at home to prevent scar tissue from contracting.

### Prognosis

With high anal atresia, many children have problems controlling bowel function. Most also become constipated. With low anal atresia, children generally have good bowel control, but they may still become constipated.

### Prevention

There is no known way to prevent anal atresia.

### Resources

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Holcomb, George W., III, and J. Patrick Murphy. *Ashcraft's Pediatric Surgery*. 5th ed. Philadelphia: Saunders, 2009.

Jeanine Barone Physiologist

## Anal cancer

### Definition

**Anal cancer** is an uncommon form of cancer affecting the anus. The anus is the inch-and-a-half-long end portion of the large intestine, which opens to allow solid wastes to exit the body. Other parts of the large intestine include the colon and the rectum.

### Demographics

Approximately 5,000 Americans were diagnosed with anal cancer in 2009, and an estimated 700 individuals died of the disease during this same interval, according to the American Cancer Society. Anal cancers are fairly rare: they make up only 1% to 2% of cancers affecting the digestive system. This type of cancer is diagnosed much less frequently than cancers of the colon and rectum. The disease affects women somewhat more often than men. As the average age of the general population increases, the incidence of anal cancer is also increasing. The average age at diagnosis for most anal cancers is 60 years and older.

### Description

Different cancers can develop in different parts of the anus, part of which is inside the body and part of

which is outside. Sometimes abnormal changes of the anus are harmless in their early stages but may later develop into cancer. Some **anal warts**, for example, contain precancerous areas and can develop into cancer. Types of anal cancer include:

- **Squamous cell carcinomas**—Most anal cancers diagnosed in the United States are squamous cell carcinomas, which arise from the cells lining the anal margin and the anal canal. The anal margin is the part of the anus that is half inside and half outside the body, and the anal canal is the part of the anus that is inside the body. The earliest form of squamous cell carcinoma is known as carcinoma in situ, or Bowen's disease.
- **Cloacogenic carcinomas**—Often listed as a subclass of squamous cell cancer of the anus, these tumors develop in the transitional zone, or cloaca, which is a ring of tissue between the anal canal and the rectum. Other terms for this type of tumor are basaloid or transitional cell carcinoma of the anus.
- **Adenocarcinomas**—A small percentage of anal cancers are classified as adenocarcinomas, which affect glands in the anal area.
- **Basal cell carcinoma or malignant melanoma**—A very small percentage of anal cancers are either basal cell carcinomas, or malignant melanomas, two types of skin cancer. Malignant melanomas, which develop from skin cells that produce the brown pigment called melanin, are far more common on areas of the body exposed to the sun.

Two other very rare types of anal cancers are Paget's disease (not the same as Paget's disease of the bone) and gastrointestinal stromal tumors.

### Risk factors

Most cases of squamous cell carcinoma of the anus appear to be linked to infection by the **human papilloma virus** (HPV). This same virus causes most cases of **cervical cancer**. Therefore, women who have been diagnosed with cervical cancer are considered to be at high risk for the development of anal cancer. HPV can be spread during vaginal, anal, and oral intercourse. The HPV subtype most likely to cause anal cancer is HPV-16. HPV subtypes HPV-6 and HPV-11 cause most cases of genital and anal **warts**.

Individuals infected with the human **immunodeficiency** virus (HIV) are also at increased risk for the development of anal cancer. A history of multiple sexual partners increases risk for HIV and HPV infection and also increases risk for anal cancer. Anal intercourse, especially in individuals younger than age 30, increases the risk for anal cancer in both men and women.

## KEY TERMS

**Biopsy**—A procedure in which a small piece of body tissue is removed and examined under a microscope for cancer.

**Chemotherapy**—A cancer treatment in which drugs delivered into the bloodstream kill cancer cells or make them more vulnerable to radiation therapy.

**Human immunodeficiency virus (HIV)**—The virus that causes acquired immune deficiency syndrome (AIDS).

**Human papillomavirus (HPV)**—A virus with many subtypes, some of which cause cell changes that increase the risk of certain cancers.

**Lymph nodes**—Bean-shaped structures found throughout the body that produce and store infection-fighting cells.

**Radiation therapy**—A cancer treatment that uses high-energy rays to kill or weaken cancer cells. Radiation may be delivered externally or internally via surgically implanted pellets.

Smokers are at higher risk, as are individuals with weakened immune systems, such as transplant patients taking **immunosuppressant drugs**.

### Causes and symptoms

The exact cause of most anal cancers is unknown. Symptoms of anal cancer resemble those found in other harmless conditions. They include **pain**, **itching** and bleeding, straining during a bowel movement, change in bowel habits, change in the diameter of the stool, discharge from the anus, and swollen lymph nodes in the anal or groin area.

### Diagnosis

#### Examination

Anal cancer is sometimes diagnosed during routine physicals, or during minor procedures such as hemorrhoid removal. It may also be diagnosed during a **digital rectal examination (DRE)**, when a physician inserts a gloved, lubricated finger into the anus to feel for unusual growths. Digital rectal exams are typically done to check for **prostate cancer** and are sometimes part of routine pelvic exams in women.

#### Tests

Radiologic tests used to aid diagnosis include x ray, computed tomography (CT) scans, **magnetic resonance imaging (MRI)** and positron emission testing (**PET**) scans.

#### Procedures

Other diagnostic procedures for anal cancer include: **anoscopy**, which is a procedure that involves use of a special device to examine the anus; proctoscopy, a procedure that involves use of a lighted scope to see the anal canal; and transrectal ultrasound,

which uses sound waves to create an image of the anus and nearby tissues.

A biopsy is performed on any suspicious growths; that is, a tiny specimen of the growth is removed and examined under a microscope for cancer cells. A procedure called a fine needle aspiration biopsy, in which a needle is used to withdraw fluid from lymph nodes located near the growth, may also be performed to make sure the cancer has not spread to these nodes.

### Treatment

#### Traditional

Anal cancer is treated using three methods, used either in concert or individually: surgery, **radiation therapy**, and **chemotherapy**.

Two types of surgery may be performed. A local resection, performed if the cancer is small and has not spread, removes the tumor and an area of tissue around the tumor. A more extensive procedure, an abdominoperineal (AP) resection, is a more complex procedure in which the anus and the lower rectum are removed, and an opening called a **colostomy** is created for body wastes to exit. This procedure is fairly uncommon because radiation and chemotherapy are just as effective. AP resection may be used however, if radiation and chemotherapy are not effective or if the cancer recurs after treatment with radiation and chemotherapy.

#### Drugs

Chemotherapy fights cancer using drugs, which may be delivered via pill or needle. Some chemotherapy types kill cancer cells directly, while others act indirectly by making cancer cells more vulnerable to radiation. The main drugs used to treat anal cancer are 5-fluorouracil (5-FU) and mitomycin or

5-FU and cisplatin. Side effects of chemotherapy, which damages normal cells in addition to cancer cells, may include **nausea and vomiting**, hair loss, loss of appetite, **diarrhea**, mouth sores, **fatigue**, **shortness of breath**, and a weakened immune system.

## Prognosis

Anal cancer is often curable. The chance of recovery depends on the stage of the cancer at the time of diagnosis and the patient's general health.

The overall five year survival rate for anal cancer is 60% in men and 78% in women. Five year relative survival rates for anal cancer diagnosed in localized stages is 89%, 61% for cancer diagnosed with regional spread, and 30% for individuals diagnosed with anal cancers that have already metastasized to distant sites in the body.

## Prevention

Reducing the risks of the **sexually transmitted diseases** HPV and HIV also reduces the risk of anal cancer. Results of recent research indicate that as many as 80% of anal cancers could be prevented by **vaccination** against HPV subtypes 16 and 18. In addition, quitting **smoking** lowers the risk of anal cancer. In adults considered to be at low risk for anal cancer over the age of 50, screening as part of exams for **colon cancer**, prostate cancer, and during pelvic exams for women may lead to earlier detection if an anal tumor is present. Screening procedures specific to anal cancer may be recommended for members of high risk groups.

## Resources

### PERIODICALS

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Daling, J.R., et al. "Human Papilloma Virus, Smoking, and Sexual Practices in the Etiology of Anal Cancer." *Cancer* 101 (2004): 270-280.

### OTHER

Abbas, A., Yang, G., Fakih, M. "Management of Anal Cancer in 2010: Overview, Screening, and Diagnosis." *Oncology* 24 (April 12, 2010). <http://www.cancernet-work.com/gastrointestinal-cancer/content/article/10165/1553005> accessed June 12, 2010.

## ORGANIZATIONS

- American Cancer Society, 1599 Clifton Road, NE, Atlanta, GA, 30329 (800) ACS-2345 (404) 329-7530, <http://www.cancer.org>.
- American College of Gastroenterology, P.O. Box 342260, Bethesda, MD, 20827-2260 (301) 263-9000, <http://www.acg.gi.org>.
- American Gastroenterological Association, 4930 Del Ray Avenue, Bethesda, MD, 20814 (301) 654-2055, <http://www.gastro.org>.
- American Society of Colon and Rectal Surgeons, 85 W. Algonquin Road, Suite 550, Arlington Heights, IL, 60005 (847) 290-9184, <http://www.fascrs.org>.
- National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, Public Inquiries Office, 6116 Executive Boulevard, Suite 300, Bethesda, MD, 20892-8322 (800) 422-6237, <http://www.cancer.gov>.
- United Ostomy Association of America, P.O. Box 66, Fairview, TN, 37062-0066 (800) 826-0826, <http://www.uoaa.org>.

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**Anal fissure** see **Anorectal disorders**

## Anal warts

### Definition

Anal **warts**, also known as condyloma acuminata, are small warts that can occur in the rectum.

### Description

Initially appear as tiny blemishes that can be as small as the head of a pin or grow into larger cauliflower-like protuberances. They can be yellow, pink, or light brown in color, and only rarely are painful or uncomfortable. In fact, infected individuals often are unaware that they exist. Most cases are caused by sexual transmission.

Most individuals have between one to 10 **genital warts** that range in size from roughly 0.5-1.9 cm<sup>2</sup>. Some will complain of painless bumps or **itching**, but often, these warts can remain completely unnoticed.

### Causes and symptoms

Condyloma acuminatum is one of the most common sexually transmitted disease (STD) in the United States. Young adults aged 17 to 33 years are at greatest risk. Risk factors include **smoking**, using **oral contraceptives**, having multiple sexual partners, and an early

## KEY TERMS

**Electrocoagulation**—A technique using electrical energy to destroy the warts. Usually done for warts within the anus with a local anesthesia, electrocoagulation is most painful form of therapy, and can cause both bleeding and discharge from the anus.

coital age. In addition, individuals who have a history of immunosuppression or anal intercourse are also at risk.

Roughly 90% of all anal warts are caused by the **human papilloma virus** (HPV) types 6 and 11, which are the least likely of over 60 types of HPV to become cancerous. Anal warts are usually transmitted through direct sexual contact with someone who is infected with condyloma acuminata anywhere in the genital area, including the penis and vagina. Studies have shown that roughly 75% of those who engage in sexual contact with someone infected with condyloma acuminata will develop these warts within three months.

### Treatment

According to guidelines from the Centers for Disease Control (CDC), the treatment of all genital warts, including anal warts, should be conducted according to the methods preferred by the patient, the medications or procedures most readily available, and the experience of the patient's physician in removing anal warts.

Treatment options include electrical cauterity, surgical removal, or both. Warts that appear inside the anal canal will almost always be treated with cauterization or surgical removal. Surgical removal, also known as excision, has the highest success rates and lowest recurrence rates. Indeed, studies have shown that initial cure rates range from 63–91%.

Unfortunately, most cases require numerous treatments because the virus that causes the warts can live in the surrounding tissue. The area may seem normal and wart-free for six months or longer before another wart develops.

Electrocoagulation, a technique that uses electrical energy to destroy the warts, is usually the most painful of the procedures done to eliminate condyloma acuminata of the anus, and is usually reserved for larger warts. It is done with **local anesthesia**, and may cause discharge or bleeding from the anus.

Follow-up visits to the physician are necessary to make sure that the warts have not recurred. It is recommended that these patients see their physicians every three to six months for up to 1.5 years, which is how long the incubation period is for the HPV virus.

Carbon dioxide laser treatment and electrodesiccation are other options, but these are usually reserved for extensive warts or those that continue to recur despite numerous treatments. However, because HPV virus can be transmitted via the smoke caused by these procedures, they are usually reserved for the worst infections.

For small warts that affect only the skin around the anus, several medications are available, which can be applied directly to the surface of the warts by a physician or by the patients themselves.

Such medications include podophyllum resin (Podocon-25, Pod-Ben-25), a substance made from the cytotoxic extracts of several plants. This agent offers a cure rate of 20–50% when used alone, and is applied by the physician weekly and then washed off 6 hours later by the patient.

Podofilox (Condylox) is another agent, and is available for patients to use at home. It can be applied twice daily for up to four weeks. Podofilox offers a slightly higher cure rate than podophyllin, and can also be used to prevent warts.

Trichloroacetic and bichloroacetic acids are available in several concentrations up to 80% for the treatment of condyloma acuminata. These acids work to cauterize the skin, and are quite caustic. Nevertheless, they cause less irritation and overall body effects than the other agents mentioned above. Recurrence, however, is higher with these acids.

Bleomycin (Blenoxane) is another treatment option, but it has several drawbacks. First, it must be administered by a physician into each lesion via injection, but it can have a host of side effects, and patients must be followed carefully by their physician.

Imiquimod 5% cream is also available for patients to apply themselves. It is to be applied three times weekly, for up to 16 weeks, and has been shown to clear warts within eight to 10 weeks.

Finally, the interferon drugs, which are naturally occurring proteins that have antiviral and antitumor effects, are available. These include interferon alfa 2a and 2b (Roferon, Intron A), which are to be injected into each lesion twice a week for up to eight weeks.

### Prognosis

Once a diagnosis of anal warts has been made, further outbreaks can be controlled or sometimes prevented with proper care. Unfortunately, many cases of

anal warts either fail to respond to treatment or recur. Patients have to undergo roughly six to nine treatments over several months to assure that the warts are completely eradicated.

Recurrence rates have been estimated to be over 50% after one year and may be due to the long incubation of HPV (up to 1.5 years), deep lesions, undetected lesions, virus present in surrounding skin that is not treated.

### Prevention

Sexual abstinence and monogamous relationships can be the most effective form of prevention, and **condoms** may also decrease the chances of transmission of condyloma acuminata. Abstinence from sexual relations with people who have anal or genital warts can prevent infection. Unfortunately, since many people may not be aware that they have this condition, this is not always possible.

Individuals infected with anal warts should have follow-up checkups every few weeks after their initial treatment, after which self-exams can be done.

Sexual partners of people who have anal warts should also be examined, as a precautionary preventive measure.

Finally, 5-flourouracil (Adrucil, Efudex, Fluoroplex) may be useful to prevent recurrence once the warts have been removed. Treatment must, however, be initiated within one month of wart removal.

### Resources

#### OTHER

<http://www.emedicine.com>.  
<http://www.mayohealth.org>.

#### ORGANIZATIONS

Centers for Disease Control and Prevention. Sexually Transmitted Diseases, 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, <http://www.cdc.gov/STD/>.

Liz Meszaros

## Analgesics

### Definition

Analgesics are medicines that relieve **pain**.

### Purpose

Analgesics are those drugs that mainly provide pain relief. The primary classes of analgesics are

## KEY TERMS

**Acute pain**—Pain that is usually temporary and results from something specific, such as a surgery, an injury, or an infection.

**Analgesic**—Medicine used to relieve pain.

**Chronic pain**—Pain that lasts more than three months and threatens to disrupt daily life.

**Inflammation**—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

**Osteoarthritis**—Joint pain resulting from damage to the cartilage.

**Peripheral nervous system**—Nerves that are not found in the brain or spinal cord.

the **narcotics**, including additional agents that are chemically based on the morphine molecule but have minimal **abuse** potential; **nonsteroidal anti-inflammatory drugs** (NSAIDs) including the salicylates; and **acetaminophen**. Other drugs, notably the **tricyclic antidepressants** and anti-epileptic agents such as gabapentin, have been used to relieve pain, particularly neurologic pain, but are not routinely classified as analgesics. Analgesics provide symptomatic relief, but generally have no effect on the cause, although NSAIDs, by virtue of their anti-inflammatory and pain relief activity, may be beneficial in both regards.

### Description

Pain has been classified as “productive” pain and “non-productive” pain. While this distinction has no physiologic meaning, it may serve as a guide to treatment. “Productive” pain has been described as a warning of injury, and so may be both an indication of need for treatment and a guide to diagnosis. “Non-productive” pain by definition serves no purpose either as a warning or diagnostic tool.

Although pain syndromes may be dissimilar, the common factor is a sensory pathway from the affected organ to the brain. Analgesics work at the level of the nerves, either by blocking the signal traveling from the peripheral nervous system so that it does not reach the brain, or by altering the interpretation of the signal by the brain. There is a high degree of variation in both an individual's tolerance for pain and in the way an individual responds to various analgesics. Selection of an appropriate analgesic is based on consideration of the risk-benefit factors of

each class of drugs, based on type of pain, severity of pain, risk of adverse effects, and response of the individual to treatment.

Traditionally, pain has been divided into two classes: acute pain and chronic pain.

### **Acute pain**

Acute pain is self limiting in duration, and includes post-operative pain, pain of injury, and **childbirth**. Because acute pain is expected to be short term, the long-term side effects of analgesic therapy generally may be ignored. Thus, these patients may safely be treated with narcotic analgesics without concern about possible **addiction**, or NSAIDs with only limited concern for the risk of ulcers. Drugs and doses should be adjusted based on observation of healing rate, switching patients from high to low doses, and from narcotic analgesics to non-narcotics when circumstances permit.

An important consideration in the management of severe pain is that patients should not be subject to the return of pain. Analgesics should be dosed adequately to ensure that the pain is at least tolerable. Drug administration should be frequent enough to avoid the **anxiety** that accompanies the anticipated return of pain.

### **Chronic pain**

Chronic pain is pain lasting more than three months and severe enough to impair function. It is more difficult to treat than acute pain, since the anticipated side effects of the analgesics are more difficult to manage. In the case of narcotic analgesics this means considering the addiction potential, as well as respiratory depression and **constipation**. For the NSAIDs, the risk of gastric ulcers limit dose. Generally, chronic **pain management** requires a combination of drug therapy, life-style modification, and other treatment modalities.

While some classes of drugs, such as the narcotic agonist/antagonist drugs buprenorphine, nalbuphine, and pentazocine, and the selective COX-2 inhibitor celecoxib (Celebrex) represent an advance in reduction of adverse effects, they are still not fully suitable for long-term management of severe pain. In 2004, the COX-2 inhibitor rofecoxib (Vioxx) was withdrawn from the market in the United States followed by valdecoxib (Bextra) in 2005 because of an increased risk of **heart attack** and **stroke** and severe skin toxicity. Celecoxib (Celebrex) remains the only COX-2 inhibitor available in the United States. It does not carry the

same increased cardiovascular risks as the withdrawn drugs.

### **Narcotic analgesics**

The narcotic analgesics, also termed opioids, are all derived from opium. The class includes morphine, codeine, and a number of semi-synthetics including meperidine (Demerol), oxycodone (OxyContin), oxymorphone (Opana), fentanyl (Duragesic, Fentanyl patch), and others. The narcotic analgesics vary in potency, but all are effective in treatment of pain when used in adequate doses. Adverse effects are dose related. Because these drugs are all addictive, they are controlled under federal and state laws. A variety of dosage forms are available, including oral solids, liquids, intravenous, intrathecal injections (injections into the fluid surrounding the spinal cord and brain), and transcutaneous (skin) patches.

### **NSAID analgesics**

NSAIDs are effective analgesics even at doses too low to have any anti-inflammatory effects. There are a number of chemical classes, but all have similar therapeutic effects and side effects. Common NSAIDs available without prescription include naproxen (Aleve), ibuprofen (Advil, Motrin, Pamprin, Nuprin) and **aspirin**. Ibuprofen and aspirin act more rapidly but for a shorter duration than naproxen. Over-the-counter NSAIDs are appropriate only for oral administration. Other oral NSAIDs are available only by prescription. In addition prescription ketorolac (Toradol) is appropriate for injection and may be used in moderate to severe pain for short periods.

Acetaminophen (Tylenol) is a non-narcotic analgesic with no anti-inflammatory properties. It is appropriate for mild to moderate pain. Although the drug is well tolerated in normal doses, it may have significant liver toxicity at high doses. Because acetaminophen is largely free of side effects at therapeutic doses, it has been considered the first choice for mild pain, including that of **osteoarthritis**.

Topical analgesics (topical being those that are applied on the skin) have become much more popular in recent years. Those applied for local effect include capsaicin, methylsalicylate, and transdermal lidocaine. Transdermal fentanyl may be applied for systemic (the entire body in general) effect. In some cases, these topical agents reduce the need for drug therapy. Sales of pain relief patches have increased substantially in recent years. They are particularly useful

for elderly patients who may not want to take a lot of tablets.

### Recommended dosage

Appropriate dosage varies by drug, and should be determined by the type of pain, as well as other risks associated with patient's age and condition. For example, narcotic analgesics should usually be avoided in patients with a history of **substance abuse**, but may be fully appropriate in patients with **cancer** pain. Similarly, because narcotics are more rapidly metabolized in patients who have used these drugs for a long period, higher than normal doses may be needed to provide adequate pain management. NSAIDs, although comparatively safe in adults, represent an increased risk of gastrointestinal bleeding in patients over the age of 60.

### Precautions

Narcotic analgesics may be contraindicated in patients with respiratory depression. NSAIDS may be hazardous to patients with ulcers or an ulcer history. They should be used with care in patients with renal (kidney) disease or blood **coagulation disorders**. NSAIDs should not be given to patients who are allergic to aspirin.

### Side effects

Each drug's adverse effects should be reviewed individually. Drugs within a class may vary in their frequency and severity of adverse effects.

The primary adverse effects of the narcotic analgesics are addiction, constipation, and respiratory depression. Because narcotic analgesics stimulate the production of enzymes that cause the metabolism of these drugs, patients on narcotics for a prolonged period may require increasing doses. This is not the same thing as addiction, and is not a reason for withholding medication from patients in severe pain.

NSAIDs can lead to ulcers and may cause kidney problems. Gastrointestinal discomfort is common especially with prolonged high doses, although in some cases, these drugs may cause ulcers without the warning of gastrointestinal distress. Platelet aggregation (blood clotting) problems may occur, although not to the same extent as is seen with aspirin.

### Interactions

Interactions depend on the specific type of analgesic. Information on specific interactions can be

found by reading the packaging information or by asking the pharmacist or prescribing physician.

## Resources

### BOOKS

Wallace, Mark S., and Peter S. Staats. *Pain Medicine and Management: Just the Facts*. New York: McGraw-Hill Professional, 2004.

### OTHER

Helm, Standiford. "Pain Relief Medications." *eMedicine Health.com*. July 19, 2007 [accessed June 2, 2008]. [http://www.emedicinehealth.com/pain\\_medications/article\\_em.htm](http://www.emedicinehealth.com/pain_medications/article_em.htm).

Krames, Elliot. "Pain Medicine—Using the Tools of the Trade." *National Pain Foundation*. March 27, 2008 [accessed June 2, 2008]. [http://www.pacpain.com/docs/PPTC\\_Tools\\_of\\_the\\_trade.pdf](http://www.pacpain.com/docs/PPTC_Tools_of_the_trade.pdf).

"Over-the-counter Pain Medications: Reading the Labels." *MayoClinic.com*. April 5, 2007 [accessed June 2, 2008]. <http://www.mayoclinic.com/health/pain-medications/PN00066>.

### ORGANIZATIONS

American Pain Foundation, 201 North Charles Street, Suite 710, Baltimore, MD, (888) 615-7246, info@painfoundation.org, <http://www.painfoundation.org>.

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## Analgesics, opioid

### Definition

Opioid **analgesics**, also known as narcotic analgesics, are **pain** relievers that act on the central nervous system. Like all **narcotics**, they may become habit-forming if used over long periods.

### Purpose

Opioid analgesics are used to relieve pain from a variety of conditions. Some are used before or during surgery (including dental surgery) both to relieve pain and to make anesthetics work more effectively. They may also be used for the same purposes during labor and delivery.

Opioids are also given to relieve the pain of terminal **cancer**, **diabetic neuropathy**, lower back pain, and other chronic diseases or disorders. The World Health Organization (WHO) has established a three-stage "ladder" for the use of opioids in managing cancer pain.

<b>Opioid analgesics</b>				
Drug	Route of administration	Onset of action (min)	Time to peak effect (min)	Duration of action (h)
<b>Strong agonists</b>				
Fentanyl (Sublimaze)	IM IV	7–15 1–2	20–30 3–5	1–2 0.5–1
Hydromorphone (Dilaudid)	Oral IM IV Sub-Q	30 15 10–15 30	90–120 30–60	4 2–3 15–30
Levorphanol (Levo-Dromoran)	Oral IM IV Sub-Q	10–60 — 10–60	90–120 60 within 20	4–5 4–5
Meperidine (Demerol)	Oral IM IV Sub-Q	15 10–15 30–50 1	60–90 2–4	2–4
Methadone (Dolophine)	Oral IM IV	30–60 10–20	90–120 60–120	4–6 4–5
Morphine (many trade names)	Oral IM IV Sub-Q Epidural	— 10–30 — 10–30	60–120 30–60 20	4–5 4–5 4–5
Oxycodone, extended release (Oxycontin)	Oral	—	—	8–12
Oxymorphone (Numorphan)	IM IV Sub-Q Rectal	10–15 5–10	30–90 15–30	3–6 3–4
<b>Mild-to-moderate agonists</b>				
Butorphanol	IM IV	10–30 2–3	30–60 30	3–4 2–4
Codeine (many trade names)	Oral IM Sub-Q	30–40 10–30 10–30	60–120 30–60 —	4 4 4
Hydrocodone (Hycodan)	Oral	10–30	30–60	4–6
Nalbuphine (Nubain)	IM IV Sub-Q	within 15 2–3 within 15	60 30 —	3–6 3–4 3–6
Oxycodone, immediate release (Percodan)	Oral	—	60	3–4
Pentazocine (Talwin)	Oral IM IV	15–30 15–20 2–3	60–90 30–60 15–30	3 2–3 2–3
Propoxyphene (Darvon, Dolene)	Oral Sub-Q	15–60 15–20	120 30–60	4–6 2–3

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## Description

Opioid analgesics relieve pain by acting directly on the central nervous system. However, this can also lead to unwanted side effects, such as drowsiness, **dizziness**, breathing problems, **nausea**, and physical or mental dependence.

## U.S. brand names

U.S. brand names for some drugs in this category include:

- codeine
- propoxyphene (Darvon) (taken off the market in November 2010)

## KEY TERMS

**Analgesic**—Medicine used to relieve pain.

**Central nervous system**—The brain and spinal cord.

**Colitis**—Inflammation of the colon (large bowel).

**Hallucination**—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

**Inflammation**—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

**Narcotic**—A drug derived from opium or compounds similar to opium. Such drugs are potent

pain relievers and can affect mood and behavior. Long-term use of narcotics can lead to dependence and tolerance.

**Tolerance**—A decrease in sensitivity to a drug. When tolerance occurs, a person must take more and more of the drug to get the same effect.

**Withdrawal symptoms**—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug to which he or she has become dependent.

- propoxyphene and acetaminophen (Darvocet N, taken off the market in November 2010)
- meperidine (Demerol)
- hydromorphone (Dilaudid)
- morphine (Astamorph PF, Avinza, Depo-Dur, Duramorph, Infumorph, Kadian, MS Contin, MSIR, Oramorph SR, RMS, Roxanol)
- oxycodone (OxyContin)
- oxycodone combined with acetaminophen (Percocet, Roxicet)
- hydrocodone combined with acetaminophen (Lortab, Anexia, Vicodin)
- fentanyl (Duragesic), oxymorphone (Opana)
- methadone (Methadose)

These drugs come in many forms—tablets, syrups, suppositories, and injections, and are sold only by prescription. For some, a new prescription is required for each new supply—refills are prohibited according to federal regulations. Some of these drugs also require that a tamper-proof physical prescription be brought to the pharmacy rather than having the prescription called or faxed in by the physician.

### **Canadian brand names**

Canadian brand names for some drugs in this category include:

- codeine (Paveral)
- morphine (Epimorph, Statex)
- meperidine (Pethadol, Pethidine Hydrochloride)

### **Recommended dosage**

Recommended doses vary depending on the type of opioid analgesic and the form in which it is being used. Doses may be different for different patients

depending on their size, age, and physical condition. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for correct dosages, and make sure to understand how to take the drug. Do not stop taking the drug suddenly without checking with the physician or dentist who prescribed it. Gradually tapering (lowering) the dose may reduce the chance of withdrawal symptoms.

### **Precautions**

Anyone who uses opioid analgesics—or any narcotic—over a long time may become physically or mentally dependent on the drug. Physical dependence may lead to withdrawal symptoms when the person stops taking the medicine. Building tolerance to these drugs is also possible when they are used for a long period. Over time, the body needs larger and larger doses achieve the same level of pain relief.

Opioid analgesics should always be taken exactly as directed. Never take larger or more frequent doses, and do not take the drug for longer than directed. If the drugs do not seem to be working, consult a physician. Do not share these or any other prescription drugs with others because the drug may have a completely different effect on the person for whom it was not prescribed.

The effects of alcohol are increased by opioid analgesics. Anyone taking these drugs should not drink alcoholic beverages.

Some of these drugs may also contain **aspirin**, **caffeine**, or **acetaminophen**.

### **Pediatric**

Children are especially sensitive to opioid analgesics and may have serious breathing problems after

taking them. Children may also become unusually restless or agitated when given these drugs.

### ***Geriatric***

Like children, geriatric patients are highly sensitive to opioid analgesics and may experience serious breathing problems after taking them.

### ***Pregnant or breastfeeding***

It is generally best to avoid taking opioid analgesics during **pregnancy**. Women who are pregnant or plan to become pregnant while taking opioid analgesics should let their physicians know. No evidence exists that these drugs cause **birth defects** in people, but some do cause birth defects and other problems when given to pregnant animals in experiments. Babies can become dependent on opioid analgesics if their mothers use too much during pregnancy. This can cause the baby to go through withdrawal symptoms after birth. If taken just before delivery, some opioid analgesics may cause serious breathing problems in the newborn.

Some opioid analgesics can pass into breast milk and may affect the nursing baby. Women who are breast feeding should check with their physicians about the safety of taking these drugs.

### ***Other conditions and allergies***

The effects of opioid analgesics may be altered in the presence of these conditions:

- Head injury
- History of convulsions
- Asthma, emphysema, or any chronic lung disease
- Heart disease
- Kidney disease
- Liver disease
- HIV infection
- Underactive thyroid—the chance of side effects may be greater
- Addison's disease (a disease of the adrenal glands)
- Colitis
- Gallbladder disease or gallstones
- Enlarged prostate or other urinary problems
- Current or past alcohol abuse
- Current or past drug abuse, especially narcotic abuse
- Current or past emotional problems—The chance of side effects may be greater

Let the prescriber know about any **allergies** to food, dyes, preservatives, or other substances and about any previous reactions to opioid analgesics.

### **Side effects**

Some people experience drowsiness, dizziness, lightheadedness, or a false sense of well-being after taking opioid analgesics. Anyone who takes these drugs should not drive, use machinery, or do anything else that might be dangerous until they know how the drug affects them. **Nausea and vomiting** are common side effects, especially when beginning to take the medicine. If these symptoms do not go away after the first few doses, check with the physician or dentist who prescribed the medicine.

**Dry mouth** is another common side effect. Dry mouth can be relieved by sucking on sugarless hard candy or ice chips or by chewing sugarless gum. Saliva substitutes, which come in liquid or tablet forms, also may help. Patients who must use opioid analgesics over long periods and who have dry mouth should see their dentists, as the problem can lead to **tooth decay** and other dental problems.

These side effects may be serious and require quick medical attention. These symptoms could be signs of an overdose. Get emergency medical care immediately.

- cold, clammy skin
- bluish discoloration of the skin
- extremely small pupils
- serious difficulty breathing or extremely slow breathing
- extreme sleepiness or unresponsiveness
- severe weakness
- confusion
- severe dizziness
- severe drowsiness
- slow heartbeat
- low blood pressure
- severe nervousness or restlessness

These less common side effects do not require emergency medical care, but should have medical attention as soon as possible:

- hallucinations or a sense of unreality
- depression or other mood changes
- ringing or buzzing in the ears
- pounding or unusually fast heartbeat
- itching, hives, or rash
- facial swelling

- trembling or twitching
- dark urine, pale stools, or yellow eyes or skin (after taking propoxyphene)
- increased sweating, red or flushed face (more common after taking hydrocodone and meperidine)

The following side effects usually do not need medical attention and disappear after the first few doses. If they continue or interfere with normal activity, check with the physician who prescribed the medicine.

- headache
- loss of appetite
- restlessness or nervousness
- nightmares, unusual dreams, or problems sleeping
- weakness or fatigue
- mental sluggishness
- stomach pain or cramps
- blurred or double vision or other vision problems
- problems urinating, such as pain, difficulty urinating, frequent urge to urinate, or decreased amount of urine
- constipation

## Interactions

Anyone taking the following drugs should notify his or her physician before taking opioid analgesics:

- Central nervous system (CNS) depressants, such as antihistamines and other medicines for allergies, hay fever, or colds; tranquilizers; some other prescription pain relievers; seizure medicines; muscle relaxants; sleeping pills; some anesthetics (including dental anesthetics).
- Monoamine oxidase (MAO) inhibitors, such as phenelzine (Nardil) and tranylcypromine (Parnate). The combination of the opioid analgesic meperidine (Demerol) and MAO inhibitors is especially dangerous.
- Tricyclic antidepressants, such as amitriptyline (Elavil).
- Anti-seizure medicines, such as carbamazepine (Tegretol). May lead to serious side effects, including coma, when combined with propoxyphene and acetaminophen (Darvocet-N) or propoxyphene (Darvon). Note: Darvon and Darvacet were taken off the market in November 2010 due to adverse and dangerous side effects.
- Muscle relaxants, such as cyclobenzaprine (Flexeril).
- Sleeping pills, such as triazolam (Halcion).
- Blood-thinning drugs, such as warfarin (Coumadin).

- Naltrexone (Trexan, Revia). Cancels the effects of opioid analgesics.
- Rifampin (Rifadin).
- Zidovudine (AZT, Retrovir). Serious side effects when combined with morphine.

Opioids may also interact with certain herbal preparations sold as dietary supplements. Among the herbs known to interact with opioids are valerian (*Valeriana officinalis*), **ginseng** (*Panax ginseng*), kava kava (*Piper methysticum*), and chamomile (*Matricaria chamomilla*). It is just as important for patients to inform their doctor of herbal remedies that they take on a regular basis as it is to give the doctor a list of their other prescription medications.

## Resources

### PERIODICALS

- Manchikanti, K.N., et al. "Increasing Deaths from Opioid Analgesics in the United States: An Evaluation of an Interventional Pain Management Practice." *Journal of Opioid Management* 4, no. 5 (September-October 2008): 271-83.
- Manchikanti, K.N., L. Manchikanti, V. Pampati, and V.A. Cash. "Prevalance of Side Effects of Prolonged Low or Moderate Dose Opioid Therapy with Concomitant Benzodiazepine and/or Antidepressant Therapy in Chronic Non-cancer Pain." *Pain Physician* 12, no. 1 (January-February 2009): 259-67.
- Stanos, S.P., D.A. Fishbain, and S.M. Fishman. "Pain Management with Opioid Analgesics: Balancing Risk and Benefit." *American Journal of Physical Medicine & Rehabilitation* 88, supplement 2 (2009): S69-S99.
- Trescot, A.M., et al. "Opioids in the Management of Chronic Non-cancer Pain: An Update of the American Society of Interventional Pain Physicians (ASIPP) Guidelines." *Pain Physician* 11, supplement 2 (Mar 2008): S5-S62.

### OTHER

- "Pain PDQ." *National Cancer Institute*. April 20, 2010. <http://www.cancer.gov/cancertopics/pdq/supportive-care/pain/Patient> accessed July 21, 2010.

### ORGANIZATIONS

- The National Pain Foundation, 300 E Hampden Avenue, Suite 100, Englewood, CO, 80113, <http://www.nationalpainfoundation.org>.

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Anaphylactic shock see **Anaphylaxis**

Anaphylactoid purpura see **Allergic purpura**

# Anaphylaxis

## Definition

Anaphylaxis is a rapidly progressing, life-threatening allergic reaction.

## Description

Anaphylaxis is a type of allergic reaction, in which the immune system responds to otherwise harmless substances from the environment. Unlike other allergic reactions, however, anaphylaxis can kill. Reaction may begin within minutes or even seconds of exposure, and rapidly progress to cause airway constriction, skin and intestinal irritation, and altered heart rhythms. In severe cases, it can result in complete airway obstruction, shock, and **death**.

## Causes and symptoms

### Causes

Like the majority of other allergic reactions, anaphylaxis is caused by the release of histamine and other chemicals from mast cells. Mast cells are a type of white blood cell and they are found in large numbers in the tissues that regulate exchange with the environment: the airways, digestive system, and skin.

On their surfaces, mast cells display antibodies called IgE (immunoglobulin type E). These antibodies are designed to detect environmental substances to which the immune system is sensitive. Substances from a genuinely threatening source, such as bacteria or viruses, are called antigens. A substance that most people tolerate well, but to which others have an allergic response, is called an allergen. When IgE antibodies bind with allergens, they cause the mast cell to release histamine and other chemicals, which spill out onto neighboring cells.

The interaction of these chemicals with receptors on the surface of blood vessels causes the vessels to leak fluid into surrounding tissues, causing fluid accumulation, redness, and swelling. On the smooth muscle cells of the airways and digestive system, they cause constriction. On nerve endings, they increase sensitivity and cause **itching**.

In anaphylaxis, the dramatic response is due both to extreme hypersensitivity to the allergen and its usually systemic distribution. Allergens are more likely to cause anaphylaxis if they are introduced directly into the circulatory system by injection. However, exposure by ingestion, inhalation, or skin contact can also

## KEY TERMS

**ACTH**—Adrenocorticotrophic hormone, a hormone normally produced by the pituitary gland, sometimes taken as a treatment for arthritis and other disorders.

**Antibody**—An immune system protein which binds to a substance from the environment.

**NSAIDs**—Non-steroidal antiinflammatory drugs, including aspirin and ibuprofen.

**Tracheostomy tube**—A tube which is inserted into an incision in the trachea (tracheostomy) to relieve upper airway obstruction.

cause anaphylaxis. In some cases, anaphylaxis may develop over time from less severe **allergies**.

Anaphylaxis is most often due to allergens in foods, drugs, and insect venom. Specific causes include:

- Fish, shellfish, and mollusks
- Nuts and seeds
- Stings of bees, wasps, or hornets
- Papain from meat tenderizers
- Vaccines, including flu and measles vaccines
- Penicillin
- Cephalosporins
- Streptomycin
- Gamma globulin
- Insulin
- Hormones (ACTH, thyroid-stimulating hormone)
- Aspirin and other NSAIDs
- Latex, from exam gloves or condoms, for example.

Exposure to cold or **exercise** can trigger anaphylaxis in some individuals.

### Symptoms

Symptoms may include:

- Urticaria (hives)
- Swelling and irritation of the tongue or mouth
- Swelling of the sinuses
- Difficulty breathing
- Wheezing
- Cramping, vomiting, or diarrhea
- Anxiety or confusion
- Strong, very rapid heartbeat (palpitations)
- Loss of consciousness

## Diagnosis

Anaphylaxis is diagnosed based on the rapid development of symptoms in response to a suspect allergen. Identification of the culprit may be done with RAST testing, a blood test that identifies IgE reactions to specific allergens. Skin testing may be done for less severe anaphylactic reactions.

## Treatment

Emergency treatment of anaphylaxis involves injection of adrenaline (epinephrine) which constricts blood vessels and counteracts the effects of histamine. Oxygen may be given, as well as intravenous replacement fluids. **Antihistamines** may be used for skin rash, and aminophylline for bronchial constriction. If the upper airway is obstructed, placement of a breathing tube or tracheostomy tube may be needed.

## Prognosis

The rapidity of symptom development is an indication of the likely severity of reaction: the faster symptoms develop, the more severe the ultimate reaction. Prompt emergency medical attention and close monitoring reduces the likelihood of death. Nonetheless, death is possible from severe anaphylaxis. For most people who receive rapid treatment, recovery is complete.

## Prevention

Avoidance of the allergic trigger is the only reliable method of preventing anaphylaxis. For insect allergies, this requires recognizing likely nest sites. Preventing **food allergies** requires knowledge of the prepared foods or dishes in which the allergen is likely to occur, and careful questioning about ingredients when dining out. Use of a Medic-Alert tag detailing drug allergies is vital to prevent inadvertent administration during a medical emergency.

People prone to anaphylaxis should carry an “Epi-pen” or “Ana-kit,” which contain an adrenaline dose ready for injection.

## Resources

### OTHER

*The Merck Page.* <http://www.merck.com>.

Richard Robinson

## Anemias

### Definition

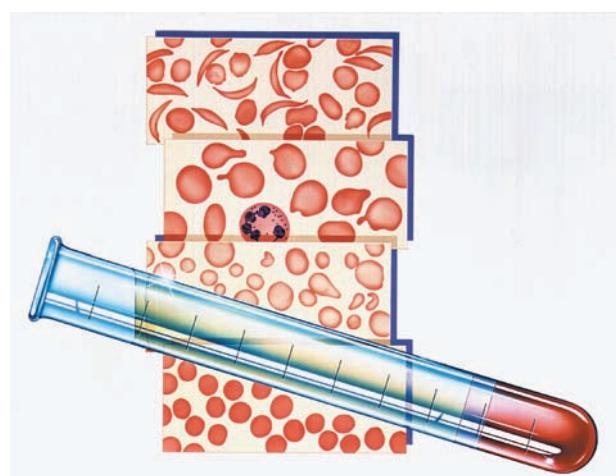
Anemia is a condition characterized by abnormally low levels of healthy red blood cells or hemoglobin (the component of red blood cells that delivers oxygen to tissues throughout the body). It is sometimes referred to as iron-poor blood or “tired blood.”

### Demographics

The exact number of people in any country with anemia is difficult to determine because the disorder often goes undiagnosed. According to the National Heart, Lung, and Blood Institute (NHLBI), anemia affects more than 3 million Americans. Other sources estimate that 4% of men and 8% of women in the general populations of Canada, the United States, and Western Europe have mild anemia. It is thought that the rates of anemia are 2-5 times higher in the developing countries.

According to the World Health Organization (WHO), iron deficiency is the most important nutritional disorder in the world. WHO estimates that 80% of the world’s population may be iron deficient. The prevalence of vitamin B<sub>12</sub> deficiency among the geriatric population is estimated at 5-15%.

Although the prevalence of anemia is greater in women than men aged less than 75, by age 75, male prevalence surpasses female prevalence by about 5%.



An illustration of normal red blood cells (left) and those in three different types of anemia (from left), iron-deficiency anemia, megaloblastic anemia, and sickle cell anemia.  
(Custom Medical Stock Photo, Inc. Reproduced by permission.)

## Description

WHO defines anemia as a hemoglobin level lower than 13 g/dL in men and lower than 12 g/dL in women. Hemoglobin is a protein found in red blood cells (RBCs). It has an active site called a heme that contains iron. The heme iron binds oxygen in the lungs for transport to the rest of the body where it releases the oxygen. A decrease of RBCs means a decrease of hemoglobin and a decrease of iron levels. Iron is essential to most life forms and to human health. A deficiency of iron impairs oxygen delivery to cells, resulting in **fatigue**, poor physical performance, and decreased immunity.

The tissues of the human body need a regular supply of oxygen to stay healthy. Red blood cells live for only about 120 days. When they die, the iron they contain is returned to the bone marrow and used to create new red blood cells. Anemia develops when heavy bleeding causes significant iron loss; when something happens to slow down the production of red blood cells; or to increase the rate at which they are destroyed.

### *Types of anemia*

Anemia can be mild, moderate, or severe enough to lead to life-threatening complications. More than 400 different types of anemia have been identified, many of which are rare.

**IRON DEFICIENCY ANEMIA.** The onset of **iron deficiency anemia** is gradual and, at first, there may not be any symptoms. The deficiency begins when the body loses more iron than it derives from food and other sources. Because depleted iron stores cannot meet the red blood cell's needs, fewer red blood cells develop. In this early stage of anemia, the red blood cells look normal but they are reduced in number. Then the body tries to compensate for the iron deficiency by producing more red blood cells, which are characteristically small in size. Symptoms of anemia develop at this stage.

**FOLIC ACID DEFICIENCY ANEMIA.** **Folic acid** anemia is especially common in infants and teenagers. Although this condition usually results from a dietary deficiency, it is sometimes due to inability to absorb enough folic acid from such foods as:

- cheese
- eggs
- fish
- green vegetables
- meat
- milk

- mushrooms

- yeast

**Smoking** raises the risk of developing this condition by interfering with the absorption of vitamin C, which the body needs to absorb folic acid. Folic acid anemia can be a complication of **pregnancy**, when a woman's body needs eight times more folic acid than it does otherwise.

**VITAMIN B<sub>12</sub> DEFICIENCY ANEMIA.** Less common in the United States and Canada than folic acid anemia, vitamin B<sub>12</sub> deficiency anemia is another type of megaloblastic anemia that develops when the body fails to absorb enough of this nutrient. Necessary for the creation of red blood cells, B<sub>12</sub> is found in meat and vegetables.

Large amounts of B<sub>12</sub> are stored in the body, so this condition may not become apparent until as much as four years after B<sub>12</sub> absorption stops or slows down. The resulting drop in red blood cell production can cause:

- loss of muscle control
- loss of sensation in the legs, hands, and feet
- soreness or burning of the tongue
- weight loss
- yellow-blue color blindness

The most common form of B<sub>12</sub> deficiency is **pernicious anemia**. Since most people who eat meat or eggs get enough B<sub>12</sub> in their **diets**, a deficiency of this vitamin usually means that the body is not absorbing it properly. This problem can occur among people who have had intestinal surgery or among those who do not produce adequate amounts of intrinsic factor, a chemical secreted by the stomach lining that combines with B<sub>12</sub> to help its absorption in the small intestine.

Pernicious anemia usually strikes between the ages of 50 and 60. **Eating disorders** or an unbalanced diet increase the risk of developing pernicious anemia. So do:

- diabetes mellitus
- gastritis, stomach cancer, or stomach surgery
- thyroid disease
- family history of pernicious anemia

**VITAMIN C DEFICIENCY ANEMIA.** A rare disorder that causes the bone marrow to manufacture abnormally small red blood cells, vitamin C deficiency anemia results from a severe and long-standing dietary deficiency.

**HEMOLYTIC ANEMIA.** Some people are born with **hemolytic anemia**. Some acquire this condition, in

which infection or antibodies destroy red blood cells more rapidly than bone marrow can replace them.

Hemolytic anemia can enlarge the spleen, accelerating the destruction of red blood cells (hemolysis). Other complications of hemolytic anemia include:

- pain
- shock
- gallstones and other serious health problems

**THALASSEMIA.** An inherited form of hemolytic anemia caused by mutations on either chromosome 11 or chromosome 16, **thalassemia** stems from the body's inability to manufacture as much normal hemoglobin as it needs. There are two categories of thalassemia, depending on which of the amino acid chains is affected (hemoglobin is composed of four chains of amino acids). In alpha-thalassemia, there is an imbalance in the production of the alpha chain of amino acids; in beta-thalassemia, there is an imbalance in the beta chain. Alpha-thalassemias most commonly affect people of African descent (25% have at least one gene for the disorder); beta-thalassemias most commonly affect people of Mediterranean ancestry and Southeast Asians. The most severe form of beta-thalassemia is also known as Cooley's anemia, named for the American pediatrician who first identified it.

Characterized by production of red blood cells that are unusually small and fragile, thalassemia affects only people who inherit the gene for it from both parents. This pattern is called autosomal recessive inheritance.

**AUTOIMMUNE HEMOLYTIC ANEMIAS.** Warm antibody hemolytic anemia is the most common type of this disorder. This condition occurs when the body produces autoantibodies that coat red blood cells. The coated cells are destroyed by the spleen, liver, or bone marrow.

Warm antibody hemolytic anemia is more common in women than in men. About one-third of patients who have warm antibody hemolytic anemia also have lymphoma, leukemia, lupus, or connective tissue disease.

In cold antibody hemolytic anemia, the body attacks red blood cells at or below normal body temperature. The acute form of this condition frequently develops in people who have had **pneumonia**, mononucleosis, or other acute infections. It tends to be mild and short-lived, and disappears without treatment.

Chronic cold antibody hemolytic anemia is most common in women and most often affects those who are over 40 and who have arthritis. This condition usually lasts for a lifetime, generally causing few

symptoms. However, exposure to cold temperatures can accelerate red blood cell destruction, causing fatigue, joint aches, and discoloration of the arms and hands.

**SICKLE CELL ANEMIA.** Sickle cell anemia is a chronic, incurable condition that causes the body to produce defective hemoglobin, which forces red blood cells to assume an abnormal crescent shape. Unlike normal oval cells, fragile sickle cells can't hold enough hemoglobin to nourish body tissues. The deformed shape makes it hard for sickle cells to pass through narrow blood vessels. When capillaries become obstructed, a life-threatening condition called sickle cell crisis is likely to occur.

Sickle cell anemia is hereditary. It almost always affects blacks and people of Mediterranean descent. A child who inherits the sickle cell gene from each parent will have the disease. A child who inherits the sickle cell gene from only one parent carries the sickle cell trait, but does not have the disease.

**APLASTIC ANEMIA.** Sometimes curable by bone marrow transplant, but potentially fatal, **aplastic anemia** is characterized by decreased production of red and white blood cells and platelets (disc-shaped cells that allow the blood to clot). This disorder may be inherited or acquired as a result of:

- recent severe illness
- long-term exposure to industrial chemicals
- use of anticancer drugs and certain other medications

**ANEMIA OF CHRONIC DISEASE.** **Cancer**, chronic infection or inflammation, and kidney and **liver disease** often cause mild or moderate anemia. Chronic liver failure generally produces the most severe symptoms. People infected with the Human **immunodeficiency** virus (HIV) that causes **AIDS** often face severe fatigue.

### Risk factors

Risk factors for anemia include a variety of medical, genetic, environmental, and lifestyle factors:

- Female sex. Menstruation and pregnancy increase the risk of anemia during a woman's childbearing years.
- Race. African Americans and people of Saudi Arabian ancestry are at increased risk of sickle cell anemia, while people of Mediterranean ancestry are at increased risk of thalassemia.
- Family history of anemia.
- Intestinal disorders that affect the body's ability to absorb nutrients. These include parasitic infections

## KEY TERMS

**Anemia of chronic disease (ACD)**—A blood disorder that results from a medical condition that affects the production and lifespan of red blood cells.

**Aplastic**—Exhibiting incomplete or faulty development.

**Cooley's anemia**—Another name for the most severe form of beta-thalassemia. It is named for Thomas Benton Cooley (1871–1945), an American pediatrician who first described it in the children of Italian immigrants.

**Erythropoietin**—A hormone that stimulates production of red blood cells.

**Hematocrit**—A laboratory test that determines the percentage of packed red blood cells in a given volume of blood.

**Hematology**—The medical specialty that deals with the blood and the organs that form blood.

**Hemoglobin**—An iron-containing pigment of red blood cells composed of four amino acid chains (alpha, beta, gamma, delta) that delivers oxygen from the lungs to the tissues of the body.

**Immunosuppressant**—A medicine that blocks the body's immune response.

**Megaloblast**—A large erythroblast (a red marrow cell that synthesizes hemoglobin).

**Pica**—A medical disorder characterized by cravings for dirt, ice cubes, paper, starch, clay, or other non-nutritive items. It is often a sign of iron deficiency or hemolytic anemia.

**Red blood cell (RBC)**—A cell found in blood that contains haemoglobin to bind oxygen and carry it to all parts of the body.

**Sickle cell anemia**—A blood disorder in which the body produces abnormally shaped red blood cells that look like a crescent or sickle and also contain an abnormal form of hemoglobin, which interferes with oxygen delivery to tissues.

**Sideroblastic anemia**—A disorder in which the body has adequate iron but is unable to incorporate it into hemoglobin.

**Thalassemia**—An inherited blood disorder characterized by abnormal red blood cells that are unable to carry enough oxygen throughout the body.

like hookworm as well as disorders like Crohn's disease.

- Chronic diseases like diabetes, kidney failure, liver disease, or cancer.
- Workplace exposure to toxic chemicals.
- Malnutrition.
- Alcoholism.
- Adherence to a strict vegetarian or vegan diet.
- Age below 2 years. Infants who drink a lot of cow's milk may not get enough iron in their diet.
- High levels of athletic activity. Such vigorous sports as jogging, long-distance running, and basketball can cause red blood cells to break down more rapidly in the bloodstream.

### Causes and symptoms

#### Causes

Anemia is caused by bleeding, decreased red blood cell production, or increased red blood cell destruction. Poor diet can contribute to vitamin deficiency and iron deficiency anemias in which fewer red blood cells are produced. Hereditary disorders and certain diseases can cause increased blood cell

destruction. However, excessive bleeding is the most common cause of anemia, and the speed with which blood loss occurs has a significant effect on the severity of symptoms. Chronic blood loss is usually a consequence of:

- cancer
- gastrointestinal tumors
- diverticulosis
- polyposis
- heavy menstrual flow
- hemorrhoids
- nosebleeds
- stomach ulcers
- long-standing alcohol abuse

Acute blood loss is usually the result of:

- childbirth
- injury
- a ruptured blood vessel
- surgery

When a large amount of blood is lost within a short time, blood pressure and the amount of oxygen

in the body drop suddenly. **Heart failure** and **death** can follow.

Loss of even one-third of the body's blood volume in the space of several hours can be fatal. More gradual blood loss is less serious, because the body has time to create new red blood cells to replace those that have been lost.

### Symptoms

Weakness, fatigue, and a run-down feeling may be signs of mild anemia. Skin that is pasty or sallow, or lack of color in the creases of the palm, gums, nail beds, or lining of the eyelids are other signs of anemia. Someone who is weak, tires easily, is often out of breath, and feels faint or dizzy may be severely anemic.

Other symptoms of anemia are:

- angina pectoris (chest pain, often accompanied by a choking sensation that provokes severe anxiety)
- pica (cravings for ice, paint chips, starch, clay, dirt, or other nonfood items)
- headache
- inability to concentrate, memory loss
- inflammation of the mouth (stomatitis) or tongue (glossitis)
- insomnia
- irregular heartbeat
- loss of appetite
- nails that are dry, brittle, or ridged
- rapid breathing
- sores in the mouth, throat, or rectum
- sweating
- swelling of the hands and feet
- thirst
- tinnitus (ringing in the ears)
- unexplained bleeding or bruising

In pernicious anemia, the tongue feels unusually slick. A patient with pernicious anemia may have:

- problems with movement or balance
- tingling in the hands and feet
- confusion, depression, and memory loss

Pernicious anemia can damage the spinal cord. A doctor should be notified whenever symptoms of this condition occur.

A doctor should also be notified if a patient who has been taking iron supplements develops:

- diarrhea
- cramps
- vomiting

### Diagnosis

Personal and family health history may suggest the presence of certain types of anemia. Anemia does not always have noticeable symptoms, however, and is sometimes diagnosed in the course of an examination for another disease or disorder.

### Examination

An office examination can yield some clues to anemia. The doctor may discover that the patient's heartbeat is irregular, that breathing is uneven or unusually rapid, or that the liver and spleen are enlarged. In some cases a **pelvic exam** (in women) or a rectal exam will indicate that the patient is losing blood.

### Tests

Laboratory tests that measure the percentage of red blood cells or the amount of hemoglobin in the blood are used to confirm diagnosis and determine which type of anemia is responsible for a patient's symptoms. X rays and examinations of bone marrow may be used to identify the source of bleeding.

Other tests that may be done include tests of the types of hemoglobin as well as the total amount of hemoglobin present in the patient's blood; measurement of the number of reticulocytes (young blood cells) in the blood; tests that measure the level of iron in the body; tests for vitamin deficiencies; and tests for signs of kidney failure. Children may be tested for signs of **lead poisoning**.

### Procedures

The doctor may send the patient to a gastroenterologist for an **endoscopy** if blood is found in the patient's stool. An endoscopy is a diagnostic procedure in which a tube is inserted into the patient's body to pinpoint the location of bleeding, tumors, or other problems.

### Treatment

#### Traditional

Treatment for anemia depends on what is causing the anemia:

- Iron deficiency anemia is usually treated with iron supplements, prescribed for several months or longer.
- A lifelong regimen of B<sub>12</sub> shots is necessary to control symptoms of pernicious anemia. The patient may be

advised to limit physical activity until treatment restores strength and balance.

- Folate deficiency anemia is treated with folic acid supplements.
- ACD can be treated with epoetin, a synthetic erythropoietin that stimulates the production of RBCs, but the focus is on treating the underlying disease.
- Aplastic anemia may be treated with blood transfusions to increase levels of red blood cells, or bone marrow transplants if the bone marrow cannot produce healthy blood cells.
- Anemia of chronic disease can be treated with erythropoietin, a hormone that stimulates production of red blood cells. It is sometimes used to treat anemia from kidney disease or cancer chemotherapy.
- Hemolytic anemia is treated by managing related infections and drugs that suppress the immune system (immunosuppressants). There is no specific treatment for cold-antibody hemolytic anemia. About one-third of patients with warm-antibody hemolytic anemia respond well to large doses of intravenous and oral corticosteroids, which are gradually discontinued as the patient's condition improves. Patients with this condition who don't respond to medical therapy must have the spleen surgically removed. This operation controls anemia in about one-half of the patients on whom it's performed. Immune-system suppressants are prescribed for patients whose surgery is not successful.
- Sickle cell anemia treatment may include the administration of oxygen, pain-relieving drugs, and fluids to reduce pain and prevent complications. Psychotherapy or counseling may help patients deal with the emotional impact of this condition.

In addition to iron, **vitamins**, and medicines prescribed to treat the underlying causes of anemia or to increase the production of RBCs, blood transfusions may be prescribed in some cases, as well as surgery to stop serious or life-threatening bleeding when it is causing anemia, for example, to control chronic bleeding from a stomach ulcer.

Medication or surgery may also be necessary to control heavy menstrual flow, repair a bleeding ulcer, or remove polyps (growths or nodules) from the bowels.

Patients with thalassemia usually do not require treatment. However, people with Cooley's anemia may require periodic hospitalization for blood transfusions and/or **bone marrow transplantation**.

## *Drugs*

Patients with sickle cell anemia may require **pain** relievers to treat periodic crises caused by the disease. Children with sickle cell anemia are usually given penicillin from 2 months to 5 years of age to prevent infections. Another drug that helps some patients with sickle cell anemia is hydroxyurea, a drug developed to treat cancer. Hydroxyurea stimulates the production of fetal hemoglobin, a type of hemoglobin usually found only in newborns. It can reduce the need for blood transfusions and the frequency of sickle cell crises.

## *Alternative*

### *Home remedies*

Anyone who has anemia caused by poor **nutrition** should modify his or her diet to include more vitamins, **minerals**, and iron. Vitamin C can stimulate iron absorption. The following foods are also good sources of iron:

- almonds
- broccoli
- dried beans
- dried fruits
- enriched breads and cereals
- lean red meat
- liver
- potatoes
- poultry
- rice
- shellfish
- tomatoes

Because light and heat destroy folic acid, fruits and vegetables should be eaten raw or cooked as little as possible.

## *Alternative treatment*

As is the case in standard medical treatment, the cause of the specific anemia will determine the alternative treatment recommended. If the cause is a deficiency, for example iron deficiency, folic acid deficiency, B<sub>12</sub> deficiency, or vitamin C deficiency, supplementation is the treatment. For extensive blood loss, the cause should be identified and corrected. Other types of anemias should be addressed on a deep healing level with crisis intervention when necessary.

Many alternative therapies for iron-deficiency anemia focus on adding iron-rich foods to the diet or

on techniques to improve circulation and digestion. Iron supplementation, especially with iron citrate (less likely to cause **constipation**), is used by alternative practitioners. This supplement can be given in combination with herbs that are rich in iron. Some examples of iron-rich herbs are dandelion (*Taraxacum officinale*), parsley (*Petroselinum crispum*), and nettle (*Urtica dioica*). The homeopathic remedy ferrum phosphoricum can also be helpful.

An iron-rich herbal tonic can also be made using the following recipe:

- soak 1/2 oz of yellow dock root and 1/2 oz dandelion root in 1 qt of boiled water for four to 8 hours
- strain and simmer until the amount of liquid is reduced to 1 cup
- remove from heat and add 1/2 cup black strap molasses, mixing well
- store in refrigerator; take 1 tsp-2 Tbsp daily

Other herbal remedies used to treat iron-deficiency anemia aim to improve the digestion. Gentian (*Gentiana lutea*) is widely used in Europe to treat anemia and other nutritionally based disorders. The bitter qualities of gentian help stimulate the digestive system, making iron and other nutrients more available for absorption. This bitter herb can be brewed into tea or purchased as an alcoholic extract (tincture).

Other herbs recommended to promote digestion include:

- anise (*Pimpinella anisum*)
- caraway (*Carum carvi*)
- cumin (*Cuminum cyminum*)
- linden (*Tilia spp.*)
- licorice (*Glycyrrhiza glabra*)

Traditional Chinese treatments for anemia include:

- acupuncture to stimulate a weakened spleen
- asian ginseng (*Panax ginseng*) to restore energy
- dong quai (*Angelica sinensis*) to control heavy menstrual bleeding
- a mixture of dong quai and Chinese foxglove (*Rehmannia glutinosa*) to clear a sallow complexion

## Prognosis

The prognosis of anemia depends on its cause.

### Folic acid and iron deficiency anemias

It usually takes three to six weeks to correct folic acid or iron deficiency anemia. Patients should continue taking supplements for another six months to

replenish iron reserves. They should have periodic blood tests to make sure the bleeding has stopped and the anemia has not recurred.

### Pernicious anemia

Although pernicious anemia is considered incurable, regular B<sub>12</sub> shots will alleviate symptoms and reverse complications. Some symptoms will disappear almost as soon as treatment begins.

### Aplastic anemia

Aplastic anemia can sometimes be cured by bone marrow transplantation. If the condition is due to immunosuppressive drugs, symptoms may disappear after the drugs are discontinued.

### Sickle cell anemia

The prognosis for sickle cell anemia is still relatively poor. With the exception of children who benefit from bone marrow transplantation, most people with sickle cell anemia have shortened life expectancies. As recently as the 1990s, the average life span for patients with the disease was 42 years for males and 48 years for females. About half of patients diagnosed with the disease live into their early fifties.

### Thalassemia

Patients with mild beta thalassemia have a normal life expectancy with generally good health, although like patients with alpha thalassemia, they should be informed about the hereditary nature of their condition. The prognosis for patients with Cooley's anemia depends on their compliance with therapy. Untreated Cooley's anemia usually leads to death from heart failure or infection before age 20.

### Hemolytic anemia

Acquired hemolytic anemia can generally be cured when the cause is removed.

## Prevention

Inherited anemias cannot be prevented although they can be diagnosed before birth by **amniocentesis**. **Genetic counseling** can help parents cope with questions and concerns about transmitting disease-causing genes to their children.

Avoiding excessive use of alcohol, quitting smoking, eating a balanced diet that contains plenty of iron-rich foods, and taking a daily multivitamin can help prevent anemia.

Methods of preventing specific types of anemia include:

- avoiding lengthy exposure to industrial chemicals and drugs known to cause aplastic anemia
- not taking medication that has triggered hemolytic anemia and not eating foods that have caused hemolysis (breakdown of red blood cells)
- receiving regular B<sub>12</sub> shots to prevent pernicious anemia resulting from gastritis or stomach surgery

### **Nutrition/Dietetic concerns**

Iron deficiency anemia has been associated with a low dietary intake of iron. There are two forms of dietary iron: heme and nonheme. Heme iron is the best source of iron and is found in animal foods such as red meats, fish, and poultry. Nonheme iron is found in plant foods such as lentils and beans, and is also the form of iron added to iron-enriched foods. Folate is found in citrus juices and fruits, dark green leafy vegetables, legumes and fortified breakfast cereals. Vitamin B<sub>12</sub> requirements are met by eating meat and dairy products.

### **Health care team roles**

Anemia is often overlooked as a priority associated with quality patient care. Identifying the underlying causes of anemia in patients is critical to positive care outcomes and requires early assessment and intervention. The entire health care team plays a critical role in the well-being and quality of life of patients with anemia by understanding the disease and appropriate treatments, and by providing patients with any materials and education needed to understand the disease and its treatment.

### **Caregiver concerns**

Anemia can have a significant impact on the quality of life of older adults. Anemia from iron deficiency often results from poor nutrition in this age group. Caregivers need to focus on the age-related physiologic changes underlying this condition and whether anemia correction can improve quality of life. The prevalence of blood loss/iron deficiency as a cause of anemia in the elderly points to the importance of recognizing this diagnosis in these patients.

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## ORGANIZATIONS

American Society of Hematology (ASH), 1900 M Street, NW, Suite 200, Washington, DC, 20036 202-776-0544 202-776-0545, ash@hematology.org, <http://www.hematology.org/>.

Cooley's Anemia Foundation, 330 Seventh Avenue, #900, New York, NY, 10001 800-522-7222 212-279-5999, <http://www.thalassemia.org>.

National Heart, Lung, and Blood Institute (NHLBI), Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105 301-592-8573 240-629-3246, [nhlbiinfo@nhlbi.nih.gov](mailto:nhlbiinfo@nhlbi.nih.gov), <http://www.nhlbi.nih.gov/>.

Sickle Cell Disease Association of America (SCDAA), 231 East Baltimore Street, Suite 800, Baltimore, MD, 21202 410-528-1555 800-421-8453 410-528-1495, [sedaa@sicklecelldisease.org](mailto:sedaa@sicklecelldisease.org), <http://www.sicklecell disease.org/> index.phtml.

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Anencephaly see **Congenital brain defects**

## Anesthesia, general

### Definition

General anesthesia is the induction of a state of unconsciousness with the absence of **pain** sensation over the entire body, through the administration of anesthetic drugs. It is used during certain medical and surgical procedures.

### Types of anesthetics

Type	Names	Route(s) of administration	Effect
General	Enflurane, halothane, isoflurane, ketamine, nitrous oxide, propofol, thiopental	Intravenously, inhalation	Produces total unconsciousness affecting the entire body
Regional	Chlorprocaine, lidocaine, mepivacaine	Intravenously, nerve block	Temporarily interrupts transmission of nerve impulses (temperature, touch, pain) and motor functions in a large area to be treated; does not produce unconsciousness
Local	Bupivacaine, lidocaine, procaine, tetracaine	Local infiltration	Temporarily blocks transmission of nerve impulses and motor functions in a specific area; does not produce unconsciousness
Topical	Benzocaine, butamben, dibucaine, lidocaine, pramoxine, tetracaine	Dermal (sprays, ointments, creams, gels)	Temporarily blocks nerve endings in skin and mucous membranes; does not produce unconsciousness

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### Purpose

General anesthesia has many purposes including:

- pain relief
- blocking memory of the procedure
- producing unconsciousness
- inhibiting normal body reflexes to make surgery safe and easier to perform
- relaxing the muscles of the body

### Description

Anesthesia performed with general anesthetics occurs in four stages which may or may not be observable because they can occur very rapidly:

- Stage One: Analgesia. The patient experiences analgesia or a loss of pain sensation but remains conscious and can carry on a conversation.
- Stage Two: Excitement. The patient may experience delirium or become violent. Blood pressure rises and becomes irregular, and breathing rate increases. This stage is typically bypassed by administering a

## KEY TERMS

**Amnesia**—The loss of memory.

**Analgesia**—A state of insensitivity to pain even though the person remains fully conscious.

**Anesthesiologist**—A medical specialist who administers an anesthetic to a patient before he is treated.

**Anesthetic**—A drug that causes unconsciousness or a loss of general sensation.

**Arrhythmia**—Abnormal heart beat.

**Barbiturate**—A drug with hypnotic and sedative effects.

**Catatonia**—Psychomotor disturbance characterized by muscular rigidity, excitement or stupor.

**Hypnotic agent**—A drug capable of inducing a hypnotic state.

**Hypnotic state**—A state of heightened awareness that can be used to modulate the perception of pain.

**Hypoxia**—Reduction of oxygen supply to the tissues.

**Malignant hyperthermia**—A type of reaction (probably with a genetic origin) that can occur during

general anesthesia and in which the patient experiences a high fever, muscle rigidity, and irregular heart rate and blood pressure.

**Medulla oblongata**—The lowest section of the brain-stem, located next to the spinal cord. The medulla is the site of important cardiac and respiratory regulatory centers.

**Neurotransmitter**—One of a group of chemicals secreted by a nerve cell (neuron) to carry a chemical message to another nerve cell, often as a way of transmitting a nerve impulse. Examples of neurotransmitters include acetylcholine, dopamine, serotonin, and norepinephrine.

**Opioid**—Any morphine-like synthetic narcotic that produces the same effects as drugs derived from the opium poppy ( opiates), such as pain relief, sedation, constipation and respiratory depression.

**Pneumothorax**—A collapse of the lung.

**Stenosis**—A narrowing or constriction of the diameter of a passage or orifice, such as a blood vessel.

barbiturate, such as sodium pentothal, before the anesthesia.

- Stage Three: Surgical Anesthesia. During this stage, the skeletal muscles relax, and the patient's breathing becomes regular. Eye movements slow, then stop, and surgery can begin.
- Stage Four: Medullary Paralysis. This stage occurs if the respiratory centers in the medulla oblongata of the brain that control breathing and other vital functions cease to function. Death can result if the patient cannot be revived quickly. This stage should never be reached. Careful control of the amounts of anesthetics administered prevent this occurrence.

Agents used for general anesthesia may be either gases or volatile liquids that are vaporized and inhaled with oxygen, or drugs delivered intravenously. A combination of inhaled anesthetic gases and intravenous drugs are usually delivered during general anesthesia; this practice is called balanced anesthesia and is used because it takes advantage of the beneficial effects of each anesthetic agent to reach surgical anesthesia. If necessary, the extent of the anesthesia produced by inhaling a general anesthetic can be rapidly modified by adjusting the concentration of the anesthetic in the oxygen that is breathed by the patient. The degree of anesthesia produced by an intravenously injected

anesthetic is fixed and cannot be changed as rapidly. Most commonly, intravenous anesthetic agents are used for induction of anesthesia and then followed by inhaled anesthetic agents.

General anesthesia works by altering the flow of **sodium** ions into nerve cells (neurons) through the cell membrane. Exactly how the anesthetic does this is not understood since the drug apparently does not bind to any receptor on the cell surface and does not seem to affect the release of chemicals that transmit nerve impulses (neurotransmitters) from the nerve cells. It is known, however, that when the sodium ions do not get into the neurons, nerve impulses are not generated and the brain becomes unconscious, does not store memories, does not register pain impulses from other areas of the body, and does not control involuntary reflexes. Although anesthesia may feel like deep sleep, it is not the same as sleep. In sleep, some parts of the brain speed up while others slow down. Under anesthesia, the loss of consciousness is more widespread.

When general anesthesia was first introduced in medical practice, ether and chloroform were inhaled with the physician manually covering the patient's mouth. Since then, general anesthesia has become much more sophisticated. During most surgical procedures, anesthetic agents are now delivered and controlled

by computerized equipment that includes anesthetic gas monitoring as well as patient monitoring equipment. Anesthesiologists are the physicians that specialize in the delivery of anesthetic agents. Currently used inhaled general anesthetics include halothane, enflurane, isoflurane, desflurane, sevoflurane, and nitrous oxide.

- Halothane (Fluothane) is a powerful anesthetic and can easily be overadministered. This drug causes unconsciousness but little pain relief so it is often used with other agents to control pain. Very rarely, it can be toxic to the liver in adults, causing death. It also has the potential for causing serious cardiac arrhythmias. Halothane has a pleasant odor, and was frequently the anesthetic of choice for use with children, but since the introduction of sevoflurane in the 1990s, halothane use has declined.
- Enflurane (Ethrane) is less potent and results in a more rapid onset of anesthesia and faster awakening than halothane. In addition, it acts as an enhancer of paralyzing agents. Enflurane has been found to increase intracranial pressure and the risk of seizures; therefore, it should not be used in patients with seizure disorders.
- Isoflurane (Forane) is not toxic to the liver but can cause some cardiac irregularities. Isoflurane is often used in combination with intravenous anesthetics for anesthesia induction. Awakening from anesthesia is faster than it is with halothane and enflurane.
- Desflurane (Suprane) may increase the heart rate and should not be used in patients with aortic valve stenosis; however, it does not usually cause heart arrhythmias. Desflurane may cause coughing and excitation during induction and is therefore used intravenously. Desflurane is rapidly eliminated and awakening is therefore faster than with other inhaled agents.
- Sevoflurane (Ultane) may also cause increased heart rate and should not be used in patients with narrowed aortic valve (stenosis); however, it does not usually cause heart arrhythmias. Unlike desflurane, sevoflurane does not cause any coughing or other related side effects, and can therefore be used without intravenous agents for rapid induction. For this reason, sevoflurane is replacing halothane for induction in pediatric patients. Like desflurane, this agent is rapidly eliminated and allows rapid awakening.
- Nitrous oxide (laughing gas) is a weak anesthetic and is used with other agents, such as thiopental, to produce surgical anesthesia. It has the fastest induction and recovery and is the safest because it does not slow breathing or blood flow to the brain. However, it diffuses rapidly into air-containing cavities and can

result in a collapsed lung (pneumothorax) or lower the oxygen contents of tissues (hypoxia).

Commonly administered intravenous anesthetic agents include ketamine, thiopental, opioids, and propofol.

- Ketamine (Ketalar) affects the senses, and produces a dissociative anesthesia (catatonia, amnesia, analgesia) in which the patient may appear awake and reactive, but cannot respond to sensory stimuli. These properties make it especially useful for use in developing countries and during warfare medical treatment. Ketamine is frequently used in pediatric patients because anesthesia and analgesia can be achieved with an intramuscular injection. It is also used in high-risk geriatric patients and in shock cases, because it also provides cardiac stimulation.
- Thiopental (Pentothal) is a barbiturate that induces a rapid hypnotic state of short duration. Because thiopental is slowly metabolized by the liver, toxic accumulation can occur; therefore, it should not be continuously infused. Side effects include nausea and vomiting upon awakening.
- Opioids include fentanyl, sufentanil, and alfentanil, and are frequently used before anesthesia and surgery as a sedative and analgesic, as well as a continuous infusion for primary anesthesia. Because opioids rarely affect the cardiovascular system, they are particularly useful for cardiac surgery and other high-risk cases. Opioids act directly on spinal cord receptors, and are frequently used in epidurals for spinal anesthesia. Side effects may include nausea and vomiting, itching, and respiratory depression.
- Propofol (Diprivan) is a nonbarbiturate hypnotic agent and the most recently developed intravenous anesthetic. Its rapid induction and short duration of action are identical to thiopental, but recovery occurs more quickly and with much less nausea and vomiting. Also, propofol is rapidly metabolized in the liver and excreted in the urine, so it can be used for long durations of anesthesia, unlike thiopental. Hence, propofol is rapidly replacing thiopental as an intravenous induction agent. It is used for general surgery, cardiac surgery, neurosurgery, and pediatric surgery.

General anesthetics are given only by anesthesiologists, the medical professionals trained to use them. These specialists consider many factors, including a patient's age, weight, medication **allergies**, medical history, and general health, when deciding which anesthetic or combination of anesthetics to use. General anesthetics are usually inhaled through a mask or a breathing tube or injected into a vein, but are also sometimes given rectally.

General anesthesia is much safer today than it was in the past. This progress is due to faster-acting anesthetics, improved safety standards in the equipment used to deliver the drugs, and better devices to monitor breathing, heart rate, blood pressure, and brain activity during surgery. Unpleasant side effects are also less common.

### **Recommended dosage**

The dosage depends on the type of anesthetic, the patient's age and physical condition, the type of surgery or medical procedure being done, and other medication the patient takes before, during, or after surgery.

### **Precautions**

Although the risks of serious complications from general anesthesia are very low, they can include **heart attack**, **stroke**, brain damage, and **death**. Anyone scheduled to undergo general anesthesia should thoroughly discuss the benefits and risks with a physician. The risks of complications depend, in part, on a patient's age, sex, weight, allergies, general health, current medications, and history of **smoking**, drinking alcohol, and illicit drug use. Some of these risks can be minimized by ensuring that the physician and anesthesiologist are fully informed of the detailed health condition of the patient, including any drugs that he or she may be using. Older people are especially sensitive to the effects of certain anesthetics and may be more likely to experience side effects from these drugs.

Patients who have had general anesthesia should not drink alcoholic beverages or take medications that slow the central nervous system (e.g., **antihistamines**, sedatives, tranquilizers, sleep aids, certain pain relievers, **muscle relaxants**, and anti-seizure medication) for at least 24 hours, except under a doctor's care.

### **Special conditions**

People with certain medical conditions are at greater risk of developing problems with anesthetics. Before undergoing general anesthesia, anyone with the following conditions should absolutely inform their doctor.

**ALLERGIES.** Anyone who has had allergic or other unusual reactions to **barbiturates** or general anesthetics in the past should notify the doctor before having general anesthesia. In particular, people who have had malignant hyperthermia or whose family members have had malignant hyperthermia during or after being given an anesthetic should inform the physician. Signs of malignant hyperthermia include rapid, irregular heartbeat, breathing problems, very high **fever**, and muscle tightness or spasms. These symptoms can occur following the administration of

general anesthesia using inhaled agents, especially halothane. In addition, the doctor should also be told about any allergies to foods, dyes, preservatives, or other substances.

**PREGNANCY.** The effects of anesthetics on pregnant women and fetuses vary, depending on the type of drug. In general, giving large amounts of general anesthetics to the mother during labor and delivery may make the baby sluggish after delivery. Pregnant women should discuss the use of anesthetics during labor and delivery with their doctors. Pregnant women who may be given general anesthesia for other medical procedures should ensure that the treating physician is informed about the **pregnancy**.

**BREASTFEEDING.** Some general anesthetics pass into breast milk, but they have not been reported to cause problems in nursing babies whose mothers were given the drugs.

**OTHER MEDICAL CONDITIONS.** Before being given a general anesthetic, a patient who has any of the following conditions should inform his or her doctor:

- neurological conditions, such as epilepsy or stroke
- problems with the stomach or esophagus, such as ulcers or heartburn
- eating disorders
- loose teeth, dentures, bridgework
- heart disease or family history of heart problems
- lung diseases, such as emphysema or asthma
- history of smoking
- immune system diseases
- arthritis or any other conditions that affect movement
- diseases of the endocrine system, such as diabetes or thyroid problems

### **Side effects**

Because general anesthetics affect the central nervous system, patients may feel drowsy, weak, or tired for as long as a few days after having general anesthesia. Fuzzy thinking, blurred vision, and coordination problems are also possible. For these reasons, anyone who has had general anesthesia should not drive, operate machinery, or perform other activities that could endanger themselves or others for at least 24 hours, or longer if necessary.

Most side effects usually disappear as the anesthetic wears off. A nurse or doctor should be notified if these or other side effects persist or cause problems, such as:

- headache
- vision problems, including blurred or double vision
- shivering or trembling
- muscle pain
- dizziness, lightheadedness, or faintness
- drowsiness
- mood or mental changes
- nausea or vomiting
- sore throat
- nightmares or unusual dreams

A doctor should be notified as soon as possible if any of the following side effects occur within two weeks of having general anesthesia:

- severe headache
- pain in the stomach or abdomen
- back or leg pain
- severe nausea
- black or bloody vomit
- unusual tiredness or weakness
- weakness in the wrist and fingers
- weight loss or loss of appetite
- increase or decrease in amount of urine
- pale skin
- yellow eyes or skin

## Interactions

General anesthetics may interact with other medicines. When this happens, the effects of one or both of the drugs may be altered or the risk of side effects may be greater. Anyone scheduled to undergo general anesthesia should inform the doctor about all other medication that he or she is taking. This includes prescription drugs, nonprescription medicines, herbal remedies, and street drugs. Serious and possibly life-threatening reactions may occur when general anesthetics are given to people who use street drugs, such as **cocaine**, **marijuana**, phencyclidine (PCP or angel dust), amphetamines (uppers), barbiturates (downers), heroin, or other **narcotics**. Anyone who uses these drugs should make sure their doctor or dentist knows what they have taken.

## Resources

### OTHER

“Anesthesia: A Look at Local, Regional, and General Anesthesia.” *MayoClinic.com*. June 16, 2006 [cited June 3, 2008]. <http://www.mayoclinic.com/health/anesthesia/SC00026>.

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“Understanding Anesthesia.” *National Institute of General Medical Sciences*. [accessed June 3, 2008]. [http://www.nigms.nih.gov/Publications/factsheet\\_Anesthesia.htm](http://www.nigms.nih.gov/Publications/factsheet_Anesthesia.htm).

## ORGANIZATIONS

American Academy of Anesthesiologist Assistants, 2209 Dickens Road, Richmond, VA, 23230-2005, (804) 565-6353, (888) 443-6353, <http://www.anesthetist.org>.

American Society of Anesthesiologists, 520 N. Northwest Highway, Park Ridge, IL, 60068-2573, (847) 825-5586, (847) 825-1692, <http://www.asahq.org>.

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## Anesthesia, local

### Definition

Local or regional anesthesia involves the injection or application of an anesthetic drug to a specific area of the body, as opposed to the entire body and brain as occurs during **general anesthesia**.

### Purpose

Local anesthetics are used to prevent patients from feeling **pain** during medical, surgical, or dental procedures. Over-the-counter local anesthetics are also available to provide temporary relief from pain, irritation, and **itching** caused by various conditions, such as **cold sores**, **canker sores**, sore throats, **sunburn**, insect **bites**, **poison ivy**, and minor cuts and scratches.

Types of surgery or medical procedures that regularly make use of local or regional anesthesia include the following:

- biopsies in which skin or tissue samples are taken for diagnostic procedures
- childbirth
- surgeries on the arms, hands, legs, or feet
- eye surgery
- surgeries involving the urinary tract or sexual organs

## KEY TERMS

**Canker sore**—A painful sore inside the mouth.

**Cold sore**—A small blister on the lips or face, caused by a virus. Also called a fever blister.

**Epidural space**—The space surrounding the spinal fluid sac.

**Malignant hyperthermia**—A type of reaction (probably with a genetic basis) that can occur during general anesthesia in which the patient experiences a high fever, the muscles become rigid, and the heart rate and blood pressure fluctuate.

**Subarachnoid space**—The space surrounding the spinal cord that is filled with cerebrospinal fluid.

**Topical**—Not ingested; applied to the outside of the body, for example to the skin, eye, or mouth.

Surgeries involving the chest and abdomen are usually performed under general anesthesia.

Local and regional anesthesia have advantages over general anesthesia in that patients can avoid some unpleasant side effects, can receive longer lasting pain relief, have reduced blood loss, and maintain a sense of psychological comfort by not losing consciousness.

### Description

Regional anesthesia typically affects a larger area than local anesthesia, for example, everything below the waist. As a result, regional anesthesia may be used for more involved or complicated surgical or medical procedures. Regional anesthetics are injected. Local anesthesia involves the injection into the skin or muscle or application to the skin of an anesthetic directly where pain will occur. Local anesthesia can be divided into four groups: injectable, topical, dental (non-injectable), and ophthalmic.

Local and regional anesthesia work by altering the flow of **sodium** molecules into nerve cells or neurons through the cell membrane. Exactly how the anesthetic does this is not understood, since the drug apparently does not bind to any receptor on the cell surface and does not seem to affect the release of chemicals that transmit nerve impulses (neurotransmitters) from the nerve cells. It is known, however, that when the sodium molecules do not get into the neurons, nerve impulses are not generated and

pain impulses are not transmitted to the brain. The duration of action of an anesthetic depends on the type and amount of anesthetic administered.

### Regional anesthesia

Types of regional anesthesia include:

- **Spinal anesthesia.** Spinal anesthesia involves the injection of a small amount of local anesthetic directly into the cerebrospinal fluid surrounding the spinal cord (the subarachnoid space). Blood pressure drops are common but are easily treated.
- **Epidural anesthesia.** Epidural anesthesia involves the injection of a large volume of local anesthetic directly into the space surrounding the spinal fluid sac (the epidural space), not into the spinal fluid. Pain relief occurs more slowly but is less likely to produce blood pressure drops. Also, the block can be maintained for long periods, even days.
- **Nerve blocks.** Nerve blocks involve the injection of an anesthetic into the area around a nerve that supplies a particular region of the body, preventing the nerve from carrying nerve impulses to the brain.

Anesthetics may be administered with another drug, such as epinephrine (adrenaline), which decreases bleeding, and sodium bicarbonate to decrease the acidity of a drug so that it will work faster. In addition, drugs may be administered to help a patient remain calm and more comfortable or to make them sleepy.

### Local anesthesia

**INJECTABLE LOCAL ANESTHETICS.** These medicines are given by injection to numb and provide pain relief to some part of the body during surgery, dental procedures, or other medical procedures. They are given only by a trained health care professional and only in a doctor's office or a hospital. Some commonly used injectable local anesthetics are procaine (Novocain), lidocaine (Dyclone, Dilocaine, L-Caine, Nervocaine, Xylocaine, and other brands), and tetracaine (Pontocaine).

**TOPICAL ANESTHETICS.** Topical anesthetics, such as benzocaine, lidocaine, dibucaine, pramoxine, butamben, and tetracaine, relieve pain and itching by deadening the nerve endings in the skin. They are ingredients in a variety of nonprescription products that are applied to the skin to relieve the discomfort of sunburn, insect bites or **stings**, poison ivy, and minor cuts, scratches, and **burns**. These products are sold as creams, ointments, sprays, lotions, and gels.

**DENTAL ANESTHETICS (NON-INJECTABLE).** Some local anesthetics are intended for pain relief in the mouth or throat. They may be used to relieve throat pain, **teething** pain, painful canker sores, toothaches, or discomfort from dentures, braces, or bridgework. Some dental anesthetics are available only with a doctor's prescription. Others may be purchased without a prescription, including products such as Num-Zit, Orajel, Chloraseptic lozenges, and Xylocaine.

**OPHTHALMIC ANESTHETICS.** Other local anesthetics are designed for use in the eye. The ophthalmic anesthetics proparacaine and tetracaine are used to numb the eye before certain eye examinations. Eye doctors may also use these medicines before measuring eye pressure or removing stitches or **foreign objects** from the eye. These drugs are to be given only by a trained health care professional.

### Recommended dosage

The recommended dosage depends on the type of local anesthetic and the purpose for which it is being used. When using a nonprescription local anesthetic, follow the directions on the package. Questions concerning how to use a product should be referred to a medical doctor, dentist, or pharmacist.

### Precautions

People who strongly feel that they cannot psychologically cope with being awake and alert during certain procedures may not be good candidates for local or regional anesthesia. Other medications may be given in conjunction with the anesthetic, however, to relieve **anxiety** and help the patient relax.

Local anesthetics should be used only for the conditions for which they are intended. For example, a topical anesthetic meant to relieve sunburn pain should not be used on cold sores. Anyone who has had an unusual reaction to any local anesthetic in the past should check with a doctor before using any type of local anesthetic again. The doctor should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Older people may be more sensitive to the effects of local anesthetics, especially lidocaine. This increased sensitivity may increase the risk of side effects. Older people who use nonprescription local anesthetics should be especially careful not to use more than the recommended amount. Children also may be especially sensitive to the effects of some local anesthetics, which may increase the chance of side effects. Anyone using these medicines on a child should be careful not to use more than the amount

that is recommended for children. Certain types of local anesthetics should not be used at all young children. Follow package directions carefully and check with a doctor or pharmacist if there are any questions.

### Regional anesthetics

Serious, possibly life-threatening, side effects may occur when anesthetics are given to people who use street drugs. Anyone who uses **cocaine**, **marijuana**, amphetamines, **barbiturates**, phencyclidine (PCP, or angel dust), heroin, or other street drugs should make sure their doctor or dentist knows what they have used.

Patients who have had a particular kind of reaction called malignant hyperthermia (or who have one or more family members who have had this problem) during or just after receiving a general anesthetic should inform their doctors before receiving any kind of anesthetic. Signs of malignant hyperthermia include fast and irregular heartbeat, very high **fever**, breathing problems, and **muscle spasms** or tightness.

Although problems are rare, some unwanted side effects may occur when regional anesthetics are used during labor and delivery. These anesthetics can prolong labor and increase the risk of **Cesarean section**. Pregnant women should discuss with their doctors the risks and benefits of being given these drugs.

Patients should not drive or operate other machinery immediately following a procedure involving regional anesthesia, due to **numbness** and weakness, or if local anesthesia also included drugs to make the patient sleep or strong pain medications. Injection sites should be kept clean, dry, and uncovered to prevent infection.

### Injectable local anesthetics

Until the anesthetic wears off, patients should be careful not to injure the numbed area. If the anesthetic was used in the mouth, do not eat or chew gum until feeling returns.

### Topical anesthetics

Unless advised by a doctor, topical anesthetics should not be used on or near any part of the body with large sores, broken or scraped skin, severe injury, or infection. They should also not be used on large areas of skin. Some topical anesthetics contain alcohol and should not be used near an open flame, or while **smoking**.

Anyone using a topical anesthetic should be careful not to get this medication in the eyes, nose, or

mouth. When using a spray form of this medication, do not spray it directly on the face, but apply it to the face with a cotton swab or sterile gauze pad. After using a topical anesthetic on a child, make sure the child does not get the medicine in his or her mouth.

Topical anesthetics are intended for the temporary relief of pain and itching. They should not be used for more than a few days at a time. Check with a doctor if:

- the discomfort continues for more than seven days
- the problem gets worse
- the treated area becomes infected
- new signs of irritation, such as skin rash, burning, stinging, or swelling appear

### **Dental anesthetics (non-injectable)**

Dental anesthetics should not be used if certain kinds of infections are present. Check package directions or check with a dentist or medical doctor if uncertain. Dental anesthetics should be used only for temporary pain relief. If problems such as **toothache**, mouth sores, or pain from dentures or braces continue, check with a dentist. Check with a doctor if **sore throat** pain is severe, lasts more than two days, or is accompanied by other symptoms such as fever, **headache**, skin rash, swelling, **nausea**, or **vomiting**.

Patients should not eat or chew gum while the mouth is numb from a dental anesthetic. There is a risk of accidentally biting the tongue or the inside of the mouth. Also nothing should be eaten or drunk for one hour after applying a dental anesthetic to the back of the mouth or throat, since the medicine may interfere with swallowing and may cause **choking**. If normal feeling does not return to the mouth within a few hours after receiving a dental anesthetic or if it is difficult to open the mouth, check with a dentist.

### **Ophthalmic anesthetics**

When anesthetics are used in the eye, it is important not to rub or wipe the eye until the effect of the anesthetic has worn off and feeling has returned. Rubbing the eye while it is numb could cause injury.

### **Side effects**

Side effects of regional or local anesthetics vary depending on the type of anesthetic used and the way it is administered. Anyone who has unusual symptoms following the use of an anesthetic should get in touch with his or her doctor immediately.

There is a small risk of developing a severe headache called a spinal headache following a spinal or

epidural block. This headache is severe when the patient is upright and hardly felt when the patient lies down. Though rare, it can occur and can be treated by performing a blood patch, in which a small amount of the patient's own blood is injected into the area in the back where the anesthetic was injected. The **blood clots** and closes up any area that may have been leaking spinal fluid. Relief is almost immediate. Finally, blood clots or **abscess** can form in the back, but these are also readily treatable and so pose little risk.

A physician should be notified immediately if any of these symptoms occur:

- large swellings that look like hives on the skin, in the mouth, or in the throat
- severe headache
- blurred or double vision
- dizziness or lightheadedness
- drowsiness
- confusion
- anxiety, excitement, nervousness, or restlessness
- convulsions (seizures)
- feeling hot, cold, or numb
- ringing or buzzing in the ears
- shivering or trembling
- sweating
- pale skin
- slow or irregular heartbeat
- breathing problems
- unusual weakness or tiredness

### **Interactions**

Some anesthetic drugs may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who receives a regional or local anesthetic should let the doctor know all other drugs he or she is taking including prescription drugs, nonprescription drugs, and street drugs (such as cocaine, marijuana, and heroin).

### **Resources**

#### **BOOKS**

Harvey, Richard A., and Pamela C. Champe. *Lippincott's Illustrated Reviews: Pharmacology*. 4th ed. Philadelphia: Lippincott Williams & Wilkins, 2008.

Nancy Ross-Flanigan

## Aneurysmectomy

### Definition

Aneurysmectomy is a surgical procedure performed to repair a weak area in the aorta. The aorta is the largest artery in the body and the main blood vessel leading away from the heart.

### Purpose

The purpose of aneurysmectomy is to repair an **aortic aneurysm** that is likely to rupture if left in place. Aneurysmectomy is indicated for an aortic aneurysm that grows to at least 2 in (5 cm) or for an aortic aneurysm of any size that is symptomatic, tender, or enlarging rapidly.

### Precautions

Aneurysmectomy may not be appropriate for patients with severely debilitating diseases such as **cancer**, **emphysema**, and **heart failure**.

### Description

An aortic aneurysm is a bulge in the wall of the aorta that is usually due to arteriosclerosis or **atherosclerosis**. People who are 50–80 years old are most likely to develop an aortic aneurysm, with men four times more likely to develop one than women.

An aortic aneurysm develops and grows slowly. It rarely produces symptoms and is usually only diagnosed by accident during a routine physical exam or on an x ray or ultrasound done for another reason. As the aneurysm grows larger, the risk of bursting with no warning, which causes catastrophic bleeding, rises. A ruptured aortic aneurysm can cause sudden loss of a fatal amount of blood within minutes or it can leak in a series of small bleeds that lead within hours or days to massive bleeding. A leaking aortic aneurysm that is not treated is always fatal.

Aneurysmectomy is performed to repair the two most common types of aortic aneurysms: abdominal aortic aneurysms that occur in the abdomen below the kidneys, and thoracic aortic aneurysms that occur in the chest. It is major surgery performed in a hospital under **general anesthesia** and involves removing debris and then implanting a flexible tube (graft) to replace the enlarged artery. Aneurysmectomy for an aneurysm of the ascending aorta (the first part of the aorta that travels upward from the heart) requires the use of a heart-lung machine that temporarily stops the heart while the aneurysm is repaired. Aneurysmectomy requires a one-week hospital stay; the recovery period is five weeks.

### KEY TERMS

**Aneurysm**—A weakening in the muscular walls of a part of the artery which causes the damaged section to enlarge or sag, giving it a balloon-like appearance.

**Aorta**—The main blood vessel that leads away from the heart and the body's largest artery. The aorta carries blood from the heart through the chest and abdomen, providing major branches to all of the organs in the body.

**Arteriosclerosis**—Hardening of the arteries that occurs as part of the aging process.

**Artery**—A blood vessel that carries blood from the heart to the body's tissues.

**Atherosclerosis**—A form of arteriosclerosis in which cholesterol-containing fatty deposits accumulate in the innermost walls of the heart's arteries.

**Thoracic**—Relating to the chest.

During surgery, the site of the aneurysm (either the abdomen or the chest) is opened with an incision to expose the aneurysm. The aorta is clamped above and below the aneurysm to stop the flow of blood. Then, an incision is made in the aneurysm. An artificial Dacron tube is sewn in place above and below the opened aneurysm, but the aneurysm is not removed. Plaque or clotted blood are cleaned from the diseased tissue. The clamps are removed and blood flow is re-established through the graft. The wall of the aneurysm is wrapped around the graft to protect it and the skin of the abdomen or chest is sewn up.

Aneurysmectomy can be performed as elective or emergency surgery. Elective aneurysmectomy takes about an hour and is far safer than emergency aneurysmectomy, with a mortality rate of 3–5% for elective abdominal aneurysmectomy and 5–10% for elective thoracic aneurysmectomy. When an aneurysm ruptures, 62% of patients die before they reach the hospital. Of those who make it into emergency aneurysmectomy, 50% die. After a successful aneurysmectomy, the patient has nearly the same life expectancy as other people of the same age.

### Preparation

Before elective aneurysmectomy, blood studies, a **chest x ray**, cardiac catheterization, electrocardiogram (ECG), and ultrasound are performed.

## Aftercare

After aneurysmectomy, the patient is monitored in an Intensive Care Unit for the first 24–48 hours. Follow-up tests include ECG, chest x ray, and ultrasound.

## Risks

Elective aneurysmectomy has a 5–10% rate of complications, such as bleeding, kidney failure, respiratory complications, **heart attack**, **stroke**, infection, limb loss, bowel **ischemia**, and **impotence**. These complications are many times more common in emergency aneurysmectomy.

## Resources

### PERIODICALS

Donaldson, M. C., M. Belkin, and A. D. Whittemore. “Mesenteric Revascularization During Aneurysmectomy.” *Surgery Clinic of North America* 77 (April 1997): 443–459.

### ORGANIZATIONS

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, <http://www.americanheart.org>.  
National Heart, Lung, and Blood Institute (NHLBI), Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105 (301) 592-8573 TTY: (240) 629-3255, (240) 629-3246, [nhlbiinfo@nhlbi.nih.gov](mailto:nhlbiinfo@nhlbi.nih.gov), <http://www.nhlbi.nih.gov/>.

Lori De Milto

**Aneurysms** see **Aneurysmectomy; Cerebral aneurysm; Ventricular aneurysm**

## Angina

### Definition

Angina is **pain**, “discomfort,” or pressure localized in the chest that is caused by an insufficient supply of blood (**ischemia**) to the heart muscle. It is also sometimes characterized by a feeling of **choking**, suffocation, or crushing heaviness. This condition is also called angina pectoris.

### Description

Often described as a muscle spasm and choking sensation, the term “angina” is used primarily to describe chest (thoracic) pain originating from insufficient oxygen to the heart muscle. An episode of angina is not an actual **heart attack**, but rather pain that results from the heart

## KEY TERMS

**Ischemia**—Decreased blood supply to an organ or body part, often resulting in pain.

**Myocardial infarction**—A blockage of a coronary artery that cuts off the blood supply to part of the heart. In most cases, the blockage is caused by fatty deposits.

**Myocardium**—The thick middle layer of the heart that forms the bulk of the heart wall and contracts as the organ beats.

muscle temporarily receiving too little blood. This temporary condition may be the result of demanding activities such as **exercise** and does not necessarily indicate that the heart muscle is experiencing permanent damage. In fact, episodes of angina seldom cause permanent damage to heart muscle.

Angina can be subdivided further into two categories: angina of effort and variant angina.

### *Angina of effort*

Angina of effort is a common disorder caused by the narrowing of the arteries (**atherosclerosis**) that supply oxygen-rich blood to the heart muscle. In the case of angina of effort, the heart (coronary) arteries can provide the heart muscle (myocardium) adequate blood during rest but not during periods of exercise, **stress**, or excitement—any of which may precipitate pain. The pain is relieved by resting or by administering nitroglycerin, a medication that reduces ischemia of the heart. Patients with angina of effort have an increased risk of heart attack (myocardial infarction).

### *Variant angina*

Variant angina is uncommon and occurs independently of atherosclerosis which may, however, be present as an incidental finding. Variant angina occurs at rest and is not related to excessive work by the heart muscle. Research indicates that variant angina is caused by coronary artery muscle spasm of insufficient duration or intensity to cause an actual heart attack.

### Causes and symptoms

Angina causes a pressing pain or sensation of heaviness, usually in the chest area under the breast bone (sternum). It occasionally is experienced in the shoulder, arm, neck, or jaw regions. Because episodes of angina occur when the heart’s need for oxygen increases beyond

the oxygen available from the blood nourishing the heart, the condition is often precipitated by physical exertion. In most cases, the symptoms are relieved within a few minutes by resting or by taking prescribed angina medications. Emotional stress, extreme temperatures, heavy meals, cigarette **smoking**, and alcohol can also cause or contribute to an episode of angina.

## Diagnosis

Physicians can usually diagnose angina based on the patient's symptoms and the precipitating factors. However, other diagnostic testing is often required to confirm or rule out angina, or to determine the severity of the underlying heart disease.

### *Electrocardiogram (ECG)*

An electrocardiogram is a test that records electrical impulses from the heart. The resulting graph of electrical activity can show if the heart muscle isn't functioning properly as a result of a lack of oxygen. Electrocardiograms are also useful in investigating other possible abnormal features of the heart.

### *Stress test*

For many individuals with angina, the results of an electrocardiogram while at rest will not show any abnormalities. Because the symptoms of angina occur during stress, the functioning of the heart may need to be evaluated under the physical stress of exercise. The **stress test** records information from the electrocardiogram before, during, and after exercise in search of stress-related abnormalities. Blood pressure is also measured during the stress test and symptoms are noted. A more involved and complex stress test (for example, thallium scanning) may be used in some cases to picture the blood flow in the heart muscle during the most intense time of exercise and after rest.

### *Angiogram*

The angiogram, which is basically an x ray of the coronary artery, has been noted to be the most accurate diagnostic test to indicate the presence and extent of coronary disease. In this procedure, a long, thin, flexible tube (catheter) is maneuvered into an artery located in the forearm or groin. This catheter is passed further through the artery into one of the two major coronary arteries. A dye is injected at that time to help the x rays "see" the heart and arteries more clearly. Many brief x rays are made to create a "movie" of blood flowing through the coronary arteries, which will reveal any possible narrowing that causes a

decrease in blood flow to the heart muscle and associated symptoms of angina.

## Treatment

### *Conservative treatment*

Artery disease causing angina is addressed initially by controlling existing factors placing the individual at risk. These risk factors include cigarette smoking, high blood pressure, high cholesterol levels, and **obesity**. Angina is often controlled by medication, most commonly with nitroglycerin. This drug relieves symptoms of angina by increasing the diameter of the blood vessels carrying blood to the heart muscle. Nitroglycerin is taken whenever discomfort occurs or is expected. It may be taken by mouth by placing the tablet under the tongue or transdermally by placing a medicated patch directly on the skin. In addition, **beta blockers** or **calcium channel blockers** may be prescribed to also decrease the demand on the heart by decreasing the rate and workload of the heart.

### *Surgical treatment*

When conservative treatments are not effective in the reduction of angina pain and the risk of heart attack remains high, physicians may recommend **angioplasty** or surgery. Coronary artery bypass surgery is an operation in which a blood vessel (often a long vein surgically removed from the leg) is grafted onto the blocked artery to bypass the blocked portion. This newly formed pathway allows blood to flow adequately to the heart muscle.

Another procedure used to improve blood flow to the heart is balloon angioplasty. In this procedure, the physician inserts a catheter with a tiny balloon at the end into a forearm or groin artery. The catheter is then threaded up into the coronary arteries and the balloon is inflated to open the vessel in narrowed sections. Other techniques using laser and mechanical devices are being developed and applied, also by means of catheters.

### *Alternative treatment*

During an angina episode, relief has been noted by applying massage or kinesiological methods, but these techniques are not standard recommendations by physicians. For example, one technique places the palm and fingers of either hand on the forehead while simultaneously firmly massaging the sternum (breast bone) up and down its entire length using the other hand. This is followed by additional massaging by the fingertip and thumb next to the sternum, on each side.

Once the angina has subsided, the cause should be determined and treated. Atherosclerosis, a major associated cause, requires diet and lifestyle adjustments, primarily including regular exercise, reduction of dietary sugar and saturated fats, and increase of dietary fiber. Both conventional and alternative medicine agree that increasing exercise and improving diet are important steps to reduce high cholesterol levels. Alternative medicine has proposed specific cholesterol-lowering treatments, with several gaining the attention and interest of the public. One of the most recent popular treatments is garlic (*Allium sativum*). Some studies have shown that adequate dosages of garlic can reduce total cholesterol by about 10%, LDL (bad) cholesterol by 15%, and raise HDL (good) cholesterol by 10%. Other studies have not shown significant benefit. Although its effect on cholesterol is not as great as that achieved by medications, garlic may possibly be of benefit in relatively mild cases of high cholesterol, without causing the side effects associated with **cholesterol-reducing drugs**. Other herbal remedies that may help lower cholesterol include alfalfa (*Medicago sativa*), fenugreek (*Trigonella foenum-graecum*), Asian **ginseng** (*Panax ginseng*), and tumeric (*Curcuma longa*).

**Antioxidants**, including vitamin A (beta carotene), vitamin C, vitamin E, and selenium, can limit the oxidative damage to the walls of blood vessels that may be a precursor of atherosclerotic plaque formation.

## Prognosis

The prognosis for a patient with angina depends on its origin, type, severity, and the general health of the individual. A person who has angina has the best prognosis if he or she seeks prompt medical attention and learns the pattern of his or her angina, such as what causes the attacks, what they feel like, how long episodes usually last, and whether medication relieves the attacks. If patterns of the symptoms change significantly, or if symptoms resemble those of a heart attack, medical help should be sought immediately.

## Prevention

In most cases, the best prevention involves changing one's habits to avoid bringing on attacks of angina. If blood pressure medication has been prescribed, compliance is a necessity and should be a priority as well. Many healthcare professionals—including physicians, dietitians, and nurses—can provide valuable advice on proper diet, weight control, blood cholesterol levels, and blood pressure. These professionals

also offer suggestions about current treatments and information to help stop smoking. In general, the majority of those with angina adjust their lives to minimize episodes of angina, by taking necessary precautions and using medications if recommended and necessary. **Coronary artery disease** is the underlying problem that should be addressed.

## ORGANIZATIONS

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, <http://www.nhlbi.nih.gov>.  
American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, <http://www.americanheart.org>.

Jeffrey P. Larson RPT

Angioedema see **Hives**

Angiogram see **Angiography**

## Angiography

### Definition

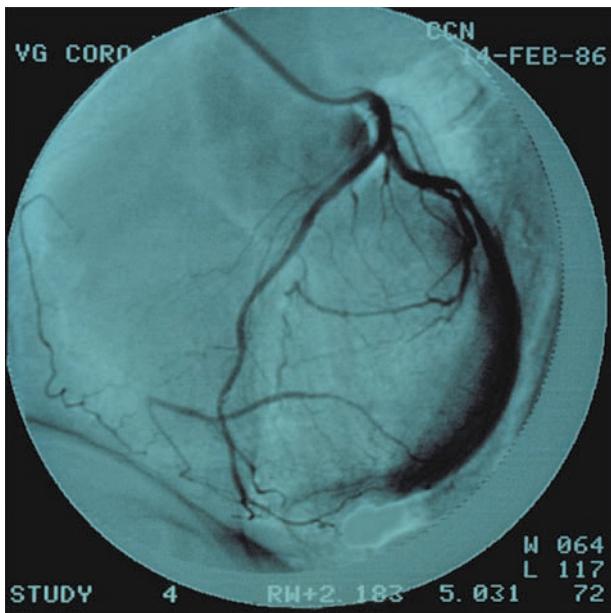
Angiography is the x-ray (radiographic) study of the blood vessels. An angiogram uses a radiopaque substance, or contrast medium, to make the blood vessels visible under x ray. The key ingredient in most radiographic contrast media is iodine. Arteriography is a type of radiographic examination that involves the study of the arteries.

### Purpose

Angiography is used to detect abnormalities, including narrowing (stenosis) or blockages in the blood vessels (called occlusions) throughout the circulatory system and in some organs. The procedure is commonly used to:

- identify atherosclerosis
- diagnose heart disease
- evaluate kidney function
- detect kidney cysts or tumors
- map renal anatomy in transplant donors
- detect an aneurysm
- detect a tumor, blood clot, or arteriovenous malformations in the brain
- diagnose problems with the retina of the eye

Angiography also is used to provide surgeons with an accurate vascular “map” of the heart before open-



An angiogram of a coronary artery. (© CNRI/Phototake. — All rights reserved.)

heart surgery, or of the brain before **neurosurgery**. Angiography may be used after penetrating trauma, like a gunshot or knife wound, to detect blood vessel injury; it may be used to check the position of shunts and stents placed by physicians into blood vessels.

### Precautions

Patients with **kidney disease** or injury may suffer further kidney damage from the contrast media used for angiography. Patients who have blood-clotting problems, have a known allergy to contrast media, or are allergic to iodine may also not be suitable candidates for an angiography procedure. Newer types of contrast media classified as non-ionic are less toxic and cause fewer side effects than traditional ionic agents. Because x rays carry risks of ionizing radiation exposure to the fetus, pregnant women are also advised to avoid this procedure.

### Description

Before the angiographic procedure, patients are briefed on the details of the test, the benefits and risks, and the possible complications involved, and asked to sign an informed consent form. Most angiographic procedures are paid for by major medical insurance. Patients should check with their individual insurance plans to determine their coverage.

Angiography requires the injection of a contrast medium that makes the blood vessels visible to x ray. The contrast medium is injected through a procedure known as arterial puncture. The puncture is usually made in the groin area, armpit, inside elbow, or neck.

Patients undergoing an angiogram are advised to stop eating and drinking eight hours before the procedure. They must remove all jewelry before the procedure and change into a hospital gown. If the arterial puncture is to be made in the armpit or groin area, shaving may be required. A sedative may be administered to relax the patient for the procedure. An intravenous (IV) line is also inserted into a vein in the patient's arm before the procedure begins in case medication or blood products are required during the angiogram or complications arise.

The site is cleaned with an antiseptic agent and injected with a local anesthetic. Then, a small incision is made in the skin to help the needle pass. A needle containing a solid inner core called a stylet is inserted through the incision and into the artery. When the radiologist has punctured the artery with the needle, the stylet is removed and replaced with another long wire called a guide wire. It is normal for blood to spurt out of the needle before the guide wire is inserted.

The guide wire is fed through the outer needle into the artery to the area that requires angiographic study. A fluoroscope displays a view of the patient's vascular system and is used to direct the guide wire to the correct location. Once it is in position, the needle is then removed, and a catheter is threaded over the length of the guide wire until it reaches the area of study. The guide wire is then removed, and the catheter is left in place in preparation for the injection of the contrast medium.

Depending on the type of angiographic procedure being performed, the contrast medium is either injected by hand with a syringe or is mechanically injected with an automatic injector, sometimes called a power injector, connected to the catheter. An automatic injector is used frequently because it is able to deliver a large volume of contrast medium very quickly to the angiographic site. Usually a small test injection is made by hand to confirm that the catheter is in the correct position.

The patient is told that the injection will start, and is instructed to remain very still. The injection causes some mild to moderate discomfort. Possible side effects or reactions include **headache**, **dizziness**, irregular heartbeat, **nausea**, warmth, burning sensation, and chest **pain**, but they usually last only momentarily. To view the area of study from different angles or perspectives, the patient may be asked to change positions several times, and subsequent contrast medium

## KEY TERMS

**Aneurysm**—An abnormal bulge of an artery that can rupture leading to hemorrhage.

**Arteriovenous malformation**—An abnormal tangle of arteries and veins.

**Arteriosclerosis**—A chronic condition characterized by thickening and hardening of the arteries and the build-up of plaque on the arterial walls. Arteriosclerosis can slow or impair blood circulation.

**Carotid artery**—An artery located in the neck.

**Catheter**—A long, thin, flexible tube used in angiography to inject contrast material into the arteries.

**Cirrhosis**—A condition characterized by the destruction of healthy liver tissue. A cirrhotic liver is scarred and cannot break down the proteins in the bloodstream. Cirrhosis is associated with portal hypertension.

**Embolism**—A blood clot, air bubble, or clot of foreign material that travels and blocks the flow of blood in an artery. When blood supply to a tissue or organ is blocked by an embolism, infarction (death of the tissue the artery feeds) occurs. Without immediate and appropriate treatment, an embolism can be fatal.

**Femoral artery**—An artery located in the groin area that is the most frequently accessed site for arterial puncture in angiography.

**Fluorescein dye**—An orange dye used to illuminate the blood vessels of the retina in fluorescein angiography.

**Fluoroscope**—An imaging device that displays “moving x rays” of the body. Fluoroscopy allows the radiologist to visualize the guide wire and catheter he or she is moving through the patient’s artery.

**Guide wire**—A wire that is inserted into an artery to guide a catheter to a certain location in the body.

**Ischemia**—A lack of normal blood supply to a organ or body part because of blockages or constriction of the blood vessels.

**Necrosis**—Cellular or tissue death; skin necrosis may be caused by multiple, consecutive doses of radiation from fluoroscopic or x-ray procedures.

**Plaque**—Fatty material that is deposited on the inside of the arterial wall.

**Portal hypertension**—A condition caused by cirrhosis of the liver. It is characterized by impaired or reversed blood flow from the portal vein to the liver, an enlarged spleen, and dilated veins in the esophagus and stomach.

**Portal vein thrombosis**—The development of a blood clot in the vein that brings blood into the liver. Untreated portal vein thrombosis causes portal hypertension.

**Retina**—Light-sensitive tissue on the back of the eye that receives images and converts them into nerve impulses to be sent to the brain by way of the optic nerve.

injections may be administered. During any injection, the patient or the imaging equipment may move.

Throughout the injection procedure, radiographs (x-ray pictures) or fluoroscopic images are obtained. Because of the high pressure of arterial blood flow, the contrast medium dissipates through the patient’s system quickly and becomes diluted, so images must be obtained in rapid succession. One or more automatic film changers may be used to capture the required radiographic images. In many imaging departments, angiographic images are captured digitally, obviating the need for film changers. The ability to capture digital images also makes it possible to manipulate the information electronically allowing for a procedure known as digital subtraction angiography (DSA). Because every image captured is comprised of tiny picture elements called pixels, computers can be used to manipulate the information in ways that enhance diagnostic information. One common approach is to electronically

remove or (subtract) bony structures that otherwise would be superimposed over the vessels being studied, hence the name digital subtraction angiography.

Once the x rays are complete, the catheter is slowly and carefully removed from the patient. Manual pressure is applied to the site with a sandbag or other weight for 10–20 minutes to allow for clotting to take place and the arterial puncture to reseal itself. A pressure bandage is then applied.

### ***Computerized tomography angiography (CTA)***

Computerized tomography angiography (CTA), a newer technique, is used in the evaluation of blood vessel narrowing and blockage. It is less invasive than catheter angiography described above. Instead of injecting contrast material through a catheter, the material is administered intravenously through a vein in the arm. This causes less discomfort. Patients who are unable to

undergo catheter angiography may be candidates for CTA or MRI angiography described below.

CTA is especially useful in screening for arterial disease and in patients with intracranial aneurysms. CTA is particularly useful in delineating the relationship of vascular lesions with bony anatomy close to the skull base. While such lesions can be demonstrated with standard angiography, it often requires studying several projections of the two-dimensional films rendered with standard angiography. CTA is ideal for more anatomically complex skull-base lesions because it clearly demonstrates the exact relationship of the bony anatomy with the vascular pathology. This is not possible using standard angiographic techniques.

Once the information from a CTA scan has been captured, a computer is used to process and reconstruct images. The approach yields shaded surface displays of the actual vascular anatomy that are three dimensional and clearly show the relationship of the bony anatomy with the vascular pathology.

The CTA procedure takes about an hour. During actual scanning, the patient must remain still for 10–30 minutes. Individuals who experience claustrophobia may be distressed by this procedure.

#### **Magnetic resonance angiography (MRA)**

Angiography can also be performed using MRI (**magnetic resonance imaging**) scanners. The technique is called MRA (magnetic resonance angiography). A contrast medium is not usually used, but may be used in some body applications. The active ingredient in the contrast medium used for MRA is one of the rare earth elements, gadolinium. Some MRI angiograms do not require the use of contrast material. When needed, the contrast agent is injected into an arm vein, and images are acquired with careful attention being paid to the timing of the injection and selection of MRI specific imaging parameters. Once the information has been captured, a workstation is used to process and reconstruct the images. The post-processing capabilities associated with CTA and MRA yield three-dimensional representations of the vascular pathology being studied and can also be used to either enhance or subtract adjacent anatomical structures.

Individuals who have any artificial metal implanted parts (e.g., implanted defibrillator, cardiac pacemaker, cochlear implant, screws, plates, surgical staples, shrapnel, artificial joints, intrauterine device [IUD]) should tell their physician and the MRA technologist before the procedure. In some cases, the metal

inside the body may heat up during the procedure making it unsafe to perform an MRA.

Most angiograms follow the general procedures outlined above, but vary slightly depending on the area of the vascular system being studied. A variety of common angiographic procedures are outlined below.

#### **Cerebral angiography**

Cerebral angiography is used to detect aneurysms, stenosis, **blood clots**, and other vascular irregularities in the brain. The catheter is inserted into the femoral or carotid artery, and the injected contrast medium travels through the blood vessels in the brain. Patients frequently experience headache, warmth, or a burning sensation in the head or neck during the injection portion of the procedure. A cerebral angiogram takes two to four hours to complete.

#### **Coronary angiography**

Coronary angiography is administered by a cardiologist with training in radiology or, occasionally, by a radiologist. The arterial puncture is typically made in the femoral artery, and the cardiologist uses a guide wire and catheter to perform a contrast injection and x-ray series on the coronary arteries. The catheter may also be placed in the left ventricle to examine the mitral and aortic valves of the heart. If the cardiologist requires a view of the right ventricle of the heart or of the tricuspid or pulmonic valves, the catheter is inserted through a large vein and guided into the right ventricle. The catheter also serves the purpose of monitoring blood pressures in these different locations inside the heart. The angiographic procedure takes several hours, depending on the complexity of the procedure.

#### **Pulmonary angiography**

Pulmonary, or lung, angiography is performed to evaluate blood circulation to the lungs. It is also considered the most accurate diagnostic test for detecting a **pulmonary embolism**. The procedure differs from cerebral and coronary angiography in that the guide wire and catheter are inserted into a vein instead of an artery, and are guided up through the chambers of the heart and into the pulmonary artery. Throughout the procedure, the patient's vital signs are monitored to ensure that the catheter does not cause **arrhythmias**, or irregular heartbeats. The contrast medium is then injected into the pulmonary artery where it circulates through the lungs' capillaries. The test typically takes up to 90 minutes and carries more risk than other angiography procedures.

### **Kidney (renal) angiography**

Patients with chronic renal disease or injury can suffer further damage to their kidneys from the contrast medium used in a renal angiogram, yet they often require the test to evaluate kidney function. These patients should be well hydrated with an intravenous saline drip before the procedure, and may benefit from available medications (e.g., dopamine) that help to protect the kidney from further injury associated with contrast agents. During a renal angiogram, the guide wire and catheter are inserted into the femoral artery in the groin area and advanced through the abdominal aorta, the main artery in the abdomen, and into the renal arteries. The procedure takes approximately one hour.

### **Fluorescein angiography**

Fluorescein angiography is used to diagnose retinal problems and circulatory disorders. It is typically conducted as an outpatient procedure. The patient's pupils are dilated with eye drops, and he or she rests the chin and forehead against a bracing apparatus to keep it still. Sodium fluorescein dye is then injected with a syringe into a vein in the patient's arm. The dye travels through the patient's body and into the blood vessels of the eye. The procedure does not require x rays. Instead, a rapid series of close-up photographs of the patient's eyes are taken, one set immediately after the dye is injected, and a second set approximately 20 minutes later once the dye has moved through the patient's vascular system. The entire procedure takes up to one hour.

### **Celiac and mesenteric angiography**

Celiac and mesenteric angiography involves radiographic exploration of the celiac and mesenteric arteries, arterial branches of the abdominal aorta that supply blood to the abdomen and digestive system. The test is commonly used to detect aneurysm, thrombosis, and signs of **ischemia** in the celiac and mesenteric arteries, and to locate the source of gastrointestinal bleeding. It is also used in the diagnosis of a number of conditions, including portal **hypertension** and **cirrhosis**. The procedure can take up to three hours, depending on the number of blood vessels studied.

### **Splenoportography**

A splenoportograph is a variation of an angiogram that involves the injection of contrast medium directly into the spleen to view the splenic and portal veins. It is used to diagnose blockages in the splenic vein and portal-vein thrombosis and to assess the patency and location of the vascular system prior to **liver transplantation**.

Most angiographic procedures are paid for by major medical insurance. Patients should check with their individual insurance plans to determine their coverage.

### **Aftercare**

Because life-threatening internal bleeding is a possible complication of an arterial puncture, an overnight stay in the hospital is sometimes recommended following an angiographic procedure, particularly with cerebral and coronary angiography. If the procedure is performed on an outpatient basis, the patient is typically kept under close observation for a period of at six to 12 hours before being released. If the arterial puncture was performed in the femoral artery, the patient is instructed to keep his or her leg straight and relatively immobile during the observation period. The patient's blood pressure and vital signs are monitored, and the puncture site observed closely. Pain medication may be prescribed if the patient is experiencing discomfort from the puncture, and a cold pack is often applied to the site to reduce swelling. It is normal for the puncture site to be sore and bruised for several weeks. The patient may also develop a hematoma at the puncture site, a hard mass created by the blood vessels broken during the procedure. Hematomas should be watched carefully, as they may indicate continued bleeding of the arterial puncture site.

Angiography patients are also advised to have two to three days of rest after the procedure in order to avoid placing any undue **stress** on the arterial puncture site. Patients who experience continued bleeding or abnormal swelling of the puncture site, sudden dizziness, or chest pain in the days following an angiographic procedure should seek medical attention immediately.

Patients undergoing a fluorescein angiography should not drive or expose their eyes to direct sunlight for 12 hours following the procedure.

### **Risks**

Because angiography involves puncturing an artery, internal bleeding, or hemorrhage are possible complications of the test. As with any invasive procedure, infection of the puncture site or bloodstream is also a risk, but this is rare.

A **stroke** or **heart attack** may be triggered by an angiogram if blood clots or plaque on the inside of the arterial wall are dislodged by the catheter and form a blockage in the blood vessels, or if the vessel undergoes temporary narrowing or spasm from irritation by the catheter. The heart may also become irritated by the movement of the catheter through its chambers during pulmonary and coronary angiographic procedures, and arrhythmias may develop.

Patients who develop an allergic reaction to the contrast medium used in angiography may experience a variety of symptoms, including swelling, difficulty breathing, **heart failure**, or a sudden drop in blood pressure. If the patient is aware of the allergy before the test is administered, certain medications can be administered at that time to counteract the reaction.

Angiography involves minor exposure to radiation through the x rays and fluoroscopic guidance used in the procedure. Unless the patient is pregnant, or multiple radiological or fluoroscopic studies are required, the dose of radiation incurred during a single procedure poses little risk. However, multiple studies requiring fluoroscopic exposure that are conducted in a short time period have been known to cause skin necrosis in some individuals. This risk can be minimized by careful monitoring and documentation of cumulative radiation doses administered to these patients, particularly in those who have therapeutic procedures performed along with the diagnostic angiography.

## Normal results

The results of an angiogram or arteriogram depend on the artery or organ system being examined. Generally, test results should display a normal and unimpeded flow of blood through the vascular system. Fluorescein angiography should result in no leakage of fluorescein dye through the retinal blood vessels.

Abnormal results of an angiogram may display a narrowed blood vessel with decreased arterial blood flow (ischemia) or an irregular arrangement or location of blood vessels. The results of an angiogram vary widely by the type of procedure performed, and should be interpreted by and explained to the patient by a trained radiologist.

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American College of Radiology, 1891 Preston White Drive, Reston, VA, 20191 (703) 648-8900, <http://www.acr.org>.

Radiological Society of North America (RSNA), 820 Jorie Blvd, Oak Brook, IL, 60523-2251 (800) 381-6660 (630) 571-7837, <http://www.rsna.org>.

Society of Interventional Radiology, 3975 Fair Ridge Drive, Suite 400 North, Fairfax, VA, 22033 (703) 691-1805 (800) 488-7284 (703) 691-1855, <http://www.sirweb.org>.

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Angiomas see **[Birthmarks](#)**

## Angioplasty

### Definition

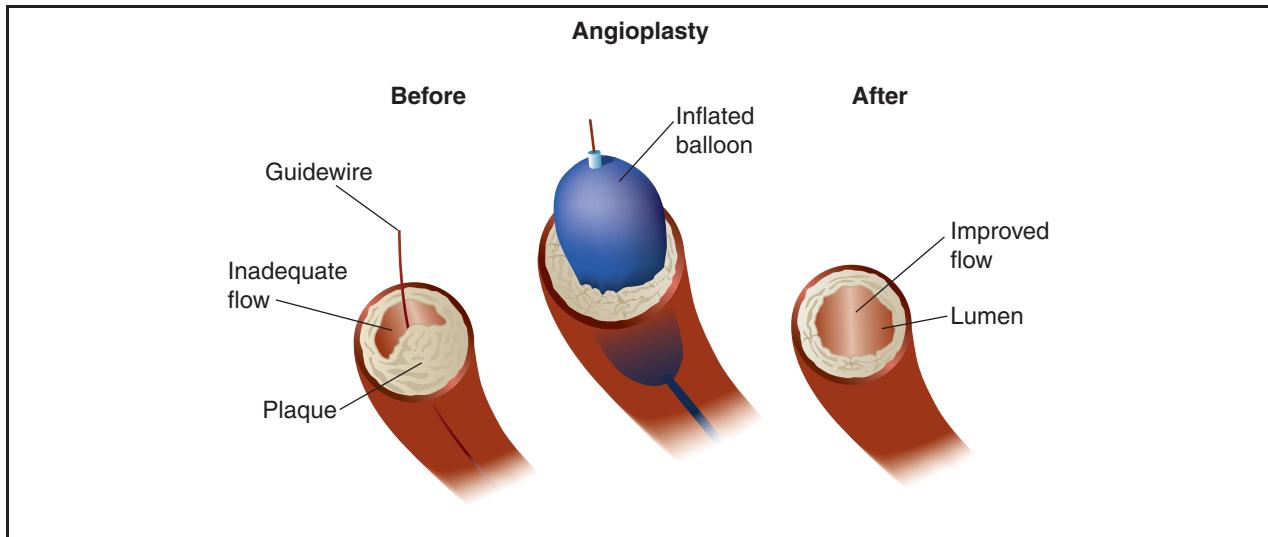
Angioplasty is a procedure used to widen narrowed or partially blocked (occluded) blood vessels. There are various types of angioplasty. The specific names of these procedures are derived from the type of equipment used and the path of entry into the blood vessel. For example, percutaneous transluminal angioplasty (PTA) means that the vessel is entered through the skin (percutaneous) and that the catheter is moved into the blood vessel of interest through the same vessel or one that communicates with it (transluminal). In the case of an angioplasty involving the coronary arteries, the point of entry might be the femoral artery in the groin, with the catheter/guide-wire system passed through the aorta to the heart and the origin of the coronary arteries at the base of the aorta just outside the aortic valve.

### Purpose

An angioplasty is done to reopen a partially blocked blood vessel so that blood can flow through it again at a normal rate. In patients with an occlusive **vascular disease** such as **atherosclerosis**, the flow of blood to other organs or remote parts of the body is limited by the narrowing (stenosis) of the vessel's lumen due to fatty deposits or patches known as plaque. Once the vessel has been widened, an adequate blood flow is restored, but the vessel may narrow again over time (restenosis) at the same location and the procedure may need to be repeated.

### Description

Angioplasties were originally performed by dilating the blood vessel with the introduction of larger and



**In balloon angioplasty, plaque is pushed out of the clogged artery by the inflation of the balloon device.** (Illustration by Argosy, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)

larger stiff catheters through the narrowed space. The complications that resulted from this approach led researchers to develop other ways to open the vessel with smaller devices. An alternative approach was developed in which the catheters used to perform angioplasties contain balloons that are gradually inflated to widen the vessel. Stents, which are thin collapsed tubes made of wire mesh sometimes coated with drugs that help prevent the blood vessel from re-closing can be inserted to provide structural support for the vessel. Lasers may be used to help break up the plaque or fat deposits lining the vessel. Some catheters are equipped with spinning wires or drill tips to clean out the plaque.

Angioplasty may be performed while the patient is either sedated or anesthetized, depending on which vessels are involved. If a percutaneous transluminal coronary angioplasty (PTCA) is to be performed, the patient is sedated so that he or she can report discomfort and **cough** if asked to do so. PTCA procedures are performed in **cardiac catheterization** laboratories with sophisticated monitoring devices. If angioplasty is performed in the radiology department's angiographic suite, the patient may be sedated for the procedure while a nurse monitors the patient's vital signs. Angioplasties performed by vascular surgeons are done in an operating room or specially designed vascular procedure suite.

Typically, patients are given an anticoagulant (blood thinning medication) before the procedure to assist in the prevention of thromboses (**blood clots**), even though these drugs may slow down the sealing of

the entry point of the catheter into the vein. Patients also may be given **calcium channel blockers** and nitrates to reduce the risk of vascular spasm. The angioplasty is performed using fluoroscopic guidance and contrast media. Since the decision to perform angioplasty may have been made following a diagnostic angiogram, the patient's sensitivity to contrast media containing iodine is likely to be known. The procedure may then require the use of an alternative contrast agent.

The patient's skin is cleansed with an antiseptic solution at the site where the surgeon will insert the catheter and other equipment, and the area is protected with a sterile drape. Although many angioplasties are performed by puncturing the vessel through the skin, others are done by surgically exposing the site of entry. Direct view of the vessel's puncture site aids in monitoring damage to the vessel or excessive bleeding at the site. After the vessel has been punctured and the guidewire introduced, a fluoroscope is used to monitor small amounts of contrast media that have been injected. This technique allows the surgeon to see the guidewire's movement through the vessel. If the fluoroscope has a feature called "roadmap," the amount of contrast media injected is greater in order to define the full route the guidewire will take. The fluoroscopy system then superimposes subsequent images over the roadmap while the physician moves the guidewire along the mapped route to the destination.

When the surgeon reaches the location of the stenosis, he or she inflates the balloon on the catheter that has been passed along the guidewire. The size of

## KEY TERMS

**Anticoagulant**—A type of medication given to prevent the formation of blood clots. Anticoagulants are also known as blood thinners.

**Atherosclerosis**—In this disease, deposits of fatty materials build up on the walls of arterial blood vessels, causing them to narrow or become obstructed. Blood pressure increases, leading to heart disease.

**Calcium channel blocker**—A drug that lowers blood pressure by regulating calcium-related electrical activity in the heart.

**Cardiac catheterization**—A procedure to pass a catheter to the heart and its vessels for the purpose of diagnosing coronary artery disease, assessing injury or disease of the aorta, or evaluating cardiac function.

**Contrast medium**—A substance that is swallowed or injected into the body to create clearer images in radiographic studies of internal structures.

**Electrocardiogram (EKG)**—A graphic tracing of the electrical activity of the heart. By looking at the graph, some heart abnormalities can be diagnosed.

**Embolus (plural emboli)**—A gas or air bubble, bit of tissue, blood clot, or foreign object that circulates in

the bloodstream until it lodges in a vessel. A large embolus can narrow or block the vessel, which leads to decreased blood flow in the organ supplied by that vessel.

**Fluoroscopy**—A radiologic technique that creates x-ray images of internal body structures for immediate projection on a fluorescent screen.

**Hematoma**—A localized collection of blood in an organ or tissue due to broken blood vessels.

**Lumen**—The cavity or channel inside a blood vessel or tube-shaped organ.

**Occlusion**—An obstruction or blockage in a blood vessel.

**Patency**—Being widely open. A blood vessel that has been widened or reopened is said to be patent.

**Plaque**—In atherosclerosis, a swollen area in the lining of an artery formed by fatty deposits.

**Stenosis (plural, stenoses)**—The narrowing or constriction of an opening or passageway in the body.

**Stent**—A thin rod-like or tube-like device made of wire mesh, inserted into a vein or artery to keep the vessel open.

the balloon and the duration of its inflation depend on the size and location of the vessel. In some cases, the surgeon also may use a stent, which is opened or expanded inside the blood vessel after it has been guided to the proper location. The blood vessel may be widened before, during, or after the stent has been opened up. In cases where the vessel is tortuous (twisted) or at intersections of vessels, a graft may be necessary to strengthen the walls of the blood vessel. Stents, grafts, and balloon dilation may all be used together or separately. Sometimes radiation is used when a stent is placed.

After the surgeon has widened the blood vessel, he or she verifies its patency by using fluoroscopy and contrast media to produce an angiogram, by using intravascular ultrasound, or by using both techniques. After the imaging studies have been completed, the surgeon removes the equipment from the blood vessel and closes the puncture site.

### Risks

There is a danger of puncturing the vessel with the guidewire during an angioplasty, although the risk is very small. Patients must be monitored for hematoma

or hemorrhage at the puncture site. There is also a small risk of **heart attack**, **stroke**, and, although unlikely, death—all related to vessel spasm (transient vessel narrowing from irritation by the catheter), or from emboli (as plaque can be dislodged by the catheter or travel to the heart or brain). Abrupt closure of the coronary artery occurs in about 4% of patients.

Recurrence of stenosis, known as restenosis, is an additional potential complication. The risk of recurrence is highest in the first six months after angioplasty, with rates as high as 35% reported in some studies.

The length of the patient's hospital stay following an angioplasty depends on his or her overall health, the occurrence of complications, and the availability of home care.

### Alternatives

For some patients, **thrombolytic therapy** (treatment with drugs that dissolve blood clots) coupled with lifestyle changes is an alternative to angioplasty. Many medical centers, in fact, restrict the use of angioplasty to patients who cannot be treated with thrombolytic therapy.

## Health care team roles

Physicians often have specially trained assistants for vascular procedures. These assistants may be nurses, surgical technicians, or X-ray specialists. Cardiac catheterization laboratories will include someone specially trained in monitoring EKG equipment and vital signs. Either a nurse, nurse anesthetist, or anesthesiologist will administer **sedation** or anesthesia for the procedure.

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- American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, <http://www.americanheart.org>.
- National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573; TTY: (240) 629-3255, (240) 629-3246, [nhlbiinfo@nhlbi.nih.gov](mailto:nhlbiinfo@nhlbi.nih.gov), <http://www.nhlbi.nih.gov>.

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## Angiotensin-converting enzyme inhibitors

### Definition

Angiotensin-converting enzyme inhibitors, often called ACE inhibitors, are drugs that block the conversion of the chemical angiotensin I into angiotensin

II. Angiotensin II increases blood pressure by causing blood vessels to constrict (narrow) and increasing salt and water retention in the body. Thus, ACE inhibitors lower blood pressure by blocking the formation of angiotensin II.

### Purpose

ACE inhibitors are commonly used to treat high blood pressure. Treating high blood pressure is important because the condition puts a burden on the heart and the arteries that will lead to permanent damage over time. If left untreated, high blood pressure increases the risk of heart attacks, **heart failure**, **stroke**, and kidney failure. ACE inhibitors are also used to treat other cardiac conditions such as **coronary artery disease** and congestive heart failure (CHF), and they are given after heart attacks (myocardial infarctions). A **heart attack** damages and weakens the heart muscle. The damage continues to progress even after a person recovers from the attack. ACE inhibitor drugs help slow further damage to the heart. ACE inhibitors have also been found effective in treating certain chronic kidney diseases, including helping to slow or prevent kidney damage in people with diabetes. Occasionally they also are used to treat scleroderma and migraines.

ACE inhibitors may be used alone or in combination with other drugs. They work by preventing a naturally occurring chemical in the blood, angiotensin I, from being converted into angiotensin II. People who have high blood pressure and other cardiac problems often have high blood levels of angiotensin II. This means that their blood vessels are constricted more than normal and that excess **sodium** (salt) and water are retained in the body. These conditions force the heart to work harder. By blocking the formation of angiotensin II, ACE inhibitors help reverse these conditions so that the heart must do less work to keep blood flowing through the body.

### Description

ACE inhibitors are available only with a physician's prescription and come in tablet, capsule, and injectable forms. Some commonly used ACE inhibitors are benazepril (Lotensin), captopril (Capoten), enalapril (Vasotec), fosinopril (Monopril), lisinopril (Prinivil, Zestril), moexipril (Univasc), perindopril (Aceon, Coversy), quinapril (Accupril), ramipril (Altace, Tritace, Ramace, Ramiwin), and trandolapril (Mavik).

### Recommended dosage

The recommended dosage depends on the type of ACE inhibitor and the medical condition for which it

## KEY TERMS

**Arteries**—Blood vessels that carry blood away from the heart to the cells, tissues, and organs of the body.

**Chronic**—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

**Enzyme**—A type of protein, produced in the body, that brings about or speeds up chemical reactions.

**Fetus**—A developing baby inside the womb.

**Scleroderma**—A disease that first affects the skin and later affects certain internal organs. The first

symptoms are the hardening, thickening, and shrinking of the skin.

**Systemic lupus erythematosus (SLE)**—A chronic, inflammatory, autoimmune disorder in which the individual's immune system attacks, injures, and destroys the body's own organs and tissues. It may affect many organ systems including the skin, joints, lungs, heart, and kidneys.

**Venom**—A poisonous substance secreted by an animal, usually delivered through a bite or a sting.

is being taken. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

This medicine may work slowly and take several weeks to noticeably lower blood pressure.

Do not stop taking this medicine without checking with the physician who prescribed it.

### Precautions

A person taking an ACE inhibitor should see a physician regularly. The physician will check the blood pressure to make sure the medicine is working as it should and will note any unwanted side effects. People who have high blood pressure often feel perfectly fine. However, they should continue to see their physicians even when they feel well, so that the physician can keep a close watch on their condition. It is also important for patients to keep taking their medicine even when they feel fine.

ACE inhibitors will not cure high blood pressure, but they will help control the condition. To avoid the serious health problems that high blood pressure can cause, individuals may need to take ACE inhibitors or other blood pressure drugs for the rest of their lives. Furthermore, medication alone may not be enough. Patients with high blood pressure may also need to avoid certain foods, such as salty snacks, and keep their weight under control. The health care professional who is treating the condition can offer advice on what measures may be necessary. Patients being treated for high blood pressure should not change their **diets** without consulting their health care provider.

Anyone taking ACE inhibitors should not take any other prescription, over-the-counter (OTC), or herbal medicine without first checking with his or her

physician. Some medicines, such as certain cold remedies, may increase blood pressure.

Some people feel dizzy or lightheaded after taking the first dose of an ACE inhibitor, especially if they have been taking a diuretic (water pill). Anyone who begins an ACE inhibitor should not drive, use machines, or do anything else that might be dangerous until they have found out how the drug affects them. Such symptoms should be reported to the physician or pharmacist if they do not subside within a day or so. For the first one or two days of taking an ACE inhibitor, patients may become lightheaded when arising from bed in the morning. Patients should rise slowly to a sitting position before standing up to reduce the risk of falling.

To prevent the blood pressure from getting too low, observe these precautions:

- Do not drink alcohol without checking with the physician who prescribed this medicine.
- Certain ACE inhibitors should be taken one hour before meals. Other ACE inhibitors may be taken with or without meals. Check with a pharmacist or physician about when the drug should be taken.
- Avoid overheating when exercising or in hot weather. The loss of water from the body through heavy sweating can cause low blood pressure.
- Check with a physician if illness occurs while taking an ACE inhibitor. This is especially true if the illness involves severe nausea, vomiting, or diarrhea. Vomiting and diarrhea can cause the loss of too much water from the body, which can lead to low blood pressure.

Anyone who is taking ACE inhibitors should tell the health care professional in charge before having any surgical or dental procedures or receiving emergency treatment.

Some ACE inhibitors may change the results of certain medical tests, such as blood or urine tests. Before having medical tests, anyone taking an ACE inhibitor should alert the health care professional in charge.

Do not use a potassium supplement or a salt substitute that contains potassium without first checking with the physician who prescribed the ACE inhibitor. These drugs cause the body to retain potassium. Ingesting additional potassium may result in unsafe levels.

Patients who are being treated with bee or wasp venom to prevent allergic reactions to **stings** may have a severe allergic reaction to certain ACE inhibitors.

### **Special conditions**

People who are being treated for medical conditions with other drugs may have problems if they take ACE inhibitors. Before taking these drugs, be sure to let the physician know about all medical conditions and app prescription drugs, over-the counter drugs, herbal remedies, and dietary supplements being taken.

**ALLERGIES.** Anyone who has had unusual reactions to an ACE inhibitor in the past should let his or her physician know before taking this type of medicine again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

**PREGNANCY.** The use of ACE inhibitors in **pregnancy** can cause serious problems in the fetus or newborn. These drugs should not be used during pregnancy. Women who are pregnant or who may become pregnant should check with their physicians before using this medicine. Women who become pregnant while taking this medicine should check with their physicians immediately.

**BREASTFEEDING.** Some ACE inhibitors pass into breast milk. Women who are **breastfeeding** should check with their physicians before using ACE inhibitors.

**OTHER MEDICAL CONDITIONS.** Before using ACE inhibitors, people with any of these medical problems should make sure their physician is aware of their conditions:

- diabetes
- heart or blood vessel disease
- recent heart attack or stroke
- liver disease
- kidney disease
- kidney transplant
- scleroderma
- systemic lupus erythematosus (SLE)

### **Side effects**

The most common side effect of ACE inhibitors is a dry, continuing **cough** which occurs in about 10–30% of people using these drugs. The cough usually does not subside unless the medication is stopped. Ask the physician if the cough can be treated. Less common side effects, such as **headache**, loss of taste, unusual tiredness, **nausea**, or **diarrhea** also may occur and do not need medical attention unless they are severe or they interfere with normal activities.

More serious side effects are rare, but may occur. If any of the following side effects occur, check with a physician immediately:

- swelling of the face, lips, tongue, throat, arms, legs, hands, or feet. This is considered a medical emergency and immediate medical care should be sought. If the throat swells shut, death can result.
- itchy skin
- sudden breathing or swallowing problems
- chest pain
- hoarseness
- sore throat
- fever and chills
- stomach pain
- yellow eyes or skin

In addition, anyone who has any of the following symptoms while taking an ACE inhibitor should check with his or her physician as soon as possible:

- dizziness, lightheadedness, fainting
- confusion
- nervousness
- fever
- joint pain
- numbness or tingling in hands, feet, or lips
- weak or heavy feeling in the legs
- skin rash
- irregular heartbeat
- shortness of breath or other breathing problems

Other side effects may occur. Anyone who has unusual symptoms after taking an ACE inhibitor should get in touch with his or her physician.

### **Interactions**

ACE inhibitors may interact with certain foods, herbal medicines, dietary supplements, and other drugs. For example, captopril (Capoten) interacts with food and should be taken one hour before meals. Anyone who takes ACE inhibitors should let

the physician know all other medicines he or she is taking and should ask about foods that should be avoided. Among the foods and drugs that may interact with ACE inhibitors are:

- water pills (diuretics)
- lithium, used to treat bipolar disorder
- tetracycline, an antibiotic
- medicines or supplements that contain potassium
- salt substitutes that contain potassium

The list above does not include everything that interacts with ACE inhibitors. Be sure to check with a physician or pharmacist before combining ACE inhibitors with any other prescription, nonprescription (over-the-counter) medicine, dietary supplement, or herbal remedy.

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### ORGANIZATIONS

American College of Cardiology, Heart House, 2400 N Street, NW, Washington, DC, 20037 (202) 375-6000 (800) 253-4636 x8603 (202) 375-7000, resource @acc.org, <http://www.acc.org>.

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## Angiotensin-converting enzyme test

### Definition

This test measures blood levels of angiotensin-converting enzyme (ACE), also known as Serum Angiotensin-Converting Enzyme (SASE). The primary

## KEY TERMS

**Sarcoidosis**—Sarcoidosis is a rare disease of unknown cause in which inflammation occurs in lymph nodes and other tissues throughout the body, usually the lungs, skin, liver, and eyes.

function of ACE is to help regulate arterial pressure by converting angiotensin I to angiotensin II.

### Purpose

The ACE test is used primarily to detect and monitor the clinical course of **sarcoidosis** (a disease that affects many organs, especially the lungs), to differentiate between sarcoidosis and similar diseases, and to delineate between active and inactive sarcoid disease. Elevated ACE levels are also found in a number of other conditions, including Gaucher's disease (a rare familial disorder of fat metabolism) and **leprosy**.

### Precautions

It should be noted that people under 20 years of age normally have very high ACE levels. Decreased levels may be seen in the condition of excess fat in the blood (hyperlipidemia). Drugs that may cause decreased ACE levels include ACE inhibitor antihypertensives and **steroids**.

### Description

ACE plays an important role in the renin/aldosterone mechanism which controls blood pressure by converting angiotensin I to angiotensin II, two proteins involved in regulating blood pressure. Angiotensin I by itself is inactive, but when converted by ACE to the active form, angiotensin II, it causes narrowing of the small blood vessels in tissues, resulting in an increase in blood pressure. Angiotensin II also stimulates the hormone aldosterone, which causes an increase in blood pressure. Certain kidney disorders increase the production of angiotensin II, another cause of **hypertension**. Despite the action of ACE on blood pressure regulation, determination of this enzyme is not very helpful in the evaluation of hypertension (high blood pressure).

### Preparation

Determination of ACE levels requires a blood sample. The patient need not be **fasting**.

## Risks

Risks for this test are minimal, but may include slight bleeding from the puncture site, fainting or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

## Normal results

Normal ranges for this test are laboratory-specific but can range from 8–57 U/mL for patients over 20 years of age.

## Abnormal results

Serum ACE levels are elevated in approximately 80–90% of patients with active sarcoidosis. Thyroid hormone may have an effect on ACE activity, as hypothyroid (low thyroid) patients, as well as patients with **anorexia nervosa** with associated findings of **hypothyroidism**, may have low serum ACE activity. ACE can also be decreased in lung **cancer** (bronchogenic carcinoma).

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Janis O. Flores



**Hand laceration from a dog bite.** (© Scott Camazine/Alamy.)

## Animal bite infections

### Definition

The most common problem following an animal bite is simple infection. The saliva of dogs, cats, ferrets, and rabbits is known to contain a wide variety of bacteria. According to one recent study, bacteria or other pathogens show up in about 85% of **bites**. When an animal bites, it can then transmit pathogens into the wound. These microorganisms may grow within the wound and cause an infection. The consequences of infection range from mild discomfort to life-threatening complications.

### Description

Two to 4.5 million animal bites occur each year in the United States; about 1% of these bites require hospitalization. Animal bites result in 334,000 emergency room visits per year, which represents approximately 1% of all emergency hospital visits, at an

annual cost of \$100 million dollars in health care expenses and lost income. Children are the most frequent victims of dog bites, with 5–9 year-old boys having the highest incidence. Men are more often bitten by dogs than are women (3:1), whereas women are more often bitten by cats (3:1).

Dog bites make up 80–85% of all reported incidents. Cats account for about 10% of reported bites, and other animals (including hamsters, ferrets, rabbits, horses, raccoons, bats, skunks, and monkeys) make up the remaining 5–10%. Cat bites become infected more frequently than dog bites. A dog's mouth is rich in bacteria, but only 15–20% of dog bites become infected. In contrast, approximately 30–50% of cat bites become infected.

Many factors contribute to the infection rates, including the type of wound inflicted, the location of the wound, pre-existing health conditions in the bitten person, the extent of delay before treatment, patient compliance and the presence of a foreign body in the wound. Dogs usually inflict crush injuries because

## KEY TERMS

**Anaerobic**—Referring to an organism that can live in the absence of air or oxygen. About two-thirds of animal bites are found to contain anaerobic disease-producing organisms.

**Canines**—The two sharp teeth located next to the front incisor teeth in mammals that are used to grip and tear.

**Carnassials**—The last upper premolar teeth in the mouths of cats and other carnivores, adapted to shear or puncture food. Carnassial teeth often cause puncture wounds when a cat bites a human.

**Culture**—A laboratory procedure in which a sample from a wound, the blood or other body fluid is taken from an infected person. The sample is placed in conditions under which bacteria can grow. If bacteria grow, identification tests are done to determine the bacteria species causing the infection.

**Immunocompetence**—An individual's ability to fight off infection.

**Microorganisms**—Microscopic organisms, such as bacteria, viruses, algae and fungi.

**Pasteurellosis**—A bacterial infection caused by *Pasteurella multocida*. Pasteurellosis is characterized by inflammation around the wound site and may be accompanied by bacteria in the bloodstream and infection in tissues and organs.

**Pathogen**—Any disease-producing microorganism.

**Postexposure prophylaxis (PEP)**—Any treatment given after exposure to a disease to try to prevent the disease from occurring. In the case of rabies, PEP involves a series of vaccines given to an individual who has been bitten by an unknown animal or one that is potentially infected with the rabies virus.

**Tenosynovitis**—Inflammation of the sheath of tissue that surrounds a tendon. Tenosynovitis is a common complication of animal bites containing anaerobic bacteria.

**Zoonosis (plural, zoonoses)**—Any disease of animals that can be transmitted to humans. Rabies is an example of a zoonosis.

they have rounded teeth and strong jaws; thus, the bite of an adult dog can exert up to 200 pounds per square inch of pressure. This pressure usually results in a crushing injury, causing damage to such deep structures as bones, blood vessels, tendons, muscles, and nerves. The canine teeth in a dog's mouth are also sharp and strong, often inflicting lacerations. Cats, with their needle-like incisors and carnassial teeth, typically cause puncture **wounds**. Puncture wounds appear innocuous on the surface, but the underlying injury goes deep. Cat teeth essentially inject bacteria into the bite, and the deep, narrow wound is difficult to clean. Persons with impaired immunocompetence—for example, individuals with HIV infection—are especially vulnerable to infection from cat bites. Lastly, bites or **stings** from marine creatures (sharks, rays, eels, etc.) require immediate medical attention as these bites may contain disease organisms unique to the ocean environment as well as causing severe loss of blood.

The bacterial species most commonly found in bite wounds include *Pasteurella multocida*, *Staphylococcus aureus*, *Pseudomonas* sp., and *Streptococcus* sp. *P. multocida*, the root cause of pasteurellosis, is especially prominent in cat bite infections. Other infectious diseases from animal bites include **cat-scratch disease**, **tetanus** and **rabies**.

Doctors are increasingly aware of the importance of checking animal bite wounds for anaerobic organisms, which are microbes that can live and multiply in the absence of air or oxygen. A study published in 2003 reported that about two-thirds of animal bite wounds contain anaerobes. These organisms can produce such complications as septic arthritis, tenosynovitis, **meningitis**, and infections of the lymphatic system.

With regard to the most common types of domestic pets, it is useful to note that biting and other aggressive behavior has different causes in dogs and cats. To some extent these differences are rooted in divergent evolutionary pathways, but they have also been influenced by human interference through selective breeding. Dogs were first domesticated by humans as early as 10,000 b.c. for hunting and as guard or attack dogs. Many species travel in packs or groups in the wild, and many human fatalities resulting from dog bites involve a large group of dogs attacking one or two persons. In addition, dogs typically relate to humans according to a hierarchical model of dominance and submission, and many of the techniques of dog training are intended to teach the dog to respect human authority. Certain breeds of dogs are much more likely to attack humans than others; those most often involved in fatal attacks are pit bulls, Rottweilers, German shepherds, huskies, and mastiffs.

According to the Centers for Disease Control (CDC), there are between 15 and 20 fatal dog attacks on humans in the United States each year. There are several assessment or evaluation scales that veterinarians or animal trainers can use to score individual or mixed-breed dogs for dominant or aggressive behavior.

Unlike dogs, cats were not domesticated until about 3000 B.C., and were important to ancient civilizations as rodent catchers and household companions rather than as protectors or hunters of wild game. Biologists classify cats as solitary predators rather than as pack or herd animals; as a result, cats do not relate to humans as authority figures in the same way that dogs do, and they do not form groups that attack humans when threatened or provoked. In addition, domestic cats have been selectively bred for appearance rather than for fierceness or aggression. Most cat bites are the result of fear on the cat's part (as when being placed in a carrier for a trip to the vet) or a phenomenon known as petting-induced aggression. Petting-induced aggression is a behavior in which a cat that has been apparently enjoying contact with a human suddenly turns on the human and bites. This behavior appears to be more common in cats that had no contact with humans during their first seven weeks of life. In other cats, this type of aggression appears to be related to a hypersensitive nervous system; petting or cuddling that was pleasurable to the cat for a few seconds or minutes becomes irritating, and the cat bites as a way of indicating that it has had enough. In older cats, petting-induced aggression is often a sign that the cat feels **pain** from touching or pressure on arthritic joints in its neck or back.

## Causes and symptoms

The most common sign of infection from an animal bite is inflammation. The skin around the wound is red and feels warm, and the wound may exude pus. Nearby lymph glands may be swollen. Complications can arise if the infection is not treated and spreads into deeper structures or into the bloodstream. If the bite is deep or occurs on the hand or at a joint, complications are more likely.

Live disease-causing bacteria within the bloodstream and tissues cause complications far from the wound site. Such complications include meningitis, brain abscesses, **pneumonia** and lung abscesses, and heart infections, among others. These complications can be fatal. Deep bites or bites near joints can damage joints and bones, causing inflammation of the bone and bone marrow or septic arthritis.

Cat-scratch disease is caused by *Bartonella henselae*, a bacterium that is carried in cat saliva; infection may be transmitted by a bite or scratch. Approximately 22,000 cases are reported each year in the United States; worldwide, nine out of every 100,000 individuals become infected. More than 80% of reported cases occur in persons under the age of 21. The disease is not normally severe in individuals with healthy immune systems. Symptoms may become serious, however, in immunocompromised individuals, such as those with acquired immune deficiency syndrome (**AIDS**) or those undergoing **chemotherapy**. Common symptoms include an inflamed sore in the area of the bite or scratch, swollen lymph nodes, **fever**, **fatigue**, and rash.

Rabies is caused by a virus that is transmitted through the bite of an animal that is already infected. It is classified as a **zoonosis**, which is a term that refers to any disease of animals that can be transmitted to humans. More than 90% of animal rabies cases occur in such wild animals as skunks, bats, and raccoons, with such domestic animals as dogs and cats accounting for fewer than 10% of cases. The World Health Organization (WHO) estimates that more than 55,000 individuals worldwide die each year as a result of rabies. The highest incidence of rabies deaths, more than 95%, occurs in Asia and Africa. Rabies is nowadays rare in the United States, as a result of good animal control practices. Onset is delayed, usually weeks to months after the person has been bitten. Early symptoms of rabies include fever, **headache**, and flu-like symptoms. These progress to **anxiety**, **hallucinations**, **muscle spasms**, partial **paralysis**, fear of water (hydrophobia), and other neurological symptoms as the virus spreads to the central nervous system. Medical treatment must be sought soon after exposure because **death** invariably follows once the infection becomes established.

## Diagnosis

A medical examination involves taking the history of the injury and assessing the wound type and damage. Tetanus immunization and general health status are checked. An x ray may be ordered to assess bone damage and to check for **foreign objects** in the wound. Wound cultures are done for infected bites if the victim is at high risk for complications or if the infection does not respond to treatment. Evaluation of possible exposure to rabies is also important. A biting animal suspected of having rabies is usually apprehended, tested, and observed for a period of time for evidence of pre-existing infection.

## Treatment

Treatment depends on the wound type, its site, and risk factors for infection. All wounds are cleaned and disinfected as thoroughly as possible. Bites to the head and face usually receive sutures, as do severe lacerations elsewhere. Puncture wounds are left open. If **abscess** formation occurs, the physician may perform an incision so as to drain the abscess.

If infection occurs, **antibiotics** are prescribed. Antibiotics may also be used for infection prevention. Since a single bite wound may contain many different types of bacteria, no single antibiotic is always effective. Commonly prescribed antibiotics are penicillin or a combination of amoxicillin and clavulanate potassium. Aztreonam has been reported to be effective in treating infections caused by *P. multocida*.

Because rabies is caused by a virus, antibiotics are not effective. In addition, there is no known cure for the disease once symptoms become apparent. It is therefore recommended that individuals with a high risk of contracting the disease (veterinarians, animal handlers, some laboratory workers) receive preexposure **vaccination**. Individuals bitten by an unknown or potentially rapid animal should receive postexposure vaccination, also called postexposure **prophylaxis** (PEP). The PEP regimen consists of one dose of vaccine given at the initial visit as well as one dose of human immune globulin. Additional doses of vaccine are given on days 3, 7, 14, and 28.

## Prognosis

Once a bacterial infection is halted, the bite victim usually recovers fully. There is no known cure for rabies once symptoms become evident and death is almost certain. Prognosis improves greatly with post-exposure prophylaxis.

## Prevention

Preventing bites obviously prevents subsequent infections. With regard to domestic pets, parents should inform themselves about the aggression level and other characteristics of a particular breed before bringing a purebred pet dog into the family, and consider having a specific dog evaluated by a veterinarian or animal behaviorist before adopting it. In addition, parents should make sure that the dog has been neutered or spayed, since intact dogs of either sex are more likely to bite than those that have been altered. Cat bites can often be prevented by learning about a cat's body language and recognizing the signs of petting-induced aggression. These include dilating pupils, a low growl, stiffening of the body, twitching

of the tail, and flattening the ears backward against the head.

Children under 12 years of age are at a higher risk for bites due to their small size and their inexperience with animals; therefore, they should be supervised with animals and taught to act appropriately around them. In particular, children should be taught not to tease a dog by pulling its fur or tail; to leave a dog alone while it is eating; and to avoid running or screaming in the presence of a dog, as the animal is more likely to chase a moving object. Direct eye contact with a threatening dog should be avoided, as the dog may interpret that as aggression. It is best to stand still if at all possible, with feet together and arms against the chest; most dogs will lose interest in an object that is not moving, and will eventually go away.

A wild animal that is unusually aggressive or behaving strangely (e.g. a raccoon or bat that is active during the daytime or is physically uncoordinated) should be avoided and reported to the local animal control authorities; it may be infected with the rabies virus. Wild animals should not be taken in as pets, and garbage or pet food that might attract wild animals should not be left outside the home or camp site. People should also avoid trying to break up fights between animals and should as a rule approach unknown cats and dogs very cautiously, especially on their territory. Finally, animals should not be trained to fight.

Domestic pets should be vaccinated against rabies; people should consult a veterinarian for advice about the frequency of booster vaccinations for the area in which they live. In addition, people who are traveling to countries where rabies is endemic should consider vaccination before leaving the United States.

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#### ORGANIZATIONS

- American Academy of Emergency Medicine (AAEM), 555 East Wells Street, Suite 1100, Milwaukee, WI, 53202, (414) 276-3349, (800) 884-2235, <http://www.aaem.org>.
- American Veterinary Medical Association (AVMA), 1931 North Meacham Road, Suite 100, Schaumburg, IL, 60173-4360, (847) 925-1329, (800) 248-2862, <http://www.avma.org>.
- Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, [cdcinfo@cdc.gov](mailto:cdcinfo@cdc.gov), <http://www.cdc.gov>.

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## Ankylosing spondylitis

### Definition

Ankylosing spondylitis (AS) refers to inflammation of the joints in the spine. AS is also known as rheumatoid spondylitis or Marie-Strümpell disease.

### KEY TERMS

**Ankylosing**—When bones of a joint are fused, stiff, or rigid.

**HLA-B27**—An antigen or protein marker on cells that may indicate ankylosing spondylitis.

**Immune suppressing**—Anything that reduces the activity of the immune system.

**Inflammation**—A reaction of tissues to disease or injury, often associated with pain and swelling.

**Spondylitis**—An inflammation of the spine.

### Description

A form of arthritis, AS is characterized by chronic inflammation, causing **pain** and stiffness of the back, progressing to the chest and neck. Eventually, the whole back may become curved and inflexible if the bones fuse (this is known as "bamboo spine"). AS is a systemic disorder that may involve multiple organs, such as the:

- eye (causing an inflammation of the iris, or iritis)
- heart (causing aortic valve disease)
- lungs
- skin (causing a scaly skin condition, or psoriasis)
- gastrointestinal tract (causing inflammation within the small intestine, called ileitis, or inflammation of the large intestine, called colitis)

Less than 1% of the population has AS; however, 20% of AS sufferers have a relative with the disorder.

### Causes and symptoms

Genetics play an important role in the disease, but the cause of AS is still unknown. More than 90% of patients have a gene called HLA-B27, but only 10–15% of those who inherit the gene develop the disease. Symptoms of AS include:

- low back and hip pain and stiffness
- difficulty expanding the chest
- pain in the neck, shoulders, knees, and ankles
- low-grade fever
- fatigue
- weight loss

AS is seen most commonly in males 30 years old and older. Initial symptoms are uncommon after the age of 30, although the diagnosis may not be

established until after that age. The incidence of AS in Afro-Americans is about 25% of the incidence in Caucasians.

## Diagnosis

Doctors usually diagnose the disease simply by the patient's report of pain and stiffness. Doctors also review spinal and pelvic x rays since involvement of the hip and pelvic joints is common and may be the first abnormality seen on the x ray. The doctor may also order a blood test to determine the presence of HLA-B27 antigen. When a diagnosis is made, patients may be referred to a rheumatologist, a doctor who specializes in treating arthritis. Patients may also be referred to an orthopedic surgeon, a doctor who can surgically correct joint or bone disorders.

## Treatment

Physical therapists prescribe exercises to prevent a stooped posture and breathing problems when the spine starts to fuse and ribs are affected. Back braces may be used to prevent continued deformity of the spine and ribs. Only in severe cases of deformity is surgery performed to straighten and realign the spine, or to replace knee, shoulder, or hip joints.

## Alternative treatment

To reduce inflammation various herbal remedies, including white willow (*Salix alba*), yarrow (*Achillea millefolium*), and lobelia (*Lobelia inflata*), may be helpful. **Acupuncture**, performed by a trained professional, has helped some patients manage their pain. Homeopathic practitioners may prescribe such remedies as *Bryonia* and *Rhus toxicodendron* for pain relief.

## Prognosis

There is no cure for AS, and the course of the disease is unpredictable. Generally, AS progresses for about 10 years and then its progression levels off. Most patients can lead normal lives with treatment to control symptoms.

## Prevention

There is no known way to prevent AS.

## Resources

### OTHER

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## ORGANIZATIONS

- Arthritis Foundation, P.O. Box 7669, Atlanta, GA, 30357-0669, (404) 872-7100, <http://www.arthritis.org>.
- National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS), 1 AMS Circle, Bethesda, MD, 20892-3675, (301) 495-4484, (301) 718-6366, (877) 226-4267, [NIAMSiinfo@mail.nih.gov](mailto:NIAMSiinfo@mail.nih.gov), <http://www.niams.nih.gov>.
- Spondylitis Association of America, P.O. Box 5872, Sherman Oaks, CA, 91413, (818) 892-1616, (818) 892-1611, <http://www.spondylitis.org>.

Jeanine Barone Physiologist

Anorectal abscess see **Anorectal disorders**

## Anorectal disorders

### Definition

Anorectal disorders are a group of medical disorders that occur at the junction of the anal canal and the rectum.

### Description

The anal canal, also called the anus, is the opening at the bottom end of the digestive tract and is a combination of external skin and tissue from the digestive tract. It has many sensory nerves and is sensitive to **pain**. The rectum is the last section of the digestive tract and has a mucus layer as its inside surface. It has very few sensory nerves and is, therefore, relatively insensitive to pain. The anal canal has a ring of muscle, called the anal sphincter, which keeps the anus closed. There are a number of different anorectal disorders.

### Causes and symptoms

An anal fissure is a tear in the lining of the anus that is usually caused by a hard bowel movement. Fissures are painful and bleed when the tissue is stressed during bowel movements.

Anorectal abscesses are characterized by pus-forming infections in the anorectal region. Painful abscesses form under the skin.

An anorectal **fistula** is an abnormal opening or channel from the anorectal area to another part of the body. Typically, the channel leads to pockets of skin near the anus. When seen in infants, anorectal fistulas

are considered **birth defects**. These are seen more frequently in boys than in girls. Fistulas are also seen more frequently in people who have other diseases, including **Crohn's disease, tuberculosis, cancer**, and **diverticulitis**. Anorectal fistulas also occur following anorectal abscesses or other injury to the anal area. Fistulas are usually painful and discharge pus.

## Diagnosis

Diagnosis is made by visual inspection of the skin around the anus. Also, the doctor may probe the rectum with a gloved finger. An anoscope is a short instrument that allows the physician to view the inside of the anus. A proctoscope is a longer, rigid viewing tube of approximately six to ten inches in length, which may be used to look for anorectal disorders. A sigmoidoscope is a longer, flexible tube, that allows the physician to view up to about two feet of the inside of the large intestine. Tissue samples and material for microbial culture may be obtained during the examination.

## Treatment

Treatment usually isn't required for **hemorrhoids**. Most hemorrhoids will heal if the patient takes stool softeners to relieve the **constipation**. Enlarged blood vessels can be eliminated by surgery if they are considered a severe problem. In the case of fissures, treatment involves stool softeners that eliminate **stress** on the fissure during bowel movements, which allows the fissure to heal. If the fissure doesn't heal, surgery is required. Treatment for anorectal abscesses consists of cutting the **abscess** and draining the pus. Fistulas are treated by surgery. The usual treatment for **proctitis** is **antibiotics**.

## Resources

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Beers, Mark H., Robert S. Porter, and Thomas V. Jones, eds. *The Merck Manual of Diagnosis and Therapy*. 18th ed. Whitehouse Station, NJ: Merck Research Laboratories, 2006.

John T. Lohr PhD

Anorectal fistula see **Anorectal disorders**

## Anorexia nervosa

### Definition

Anorexia nervosa is a psychiatric disorder characterized by an unrealistic fear of weight gain, self-starvation, and conspicuous distortion of body image.

The individual is obsessed with becoming increasingly thinner and limits food intake to the point where health is compromised. The disorder can be fatal. The name comes from two Latin words that mean nervous inability to eat.

## Demographics

Anorexia is a disorder of industrialized countries where food is abundant and the culture values a thin appearance. About 1% of Americans are anorectic and female anorectics outnumber males 10:1. In men the disorder is more often diagnosed in homosexuals than in heterosexuals. Some experts believe that number of diagnosed anorectics represents only the most severe cases, and that many more people have anorexic tendencies, but their symptoms do not rise to the level needed for a medical diagnosis.

Anorexia has been characterized as a "rich white girl" disorder. Most anorectics are white, and about three-quarters of them come from households at the middle income level or above. However, in the 2000s, the number of blacks and Hispanics diagnosed with anorexia has increased.

Anorexia can occur in people as young as age 7. However, the disorder most often begins during adolescence. It is most likely to start at one of two times, either age 14 or 18. Interestingly, this corresponds with the age of transitioning into and out of high school. There is a secondary peak of individuals who become anorexic in their 40s. The younger the age at which anorexic behavior starts, the more difficult it is to cure. Preteens who develop anorexia often show signs of compulsive behavior and depression in addition to anorexia.

## Description

Anorexia is often thought of as a modern problem, but the English physician Richard Morton first described it in 1689. In the twenty-first century anorexia nervosa is recognized as a psychiatric disorder in the *Diagnostic and Statistical Manual for Mental Disorders Fourth Edition (DSM-IV-TR)* published by the American Psychiatric Association.

Individuals with anorexia are on an irrational, unrelenting quest to lose weight, and no matter how much they lose and how much their health is compromised, they want to lose more weight. Recognizing the development of anorexia can be difficult, especially in a society that values and glamorizes thinness. Dieting is often the trigger that starts a person down the road to anorexia. The future anorectic may begin by skipping meals or taking only tiny portions. She (most

anorectics are female) always has an excuse for why she does not want to eat, whether it is not feeling hungry, feeling ill, having just eaten with someone else, or not liking the food served. She also begins to read food labels and knows exactly how many calories and how much fat are in everything she eats. Many anorectics practically eliminate fat and sugar from their **diets** and seem to live on diet soda and lettuce. Some future anorectics begin to **exercise** compulsively to burn extra calories. Eventually these practices have serious health consequences. At some point, the line between problem eating and an eating disorder is crossed.

Anorectics spend a lot of time looking in the mirror, obsessing about clothing size, and practicing negative self-talk about their bodies. Some are secretive about eating and will avoid eating in front of other people. They may develop strange eating habits such as chewing their food and then spitting it out, or they may have rigid ideas about “good” and “bad” food. Anorectics will lie about their eating habits and their weight to friends, family, and healthcare providers. Many anorectics experience depression and **anxiety disorders**.

There are two major subtypes of anorectics. Restrictive anorectics control their weight by rigorously limiting the amount of calories they eat or by **fasting**. They may exercise excessively or abuse drugs or herbal remedies claim to increase the rate at which the body burns calories. Purge-type anorectics eat and then get rid of the calories and weight by self-induced **vomiting**, excessive laxative use, and abuse of **diuretics** or **enemas**.

### Risk factors

Competitive athletes of all races have an increased risk of developing anorexia nervosa, especially in sports where weight is tied to performance. Jockeys, wrestlers, figure skaters, cross-country runners, and gymnasts (especially female gymnasts) have higher than average rates of anorexia. People such as actors, models, cheerleaders, and dancers (especially ballet dancers) who are judged mainly on their appearance are also at high risk of developing the disorder.

## Causes and symptoms

### Causes

Anorexia is a complex disorder that does not have a single cause but appears to result from the interaction of cultural and biological factors. Research suggests that some people have a predisposition toward anorexic and that something then triggers the

behavior, which then becomes self-reinforcing. Hereditary, biological, psychological and social factors all appear to play a role.

While the precise cause of the disorder is not known, it has been linked to the following:

- **Heredity.** Twin studies show that if one twin has anorexia nervosa, the other has a greater likelihood of developing the disorder. Having a close relative, usually a mother or a sister, with anorexia nervosa also increases the likelihood of other (usually female) family members developing the disorder. However, when compared to many other diseases, the inherited component of anorexia nervosa appears to be fairly small.
- **Biological factors.** There is some evidence that anorexia nervosa is linked to abnormal neurotransmitter activity in the part of the brain that controls pleasure and appetite. Neurotransmitters are also involved in other mental disorders such as depression. Research in this area is relatively new and the findings are unclear. People with anorexia tend to feel full sooner than other people. Some researchers believe that this is related to the fact that stomach of people with anorexia tends to empty more slowly than normal; others think it may be related to the appetite control mechanism of the brain.
- **Psychological factors.** Certain personality types appear to be more vulnerable to developing anorexia nervosa. Anorectics tend to be perfectionists who have unrealistic expectations about how they “should” look and perform. They tend to have a black-or-white, right-or-wrong, all-or-nothing way of seeing situations. Many anorectics lack a strong sense of identity and instead take their identity from pleasing others. Virtually all anorectics have low-self worth. Many experience depression and anxiety disorders, although researchers do not know if this is a cause or a result of the eating disorder.
- **Social factors.** Anorectics are more likely to come either from overprotective families or disordered families where there is a lot of conflict and inconsistency. Either way, the anorectic feels a need to be in control of something, and that something becomes body weight. The family often has high, sometimes unrealistic and rigid, expectations. Often something stressful or upsetting triggers the start of anorexic behaviors. This may be as simple as a family member teasing about the person’s weight, nagging about eating junk food, commenting on how clothes fit, or comparing the person unfavorably to someone who is thin. Life events such as moving, starting a new school, breaking up with a boyfriend, or even

## KEY TERMS

**Amenorrhea**—Absence of the menses in a female who has begun to have menstrual periods.

**Body dysmorphic disorder**—A psychiatric disorder marked by preoccupation with an imagined physical defect.

**Diuretic**—A substance that removes water from the body by increasing urine production.

**Electrolyte**—Ions in the body that participate in metabolic reactions. The major human electrolytes are sodium ( $\text{Na}^+$ ), potassium ( $\text{K}^+$ ), calcium ( $\text{Ca}^{2+}$ ), magnesium ( $\text{Mg}^{2+}$ ), chloride ( $\text{Cl}^-$ ), phosphate ( $\text{HPO}_4^{2-}$ ), bicarbonate ( $\text{HCO}_3^-$ ), and sulfate ( $\text{SO}_4^{2-}$ ).

**Hyperalimentation**—A method of re-feeding anorectics by infusing liquid nutrients and electrolytes directly into central veins through a catheter.

**Lanugo**—A soft, downy body hair that develops on the chest and arms of anorexic women.

**Neurotransmitter**—One of a group of chemicals secreted by a nerve cell (neuron) to carry a chemical message to another nerve cell, often as a way of transmitting a nerve impulse. Examples of neurotransmitters include acetylcholine, dopamine, serotonin, and norepinephrine.

**Purging**—The use of vomiting, diuretics, or laxatives to clear the stomach and intestines after a binge.

**Russell's sign**—Scraped or raw areas on the patient's knuckles, caused by self-induced vomiting.

**Superior mesenteric artery syndrome**—A condition in which a person vomits after meals due to blockage of the blood supply to the intestine.

entering puberty and feeling awkward about one's changing body can trigger anorexic behavior. Overlaying the family situation is the unrelenting media message that thin is good and fat is bad; thin people are successful, glamorous, and happy, fat people are stupid, lazy, and failures.

Although anorexia nervosa is still considered a disorder that largely affects women, its incidence in the male population is rising. Less is known about the causes of anorexia in males, but some risk factors are the same as for females. These include certain occupational goals (e.g., jockey) and increasing media emphasis on external appearance in men. Moreover, homosexual males are under pressure to conform to an ideal body weight that is about 20 pounds lighter than the standard "attractive" weight for heterosexual males.

### **Signs and Symptoms**

Anorexic behavior has physical and psychological consequences. These include:

- excessive weight loss; loss of muscle
- stunted growth and delayed sexual maturation in preteens
- gastrointestinal complications: liver damage, diarrhea, constipation, bloating, stomach pain
- cardiovascular complications: irregular heartbeat, low pulse rate, cardiac arrest
- urinary system complications: kidney damage, kidney failure, incontinence, urinary tract infections

- skeletal system complications: loss of bone mass, increased risk of fractures, teeth eroded by stomach acid from repeat vomiting
- reproductive system complications (women): irregular menstrual periods, amenorrhea, infertility
- reproductive system complications (men): loss of sex drive, infertility
- fatigue, irritation, headaches, depression, anxiety, impaired judgment and thinking
- fainting, seizures, low blood sugar
- chronically cold hands and feet
- weakened immune system, swollen glands, increased susceptibility to infections
- development of fine hair called lanugo on the shoulders, back, arms, and face, head hair loss, blotchy, dry skin
- potentially life-threatening electrolyte imbalances
- coma
- increased risk of self-mutilation (cutting)
- increased risk of suicide
- death

### **Diagnosis**

Diagnosis of anorexia nervosa is made when the individual meets the criteria for the disorder outlined in the *DSM IV-TR*.

Anorexia is diagnosed when most of the following conditions are present:

- an overriding obsession with food and thinness that controls activities and eating patterns every hour of every day
- the individual weighs less than 85% of the average weight for his or her age and height group and willfully and intentionally refuses to maintain an appropriate body weight
- extreme fear of gaining weight or becoming fat, even when the individual is significantly underweight
- a distorted self-image that fuels a refusal to admit to being underweight, even when this is demonstrably true
- refusal to admit that being severely underweight is dangerous to health
- for women, three missed menstrual periods in a row after menstruation has been established

Diagnosis is based on several factors including a patient history, **physical examination**, laboratory tests, and a mental status evaluation. A patient history is less helpful in diagnosing anorexia than in diagnosing many diseases because many people with anorexia lie repeatedly about how much they eat and their use of **laxatives**, enemas, and medications. The patient may, however, complain about related symptoms such as **fatigue**, headaches, **dizziness**, **constipation**, or frequent infections.

### Tests

A physical examination begins with weight and blood pressure and moves through all the signs listed above. Based on the physical exam, the physician will order laboratory tests. In general these tests will include a **complete blood count** (CBC), **urinalysis**, blood chemistries (to determine electrolyte levels), and **liver function tests**. The physician may also order an electrocardiogram to look for heart abnormalities. Other conditions including metabolic disorders, brain tumors (especially hypothalamus and pituitary gland lesions), diseases of the digestive tract, and a condition called superior mesenteric artery syndrome can cause weight loss or **vomiting** after eating. People with this condition sometimes vomit after meals because the blood supply to the intestine is blocked. The physician may perform tests needed to rule out the presence of these disorders and assess the patient's nutritional status.

The individual may be referred to a psychiatrist for a mental status evaluation. The physician will evaluate things such as whether the person is oriented in time and space, appearance, observable state of emotion (affect), attitude toward food and weight, delusional thinking, and thoughts of self-harm or **suicide**. This evaluation helps to distinguish between

anorexia and other psychiatric disorders, including depression, **schizophrenia**, social phobia, **obsessive-compulsive disorder**, and **body dysmorphic disorder**. Two diagnostic tests that are often used are the Eating Attitudes Test (EAT) and the Eating Disorder Inventory (EDI).

### Treatment

Treatment choices depend on the degree to which anorexic behavior has resulted in physical damage and whether the person is a danger to him or herself. Medical treatment should be supplemented with psychiatric treatment. Patients are frequently uncooperative and resist treatment, denying that their life may be endangered and insisting that the doctor only wants to "make them get fat."

### Traditional

Hospitalization is recommended for anorexics with any of the following characteristics:

- weight of 40% or more below normal; or weight loss over a three-month period of more than 30 pounds
- severely disturbed metabolism
- severe binging and purging
- signs of psychosis
- severe depression or risk of suicide
- family in crisis

Hospital inpatient care is first geared toward correcting problems that present as immediate medical crises, such as severe **malnutrition**, severe electrolyte imbalance, irregular heart beat, pulse below 45 beats per minute, or low body temperature. Patients are hospitalized if they are a high suicide risk, have severe clinical depression, or exhibit signs of an altered mental state. They may also need to be hospitalized to interrupt weight loss, stop the cycle of vomiting, exercising and/or laxative abuse, treat substance disorders, or for additional medical evaluation.

Day treatment or partial hospitalization where the patient goes every day to an extensive treatment program provides structured mealtimes, **nutrition** education, intensive therapy, medical monitoring, and supervision. If day treatment fails, the patient may need to be hospitalized or enter a full-time residential treatment facility.

Anorexia nervosa is a chronic disease and relapses are common and to be expected. Outpatient treatment provides medical supervision, nutrition counseling, self-help strategies, and therapy after the patient has reached some weight goals and shows stability.

A nutrition consultant or dietitian is an essential part of the team needed to successfully treat anorexia. The first treatment concern is to get the individual medically stable by increasing calorie intake and balancing electrolytes. After that, nutritional therapy is needed support the long process of recovery and stable weight gain. This is an intensive process involving of nutrition education, meal planning, nutrition monitoring, and helping the anorectic develop a healthy relationship with food.

### **Therapy**

Medical intervention helps alleviate the immediate physical problems associated with anorexia, but by itself, it rarely changes behavior. **Psychotherapy** plays a major role in the helping the anorectic understand and recover from anorexia. Several different types of psychotherapy are used depending on the individual's situation. Generally, the goal of psychotherapy is help the individual develop a healthy attitude toward their body and food. This may involve addressing at the root causes of anorexic behavior as well as addressing the behavior itself.

Some types of psychotherapy that have been successful in treating anorectics are listed below.

- Cognitive behavior therapy (CBT) is designed to change the individual's thoughts and feelings about his or her body and behaviors toward food, but it does not address why those thoughts or feelings exist. This therapy is relatively short-term
- Psychodynamic therapy, also called psychoanalytic therapy, attempts to help the individual gain insight into the cause of the emotions that trigger their anorexic behavior. This therapy tends to be longer term than CBT.
- Interpersonal therapy is short-term therapy that helps the individual identify issues and problems in relationships. The individual may be asked to look back at his or her family history to try to recognize problem areas and work toward resolving them.
- Family and couples therapy is helpful in dealing with conflict or disorder that may be a factor in perpetuating anorexic behavior. Family therapy is especially useful in helping parents who are anorectics avoid passing on their attitudes and behaviors on to their children.

### **Drugs**

Anorectics are treated with a variety of medications to address physical problems brought about by their eating disorder and to treat additional psychiatric problems such as depression, **anxiety**, and suicidal

thoughts. The medications used will vary depending on the individual, however, depression is common among anorectics and is treated often treated with **antidepressant drugs**.

### **Alternative**

Alternative treatments should serve as complementary to a conventional treatment program. Alternative therapies for anorexia nervosa include diet and nutrition counseling, herbal therapy, **hydrotherapy**, **aromatherapy**, **Ayurvedic medicine**, and mind/body medicine.

The following herbs may help reduce anxiety and depression which are often associated with this disorder:

- chamomile (*Matricaria recutita*)
- lemon balm (*Melissa officinalis*)
- linden (*Tilia spp.*) flowers

Essential oils of herbs such as bergamot, basil, chamomile, sage, and lavender may help stimulate appetite, relax the body, and fight depression. They can be diffused into the air, inhaled, massaged, or put in bath water.

Relaxation techniques such as **yoga**, **meditation**, and t'ai chi can relax the body and release **stress**, anxiety, and depression.

**Hypnotherapy** may help resolve unconscious issues that contribute to anorexic behavior.

Other alternative treatments that may be helpful include hydrotherapy, **magnetic field therapy**, **acupuncture**, **biofeedback**, Ayurvedic medicine, and **traditional Chinese medicine**.

### **Prognosis**

Anorexia nervosa is difficult to treat successfully. Medical stabilization, nutrition therapy, continued medical monitoring, and substantial psychiatric treatment give a person with anorexia the best chance of recovery. Estimates suggest that between 20% and 30% of people in treatment drop out too soon and have major relapses. Even those who stay in treatment relapse occasionally. Treating anorexia is often a long, slow, frustrating process that can cost many thousands of dollars. The earlier in life that the disorder starts and the longer the disorder continues untreated, the more difficult it is bring about recovery. Many individuals with anorexia are willfully uncooperative and do not want to recover.

About half the people treated for anorexia nervosa recover completely and are able (sometimes with

difficulty) to maintain a normal weight. Of the remaining 50% between 6% and 20% die. The most frequent causes of **death** associated with anorexia are **starvation**, electrolyte imbalance, **heart failure**, and suicide. About 20% remain dangerously underweight, and the rest remain thin. Long-term health complications are common.

## Prevention

Short of major long-term changes in the larger society, the best strategy for prevention of anorexia is the cultivation of healthy attitudes toward food, weight control, and beauty (or body image) within families. Some ways to prevent anorexia nervosa from developing are as follows:

- If you are a parent, do not obsess about your own weight and appearance in front of your children.
- Do not tease your children about their body shapes or compare them to others.
- Make it clear that you love and accept your children as they are.
- Try to eat meals together as a family whenever possible.
- Remind children that the models they see on television and in fashion magazines have extreme, not normal or healthy bodies.
- Do not put your child on a diet unless advised to by your pediatrician.
- Block your child from visiting pro-anorexia Web sites. These are sites where people with anorexia give advice on extreme weight loss techniques and support each other's distorted body image.
- If your child is a competitive athlete, get to know the coach and the coach's attitude toward weight.
- If you think your child has an eating disorder, do not wait to intervene and the professional help. The sooner the disorder is treated, the easier it is to cure.

Relapses happen to many people with anorexia. People who are recovering from anorexia can help prevent themselves from relapsing by:

- never dieting; instead plan healthy meals
- staying in treatment
- monitoring negative self-talk; practicing positive self-talk
- spending time doing something enjoyable every day
- staying busy, but not overly busy; getting at least seven hours of sleep each night
- spending time each day with people you care about and who care about you

## Resources

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- Medline Plus: Eating Disorders. U. S. National Library of Medicine. May 15, 2009 (accessed May 29, 2009). <http://www.nlm.nih.gov/medlineplus/eatingdisorders.html>.

### ORGANIZATIONS

- American Psychological Association, 750 First Street, NE, Washington, DC, 20002-4242 (202) 336-5500; TDD/TTY: (202) 336-6123 (800) 374-2721, [apa@psych.org](mailto:apa@psych.org), <http://www.apa.org>.
- National Association of Anorexia Nervosa and Related Eating Disorders (ANAD), P.O. Box 7, Highland Park, IL, 60035 (847) 831-3438 (847) 433-3996, <http://www.anad.org>.
- National Eating Disorders Association, 603 Stewart Street, Suite 803, Seattle, WA, 98101 (206) 382-3587 Help and Referral Line: (800) 931-2237. (206) 829-8501, [info@NationalEatingDisorder.org](mailto:info@NationalEatingDisorder.org), <http://www.nationaleatingdisorders.org>.

Tish Davidson A.M.

## Anoscopy

### Definition

An anoscopy is an examination of the rectum in which a small tube is inserted into the anus to screen, diagnose, and evaluate problems of the anus and anal canal.

## KEY TERMS

**Anal fissure**—An ulcer on the margin of the anus.

**Digital rectal examination**—An examination where a gloved, lubricated index finger is inserted into the rectum to check for any abnormalities.

**Polyps**—A tumor with a small flap that attaches itself to the wall of various vascular organs such as the nose, uterus and rectum. Polyps bleed easily, and if they are suspected to be cancerous they should be surgically removed.

**Vasovagal reaction**—Regarding the action of stimuli from the vagus nerve on blood vessels.

## Purpose

This test may be ordered for the evaluation of perianal or anal **pain, hemorrhoids, rectal prolapse, digital rectal examination** that shows a mass, perianal **abscess** and condyloma (a wart-like growth). An anoscopy may be performed to check for abnormal openings between the anus and the skin, or anal fissures. The test is also used to diagnose **rectal cancer**.

## Precautions

Anoscopy should not be performed on patients with acute cardiovascular problems due to the vasovagal reaction it may cause. This test is also not recommended for patients with acute abdominal problems and those with a constricted or narrowed anal canal.

## Description

Anoscopy views the anus and anal canal by using an anoscope. An anoscope is a plastic, tube-shaped speculum that is a smaller version of a sigmoidoscope. Before the anoscope is used, the doctor completes a digital **rectal examination** with a lubricated, gloved index finger. The anoscope is then lubricated and gently inserted a few inches into the rectum. This procedure enlarges the rectum to allow the doctor to view the entire anal canal with a light. If any suspicious areas are noticed, a piece of tissue can be biopsied.

During the anoscopy procedure there may be a feeling of pressure or the need to go to the bathroom. If a biopsy is taken, the patient may feel a slight pinch. The procedure is performed on an out-patient basis, and takes approximately an hour to complete.

## Preparation

The patient will be instructed to clear their rectum of stool before the procedure. This may be done by taking a laxative, enema, or other preparation that may help with the evacuation.

## Aftercare

If a biopsy is needed during an anoscopy, there may be slight anal bleeding for less than two days following the procedure. The patient may be instructed to sit in a bathtub of warm water for 10 to 15 minutes, three times a day, to help decrease the pain and swelling.

## Risks

A simple anoscopy procedure offers minimal risks. There is a limited risk of bleeding and mild pain is a biopsy is performed.

## Normal results

Normal values to look for during an anoscopy include an anal canal that appears healthy in size, color, and shape. The test also looks for no evidence of bleeding, polyps, hemorrhoids or other abnormalities.

## Abnormal results

While an anoscopy is typically performed to determine if hemorrhoids are present, other abnormal findings could include polyps, abscesses, inflammation, fissures, colorectal polyps, or **cancer**.

## Resources

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Sarg. Michael J., and Ann D. Gross. *The Cancer Dictionary*. 3rd ed. New York: Checkmark Books, 2007.

### OTHER

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Beth A. Kapes

## Anosmia

### Definition

The term anosmia means lack of the sense of smell. It may also refer to a decreased sense of smell. Ageusia, a companion word, refers to a lack of taste

## KEY TERMS

**Allergen**—Any substance that irritates only those who are sensitive (allergic) to it.

**Corticosteroids**—Cortisone, prednisone, and related drugs that reduce inflammation.

**Rhinitis**—Inflammation and swelling of the nasal membranes.

**Nasal polyps**—Drop-shaped overgrowths of the nasal membranes.

sensation. Patients who actually have anosmia may complain wrongly of ageusia, although they retain the ability to distinguish salt, sweet, sour, and bitter—humans' only taste sensations.

### Description

Of the five senses, smell ranks fourth in importance for humans, although it is much more pronounced in other animals. Bloodhounds, for example, can smell an odor a thousand times weaker than humans. Taste, considered the fifth sense, is mostly the smell of food in the mouth. The sense of smell originates from the first cranial nerves (the olfactory nerves), which sit at the base of the brain's frontal lobes, right behind the eyes and above the nose. Inhaled airborne chemicals stimulate these nerves.

There are other aberrations of smell beside a decrease. Smells can be distorted, intensified, or hallucinated. These changes usually indicate a malfunction of the brain.

### Causes and symptoms

The most common cause of anosmia is nasal occlusion caused by **rhinitis** (inflammation of the nasal membranes). If no air gets to the olfactory nerves, smell will not happen. In turn, rhinitis and **nasal polyps** (growths on nasal membranes) are caused by irritants such as allergens, infections, cigarette smoke, and other air pollutants. Tumors such as nasal polyps can also block the nasal passages and the olfactory nerves and cause anosmia. **Head injury** or, rarely, certain viral infections can damage or destroy the olfactory nerves.

### Diagnosis

It is difficult to measure a loss of smell, and no one complains of loss of smell in just one nostril. So a physician usually begins by testing each nostril

separately with a common, non-irritating odor such as perfume, lemon, vanilla, or coffee. Polyps and rhinitis are obvious causal agents a physician looks for. Imaging studies of the head may be necessary in order to detect brain injury, sinus infection, or tumor.

### Treatment

Cessation of **smoking** is the first step. Many smokers who quit discover new tastes so enthusiastically that they immediately gain weight. Attention to reducing exposure to other nasal irritants and treatment of respiratory **allergies** or chronic upper respiratory infections will be beneficial. **Corticosteroids** are particularly helpful.

### Alternative treatment

Finding and treating the cause of the loss of smell is the first approach in **naturopathic medicine**. If rhinitis is the cause, treating acute rhinitis with herbal mast cell stabilizers and herbal **decongestants** can offer some relief as the body heals. If chronic rhinitis is present, this is often related to an environmental irritant or to **food allergies**. Removal of the causative factors is the first step to healing. Nasal steams with essential oils offer relief of the blockage and tonification of the membranes. Blockages can sometimes be resolved through naso-specific therapy—a way of realigning the nasal cavities. Polyp blockage can be addressed through botanical medicine treatment as well as **hydrotherapy**. Olfactory nerve damage may not be regenerable. Some olfactory aberrations, like intensified sense of smell, can be resolved using **homeopathic medicine**.

### Prognosis

If nasal inflammation is the cause of anosmia, the chances of recovery are excellent. However, if nerve damage is the cause of the problem, the recovery of smell is much more difficult.

### Resources

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J. Ricker Polsdorfer MD

Anoxemia see **Anoxia**

# Anoxia

## Definition

Anoxia is a condition characterized by an absence of oxygen supply to an organ or a tissue.

## Description

Anoxia results when oxygen is not being delivered to a part of the body. If the condition does not involve total oxygen deprivation, it is often called hypoxia, although the two terms have been used interchangeably. A related condition, anoxemia, occurs when the blood circulates but contains a below normal amount of oxygen.

The five types of anoxia or hypoxia include hypoxicemic, anemic, affinity, stagnant, and histotoxic. Hypoxicemic anoxia happens when the oxygen pressure outside the body is so low that the hemoglobin, the chemical which carries oxygen in the red blood cells (RBCs), is unable to become fully loaded with the gas. This results in too little oxygen reaching the tissues and can occur in suffocation when a person is at high altitude, where the pressure of oxygen in the air is much less than at sea level.

Anemic anoxia results from a decrease in the amount of hemoglobin or RBCs in the blood, which reduces the ability to get oxygen to the tissues. Anemia may result from lack of production of red blood cells (iron deficiency), blood loss (hemorrhage), or shortened lifespan of red blood cells (autoimmune disease).

Affinity anoxia involves a defect in the chemistry of the blood such that the hemoglobin can no longer pick up as much oxygen from the air, even though the quantities are normal, reducing how much is delivered to the tissues.

Stagnant anoxia occurs when there is interference with the blood flow, although the blood and its oxygen-carrying abilities are normal. A common cause of general stagnant anoxia is heart disease or interference with the return of blood flow through the veins. Examples of local stagnant anoxia include exposure to cold, diseases that restrict circulation to the extremities, and ergot **poisoning**. When the tissue or organ itself has a reduced ability to accept and use the oxygen, it is called histotoxic anoxia. The classic example is cyanide poisoning, where the chemical inactivates a cellular enzyme necessary for the cell to use oxygen. Thus, tissue exposed to cyanide cannot use the oxygen even though it is in normal amounts in the bloodstream. Histotoxic anoxia can also be caused by

## KEY TERMS

**Amnesia**—Loss of memory often traceable to brain tissue damage.

**Anoxemia**—An extreme lack of oxygen in the blood.

**Hemoglobin**—A chemical found in red blood cells that transports oxygen.

**Myoclonus**—Involuntary contractions of a muscle or group of muscles.

exposure to **narcotics**, alcohol, formaldehyde, acetone, toluene, and certain anesthetic agents.

## Causes and symptoms

Anoxia and hypoxia can be caused by any number of disease states of the blood, lungs, heart and circulation including **heart attack**, severe **asthma**, or **emphysema**. It can also result from smoke or carbon monoxide inhalation, improper exposure to anesthesia, poisoning, strangulation, **near-drowning**, or high altitude exposure through mountain climbing or travel in an insufficiently pressurized airplane. Anoxia, and the resultant brain damage, is a particular problem with newborns during difficult births.

No matter what the cause of anoxia, the symptoms are similar. In severe cases, the patient is often confused and commonly stuporous or comatose (in a state of unconsciousness). Depending on the severity of the injury to the brain, the organ most sensitive to reduced oxygen intake, this condition can persist for hours, days, weeks, or even months or years. Seizures, myoclonic jerks (involuntary **muscle spasms** or twitches), and neck stiffness are some other symptoms of the anoxic condition.

Symptoms of more localized or less complete oxygen deprivation (hypoxia) include increased breathing rate, lightheadedness, **dizziness**, **tingling** or warm sensation, sweating, reduced field of vision, sleepiness, a bluish tint to skin, particularly the fingertips and lips, and behavior changes, often an inappropriate sense of euphoria.

## Diagnosis

Diagnosis of anoxia and hypoxia is commonly made through the appearance of clinical symptoms. However, suspected reduction in oxygen reaching the tissues can be confirmed using laboratory tests. The exact test that is performed is dependent on the

suspected cause of the anoxia. One systemic measure of tissue anoxia is the serum lactate (lactic acid) test. When cells are forced to produce energy without oxygen, as would happen during anoxia, lactic acid is one of the byproducts. Thus, an increase in lactic acid in the blood would indicate that tissues were starved for oxygen and are using non-oxygen pathways to produce energy. Normally, the blood contains less than 2mmol/L of lactic acid. However, some forms of anoxia do not increase lactic acid concentrations in the blood and some increases in lactic acid levels are not associated with anoxia, so an elevated value for this test is only suggestive of an anoxic or hypoxic condition.

### Treatment

The exact treatment for anoxia is dependent on the cause of the reduced oxygen reaching the tissues. However, immediate restoration of tissue oxygen levels through supplementing the patient's air supply with 100% oxygen is a common first step. Secondary steps often include support of the cardiovascular system through drugs or other treatment, treatment of lung disease, transfusions, or administration of anecdotes for poisoning, as appropriate.

### Prognosis

A good prognosis is dependent on the ability to treat the underlying cause of the low oxygen levels. If cardiovascular and respiratory systems can be supported adequately, recovery from the injury to the tissue is possible, although extent of injury to the brain can be difficult to assess. The exact amount of recovery varies with the amount of injury sustained, where significant injury brings a poorer prognosis. As recovery occurs, both psychological and neurological abnormalities may appear, persist, and can improve. Some problems seen after anoxia include mental confusion, personality changes, **amnesia** or other types of **memory loss**, **hallucinations**, and persistent myoclonus (involuntary contractions of the muscles).

### Prevention

Hypoxemic anoxia can be avoided by utilizing supplemental oxygen when in high altitudes and being aware of the early symptoms of **altitude sickness** and reducing altitude once recognized. Iron supplements can avoid anemic hypoxia, although more severe anemic states are usually caused by disease or bleeding. Maintaining good cardiovascular health through proper diet and **exercise** is a good first step to avoiding the most common cause of stagnant

anoxia. Avoiding exposure to the toxic chemicals that cause the condition can prevent histotoxic anoxia.

## Resources

### OTHER

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NINDS Anoxia/Hypoxia Information Page. The National Institute of Neurological Disorders and Stroke (NINDS). January 22, 2001. (accessed May 13, 2001). [http://www.ninds.nih.gov/health\\_and\\_medical/disorders/anoxia\\_doc.htm](http://www.ninds.nih.gov/health_and_medical/disorders/anoxia_doc.htm).

### ORGANIZATIONS

Brain Injury Association of America, 1608 Spring Hill Road, Suite 110, Vienna, VA, 22182, (703) 761-0750, (703) 761-0755, <http://www.biausa.org>.

Coma/Traumatic Brain Injury Recovery Association, 8300 Republic Airport Suite 106, Farmingdale, NY, 11735, (631) 756-1826, <http://www.comarecovery.org>.

Michelle Johnson MS, JD

## Antacids

### Definition

Antacids are medicines that neutralize stomach acid.

### Purpose

Antacids are used to relieve acid **indigestion**, upset stomach, sour stomach, and **heartburn**. Some formulations also contain dimethicone to reduce gas pains, or alginic acid, which, in combination with antacids, may help manage **gastroesophageal reflux disease** (GERD). Antacids should not be confused with gastric acid inhibitors, such as the H-2 receptor blockers (cimetidine (Tagamet), raniidine (Zantac), and others) or **proton pump inhibitors** (lansoprazole (Prevacid), omeprazole (Prilosec and others)). Although all three classes of drugs act to reduce the levels of gastric acid, their mechanisms are different, and this affects the appropriate use of the drugs. Antacids have a rapid onset and short duration of action. They are most appropriately used for rapid relief of gastric discomfort for a short period of time.

Antacids may be divided into two classes, those that work by chemical neutralization of gastric acid, most notably **sodium** bicarbonate, and those that act

## KEY TERMS

**Acid indigestion**—Stomach discomfort that results from too much acid in the stomach.

**Adsorption**—A process that occurs when molecules of a liquid or gas cling to the surface of a solid.

**Chronic**—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

**Heartburn**—A burning sensation, usually in the center of the chest, near the breastbone resulting from the presence of excess stomach acid.

**Indigestion**—A feeling of discomfort or illness that results from the inability to properly digest food.

**Inflamed bowel**—Irritation of the intestinal tract.

**Inflammation**—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

**Pregnancy safety categories**—A system for reporting the known safety issues of drugs for use during pregnancy. The ratings range from A, proven safe by well controlled studies, to X, proven harmful.

by adsorption of the acid (non-absorbable antacids), such as **calcium** and magnesium salts.

The chemical antacids generally have the most rapid onset, but may cause acid rebound. Acid rebound is a condition in which the gastric acid returns in greater concentration after the drug effect has stopped. Also, since these antacids often contain high concentrations of sodium, they may be inappropriate in people with **hypertension** who must limit their salt intake.

Calcium and magnesium salts act by adsorption of the acid and are less prone to the rebound effect. Nevertheless, they may have other significant disadvantages. These antacids are particularly prone to **drug interactions**, and individuals taking other medications must often avoid taking this type of antacid and certain other drugs together. These antacids are more effective in liquid formulations than in tablet or capsule form, and so may be inconvenient for routine dosing.

The non-absorbable antacids may have additional uses beyond control of hyperacidity. Calcium salts may be used as diet supplements to help prevent **osteoporosis**. Aluminum carbonate is useful for binding phosphate and has been found to be effective in treatment and control of hyperphosphatemia or for use with a low phosphate diet to prevent formation of phosphate urinary stones. This application is particularly valuable in patients with **chronic kidney failure**.

Antacids with aluminum and magnesium hydroxides or aluminum hydroxide alone effectively prevent significant stress ulcer bleeding in post-operative patients and those with severe **burns**.

## Recommended dosage

The dose depends on the type of antacid. The individual should consult the packaging of the particular product and his or her physician or pharmacist to determine the correct dose.

When using antacids in chewable tablet form, the tablet should be chewed thoroughly before it is swallowed. A glass of water should be drunk after taking chewable aluminum hydroxide. Lozenges should be allowed to dissolve completely in the mouth. Liquid antacids should be shaken well before using.

## Precautions

Antacids should be avoided if any signs of **appendicitis** or inflamed bowel are present. These signs include cramping, **pain**, soreness in the lower abdomen, bloating, **nausea and vomiting**.

Antacids may affect the results of some medical tests, such as those that measure how much acid the stomach produces. Healthcare providers and patients should keep this in mind when scheduling a medical test.

Antacids that contain magnesium may cause **diarrhea**. Other types of antacids may cause **constipation**.

Individuals should avoid taking antacids containing sodium bicarbonate when the stomach is uncomfortably full from eating or drinking.

Antacids should not be given to children under six years of age.

Antacids that contain calcium or sodium bicarbonate may cause side effects, such as **dizziness**, **nausea**, and **vomiting**, in people who consume large amounts of calcium (from dairy products or calcium supplements). In some cases, this can lead to permanent kidney damage. Individuals who consume large amounts of calcium should check with a physician before taking antacids containing additional calcium.

Some antacids contain large amounts of sodium, particularly sodium bicarbonate (baking soda). Anyone on a low-sodium diet should check the list of ingredients or talk to their physician or pharmacist before taking an antacid product.

Excessive use of antacids may cause or increase the severity of kidney problems. Calcium-based antacids may lead to the formation of **kidney stones**.

**PREGNANCY.** Antacids are not classified under the **pregnancy** safety categories A, B, C, D and X. Occasional use of antacids in small amounts during pregnancy is considered safe. However, pregnant women should check with their physicians before using antacids or any other medicines. Pregnant women who are consuming extra calcium should be aware that using antacids that contain sodium bicarbonate or calcium can lead to serious side effects.

**BREASTFEEDING.** Some antacids may pass into breast milk. However, no evidence exists that the ingestion of antacids through breast milk causes problems for nursing babies whose mothers use antacids occasionally.

### Side effects

Side effects are very rare when antacids are taken as directed. They are more likely when these drugs are taken in large doses or over a long time. Minor side effects include a chalky taste, mild constipation or diarrhea, thirst, stomach cramps, and whitish or speckled stools. These symptoms do not need medical attention unless they are severe, long-lasting, or interfere with normal activities.

Other uncommon side effects may occur. Anyone who has unusual symptoms after taking antacids should get in touch with a healthcare provider.

### Interactions

Antacids have multiple drug interactions, usually due to inhibition of absorption of other medications. In rare cases, the absorbable antacids may alter the acidity of the stomach contents or urine sufficiently to alter drug absorption or excretion. Individuals should talk to their doctor or pharmacist before beginning to take a new medication.

### Resources

#### BOOKS

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### ORGANIZATIONS

American College of Gastroenterology, P. O. Box 342260, Bethesda, MD, 20827-2260, (301) 263-9000, <http://www.acg.gi.org>.

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Antegrade pyelography see **Intravenous urography**

## Antenatal testing

### Definition

Antenatal testing includes any diagnostic procedures performed before the birth of a baby.

### Purpose

These tests and exams are essential for protecting the health of a pregnant woman and her developing child.

### Precautions

Some tests, such as amniocentesis, carry a small risk of a **miscarriage** or other complications that could harm the mother or baby.

### Description

Women who become pregnant undergo a wide variety of tests throughout the nine months before delivery. In the early stages, physicians order blood tests to screen for possible disorders or infections, such as human **immunodeficiency** virus (HIV), which can pass from the mother to the fetus. Later, the focus shifts to checking on fetal well-being with a variety of technological tools such as ultrasound scans. Descriptions of the most common tests and procedures used during **pregnancy** are listed below.

When a woman first learns she is pregnant, her physician will run a series of routine urine and blood tests to determine her blood type, check for anemia and **gestational diabetes**, make sure she is immune to **rubella** (German measles) and check for infectious diseases like HIV, hepatitis, chlamydia or **syphilis**.

## KEY TERMS

**Alpha fetoprotein screen**—A test that measures the level of alpha fetoprotein, a substance produced by a fetus with birth defects, in the mother's blood.

**Amniocentesis**—An invasive procedure that allows physicians to check for birth defects by collecting a sample of fetal cells from inside the amniotic sac.

**Breech position**—When a child is oriented feet first in the mother's uterus just before delivery.

**GBS**—Group B streptococci are a type of bacteria that, if passed to an infant, can cause inflammation of the brain, spinal cord, blood or lungs. In some cases, it can result in infant death.

**Ultrasound**—A device that records sound waves as they bounce off a developing fetus to create an image, which is projected onto a large computer screen.

Physicians also usually do **pelvic exam** to screen for **cervical cancer** and check the patient's blood pressure. As the pregnancy progresses, more tests will follow.

### Ultrasound

Ultrasound is a device that records sound waves as they bounce off the developing fetus to create an image, which is projected onto a large computer screen. Physicians order an ultrasound scan to listen for a fetal heartbeat, determine a woman's precise due date, check for twins, and perform other measurements of the fetus. An ultrasound scan also is known as a sonogram. The procedure takes a few minutes, is painless and usually is covered by health insurance.

The ultrasound technician will ask the pregnant woman to remove her clothes and change into a gown. The technician may rub gel on the woman's stomach, which helps the hand-held device pick up sound waves. In certain cases, the technician may insert a plastic probe into the woman's vaginal canal to get a clearer picture of the fetus. Early in pregnancy, the test may need to be done with a full bladder.

Unlike x rays, ultrasound is safe to use during pregnancy. It does not cause any known side-effects that would harm the mother or baby.

Pregnant women usually will have their first ultrasound anytime between 8 and 12 weeks of gestation. In normal cases, the technician is able to identify a fetal heartbeat, which appears as a flashing light on the

screen. Closer to the due date, physicians use ultrasound to make sure the fetus is in the correct position to exit the birth canal head first.

Sometimes an ultrasound will show that a fetus has stopped growing, or a gestational sac has formed without a fetus, and a miscarriage has occurred. Later in pregnancy, it also may show that the child is in a breech position, oriented feet first, which can cause a difficult labor.

### Tests for birth defects

Most obstetricians offer parents a variety of ways to find out if their developing child might have **birth defects** such as **spina bifida** and **Down Syndrome**. An alpha fetoprotein screen can be done through a simple blood test in the doctor's office between the 16th and 18th week of gestation. It tells the odds that their child will have a severe congenital anomaly. The test works by measuring the level of alpha fetoprotein, a substance produced by a fetus with birth defects. Low levels of alpha fetoprotein in the mother's blood may indicate Down's Syndrome. In that case, the next step for most couples is **amniocentesis** because the alpha fetoprotein test can give false-positive results. Amniocentesis is a more accurate test, but it also has higher risks of complications.

This procedure typically is used to diagnose Down Syndrome while a developing child is still in the womb, at 15-28 weeks.

During amniocentesis, a doctor inserts a needle through a woman's vaginal canal and inside her cervix. Using ultrasound as a guide, the doctor pierces the uterus to withdraw a sample of fluid from the amniotic sac. Afterwards, tiny cells shed by the fetus can be studied in the laboratory. Scientists can analyze DNA samples to determine if the fetus has Down syndrome or other genetic conditions. Amniocentesis also can determine the sex of the fetus.

Women who have a history of recurring miscarriages may not want to have this procedure.

Amniocentesis is usually performed in a doctor's office on an outpatient basis.

Common side effects include cramping and bleeding.

In about one out of every 1,000 cases, amniocentesis causes a needle to puncture the uterine wall, which could result in miscarriage.

In most cases, couples find out their baby does not have a birth defect.

If the results come back positive for Down's Syndrome or other serious conditions, the couple must decide if they want to end the pregnancy. Others use the knowledge to plan and prepare any special care needed for their future child.

### **Group B Strep**

This test is for Group B streptococci (GBS) infection.

By testing for GBS, physicians can determine if a woman is at risk of passing this infection along to her child.

Women who have had a prior child with GBS, or who have a **fever** or prolonged or premature rupture of the amniotic sac may be at higher risk for this type of infection.

GBS is a type of bacteria commonly found in the vagina and rectum. Unlike regular **strep throat**, GBS can be present in a person's body without causing any symptoms, so many women do not realize they are infected with it.

To test for the presence of GBS, doctors may take a urine sample. They also may collect samples from the vagina or rectum, which are then analyzed in a lab. This test is usually performed late in pregnancy, at 35-37 weeks of gestation.

This is a routine urine test or pelvic exam with no side effects.

In many cases, doctors do not find any evidence of this type of infection.

If a woman is found to be infected with Group B strep, physicians usually wait to treat it until just before labor begins. At that time, they may give the mother **antibiotics** so the baby is not born with the infection. Newborns who are exposed to Group B strep can have inflammation of the brain, spinal cord, blood or lungs. In some cases, this serious complication can result in infant **death**.

## **Resources**

### **BOOKS**

*Your Pregnancy & Birth: Information You Can Trust from the Leading Experts in Women's Health Care.* Washington, DC: The American College of Obstetricians and Gynecologists, 2005.

### **ORGANIZATIONS**

American College of Obstetricians and Gynecologists (ACOG), PO Box 96920, Washington, DC, 20090-6920, (202) 638-5577, <http://www.acog.org>.

March of Dimes Birth Defects Foundation, 1275 Mamaroneck Ave., White Plains, NY, 10605, (914) 997-4488, <http://www.modimes.org>.

Melissa Knopper

## **Antepartum testing**

### **Definition**

Antepartum testing consists of a variety of tests performed late in **pregnancy** to verify fetal well-being, as judged by the baby's heart rate and other characteristics. Antepartum tests include the nonstress test (NST), biophysical profile, and contraction **stress test** (CST).

### **Purpose**

Antepartum testing is performed after 32 weeks of pregnancy so that the couple and the doctor can be warned of any problems that may necessitate further testing or immediate delivery. The results reflect the adequacy of blood flow (and oxygen delivery) to the fetus from the placenta.

Antepartum tests are usually done in pregnancies at high risk for fetal complications. Various reasons include:

- any chronic illness in the mother, such as high blood pressure or diabetes
- problems with previous pregnancies, such as stillbirth
- fetal complications, such as intrauterine growth retardation (a slowing of growth of the fetus) or birth defects
- problems in the current pregnancy, including preeclampsia (serious pregnancy-induced high blood pressure), gestational (pregnancy-related) diabetes, premature rupture of the membranes, excessive amniotic fluid (the liquid that surrounds the fetus), vaginal bleeding, or placenta previa (a condition in which the placenta is positioned over the cervix instead of near the top of the uterus)
- twins or other multiple fetuses

One of the most common indications for antepartum testing is post-term pregnancy. A pregnancy should not be allowed to continue past 42 weeks. (The usual pregnancy is 40 weeks in duration). Babies should be monitored with antepartum testing starting at 41 weeks. After 41 weeks, there is an increasing risk that the placenta cannot meet the growing baby's

## KEY TERMS

**Amniotic fluid**—The liquid that surrounds the baby within the amniotic sac. Because it is composed mostly of fetal urine, a low amount of fluid can indicate inadequate placental blood flow to the fetus.

**Deceleration**—A decrease in the fetal heart rate that can indicate inadequate blood flow through the placenta.

**Oxytocin**—A natural hormone that produces uterine contractions.

**Ultrasound**—A procedure in which high-frequency sound waves are used to create a picture of the baby, used alone or with antepartum tests.

**Vibroacoustic stimulation**—In the biophysical profile, use of an artificial larynx to produce a loud noise to “awaken” the fetus.

needs for oxygen and **nutrition**. This may be reflected in decreased movements of the baby, decreased amniotic fluid, and changes in the heart rate pattern of the baby.

### Description

#### Technology

The NST and CST use a technique called **electronic fetal monitoring** to evaluate the heartbeat of the fetus. The biophysical profile is an ultrasound examination.

#### NST

The NST is usually the first antepartum test used to verify fetal well-being. It is based on the principle that when the fetus moves, its heartbeat normally speeds up. The NST assesses fetal health through monitoring accelerations of the heart rate in response to the baby’s own movements, i.e., in the absence of **stress**.

The mother lays down or sits, and an electronic fetal monitor is placed on her abdomen to monitor the fetal heart rate. The doctor records the baby’s heartbeat on a graph or “tracing” to determine whether it demonstrates correct reactivity, or acceleration of the heart rate. To record fetal movements on the tracing, the mother presses a button every time she feels the baby move. If the baby is inactive, the mother may be asked to rub her abdomen to “awaken” it. Sometimes an instrument is used to produce a loud noise to arouse

the fetus (vibroacoustic stimulation). The test usually takes between 20–45 minutes.

A baby who is receiving enough oxygen should move at least twice in a 20 minute period. The baby’s heart rate should increase at least 20 beats per minute for at least 20 seconds during these movements. The NST is the simplest and cheapest antepartum test.

### Biophysical profile

The biophysical profile is an ultrasound exam that can add additional information to the NST. During the biophysical profile, the examiner checks for various characteristics of the baby to evaluate its overall health. These include: fetal movement, fetal tone, breathing movements, and the amniotic fluid volume. Amniotic fluid volume is important because a decreased amount raises the possibility that the baby may be under stress. The five components of the test (NST is also included) are each given a score of 2 for normal (or present), 1 if decreased, and 0 for abnormal. The highest possible score is 10. The “modified” biophysical profile is another option; this includes only the NST and amniotic fluid volume.

### CST

The CST is like the NST, except that the fetus is evaluated in response to contractions of the mother’s uterus. Because it is a more complicated test, it is often used after an abnormal NST to confirm the results. Uterine contractions produce “stress” in the fetus because they temporarily stop the flow of blood and oxygen. The CST is used to confirm that the fetus does not respond to this stress by a decrease in the heart rate.

The CST is performed with the same equipment as the NST. Maternal blood pressure and fetal heart rate are recorded along with the onset, relative intensity, and duration of any spontaneous contractions. For an accurate test, the contractions should be of sufficient duration and frequency. If uterine activity does not occur naturally, a drug called oxytocin may be given to the mother intravenously (hence the test’s alternate name, the oxytocin challenge test) to provoke contractions. Another option is self-stimulation of the mother’s nipples, because this releases natural oxytocin. The fetal heart rate is observed until, ideally, three moderate contractions occur within 10 minutes.

### Preparation

The mother should eat just before the antepartum tests to help stimulate fetal activity.

## Risks

There are no appreciable risks from the NST or the biophysical profile. Ultrasound used for the biophysical profile is painless and safe because it uses no harmful radiation, and no evidence has been found that sound waves cause any adverse effects on the mother or fetus.

The frequency of antepartum testing depends on the reason for its use. All of the tests occasionally give incorrect results, which may prompt an unnecessary early delivery or cesarean. Repeat testing is important to double-check any abnormal findings.

## Normal results

In general, “negative” or normal results on antepartum testing provide reassurance that the baby is healthy and should remain so with no need for immediate delivery. While unusual, false normal results can occur.

The NST is normal (“reactive”) if two or more distinct fetal movements occur in association with appropriate accelerations of the fetal heart rate within 20 minutes. A biophysical profile score of 8-10 is considered reassuring. The CST is normal if the fetus shows no decelerations in heart rate in response to three uterine contractions within 10 minutes.

## Abnormal results

A “positive” result suggests that the baby is not receiving enough oxygen for some reason. However, it is quite possible that the test result was falsely abnormal. To confirm or monitor a suspected disorder, follow-up testing with the same or an alternate test will probably be performed at least weekly.

The NST is abnormal (“nonreactive”) if the fetal heart rate fails to speed up by at least 20 beats per minute at least two times during a 20-minute period. Abnormal decreases in the heart rate (decelerations) are also a cause for concern.

A biophysical profile score of 6 is considered a cause for concern and should be followed by further testing. Scores of 4 or less may require immediate delivery of the fetus.

Abnormal results on the CST include late decelerations, or abnormal slowing of the fetal heart rate after the uterine contractions. This can suggest that the baby is not receiving enough oxygen and may have difficulty withstanding the stress of labor and vaginal delivery. **Cesarean section** might be necessary to spare the baby the stress of labor. With either NST or CST, a

severe deceleration (a period of very slow heartbeat) can also suggest fetal distress.

The ultimate outcome will depend on the woman’s individual situation. In some cases, delivery can be postponed while medication is given to the mother or the fetus. Depending upon the readiness of the mother’s cervix, the doctor may decide to induce labor. The large fetus of a diabetic woman may require cesarean delivery; severe **preeclampsia** also may necessitate **induction of labor** or cesarean section. The doctor will determine the most prudent course of action.

## ORGANIZATIONS

American College of Obstetricians and Gynecologists (ACOG), PO Box 96920, Washington, DC, 20090-6920, (202) 638-5577, <http://www.acog.org>.

National Institute of Child Health and Human Development, Bldg 31, Room 2A32, MSC 2425, 31 Center Drive, Bethesda, MD, 20892-2425, (866) 760-5947, (800) 370-2943, <http://www.nichd.nih.gov>.

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## Anthrax

### Definition

Anthrax is an infection caused by the bacterium *Bacillus anthracis* that primarily affects livestock but that can occasionally spread to humans, affecting either the skin, intestines, or lungs. In humans, the infection can often be treated, but it is almost always fatal in animals.



**Humans suffering from anthrax often develop ulcerating nodules on the body.** (Custom Medical Stock Photo, Inc. Reproduced by permission.)

## KEY TERMS

**Antibody**—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

**Antitoxin**—An antibody that neutralizes a toxin.

**Bronchitis**—Inflammation of the mucous membrane of the bronchial tubes of the lung that can make it difficult to breathe.

**Cutaneous**—Pertaining to the skin

**Meningitis**—Inflammation of the membranes covering the brain and spinal cord called the meninges.

**Pulmonary**—Having to do with the lungs or respiratory system.

**Spore**—A dormant form assumed by some bacteria, such as anthrax, that enable the bacterium to survive high temperatures, dryness, and lack of nourishment for long periods of time. Under proper conditions, the spore may revert to the actively multiplying form of the bacteria.

## Description

Anthrax is most often found in the agricultural areas of South and Central America, southern and eastern Europe, Asia, Africa, the Caribbean, and the Middle East. In the United States, anthrax is rarely reported; however, cases of animal infection with anthrax are most often reported in Texas, Louisiana, Mississippi, Oklahoma, and South Dakota. The bacterium and its associated disease get their name from the Greek word meaning “coal” because of the characteristic coal-black sore that is the hallmark of the most common form of the disease.

During the 1800s, in England and Germany, anthrax was known either as “wool-sorter’s” or “rag-picker’s” disease because workers contracted the disease from bacterial spores present on hides and in wool or fabric fibers. Spores are the small, thick-walled dormant stage of some bacteria that enable them to survive for long periods of time under adverse conditions. The first anthrax vaccine was perfected in 1881 by Louis Pasteur.

The largest outbreak ever recorded in the United States occurred in 1957 when nine employees of a goat hair processing plant became ill after handling a contaminated shipment from Pakistan. Four of the five patients with the pulmonary form of the disease died.

Other cases appeared in the 1970s when contaminated goatskin drumheads from Haiti were brought into the U.S. as souvenirs.

Today, anthrax is rare, even among cattle, largely because of widespread animal **vaccination**. However, some serious epidemics continue to occur among animal herds and in human settlements in developing countries due to ineffective control programs. In humans, the disease is almost always an occupational hazard, contracted by those who handle animal hides (farmers, butchers, and veterinarians) or sort wool. There are no reports of the disease spreading from one person to another.

### *Anthrax as a weapon*

There has been a great deal of recent concern that the bacteria that cause anthrax may be used as a type of biological warfare, since it is possible to become infected simply by inhaling the spores, and inhaled anthrax is the most serious form of the disease. The bacteria can be grown in laboratories, and with a great deal of expertise and special equipment, the bacteria can be altered to be usable as a weapon.

The largest-ever documented outbreak of human anthrax contracted through spore inhalation occurred in Russia in 1979, when anthrax spores were accidentally released from a military laboratory, causing a regional epidemic that killed 69 of its 77 victims. In the United States in 2001, terrorists converted anthrax spores into a powder that could be inhaled and mailed it to intended targets, including news agencies and prominent individuals in the federal government. Because the United States government considers anthrax to be of potential risk to soldiers, the Department of Defense has begun systematic vaccination of all military personnel against anthrax. For civilians in the United States, the government has instituted a program called the National Pharmaceutical Stockpile program in which **antibiotics** and other medical materials to treat two million people are located so that they could be received anywhere in the country within twelve hours following a disaster or terrorist attack.

## Causes and symptoms

The naturally occurring bacterium *Bacillus anthracis* produces spores that can remain dormant for years in soil and on animal products, such as hides, wool, hair, or bones. The disease is often fatal to cattle, sheep, and goats, and their hides, wool, and bones are often heavily contaminated.

The bacteria are found in many types of soil, all over the world, and usually do not pose a problem for

humans because the spores stay in the ground. In order to infect a human, the spores have to be released from the soil and must enter the body. They can enter the body through a cut in the skin, through consuming contaminated meat, or through inhaling the spores. Once the spores are in the body, and if antibiotics are not administered, the spores become bacteria that multiply and release a toxin that affects the immune system. In the inhaled form of the infection, the immune system can become overwhelmed and the body can go into **shock**.

Symptoms vary depending on how the disease was contracted, but the symptoms usually appear within one week of exposure.

### **Cutaneous anthrax**

In humans, anthrax usually occurs when the spores enter a cut or abrasion, causing a skin (cutaneous) infection at the site. Cutaneous anthrax, as this infection is called, is the mildest and most common form of the disease. At first, the bacteria cause an itchy, raised area like an insect bite. Within one to two days, inflammation occurs around the raised area, and a blister forms around an area of dying tissue that becomes black in the center. Other symptoms may include shivering and chills. In most cases, the bacteria remain within the sore. If, however, they spread to the nearest lymph node (or, in rare cases, escape into the bloodstream), the bacteria can cause a form of blood poisoning that rapidly proves fatal.

### **Inhalation anthrax**

Inhaling the bacterial spores can lead to a rare, often-fatal form of anthrax known as pulmonary or inhalation anthrax that attacks the lungs and sometimes spreads to the brain. Inhalation anthrax begins with flu-like symptoms, namely **fever**, **fatigue**, **headache**, muscle aches, and **shortness of breath**. As early as one day after these initial symptoms appear, and as long as two weeks later, the symptoms suddenly worsen and progress to **bronchitis**. The patient experiences difficulty breathing, and finally, the patient enters a state of shock. This rare form of anthrax is often fatal, even if treated within one or two days after the symptoms appear.

### **Intestinal anthrax**

Intestinal anthrax is a rare, often-fatal form of the disease, caused by eating meat from an animal that died of anthrax. Intestinal anthrax causes stomach and intestinal inflammation and sores or lesions (ulcers), much like the sores that appear on the skin

in the cutaneous form of anthrax. The first signs of the disease are **nausea and vomiting**, loss of appetite, and fever, followed by abdominal **pain**, **vomiting** of blood, and severe bloody **diarrhea**.

## **Diagnosis**

Anthrax is diagnosed by detecting *B. anthracis* in samples taken from blood, spinal fluid, **skin lesions**, or respiratory secretions. The bacteria may be positively identified using biochemical methods or using a technique whereby, if present in the sample, the anthrax bacterium is made to fluoresce. Blood samples will also indicate elevated antibody levels or increased amounts of a protein produced directly in response to infection with the anthrax bacterium. Polymerase chain reaction (PCR) tests amplify trace amounts of DNA to show that the anthrax bacteria are present. Additional DNA-based tests are also currently being perfected.

## **Treatment**

In the early stages, anthrax is curable by administering high doses of antibiotics, but in the advanced stages, it can be fatal. If anthrax is suspected, health care professionals may begin to treat the patient with antibiotics even before the diagnosis is confirmed because early intervention is essential. The antibiotics used include penicillin, doxycycline, and ciprofloxacin. Because inhaled spores can remain in the body for a long time, antibiotic treatment for inhalation anthrax should continue for 60 days. In the case of cutaneous anthrax, the infection may be cured following a single dose of antibiotic, but it is important to continue treatment so as to avoid potential serious complications, such as inflammation of the membranes covering the brain and spinal cord (**meningitis**). In the setting of potential bioterrorism, cutaneous anthrax should be treated with a 60-day dose of antibiotics.

Research is ongoing to develop new antibiotics and antitoxins that would work against the anthrax bacteria and the toxins they produce. One Harvard professor, Dr. R. John Collier, and his team have been testing two possible antitoxins on rats. A Stanford microbiologist and a Penn State chemist have also been testing their new antibiotic against the bacteria that cause **brucellosis** and **tularemia**, as well as the bacteria that cause anthrax. All of these drugs are still in early investigational stages, however, and it is still unknown how these drugs would affect humans.

## Prognosis

Untreated anthrax is often fatal, but **death** is far less likely with appropriate care. Ten to twenty percent of patients will die from anthrax of the skin (cutaneous anthrax) if it is not properly treated. All patients with inhalation (pulmonary) anthrax will die if untreated. Intestinal anthrax is fatal 25-75% of the time.

## Prevention

Anthrax is relatively rare in the United States because of widespread animal vaccination and practices used to disinfect hides or other animal products. Anyone visiting a country where anthrax is common or where herd animals are not often vaccinated should avoid contact with livestock or animal products and avoid eating meat that has not been properly prepared and cooked.

Other means of preventing the spread of infection include carefully handling dead animals suspected of having the disease, burning (instead of burying) contaminated carcasses, and providing good ventilation when processing hides, fur, wool, or hair.

In the event that exposure to anthrax spores is known, such as in the aftermath of a terrorist attack, a course of antibiotics can prevent the disease from occurring.

In the case of contaminated mail, as was the case in the 2001 attacks, the U.S. postal service recommends certain precautions. These precautions include inspecting mail from an unknown sender for excessive tape, powder, uneven weight or lumpy spots, restrictive endorsements such as "Personal," or "Confidential," a postmark different from the sender's address, or a sender's address that seems false or that cannot be verified. Handwashing is also recommended after handling mail. In order to decontaminate batches of mail before being opened, machines that use bacteria-killing radiation could be used to sterilize the mail. These machines are similar to systems already in place on assembly lines for sterile products, such as **bandages** and medical devices, but this technique would not be practical for large quantities of mail. In addition, the radiation could damage some of the mail's contents, such as undeveloped photographic film. Microwave radiation or the heat from a clothes iron is not powerful enough to kill the anthrax bacteria.

For those in high-risk professions, an anthrax vaccine is available that is 93% effective in protecting against infection. To provide this immunity, an individual should be given an initial course of three injections, given two weeks apart, followed by booster

injections at six, 12, and 18 months and an annual immunization thereafter.

Approximately 30% of those who have been vaccinated against anthrax may notice mild local reactions, such as tenderness at the injection site. Infrequently, there may be a severe local reaction with extensive swelling of the forearm, and a few vaccine recipients may have a more general flu-like reaction to the shot, including muscle and joint aches, headache, and fatigue. Reactions requiring hospitalization are very rare. However, this vaccine is only available to people who are at high risk, including veterinary and laboratory workers, livestock handlers, and military personnel. The vaccine is not recommended for people who have previously recovered from an anthrax infection or for pregnant women. Whether this vaccine would protect against anthrax used as a biological weapon is, as yet, unclear.

## Resources

### OTHER

- "Anthrax." *New York State Department of Health Communicable Disease Fact Sheet*. <http://www.health.state.ny.us/nysdoh/consumer/anthrax.htm>.
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### ORGANIZATIONS

- Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, [cdcinfo@cdc.gov](mailto:cdcinfo@cdc.gov), <http://www.cdc.gov>.
- National Institute of Allergies and Infectious Diseases, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (301) 402-3573, (866) 284-4107, [ocpostoffice@naiid.nih.gov](mailto:ocpostoffice@naiid.nih.gov), <http://www.niaid.nih.gov>.
- World Health Organization (WHO), Avenue Appia 201211, Geneva, Switzerland, 27, 4122 791-2111, [info@who.int](mailto:info@who.int), <http://www.who.int>.

Carol A. Turkington

## Antiacne drugs

### Definition

Antiacne drugs are medicines that help clear up pimples, blackheads, whiteheads, pustules, cysts and more severe forms of **acne**.

### Purpose

Acne is a skin condition that occurs when pores or hair follicles become blocked. This blockage allows a waxy material called sebum to collect inside the pores or follicles. Normally, sebum flows out onto the skin and hair to form a protective coating, but when it cannot get out, small swellings develop on the skin surface. Bacteria and dead skin cells can also collect and can cause inflammation. Swellings that are small and not inflamed are whiteheads or blackheads. Together these are known as comedones. When comedones become inflamed, they turn into pimples. Pimples that fill with pus are called pustules.

The severity of acne is often influenced by seasonal changes; it is typically less severe in summer than in winter. In addition, acne in girls is often affected by the menstrual cycle.

Different types of antiacne drugs are used for different purposes. For example, lotions, soaps, gels, and creams containing benzoyl peroxide or tretinoin may be used to clear up mild to moderately severe acne. Isotretinoin (Accutane) is prescribed only for very severe, disfiguring acne.

Acne cannot be cured, but acne drugs can help clear the skin. Benzoyl peroxide and tretinoin work by mildly irritating the skin. This encourages skin cells to slough off, which helps open blocked pores. Benzoyl peroxide also kills bacteria, which helps prevent whiteheads and blackheads from turning into pimples. Isotretinoin shrinks the glands that produce sebum.

### Description

Benzoyl peroxide is found in many over-the-counter acne products that are applied to the skin, such as Benoxyl, Clear By Design, Neutrogena Acne, Pan-Oxyl, and some formulations of Clean & Clear, Clearasil, and Oxy. Some benzoyl peroxide products are available without a physician's prescription; others require a prescription. Azelaic acid, an acid that occurs naturally in the skin, is also used in products that treat mild-to-moderate acne.

Tretinoin (Avita, Retin-A, Renova) is available only with a physician's prescription and comes in

### Antiacne drugs

Brand name (generic name)	Possible side effects
Accutane (isotretinoin)	Conjunctivitis, dry mouth, dry skin*
Benzamycin (erythromycin and benzoyl peroxide)	Dry and itchy skin
Cleocin T (clindamycin phosphate)	Dry skin
Desquam-E (benzoyl peroxide)	Itching, red and peeling skin
Erycette (erythromycin topical)	Burning, dry skin, hives, red and peeling skin
Minocin (minocycline hydrochloride)	Diarrhea, headache, hives, peeling skin, vomiting
Retin-A (tretinoin)	Blistering, crusted, or puffy skin; darkening of the skin
Sumycin (tetracycline)	Changes in skin color, sore mouth, upset stomach

\*Note: Accutane has also been associated with more severe side effects, including depression, psychosis, and birth defects (when taken by pregnant women). For more information, visit the U.S. Food and Drug Administration Web site at: <http://www.fda.gov>.

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liquid, cream, and gel forms, which are applied to the skin. Other topical (applied to the skin) antiacne medications are adapalene (Differin) and tazarotene (Avage, Tazorac, Zorac). These are synthetic retinoids whose action is similar to that of tretinoin.

Some newer antiacne preparations combine benzoyl peroxide with **antibiotics**. One combination of benzoyl peroxide with clindamycin is sold under the trade name BenzaClin.

Isotretinoin (Accutane), which is taken by mouth in capsule form, is available only with a physician's prescription. This is a powerful drug with significant side effects. Only physicians who have experience in diagnosing and treating severe acne, such as dermatologists, should prescribe isotretinoin.

Many antiacne preparations contain compounds derived from plants that have anti-inflammatory properties. One group of researchers listed thirty-eight different plants that are beneficial in treating acne and other inflammatory skin conditions.

### Recommended dosage

The recommended dosage depends on the type of antiacne drug. These drugs come with written directions for patients and should be used only as directed. Patients who have questions about how to use the medicine should check with a physician or pharmacist.

## KEY TERMS

**Triglycerides**—A type of fat found in the blood. High levels of triglycerides can increase the risk of coronary artery disease.

Patients who use isotretinoin usually take the medicine for a few months, and then stop for at least two months. Their acne may continue to improve even after they stop taking the drug. If the condition is still severe after several months of treatment and a two-month break, the physician may prescribe a second course of treatment.

### Precautions

#### *Isotretinoin*

Isotretinoin can cause serious **birth defects**, including **mental retardation** and physical deformities. This medicine should not be used during **pregnancy**. Women who are able to bear children should not use isotretinoin unless they have very severe acne that has not cleared up with the use of other antiacne drugs. In that case, a woman who uses this drug must have a pregnancy test two weeks before beginning treatment and each month they are taking the drug. Another pregnancy test must be done one month after treatment ends. The woman must use an effective birth control method for one month before treatment begins and must continue using it throughout treatment and for one month after treatment ends. Women who are able to bear children and who want to use this medicine should discuss this information with their health care providers. Before using the medicine, they will be asked to sign a consent form stating that they understand the danger of taking isotretinoin during pregnancy and that they agree to use effective birth control.

Do not donate blood to a blood bank while taking isotretinoin or for 30 days after treatment with the drug ends. This will help reduce the chance of a pregnant woman receiving blood containing isotretinoin, which could cause birth defects.

Isotretinoin may cause a sudden decrease in night vision. If this happens, do not drive or do anything else that could be dangerous until vision returns to normal. Let the physician know about the problem promptly.

This drug may also make the eyes, nose, and mouth dry. Ask the physician about using special eye drops to relieve eye dryness. To temporarily relieve the **dry mouth**, chew sugarless gum, suck on sugarless

candy or ice chips, or use saliva substitutes, which come in liquid and tablet forms and are available without a prescription. If the problem continues for more than two weeks, check with a physician or dentist. Mouth dryness that continues over a long time may contribute to **tooth decay** and other dental problems.

Isotretinoin may increase sensitivity to sunlight. Patients being treated with this drug should avoid exposure to the sun and should not use **tanning** beds, tanning booths, or sunlamps until they know how the drug affects them.

In the early stages of treatment with isotretinoin, some people's acne seems to get worse before it starts to improve. If the condition becomes much worse or if the skin is very irritated, check with the physician who prescribed the medicine.

#### *Benzoyl peroxide and retinol-based antiacne medications*

When applying antiacne drugs to the skin, be careful not to get the medicine in the eyes, mouth, or inside of the nose. Do not put the medicine on skin that is wind burned, sunburned, or irritated, and do not apply it to open **wounds**.

Because such antiacne drugs as benzoyl peroxide and retinol-based drugs irritate the skin slightly, avoid doing anything that might cause further irritation. Wash the face with mild soap and water only two or three times a day, unless the physician says to wash it more often. Avoid using abrasive soaps or cleansers and products that might dry the skin or make it peel, such as medicated cosmetics, cleansers that contain alcohol, or other acne products that contain resorcinol, sulfur or salicylic acid.

If benzoyl peroxide, tretinoin, adapalene, or tazarotene make the skin too red or too dry or cause too much peeling, check with a physician. Using the medicine less often or using a weaker strength may be necessary.

Tretinoin may increase sensitivity to sunlight. While being treated with this medicine, avoid exposure to the sun and do not use tanning beds, tanning booths, or sunlamps. If it is not possible to avoid being in the sun, use a sunscreen with a skin protection factor (SPF) of at least 15 or wear protective clothing over the treated areas. The skin may also become more sensitive to cold and wind. People who use this medicine should protect their skin from cold and wind until they know how the medicine affects them.

Benzoyl peroxide may discolor hair or colored fabrics.

### Special conditions

People who have other medical conditions and who are taking certain other drugs may have problems if they use antiacne drugs. Before using these products, be sure to let the physician know about any of these conditions:

**ALLERGIES.** Anyone who has had unusual reactions to etretinate, isotretinoin, tretinoin, vitamin A preparations, or benzoyl peroxide in the past should let his or her physician know before using an antiacne drug. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

**PREGNANCY.** Women who are pregnant or who may become pregnant should check with a physician before using tretinoin or benzoyl peroxide. *Isotretinoin causes birth defects in humans and must not be used during pregnancy.*

**BREASTFEEDING.** No problems have been reported in nursing babies whose mothers used tretinoin or benzoyl peroxide. Women who are **breastfeeding** babies should not take isotretinoin, however, as it may cause development problems in nursing babies.

**OTHER MEDICAL CONDITIONS.** Before using antiacne drugs applied to the skin, people with any of these medical problems should make sure their physicians are aware of their conditions:

- eczema. Antiacne drugs that are applied to the skin may make this condition worse.
- sunburn or raw skin. Antiacne drugs that are applied to the skin may increase the pain and irritation of these conditions.

In people with certain medical conditions, isotretinoin may increase the amount of triglyceride (a fatty substance) in the blood. This may lead to heart or blood vessel problems. Before using isotretinoin, people with any of these medical problems should make sure their physicians are aware of their conditions:

- alcoholism or heavy drinking, now or in the past
- diabetes (or family history of diabetes). Isotretinoin may also change blood sugar levels.
- family history of high triglyceride levels in the blood
- severe weight problems.

### Side effects

#### *Isotretinoin*

Minor discomforts such as dry mouth or nose, dry eyes, dry skin, or **itching** usually go away as the body

adjusts to the drug and do not require medical attention unless they continue or are bothersome.

Other side effects should be brought to a physician's attention. These include:

- burning, redness, or itching of the eyes
- nosebleeds
- signs of inflammation of the lips, such as peeling, burning, redness or pain

Bowel inflammation is not a common side effect, but it may occur. If any of the following signs of bowel inflammation occur, stop taking isotretinoin immediately and check with a physician:

- pain in the abdomen
- bleeding from the rectum
- severe diarrhea

### *Benzoyl peroxide and retinol-based medicines*

The most common side effects of antiacne drugs applied to the skin are slight redness, dryness, peeling, and stinging, and a warm feeling to the skin. These problems usually go away as the body adjusts to the drug and do not require medical treatment.

Other side effects should be brought to a physician's attention. Check with a physician as soon as possible if any of the following side effects occur:

- blistering, crusting or swelling of the skin
- severe burning or redness of the skin
- darkening or lightening of the skin. (This effect will eventually go away after treatment with an antiacne drug ends.)
- skin rash

Other side effects are possible with any type of antiacne drug. Anyone who has unusual symptoms while using antiacne drugs should get in touch with his or her physician.

### Interactions

Using antiacne drugs with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

Patients using antiacne drugs on their skin should tell their physicians if they are using any other prescription or nonprescription (over-the-counter) medicine that they apply to the skin in the same area.

Isotretinoin may interact with other medicines. When this happens, the effects of one or both drugs may change or the risk of side effects may be greater. Anyone who takes isotretinoin should let the physician

know about all other prescription and non-prescription drugs, herbal remedies, and dietary supplements he or she is taking and should ask whether the possible interactions can interfere with drug therapy. Among the drugs that may interact with isotretinoin are:

- etretinate (Tegison), used to treat severe psoriasis. Using this medicine with isotretinoin increases side effects.
- tretinoin (Retin-A, Renova). Using this medicine with isotretinoin increases side effects.
- vitamin A or any medicine containing vitamin A. Using any vitamin A preparations with isotretinoin increases side effects. Do not take vitamin supplements containing vitamin A while taking isotretinoin.
- tetracyclines (used to treat infections). Using these medicines with isotretinoin increases the chance of swelling of the brain. Make sure the physician knows if tetracycline is being used to treat acne or another infection.

## Resources

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### ORGANIZATIONS

American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, (847) 240-1859, (866) 503-SKIN (7546), <http://www.aad.org>.

American Society of Health-System Pharmacists (ASHP), 7272 Wisconsin Avenue, Bethesda, MD, 20814, (301) 657-3000, (866) 279-0681, <http://www.ashp.org>.

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## Anti-aging diet

### Definition

The anti-aging diet is one that restricts calorie intake by 30–50% of normal or recommended intake with the goal of increasing human lifespan by at least 30%. People on the diet also have improved health providing they consume adequate **vitamins, minerals**, and other essential nutrients.

### Origins

The idea that a calorie-restrictive diet can significantly increase lifespan has been around since the 1930s. In 1935, Cornell University food researchers Clive McCay and Leonard Maynard published their first in a series of studies of experiments in which laboratory rats were fed a diet that contained one-third less calories (compared to a control group of rats) but still contained adequate amounts of vitamins, minerals, protein, and other essential nutrients. This calorie-restrictive diet provided much less energy than researchers had previously thought rats needed to maintain growth and normal activities. The rats on the lower calorie diet lived 30–40% longer than the rats on a normal calorie diet. Since then, more than 2,000 studies have been done, mostly on animals, about the connection between calorie restriction and increased longevity.

A reduced calorie diet was taken a step further by the University of California, Los Angeles, pathologist Roy Walford who studied the biology of **aging**. In 1986 he published *The 120-Year Diet* and a follow-up in 2000, *Beyond the 120-Year Diet* in which he argued that human longevity can be significantly increased by adhering to a strict diet that contains all the nutrients needed by humans but with about one-third the calories. In 1994 he co-authored *The Anti-Aging Plan: Strategies and Recipes for Extending Your Healthy Years*. His anti-aging plan is based on his own research and that of other scientists. Included is his study of diet and aging conducted as chief physician of the Biosphere 2 project in Arizona in the early 1990s. Walford was one of eight people sealed in Biosphere 2 from 1991 to 1993 in an attempt to prove that an artificial closed ecological system could sustain human life. He also co-founded the Calorie Restriction Society in 1994.

### Description

Anti-aging **diets** are regimes that reduce the number of calories consumed by 30–50% while allowing

## KEY TERMS

**Alzheimer's disease**—A degenerative disorder that effects the brain, causing dementia and loss of memory usually late in life.

**Antioxidant**—Substance that inhibits the destructive effects of oxidation in the body.

**Body mass index (BMI)**—A scale that expresses a person's weight in relation to height.

**Calorie reduction**—A decrease in the number of calories that a person consumes.

**Dexoxyribonucleic acid (DNA)**—A nucleic acid molecule in a twisted double strand, called a double helix,

that is the major component of chromosomes. DNA carries genetic information and is the basis of life.

**Free radicals**—Highly reactive atoms or molecules that can damage DNA.

**Osteoporosis**—A disease that causes bones to become porous, break easily, and heal slowly.

**Parkinson's disease**—An incurable nervous disorder marked by symptoms of trembling hands and a slow, shuffling walk.

**Testosterone**—A male sex hormone responsible for secondary sex characteristics.

the necessary amounts of vitamins, minerals, and other nutrients the body needs to sustain itself and grow. This calorie restriction has been shown to increase the lifespan of various animals, including rats, fish, fruit flies, dogs, and monkeys, by 30–50%. Some human studies have also been done—and long-term studies are underway—but evidence of its impact on humans is very limited compared to results available from the animal studies. The completed studies indicate that calorie restriction can increase the maximum human lifespan by about 30%. The problem preventing scientists from offering substantive proof that humans can greatly increase their lifespan by restricting calories is that the current maximum human lifespan is 110–120 years and full compliance with the diet is difficult. A 30% increase would extend the human lifespan to 143–156. This is an exceptionally long time for a scientific study and requires involvement of several generations of scientists. Only several hundred people have ever been documented to live past age 110 and there are only two people with confirmed documentation who have lived to at least age 120: Jeanne Louise Calmet (1875–1997) of France who lived 122 years and 164 days; and Shigechiyo Izumi (1865–1986) of Japan who lived 120 years and 237 days, according to *Guinness World Records*.

Since 1980, dozens of books have been published offering specific calorie reduction diets aimed at increasing lifespan. The most popular diets include the Okinawa Diet, Anti-Inflammation Diet, Longevity Diet, Blood Type Diet, Anti-Aging Plan, and the 120-Year Diet.

Calorie restriction is a lifelong approach to eating by significantly lowering daily calorie intake while still getting all the body's required nutrients. People who

experience **starvation** or famine receive no longevity benefits since their low calorie intake contains little **nutrition**. The diet is believed to most benefit people who start in their mid-20s, with the beneficial effects decreasing proportionately with the age one begins the diet.

Although there are variations between anti-aging diets, most reduced calorie diets recommend a core set of foods. These include vegetables, fruits, fish, soy, low-fat or non-fat dairy products, nuts, avocados, and olive oil. The primary beverages recommended are water and green or black tea.

Guidelines on calorie reduction vary from diet to diet, ranging from a 10% reduction to a 50% reduction of normal intake. Roy L. Walford (1924–2004), author of several books on anti-aging diets, says a reasonable goal is to achieve a 10–25% reduction in a person's normal weight based on age, height, and body frame. The Anti-Aging Plan diet recommends men of normal weight lose up to 18% of their weight in the first six months of the diet. For a six-foot male weighing 175 lb, that means a loss of about 31 pounds. For a small-framed woman who is five-foot, six-inches tall and weighs 120 pounds, the plan recommends losing 10% of her weight in the first six months, a loss of 12 lb.

Walford's Anti-Aging Plan is a diet based on decades of animal experimentation. It consists of computer generated food combinations and meal menus containing all of the U.S. Department of Agriculture's Recommended Daily Allowances of vitamins and other essential nutrients using foods low in calories. On the diet, the maximum number of calories allowed is 1,800 per day. There are two methods for starting the diet: rapid orientation and gradual orientation.

The rapid orientation method allows people to eat low calorie meals rich in nutrients. This is a radical change for most people and requires a good deal of willpower. All foods low in nutrients are eliminated from the diet. The nutritional value and calories in foods and meals is determined by a software program available for purchase from Walford's Calorie Restriction Society.

The gradual orientation method allows people to adopt the diet over time. The first week, people eat a high-nutrient meal on one day. This increases by one meal a week until participants are eating one meal high in nutrients every day at the end of seven weeks. Other meals during the day are low-calorie, healthy foods but there is no limit on the amount a person can eat. After two months, participants switch to eating low-calorie, high-nutrition foods for all meals.

On his Web site Walford states: "Going for longevity on the Anti-Aging Plan requires caloric limitation. We advise, however, that you view this as a lifestyle change and not a quick-fix program or a diet. Any person can physiologically adapt to this level of limitation and experience no physical hunger provided that nearly every calorie eaten is a nutrient-rich calorie."

A sample one-day low-calorie, high-nutrition menu developed by Walford is:

- Breakfast: One cup of orange juice, one poached egg, one slice of mixed whole-grain bread, and one cup of brewed coffee or tea.
- Lunch: One-half a cup of low-fat cottage cheese mixed with one-half a cup of non-fat yogurt and one tablespoon of toasted wheat germ, an apple, and one whole wheat English muffin.
- Dinner: Three ounces of roasted chicken breast without the skin, a baked potato, and one cup of steamed spinach.
- Snack: Five dates, an oat bran muffin, and one cup of low-fat milk.

The three meals and snack contain 1,472 calories, 92 g protein, 24 g fat, 234 g carbohydrates, 27 g fiber, and 310 g cholesterol.

## Function

The goal of the anti-aging diet is to slow the aging process, thereby extending the human lifespan. Even though it is not a weight loss diet, people taking in significantly fewer calories than what is considered normal by nutritionists are likely to lose weight. **Exercise** is not part of calorie reduction diets. Researchers suggest people gradually transition to a reduced

calorie diet over one or two years since a sudden calorie reduction can be unhealthy and even shorten the lifespan.

There is no clear answer as to why severely reducing calorie intake results in a longer and healthier life. Researchers have various explanations and many suggest it may be due to a combination of factors. One theory is that calorie restriction protects DNA from damage, increases the enzyme repair of damaged DNA, and reduces the potential of genes being altered to become cancerous. Other calorie reduction (CR) theories suggest:

- CR helps reduce the production of free radicals; unstable molecules that attack healthy, stable molecules. Damage caused by free radicals increases as people age.
- CR delays the age-related decline of the human immune system and improved immune function may slow aging.
- CR slows metabolism, the body's use of energy. Some scientists propose that the higher a person's metabolism, the faster they age.

## Benefits

The primary benefits of the anti-aging diet are improved health and prevention or forestalling diseases such as heart disease, **cancer**, **stroke**, diabetes, **osteoporosis**, Alzheimer's, and Parkinson's. Studies show that most physiologic functions and mental abilities of animals on reduced calorie diets correspond to those of much younger animals. The diet has also demonstrated extension of the maximum lifespan for most life forms on which it has been tested.

## Precautions

A reduced calorie diet is not recommended for people under the age of 21 since it may impair physical growth. This impairment has been seen in research on young laboratory animals. In humans, mental development and physical changes to the brain occur in teenagers and people in their early 20s that may be negatively affected by a low-calorie diet.

Other individuals advised against starting a calorie-restricted diet include women who plan on getting pregnant, women who are pregnant, and those who are nursing babies. A low body mass index (BMI), which occurs with a low-calorie diet, is a risk factor in **pregnancy** and can result in dysfunctional ovaries and **infertility**. A low BMI also can cause premature birth and low birth weights in newborns. People with existing medical conditions or diseases are discouraged from

reduced calorie diets. They should be especially cautious and consult with their physician before starting.

It is imperative that participants ensure that they continue to consume adequate levels of essential nutrients. **Nutritional supplements** and other forms of nutritional help may be necessary.

## Risks

There are a wide range of risks associated with an anti-aging, reduced calorie diet. These risks include physical, mental, social, and lifestyle issues.

- Hunger, food cravings, and obsession with food.
- Loss of strength or stamina and loss of muscle mass, which can affect physical activities, such as sports.
- Decreased levels of testosterone, which can be compensated with testosterone supplementation.
- Rapid weight loss (more than two pounds a week), which can negatively impact health
- Slower wound healing
- Reduced bone mass, which increases the risk of fracture
- Increased sensitivity to cold
- Reduced energy reserves and fatigue
- Menstrual irregularity
- Headaches
- Drastic appearance changes from loss of fat and muscle, causing people to look thin or anorexic

Social issues can arise over family meals, since not all family members may be on a reduced calorie diet. Conflict related to the types of food served, the amount of food served and the number of meals in a day, and **fasting** may develop. Other social issues involve eating in restaurants, workplace food, parties, and holidays. The long-term psychological effects of a reduced calorie diet are unknown. However, since a low calorie diet represents a major change in a person's life, psychological problems can be expected, including anorexia, binging, and obsessive thoughts about food and eating.

## Research and general acceptance

An anti-aging diet that restricts calories may slow the aging of the heart and lengthen lifespan, according to a study by Washington University School of Medicine in St. Louis, Missouri. The small study, released in 2006, followed 25 people aged 41–65 who consumed only 1,400–2,000 calories a day for six years. Results of the study showed participants had heart functions that resembled people 15 years younger and their blood pressure was significantly lower than a control group

who had a calorie intake of 2,000–3,000 per day, the amount of a normal Western diet.

A calorie-restrictive diet may reverse early stages of Parkinson's disease, according to a study released in 2005 by the Oregon Health and Science University and the Portland Veterans Affairs Medical Center in Portland, Oregon. Researchers said mice in the early stages of Parkinson's disease who had their calorie intake reduced by 50% had elevated levels of glutamate, an essential brain chemical that is lost due to Parkinson's disease. Results of this study are optimistic, but further research is necessary to prove any level of effectiveness in humans.

## Resources

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Stipp, David. “Researchers Seek Key to Anti-Aging in Calorie Cutback.” *Wall Street Journal* (October 30, 2006): A-1.

## ORGANIZATIONS

American Aging Association, The Sally Balin Medical Center, 110 Chesley Drive, Media, PA, 19063, (610) 627-2626, <http://www.americanaging.org>.

American Dietetic Association, 120 South Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (800) 877-1600, <http://www.eatright.org>.

Calorie Restriction Society, 187 Ocean Drive, Newport, NC, 28570, (800) 929-6511, <http://www.calorierestriction.org>.

National Institute on Aging, 31 Center Drive, MSC 2292, Building 31, Room 5C27, Bethesda, MD, 20892, (800) 222-2225, <http://www.nia.nih.gov>.

Ken R. Wells

## Antiandrogen drugs

### Definition

Androgens are male sex hormones. Antiandrogen drugs are a diverse group of drugs given to counteract the effects of androgens on various body organs and tissues. Some medications in this category work by lowering the body’s production of androgens, while others work by blocking the body’s ability to make use of the androgens that are produced. Antiandrogen drugs that reduce the body’s ability to produce androgens include such medications as leuprolide (Lupron, Viadur, or Eligard), goserelin (Zoladex), triptorelin (Trelstar Depot), and abarelix (Plenaxis). Antiandrogen drugs that block the body’s ability to use androgens include flutamide (Eulexin), nilutamide (Nilandron), cyproterone acetate (Cyprostat, Androcur, Cyproterone), and bicalutamide (Casodex). Flutamide, nilutamide, and bicalutamide are nonsteroidal antiandrogen drugs while cyproterone acetate is a steroid medication.

Some drugs that were originally developed to treat other conditions are sometimes categorized as antiandrogens because of their off-label uses. These drugs include medroxyprogesterone (**Depo-Provera**), a derivative of the female sex hormone progesterone that is used as a contraceptive and treatment for abnormal uterine bleeding; ketoconazole (Nizoral), an antifungal drug; and spironolactone (Aldactone), a diuretic.

### Purpose

Antiandrogen drugs may be given for any of several conditions or disorders, ranging from skin problems to mental disorders:

- Prostate cancer. Antiandrogen medications may be used to treat both early-stage and advanced prostate cancer by lowering or blocking the supply of male sex hormones that encourage the growth and spread of the cancer.
- Androgenetic alopecia. Androgenetic alopecia is a type of hair loss that is genetically determined and affects both men and women. It is sometimes called male pattern baldness.
- Acne. Acne is the result of several factors, one of which is excessive production of sebum, a whitish semi-liquid greasy substance produced by certain glands in the skin. Antiandrogens may help to clear acne by slowing down the secretion of sebum, which depends on androgen production.
- Amenorrhea. Amenorrhea, or the absence of menstrual periods in females of childbearing age, is sometimes caused by excessively high levels of androgens in the blood. Antiandrogen medications may help to restore normal menstrual periods.
- Hirsutism. Hirsutism is a condition in which women develop excessive facial and body hair in a distribution pattern usually associated with adult males. It results from abnormally high levels of androgens in the bloodstream or from increased sensitivity of the hair follicles to normal levels of androgens. Hirsutism may be a sign of polycystic ovary syndrome (PCOS), a condition in which the ovaries develop multiple large cysts and produce too much androgen.
- Gender reassignment. Antiandrogen drugs are often prescribed for male-to-female (MTF) transsexuals as part of the hormonal treatment that precedes gender reassignment surgery.
- Paraphilias. Paraphilias are a group of mental disorders characterized by intense and recurrent sexual urges or behaviors involving nonhuman objects, children, nonconsenting adults, and/or pain and humiliation. Antiandrogen drugs have been prescribed for men diagnosed with paraphilias in order to lower blood serum levels of testosterone and help them control their sexual urges.
- Virilization. Virilization is an extreme form of excessive androgen production (hyperandrogenism) in females, marked by such changes as development of male pattern baldness, voice changes, and overdevelopment of the skeletal muscles. Antiandrogens may be given to correct this condition.

## Description

Androgens affect many different tissues in the body so antiandrogen drugs are prescribed to treat diverse conditions. Antiandrogen drugs are not interchangeable. A specific antiandrogen may work well to treat one type of androgen-related medical condition while working poorly to treat another.

### *U.S. brand names*

In the United States there are several commonly prescribed antiandrogens:

- Leuprolide (Lupron, Eligard) is classified as a luteinizing hormone-releasing hormone (LHRH) agonist, which means that it resembles a chemical produced by the hypothalamus (a gland located in the brain) that lowers the level of testosterone in the bloodstream. It also reduces levels of estrogen in girls and women and may be used to treat endometriosis or tumors in the uterus. It has shown promise as a treatment for the paraphilias in juveniles and young adults.
- Goserelin (Zoladex) is also an LHRH agonist, and works in the same way as leuprolide.
- Triptorelin (Decapeptyl, Gonapeptyl) is an LHRH agonist, and works in the same way as leuprolide. It is not usually given to women.
- Abarelix (Plenaxis) works by blocking hormone receptors in the pituitary gland. It is recommended for the treatment of prostate cancer in men with advanced disease who refuse surgery, cannot take other hormonal treatments, or are poor candidates for surgery.
- Ketoconazole (Nizoral) is an antifungal drug available in tablets to be taken by mouth. Its use in treating hirsutism is off-label.
- Flutamide (Eulexin) is a nonsteroidal antiandrogen medication that blocks the use of androgen by the body.
- Nilutamide (Nilnsnton) is another nonsteroidal antiandrogen drug that works by blocking the body's use of androgens.
- Bicalutamide (Casodex) is a nonsteroidal antiandrogen medication that works in the same way as flutamide. It is used to treat prostate cancer.
- Cyproterone acetate (Androcur, Climen, Diane 35, Ginette 35) is a steroid antiandrogen drug that works by lowering testosterone production as well as blocking the body's use of androgens.
- Medroxyprogesterone (Provera, Farlutal Provera, Cycrin, Amen) is a synthetic derivative of progesterone that prevents ovulation and keeps the lining of

## KEY TERMS

**Off-label use**—Drugs in the United States are approved by the Food and Drug Administration (FDA) for specific uses based on the results of clinical trials. However, it is legal for physicians to administer these drugs for other uses. It is not legal for pharmaceutical companies to advertise drugs for off-label uses.

**Prostate**—A gland found only in men that surrounds the neck of the bladder and secretes fluid that when mixed with sperm becomes semen.

the uterus from breaking down, thus preventing uterine bleeding.

- Spironolactone (Aldactone, Spiritone) is a potassium-sparing diuretic that may be given to treat androgen excess in women.

### *Canadian brand names*

Canadian brand names for some antiandrogen drugs include:

- leuprolide—C-Eligard, Lupron, Lupron Depot
- ketoconazole—Apo-Ketoconazole, Ketoderm, Novo-Ketoconazole, Xolegel
- flutamide—Apo-Flutamide, Euflex, Nona-Flutamide, Eulexin
- nilutamide—Anadron
- bicalutamide—Apo-Bicalutamide, Casodex, Dom-Bicalutamide, Gen-Bicalutamide, Mylan-Bicalutamide, Novo-Bicalutamide, PHL-Bicalutamide, PMS-Bicalutamide, Pro-Bicalutamide, ratio-Bicalutamide, Sandoz-Bicalutamide, Zym-Bicalutamide
- medroxyprogesterone—Alti-MPA, Apo-Medroxy, Depo-Prevara, Depo-Provera, Gen-Medroxy, Novo-Medrone, Provera

## Recommended dosage

Dosage recommendations are typically individualized and should be taken as prescribed by the physician.

- Leuprolide. Leuprolide is available in an injectable form and as an implant. The implant form, used to treat prostate cancer, contains 22.5 mg of leuprolide and is inserted under the skin every three months. This type of slow-release medication is called depot form. A longer-acting implant that lasts 12 months is also available. Injectable leuprolide is injected once a

day in a 1-mg dose to treat prostate cancer. The dosage for endometriosis or uterine tumors is 3.75 mg injected into a muscle once a month for three to six months.

- Goserelin. Goserelin is implanted under the skin of the upper abdomen. The dosage for treating cancer of the prostate is one 3.6-mg implant every 28 days or one 10.8-mg implant every 12 weeks. For treating endometriosis, the dosage is one 3.6-mg implant every 28 days for six months.
- Triptorelin. Triptorelin is given as a long-lasting injection for treatment of prostate cancer or paraphilias. The usual dose for either condition is 3.75 mg, injected into a muscle once a month.
- Abarelix. Abarelix is given in 100-mg doses by deep injection into the muscles of the buttocks. It is given on days 1, 15, and 29 of treatment, then every four weeks for a total treatment duration of 12 weeks.
- Ketoconazole. For treatment of hirsutism, 400 mg by mouth once per day.
- Flutamide. Flutamide is available in capsule and tablet form. For treatment of prostate cancer, 250 mg by mouth three times a day. For virilization or hyperandrogenism in women, 250 mg by mouth three times a day. It should be used in women only when other treatments have proved ineffective.
- Nilutamide. To treat prostate cancer, nilutamide is taken in a single 300-mg daily dose by mouth for the first 30 days of therapy, then a single daily dose of 150 mg.
- Bicalutamide. Bicalutamide is taken by mouth in a single daily dose of 50 mg to treat prostate cancer.
- Cyproterone acetate. Cyproterone is taken by mouth three times a day in 100-mg doses to treat prostate cancer. The dose for treating hyperandrogenism or virilization in women is one 50-mg tablet by mouth each day for the first ten days of the menstrual cycle. Cyproterone acetate given to treat acne is usually given in the form of an oral contraceptive (Diane-35) that combines the drug (2 mg) with ethinyl estradiol (35 mg). Diane-35 is also taken as hormonal therapy by MTF transsexuals. The dose for treating paraphilias is 200–400 mg by injection in depot form every 1–2 weeks, or 50–200 mg by mouth daily.
- Medroxyprogesterone. For the treatment of paraphilias, given as an intramuscular 150-mg injection daily, weekly, or monthly, depending on the patient's serum testosterone levels, or as an oral dose of 100–400 mg daily. As hormonal therapy for MTF transsexuals, 10–40 mg per day. For polycystic ovary syndrome, 10 mg daily for 10 days.

- Spironolactone. For hyperandrogenism in women, 100–200 mg per day by mouth; for polycystic ovary syndrome, 50–200 mg per day. For the treatment of acne, 200 mg per day. For hormonal therapy for MTF transsexuals, 200–400 mg per day. A topical form of spironolactone is available for the treatment of androgenetic alopecia.

## Precautions

Individuals being prescribed an antiandrogen drug should review all prescription, over-the-counter, and herbal medicines with the prescribing physician.

### Pediatric

It is not recommended that children use antiandrogen drugs because they may interfere with proper growth and development. They should be prescribed only when other options are unavailable and the benefits would outweigh the associated side effects. Abarelix should definitely not be given to children because of the severity of this drug's possible side effects.

### Pregnant or breastfeeding

Women who are or expect to become pregnant should not take antiandrogen drugs, as they can interfere with the development of the fetus. Women who must take antiandrogens should use methods of birth control that do not contain hormones.

Several of these medications are especially risky during **pregnancy**, including leuprolide, goserelin, flutamide, spironolactone, and cyproterone acetate, which has not been approved by the FDA for use in the United States, but is approved for use in Canada and the United Kingdom.

### Other conditions and allergies

- Leuprolide. Leuprolide should not be used by patients diagnosed with spinal compression, or by patients allergic to the drug.
- Goserelin. Goserelin should not be used by patients known to be allergic to it. As with leuprolide, women taking goserelin should use methods of contraception that do not contain hormones.
- Triptorelin. Patients using triptorelin should see their doctor at regular intervals for monitoring of side effects.
- Abarelix. Abarelix should not be given to women. Because of the severity of this drug's possible side effects, doctors who prescribe it for men must be certified following successful completion of a safety program for its proper use.

- Ketoconazole. Ketoconazole should not be given to alcoholic patients or those allergic to the drug. In addition, patients using ketoconazole should have their liver function monitored by their doctor.
- Flutamide. Patients taking flutamide should have their liver function monitored carefully. They should notify their doctor at once if they have pain in the upper right side of the abdomen or a yellowish discoloration of the eyes and skin, as these are signs of liver damage. In addition, patients using this drug should not discontinue taking it without telling their doctor.
- Nilutamide. This drug should not be given to patients who are allergic to it, have severe respiratory problems, or have been diagnosed with a liver disorder. Patients taking this drug should discontinue using alcoholic beverages while they are being treated with it.
- Bicalutamide. The precautions while using this drug are the same as those for flutamide.
- Cyproterone acetate. This drug has not been approved by the Food and Drug Administration (FDA) for use in the United States, but is approved for use in Canada and the United Kingdom. It should not be used during pregnancy or lactation, or by patients with liver disease. Men who are taking this drug for treatment of paraphilic disorders should not use alcohol.
- Medroxyprogesterone. This drug should not be given to patients with a history of blood clot formation in their blood vessels. It should be used with caution in patients with asthma, seizure disorders, migraine headaches, liver or kidney disorders, or heart disease.
- Spironolactone. This drug should not be given to patients with overly high levels of potassium in the blood or to patients with liver disease or kidney failure. It should also not be given to pregnant or lactating women.

## Side effects

### *Leuprolide and goserelin*

When taking leuprolide or goserelin, men have reported side effects including pains in the chest, groin, or legs; hot flashes, loss of interest in sex, or **impotence**; bone **pain**; sleep disturbances; and mood changes. Women have reported **amenorrhea** or light and irregular menstrual periods; loss of bone density; mood changes; burning or **itching** sensations in the vagina; or pelvic pain. The side effects of goserelin may also include **nausea and vomiting**.

### *Triptorelin*

Side effects of triptorelin include pain in the bladder, difficulty urinating, or bloody or cloudy urine; pain in the side or lower back; hot flashes or **headache**; loss of interest in sex or impotence; **vomiting** or **diarrhea**; unusual bleeding or bruising; pain at the injection site; unusual tiredness or sleep disturbances; and depression or rapid mood changes. It may also cause a temporary enlargement of the tumor. This is known as tumor flare.

### *Abarelix*

Abarelix may cause immediate life-threatening allergic reactions following any dose. It may also cause a loss of bone mineral density, irregular heartbeat, hot flashes, sleep disturbances, or pain in the breasts and nipples. **Gynecomastia** has been reported in men.

### *Ketoconazole*

The side effects of ketoconazole include nausea and vomiting, loss of appetite, abdominal pain, skin rash or itching, uterine bleeding, breast pain, hair loss, and loss of interest in sex. Men may experience gynecomastia and a decline in sperm production.

### *Flutamide, bicalutamide, nilutamide*

Flutamide, bicalutamide, and nilutamide share the same side effects. These drugs have been reported to cause breast tenderness and gynecomastia in men. Other side effects include **fatigue**, nausea, flu-like symptoms, and runny nose; darkened urine; **indigestion**, **constipation**, diarrhea, or gas; bluish-colored or dry skin; **dizziness**; and liver damage. These side effects may be intensified in patients who smoke.

In addition, nilutamide may affect the ability of the eyes to adjust to sudden changes in light intensity or may make the eyes unusually sensitive to light. Another potential side effect is difficulty breathing; this is more likely to occur in Asian patients taking this drug than in Caucasians.

### *Cyproterone acetate*

Cyproterone has been reported to cause gynecomastia and impotence in men as well as loss of interest in sex. Deep venous thrombosis, and possible damage to the cardiovascular system are also possible side effects.

### *Medoxyprogesterone*

Side effects associated with medoxyprogesterone include high blood pressure, headache, nausea and

vomiting, puffy skin (**edema**), and weight gain. Changes in menstrual flow, breakthrough bleeding, and sore or swollen breasts may also occur.

### **Spironolactone**

Spironolactone may cause fatigue, headache, and drowsiness; abdominal cramps, nausea, vomiting, diarrhea, or loss of appetite; and skin **rashes** or itching. Gynecomastia and impotence have been reported in men.

### **Interactions**

The effect of antiandrogen drugs may be increased or diminished when taken with other drugs and herbal remedies. A complete review of all medications (prescription, non-prescription, and herbal) should be done with a pharmacist or physician at the time the antiandrogen is prescribed.

The antiandrogens that have reported interactions with other medications are:

- abarelix: May interact with other medications that affect heart rhythm, including procainamide, amiodarone, sotalol, and dofetilide.
- ketoconazole: Interacts with a number of drugs, including rifampin, warfarin, phenytoin, antacids, cyclosporine, terfenadine, and astemizole. It may cause a sunburn-like skin reaction if used together with alcohol.
- flutamide: Intensifies the effects of warfarin (Coumadin) and other blood-thinning medications. It has also been reported to intensify the effects of phenytoin (Dilantin), a drug given to control seizures.
- nilutamide: reported interactions are the same as for flutamide; in addition, nilutamide has been reported to intensify the effects of theophylline (Theo-Dur), a drug given to treat asthma.
- bicalutamide: reported interactions are the same as for flutamide.
- cyproterone acetate: patients taking oral medications to control diabetes may require dosage adjustments while taking this drug.
- medroxyprogesterone: patients taking phenobarbital, phenothiazine tranquilizers (chlorpromazine, perphenazine, fluphenazine, etc.), or oral medications to control diabetes should consult their doctor about dosage adjustments.
- spironolactone: Decreases the effectiveness of aspirin and anticoagulants (blood thinners). It may also interact with potassium supplements to increase the patient's blood potassium level.

## **Resources**

### **PERIODICALS**

Rathnayake, D., and R. Sinclair. "Innovative Use of Spironolactone as an Antiandrogen in the Treatment of Female Pattern Hair Loss." *Dermatologic Clinics* 28, no. 3 (July 2010): 611–8.

Sharifi, N. "New Agents and Strategies for the Hormonal Treatment of Castration-Resistant Prostate Cancer." *Expert Opinion on Investigational Drugs* 19, no. 7 (July 2010): 837–47.

Thibreau, F., et al. "The World Federation of Societies of Biological Psychiatry (WFSBP) Guidelines for the Biological Treatment of Papaphilias." *World Journal of Biological Psychiatry* (June 2010): 604–55.

### **ORGANIZATIONS**

American Academy of Dermatology (AAD), P.O. Box 4014, Schaumburg, IL, 60168 (866) 503-SKIN (7546) (847) 240-1859, <http://www.aad.org>.

American Association of Clinical Endocrinologists (AACE), 245 Riverside Ave, Suite 200, Jacksonville, FL, 32202 (904) 353-7878, <http://www.aace.com>.

National Cancer Institute Public Inquiries Office, 6116 Executive Boulevard, Room 3036A, Bethesda, MD, 20892-8322 (800) 4-CANCER, <http://www.cancer.gov>.

World Professional Association for Transgender Health (WPATH), 1300 South Second Street, Suite 180, Minneapolis, MN, 55454 (612) 624-9397 (612) 624-9541, <http://www.wpath.org>.

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## **Antianemia drugs**

### **Definition**

Antianemia drugs are therapeutic agents that increase either the number of red cells or the amount of hemoglobin in the blood.

### **Purpose**

Anemia is a general term for a large number of conditions marked by a reduction in the amount of oxygen the blood can carry. Red blood cells carry oxygen in hemoglobin, so that anemia may be caused by a deficiency of blood or red blood cells or of hemoglobin. These conditions may be caused by a variety of other conditions.

- Injury can cause significant blood loss, which in turn can cause anemia.

- Nutritional deficiency resulting in inadequate amounts of the vitamins and minerals such as iron that are needed for hemoglobin production.
- Infections and kidney disease, in which there is a deficiency of erythropoietin, a material produced in the kidneys that is essential for the production of red blood cells.
- Certain genetic conditions affect the absorption of nutrients and may lead to anemia. In sickle cell anemia, a genetic condition in which the red cells are curved rather than flat, the red cells have reduced ability to carry oxygen.

The *Merck Manual* reduces all types of anemia to three classes:

- blood loss
- inadequate production of blood
- excessive breakdown of blood cells

Anemia may be caused by one or a combination of these three factors. Drug therapy is available for many types of anemia; however, the selection of the drug depends on proper diagnosis of the cause of the anemia.

## Description

### *U.S. brand names*

Brand names for some antianemia drugs sold in the United States include:

- ferrous sulfate: Feosol, Fer-In-Sol, Fer-Iron, Slow-Fe
- ferrous gluconate: Fergon, Simron
- folic acid: Folacin
- cyanocobalamin: Nascobal
- hydroxocobalamin: Hydrobexan, Hydroxo-12, LA-12
- oxymetholone: Anadrol-50
- epoetin alfa: Epogen, Procrit
- darbepoetin alfa: Aranesp

### *Canadian brand names*

Brand names for some antianemia drugs sold in Canada include:

- ferrous sulfate: Novoferrosulfa
- ferrous gluconate: Fertinic, Novoferrogeluc
- folic acid: Apo-Folic, Novofolacid
- cyanocobalamin: Anacobin, Bedoz, Rubion
- epoetin alfa: Eprex

Anemia caused by blood loss is normally treated with either blood volume expanders such as plasma or

with related blood products. More severe blood loss may require transfusions of red blood cells.

In some cases, blood loss may be due to ulcers of the stomach or intestines. In these cases, treatment of the underlying cause will normally correct the anemia.

### *Iron deficiency*

The most common cause of anemia in adults is iron deficiency. Although the typical American diet contains enough iron to meet normal needs, individuals who are less able to absorb and store iron may not make enough hemoglobin. Although the best way to meet daily iron requirements is through improved diet, iron supplements are widely available.

Iron is normally taken in the form of ferrous sulfate. Other iron salts are commercially available and make claims of fewer or less severe side effects, but these benefits may be related to the fact that other preparations contain less iron by weight. Ferrous sulfate contains about 37% iron, while ferrous gluconate contains only about 13% iron. People who have trouble with the side effects of ferrous sulfate may benefit from specialty preparations available; however, ferrous sulfate normally offers the greatest amount of iron of all commercial products.

### *Folic acid*

**Folic acid** is found in many common foods, including liver, dried peas, lentils, oranges, whole-wheat products, asparagus, beets, broccoli, Brussels sprouts, and spinach. Some people have difficulty absorbing folic acid or in converting it from the form found in foods to the form that is active in blood formation. In these cases, folic acid tablets are appropriate for use. Folic acid supplements are routinely given to pregnant women because it is necessary for the proper development of the fetus's nervous system.

### *Vitamin B<sub>12</sub>*

Vitamin B<sub>12</sub> is also known as cyanocobalamin and hydroxocobalamin. Cyanocobalamin may be given by mouth, while hydroxocobalamin must be injected. The vitamin has many functions in the body, including maintaining the nervous system. In treatment of anemia B<sub>12</sub> is needed for the metabolism of folic acid. Lack of B<sub>12</sub> causes **pernicious anemia**, a type of anemia marked by a low red cell count and lack of hemoglobin. There are many other symptoms of pernicious anemia, including a feeling of **tingling** or **numbness**, **shortness of breath**, muscle weakness, faintness, and a smooth tongue. If pernicious anemia

## KEY TERMS

**Anabolic steroid**—Drugs derived from the male sex hormones that increase the rate of tissue growth. They are best known for increasing the rate of muscle development.

**Anemia**—Any condition in which the amount of hemoglobin in red cells, the number of red cells, or the size of the red cells in blood is reduced from the normal amount.

**Crohn's disease**—Chronic inflammation of the intestine.

**Hemochromatosis**—A disorder of iron metabolism characterized by excessive absorption of iron from food.

**Hemoglobin**—The iron-containing protein in the blood that transports oxygen from the lungs to all parts of the body.

**Hemolytic anemia**—A type of anemia marked by the breakdown of red blood cells causing the release of hemoglobin.

**Off-label use**—Drugs in the United States are approved by the Food and Drug Administration (FDA) for specific uses based on the results of clinical trials. However, it is legal for physicians to administer these drugs for other uses not specified. It is not legal for pharmaceutical companies to advertise drugs for off-label uses.

**Sickle cell anemia**—An inherited condition, marked by crescent-shaped red blood cells and red cell breakdown.

is left untreated for more than three months, permanent damage to the nerves of the spinal cord may result.

### *Anabolic steroids*

The anabolic **steroids** (nandrolone, oxymetholone, oxandrolone, and stanzolol) are the same drugs that are used improperly by body builders and other athletes to increase muscle mass. Two of these drugs, nandrolone and oxymetholone, are approved for use in treatment of anemia. Nandrolone is indicated for treatment of anemia caused by kidney failure, while oxymetholone may be used to treat anemia caused by insufficient red cell production, such as **aplastic anemia**.

All anabolic steroids are considered to be drugs of abuse under U.S. federal law.

### *Erythropoiesis-stimulating agents*

Erythropoiesis-stimulating agents (ESAs) are synthetic versions of the naturally occurring protein erythropoietin, which is made in the kidney. This protein stimulates the bone marrow to produce more red blood cells. This process takes about two weeks. ESAs include epoetin alfa (Epogen, Procrit) and darbepoetin alfa (Aranesp). Darbepoetin alpha has the same properties, but it remains active longer and requires fewer injections each week. These drugs have significant negative cardiovascular side effects and should be used only under very limited conditions. In 2007, the U.S. Food and Drug Administration (FDA) reviewed these side effects and required changes in the labeling of all ESAs to reflect these side effects and warned against off-label use.

ESAs are approved by the FDA for the following uses:

- anemia associated with chronic kidney (renal) failure
- anemia related to zidovudine (AZT) therapy in HIV-infected patients
- anemia in some cancer patients with metastatic disease who are receiving treatment with chemotherapy
- prior to surgery for certain patients who are expected to need blood transfusions and who do not want to make a presurgical donation of their blood

ESAs have been abused by athletes due to the theory that increasing the red blood cell count improves athletic performance. The potential benefits of misuse of the drug are limited, and the risks are significant. The United States and International Olympic Committees (IOC) and the National Collegiate Athletic Association (NCAA) consider the use of ESAs, sometimes called blood doping, to enhance athletic potential inappropriate and unacceptable because its use by athletes is contrary to the rules and ethical principles of athletic competition. Reliable tests are available to detect ESA use by athletes.

### **Recommended dosage**

#### *Iron supplements*

Dosage should be calculated by iron needs based on the results of laboratory tests. Manufacturers recommend one tablet a day, containing 65 mg of iron, as a supplement for patients over the age of 12 years.

### **Folic acid**

For treatment of anemia, a daily dose of 1 mg is generally used. Patients who have trouble absorbing folic acid may require higher doses.

Maintenance doses are:

- infants: 0.1 mg/day
- children (under 4 years of age): up to 0.3 mg/day
- children (over 4 years of age) and adults: 0.4 mg/day
- pregnant and lactating women: 0.8 mg/day

### **Vitamin B<sub>12</sub>**

While vitamin B<sub>12</sub> can be given by mouth for mild vitamin deficiency states, pernicious anemia should always be treated with injections, either under the skin (subcutaneous) or into muscle (intramuscular). Hydroxocobalamin should only be injected into muscle. Intravenous injections are not used because the vitamin is eliminated from the body too quickly when given this way. Elderly patients, whose ability to absorb vitamin B<sub>12</sub> through the stomach may be impaired, should also be treated with injections only.

The normal dose of cyanocobalamin is 100 mcg (micrograms) daily for six to seven days. If improvement is seen, the dose may be reduced to 100 mcg every other day for seven doses and then 100 mcg every three to four days for two to three weeks. After that, monthly injections may be required for life.

### **Anabolic steroids**

The dosage of oxymetholone must be individualized. The most common dose is 1–2 mg per kilogram of body weight per day, although doses as high as 5 mg/kg per day have been used. The response to these drugs is slow, and it may take several months to notice any benefit.

### **Erythropoiesis-stimulating agents**

Dosing schedules of ESAs vary with the cause of the anemia. All doses should be individualized and the minimum amount of drug should be used to achieve the desired results. The dose should be reduced if the hemoglobin level reaches 10–12 g/dL or if the hemoglobin level increases by more than 1 g/dL in any two-week period. The drug should be temporarily stopped if hemoglobin levels exceed 12 g/dL.

Maintenance doses, if required, should be individualized to keep the hemoglobin levels within the range of 10 to 12 g/dL.

### **Precautions**

Iron can lead to fatal **poisoning** in children. All iron supplements should be kept carefully out of reach of children.

### **Iron supplements**

Some types of anemia do not respond to iron therapy, and the use of iron should be avoided in these cases. People with acquired **hemolytic anemia**, autoimmune hemolytic anemia, **hemochromatosis**, hemolytic anemia, and hemosiderosis should not take iron supplements. Hemolytic anemia is caused by the increased breakdown of red blood cells. Hemochromatosis and hemosiderosis are conditions in which there is too much, rather than too little, absorption of iron.

Iron supplements should also be avoided by people who have gastric or intestinal ulcers, ulcerative **colitis**, or **Crohn's disease**. These conditions are marked by inflammation of the digestive tract and are made worse by use of iron.

### **Folic acid**

Before treating an anemia with folic acid, diagnostic tests must be performed to verify the cause of the anemia. Pernicious anemia caused by lack of vitamin B<sub>12</sub> shows symptoms that are very similar to those of folic acid deficiency but also causes nerve damage that shows up as a tingling sensation and feelings of numbness. Giving folic acid to patients with B<sub>12</sub> deficiency anemia improves the blood cell count, but the nerve damage continues to progress.

### **Vitamin B<sub>12</sub>**

Although vitamin B<sub>12</sub> has a very high level of safety, commercial preparations may contain preservatives that may cause allergic responses.

In patients with pernicious anemia, treatment with vitamin B<sub>12</sub> may lead to loss of potassium. Patients should be monitored for their potassium levels.

### **Anabolic steroids**

All anabolic steroids are dangerous. The following warnings represent the most significant hazards of these drugs. For a complete list, patients should consult the manufacturer's package insert.

- Peliosis hepatitis, a condition in which liver and sometimes spleen tissue is replaced with blood-filled cysts, has occurred in patients receiving androgenic anabolic steroids. Although this condition is usually

reversible by discontinuing the drug, if it is left undetected and untreated, it may lead to life-threatening liver failure or bleeding.

- Liver tumors may develop. Although most of these tumors are benign and will go away when the drug is discontinued, liver cancers may result.
- Anabolic steroids may cause changes in blood lipids, leading to atherosclerosis with greatly increased risk of heart attack.
- Masculinization may occur when used by women because anabolic steroids are derived from male sex hormones.
- Elderly men who use these drugs may be at increased risk of prostate enlargement and prostate cancer.
- Increased water retention due to anabolic steroids may lead to heart failure.
- Anabolic steroids should not be used during pregnancy, since this may cause masculinization of the fetus.
- Anabolic steroids should be used in children only if there is no possible alternative. These drugs may cause the long bones of the legs to stop growing prematurely, leading to reduction in adult height. Regular monitoring is essential.
- In patients with epilepsy, the frequency of seizures may be increased.
- In patients with diabetes, glucose tolerance may be altered. Careful monitoring is essential.

### *Erythropoiesis-stimulating agents*

ESAs should be used only when the benefits clearly outweigh the risks. Risks include an increased likelihood of fatal and nonfatal **heart attack, stroke, heart failure, and blood clots**. In **cancer** patients, tumors have been found to grow faster and survival times to be shortened in people receiving ESAs. Anyone who may need an ESA should check with their physician for the latest information concerning the risks and benefits of using these drugs.

### **Side effects**

#### *Iron supplements*

The most common side effects of iron consumption are stomach and intestinal problems, including stomach upset with cramps, **constipation, diarrhea, nausea, and vomiting**. At least 25% of patients have one or more of these side effects. The frequency and severity of the side effects increases with the dose of iron. Less frequent side effects include **heartburn** and urine discoloration.

### *Folic acid*

Folic acid is considered extremely safe, and there are no predictable side effects. Where side effects have been reported, they have been among patients taking many times more than the normal therapeutic dose of the drug.

On rare occasions allergic reactions to folic acid have been reported.

### *Vitamin B<sub>12</sub>*

Diarrhea and **itching** of the skin have been reported on rare occasions. Moreover, there have been reports of severe allergic reactions to cyanocobalamin.

### *Anabolic steroids*

The list of side effects associated with anabolic steroids is extremely long. The following list covers only the most commonly observed effects:

- acne
- increased urinary frequency
- breast growth in males
- breast pain
- persistent, painful erections
- masculinization in women

### *Erythropoiesis-stimulating agents*

In addition to the serious cardiovascular and tumor-enhancing side effects, other common adverse effects of ESAs are:

- joint pain
- chest pain
- diarrhea
- swelling
- fatigue
- fever
- weakness
- headache
- high blood pressure
- irritation at injection site
- nausea
- vomiting
- rapid heartbeat

A large number of additional adverse effects have been reported. Patients should consult the manufacturer's package insert for the full list.

## Interactions

### *Iron supplements*

Iron supplements should not be taken at the same time as **antibiotics** of either the tetracycline or quinolone types. The iron will reduce the effectiveness of the antibiotic. Iron supplements also reduce the effectiveness of levodopa, which is used in treatment of Parkinson's disease.

Iron supplements should not be used with magnesium trisilicate, an antacid, or with penicillamine, which is used for some types of arthritis.

Taking iron with vitamin C increases the absorption of iron, with no increase in side effects.

### *Folic acid*

Phenytoins, used to treat seizure disorders, interact with folic acid to reduce the effectiveness of phenytoin and increase the risk of seizures. If the two drugs must be used together, phenytoin blood levels should be monitored, and the dose may have to be increased.

Trimethoprim (an antibacterial) and methotrexate (originally an anti-cancer drug, which is also used for arthritis and **psoriasis**) act by reducing the metabolism of folic acid. Regular blood monitoring is required, and dose adjustments may be needed.

### *Vitamin B<sub>12</sub>*

Aminosalicylic acid, used to treat **tuberculosis**, may reduce the effectiveness of vitamin B<sub>12</sub>. Also, colchicine, a drug used for **gout**, may reduce the effectiveness of vitamin B<sub>12</sub>. Other infrequently used drugs or excessive use of alcohol may affect the efficacy of vitamin B<sub>12</sub>. Patients being treated for anemia should discuss with their physician or pharmacist all medications (prescription and nonprescription) and herbal or dietary supplements they are using.

### *Anabolic steroids*

Anabolic steroids should not be used in combination with anticoagulants such as warfarin (Coumadin). Anabolic steroids increase the effects of the anticoagulant, possibly leading to bleeding. If the combination cannot be avoided, careful monitoring is essential.

### *Erythropoiesis-stimulating agents*

According to the manufacturer, ESAs have no significant interaction potential with other drugs.

## Resources

### PERIODICALS

Rowland, Christopher. "Articles Renew Scrutiny of Antianemia Drugs: FDA to Review New Data for Dosage, Risk." *Boston Globe* November 16, 2006.

### OTHER

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### ORGANIZATIONS

American Society of Hematology, 2021 L St. NW, Suite 900, Washington, DC, 20036, (202) 776-0544, (202) 776-0545, <http://www.hematology.org>.

Iron Disorders Institute, P.O. Box 675, Taylors, SC, 29687, (864) 292-1175, (864) 292-1878, (888) 565-IRON (4766), <http://www.irondisorders.org>.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, <http://www.nhlbi.nih.gov>.

American Society of Hematology, 2021 L St., NW, Suite 900, Washington, DC, 20036 (202) 776-0544 (202) 776-0545, <http://www.hematology.org>.

Iron Disorders Institute, P.O. Box 675, Taylors, SC, 29687 (864) 292-1175, (888) 565-IRON (4766), (864) 292-1878, <http://www.irondisorders.org>.

National Anemia Action Council, 555 E. Wells St., Suite 100, Milwaukee, WI, 53202 (414) 225-0318 (414) 276-3349, <http://www.anemia.org>.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105 (301) 592 8573, <http://www.nhlbi.nih.gov>.

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# Antiangina drugs

## Definition

Antiangina drugs are medicines that relieve the symptoms of **angina pectoris** (severe chest **pain**).

## Purpose

The dull, tight chest pain of angina occurs when the heart's muscular wall is not getting enough oxygen. By relaxing the blood vessels, antiangina drugs reduce the heart's work load and increase the amount of oxygen-rich blood that reaches the heart. These drugs come in different forms, and are used in three main ways. They can be:

- taken regularly over a long period to reduce the number of angina attacks.
- taken just before some activity that usually brings on an attack, such as climbing stairs, to help prevent attacks.
- taken when an attack begins in order to relieve the pain and pressure.

Not every form of antiangina drug can be used in every way. Some work too slowly to prevent attacks that are about to begin or to relieve attacks that have already started. These forms can be used only to reduce the number of attacks. Sometimes two antiangina drugs are combined into one tablet. Be sure to understand how and when to use the type of antiangina drug that has been prescribed.

## Description

Antiangina drugs, also known as nitrates, come in many different forms: tablets and capsules that are swallowed; tablets that are held under the tongue, inside the lip, or in the cheek until they dissolve; stick-on patches; ointment; and in-the-mouth sprays. Commonly used antiangina drugs include isosorbide dinitrate (Isordil, Sorbitrate, and other brands) and nitroglycerin (Nitro-Bid, Nitro-Dur, Nitrolingual Spray, Nitrostat Tablets, Transderm-Nitro, and other brands).

In 2006 the United States Food and Drug Administration (FDA) approved Randex (ranolazine) as the first new drug in ten years to treat chronic angina in patients who do not respond to other drugs. Ranexa affects electrical conduction in the heart. Its mechanism of action is different from that of other antiangina drugs. All antiangina drugs are available only with a physician's prescription.

## Antiangina drugs

Brand name (generic name)	Possible side effects
Adalat, Nifedical, Procardia (nifedipine)	Constipation, dizziness, heartburn, low blood pressure, moodiness, nausea, swelling
Aspirin (many brands available)	Increased bleeding risk when taken with anticoagulants, nausea, ulcers
Calan/Calan SR, Isoptin/Isoptin SR, Verelan (verapamil)	Constipation, dizziness, fatigue, fluid retention, headache, low blood pressure, nausea
Cardene/Cardene SR (nicardipine hydrochloride)	Dizziness, drowsiness, flushing, headache, indigestion, nausea, rapid heartbeat, swelling of feet
Cardizem, Cartia XT, Dilacor XR, Diltia XT, Tiazac (diltiazem)	Dizziness, fluid retention, headache, nausea, rash
Corgard, Corzide (nadolol)	Behavioral changes, dizziness, drowsiness, fatigue
Nitrocot, Nitrolingual, NitroMist, Nitroquick, Nitrostat, Nitrotab, Nitro-Time (nitroglycerin)	Dizziness, flushing, headache, lightheadedness
Imdur, Ismo, Monoket (isosorbide mononitrate)	Dizziness, headache, rash
Isordil (isosorbide dinitrate)	Dizziness, headache, low blood pressure
Lopressor, Toprol XL (metoprolol tartrate)	Depression, diarrhea, fatigue, heartburn, rash
Norvasc (amlodipine besylate)	Dizziness, fatigue, fluid retention, headache, palpitations
Ranexa (ranolazine)	Constipation, dizziness, dry mouth, nausea, seizures, swelling of the extremities, trembling, vomiting, weakness
Tenormin (atenolol)	Dizziness, fatigue, nausea, slowed heartbeat

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## Recommended dosage

The recommended dosage depends on the type and form of antiangina drug and may be different for different patients. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Always take antiangina drugs exactly as directed. The medicine will not work if it is not taken correctly.

Do not stop taking this medicine suddenly after taking it for several weeks or more, as this could cause angina attacks to return. If it is necessary to stop taking the drug, check with the physician who prescribed it for instructions on how to reduce the dosage gradually.

## KEY TERMS

**Angina pectoris**—A feeling of tightness, heaviness, or pain in the chest, caused by a lack of oxygen in the muscular wall of the heart.

### Precautions

Remember that some forms of antiangina drugs work too slowly to relieve attacks that have already started. Check with the physician who prescribed the medicine for instructions on how to use the type that has been prescribed. Patients who are using slower-acting forms to make attacks less frequent may want to ask their physicians to prescribe a fast-acting type to relieve attacks. Another method of treating the frequency of attacks is to increase the dosage of the long-acting antiangina drug. Do this only with the approval of a physician.

These medicines make some people feel lightheaded, dizzy, or faint when they get up after sitting or lying down. To lessen the problem, get up gradually and hold onto something for support if possible. Antiangina drugs may also cause **dizziness**, lightheadedness, or **fainting** in hot weather or when people stand for a long time or **exercise**. Use caution in all these situations. Drinking alcohol while taking antiangina drugs may cause the same problems. Anyone who takes this medicine should limit the amount of alcohol consumed.

Because these drugs may cause dizziness, be careful when driving, using machines, or doing anything else that could be dangerous.

If the person is taking the form of nitroglycerin that is placed under the tongue and symptoms are not relieved within three doses taken about 5 minutes apart, the person should go to the hospital emergency room as soon as possible. A **heart attack** may be in progress.

Some people develop tolerance to antiangina drugs over time; that is, the prescribed dose of the drug no longer produces the desired effects. Anyone who seems to be developing a tolerance to this medicine should check with his or her physician.

Anyone who has had unusual reactions to antiangina drugs in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Women who are pregnant or **breastfeeding** or who may become pregnant should check with their physicians before using antiangina drugs.

Older people may be especially sensitive to the effects of antiangina drugs and thus more likely to have side effects such as dizziness and lightheadedness.

Before using antiangina drugs, people with any of these medical problems should make sure their physicians are aware of their conditions:

- recent heart attack or stroke
- kidney disease
- liver disease
- severe anemia
- overactive thyroid
- glaucoma
- recent head injury

### Side effects

A common side effect is a **headache** just after taking a dose of the medicine. These headaches usually become less noticeable as the body adjusts to the drug. Check with a physician if they are severe or they continue even after taking the medicine for a few weeks. Unless a physician says to do so, do not change the dose to avoid headaches. Other common side effects include dizziness, lightheadedness, fast pulse, flushed face and neck, **nausea** or **vomiting**, and restlessness. These problems do not need medical attention unless they do not go away or they interfere with normal activities.

Other side effects, including stomach upset and **constipation** may occur. Anyone who has unusual symptoms after taking an antiangina drug should get in touch with his or her physician.

Ranexa is used only when other **antianxiety drugs** do not control symptoms of chronic angina. This drug can have rare but serious side effects. Anyone taking the drug who experiences convulsions, swelling of the hands and feet, shaking or **tremors**, **shortness of breath**, or blood in the urine should seek medical care immediately as these are signs of an allergic reaction.

### Interactions

Antiangina drugs may interact with other medicines. This may increase the risk of side effects or change the effects of one or both drugs. Anyone who takes antiangina drugs should let the physician know all other prescription and over-the-counter medicines, herbal remedies, and dietary supplements that he or she is taking. Among the drugs that may interact with antiangina drugs are:

- other heart medicines
- blood pressure medicines
- heart antiarrhythmia medications
- aspirin
- drugs for treating HIV infection
- alcohol
- ergot alkaloids used in migraine headaches
- certain antibiotics in the myocin family (Ranexa)

## Resources

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### ORGANIZATIONS

- American College of Cardiology, Heart House, 2400 N Street NW, Washington, DC, 20037, (202) 375-6000, <http://www.acc.org>.
- American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, <http://www.americanheart.org>.
- National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592 8573, <http://www.nhlbi.nih.gov>.

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# Antiangiogenic therapy

### Definition

Antiangiogenesis therapy is one of two classifications of drugs that restores health by controlling blood vessel growth. The other type of therapy is called pro-angiogenic therapy.

### Purpose

Antiangiogenic therapy inhibits the growth of new blood vessels. New blood vessel growth plays a critical role in many disease conditions, including disorders that cause blindness, arthritis, and **cancer**. The

beneficial effects of antiangiogenic drugs are exerted in a number of ways: by disabling the agents that activate and promote cell growth, or by directly blocking the growing blood vessel cells. The inhibitory properties of angiogenesis have been discovered in more than 300 substances, ranging from molecules produced naturally in animals and plants, such as green tea extract, to new chemicals synthesized in the laboratory. A number of medicines already approved by the U.S. Food and Drug Administration (FDA) have also been found to possess antiangiogenic properties.

There are several diseases that may benefit from antiangiogenic therapy:

- Eye disease—Excessive new blood vessels growing in the eye can cause vision loss and lead to blindness. Antiangiogenic treatments may prevent progressive loss of vision or even improve eyesight in patients.
- Arthritis—Blood vessels that invade the joint release enzymes that destroy cartilage and other tissues in arthritis. Antiangiogenic drugs may relieve the arthritic pain and prevent bone joint destruction caused by these pathological and destructive blood vessels.
- Cancer—Tumors develop a blood supply to obtain oxygen and nourishment for cancer cells. By cutting off tumor vasculature (the arrangement of blood vessels in the body or in a particular organ or tissue), antiangiogenesis therapies may literally starve tumors and prevent their growth and spread. Antiangiogenesis may also prove to be useful when combined with conventional chemotherapy or radiation therapy as part of a multimodal therapeutic approach to attack cancer using different strategies simultaneously.

### Description

#### *U.S. brand names*

Brand names of drugs with antiangiogenic activity approved for use in the United States include:

- bevacizumab (Avastin)
- sorafenib (Nexavar)
- sunitinib (Sutent)
- thalidomide (Thalomid)
- erlotinib (Tarceva)

#### *Canadian brand names*

Drugs with antiangiogenic activity approved for use in Canada are the same as those used in the United States.

In the late 1990s, many medical researchers believed that antiangiogenesis was an incredible breakthrough in cancer treatment. It was safe and at first, apparently effective. But the clinical results soon

## KEY TERMS

**Angiogenesis**—The formation of new blood vessels, for example, as a result of a tumor.

**Chemotherapy**—The use of chemical agents to treat diseases, infections, or other disorders, especially cancer.

**Endothelial**—A layer of cells that lines the inside of certain body cavities, for example, blood vessels.

**Epidermal**—Referring to the thin outermost layer of the skin, itself made up of several layers, that covers and protects the underlying dermis (skin).

**Fibroblast**—A large flat cell that secretes the proteins that form collagen and elastic fibers and the substance between the cells of connective tissue.

**Ischemic**—An inadequate supply of blood to a part of the body, caused by partial or total blockage of an artery.

**Ocular neovascularization**—Abnormal or excessive formation of blood vessels in the eye.

**Peripheral vascular disease**—A disease affecting blood vessels, especially in the arms, legs, hands, and feet.

**Vascular**—Relating to blood vessels.

fell short of expectations. The tumors, it seemed, had found a way to circumvent even this most ingenious of treatment approaches. Despite the setbacks, angiogenesis remains a very tempting target, and researchers are exploring new agents and approaches to maximize the effects of antiangiogenic therapies.

Newer studies have demonstrated that in addition to differences in the regulation of new blood vessel formation in cancer compared with normal tissues, the actual blood vessels created in cancers are different from those created in normal tissues. These differences have allowed a number of antiangiogenic drugs to be developed that specifically damage tumor-associated blood vessels and not normal vessels. The goal of these drugs is to attack cancers by damaging their blood supply. Many antiangiogenic agents also appear to hasten the of tumor-associated blood vessels.

With the success of targeted agents such the antiangiogenic drug, Avastin, efforts are underway to widen and optimize the field of antiangiogenic agents. As oncology (the study of cancer) drug development accelerates, new indications are beginning to emerge for diseases such as ocular neovascularization and even **obesity**.

Antiangiogenic therapy offers a number of advantages over traditional therapies for cancer:

- Tumor cells often mutate and become resistant to chemotherapy. Because antiangiogenic drugs only target normal endothelial cells (a layer of cells that lines the inside of certain body cavities, such as blood vessels), these cells are less likely to develop acquired drug resistance.
- All tumors rely upon host vessels. Antiangiogenic agents are, therefore, theoretically effective against a broad range of cancers.

- Conventional chemotherapy and radiotherapy indiscriminately attacks all dividing cells in the body leading to side effects such as diarrhea, mouth ulcers, hair loss, and weakened immunity. Antiangiogenic drugs selectively target dividing blood vessels and cause fewer side effects.
- Antiangiogenic drugs are relatively nontoxic and work at levels well below the maximum tolerated dose, so may be given in lower doses over longer periods of time.
- Antiangiogenic treatment may take weeks or even months to exhibit its full beneficial effect, but this allows for continuous, chronic control of disease.
- Antiangiogenic drugs may also serve as a powerful supplement to traditional chemotherapy or radiation therapy.

### Recommended dosage

The recommended dosage of bevacizumab varies with the type of cancer being treated. When used in the treatment of colorectal cancer, a typical dose is 5–10 mg per kilogram of body weight every two weeks administered intravenously in combination with a fluorouracil (5-FU) based **chemotherapy** regimen.

### Precautions

#### Pregnant or breastfeeding

There have been no studies conducted related to the effects of angiogenesis inhibitors on pregnant women. However, these agents have been found to cause **birth defects** in animals. The development of blood vessels is critical to fetal development; therefore, angiogenesis inhibitors should not be taken during **pregnancy**. Women of child-bearing age who are prescribed these drugs should be counseled to use

adequate contraceptive methods during their treatments and to delay pregnancy for at least six months after cessation of therapy since the drug may take as long as 100 days to be fully removed from the body. **Breastfeeding** is also not recommended for patients taking angiogenesis inhibitors. Breastfeeding should also be delayed for at least six months after the patient has stopped taking the drug.

The effects of angiogenesis inhibitors on the fertility of humans is not known. These drugs are known to disrupt the menstrual cycle and impair fertility in animals.

### **Other conditions and allergies**

The use of the angiogenesis inhibitor bevacizumab (Avastin) can result in intestinal perforation and can cause **wounds** that have been sutured to break open, sometimes causing death. Intestinal perforation, sometimes associated with abscesses inside the abdomen, occurred throughout treatment in clinical trials with Avastin. Symptoms included abdominal **pain** associated with **constipation** and **vomiting**. Avastin therapy should be permanently discontinued in patients with intestinal perforation or wound breaks requiring medical intervention. Serious, and in some cases fatal, **hemoptysis** (coughing up of blood or mucus containing blood) has occurred in patients with **non-small cell lung cancer** treated with chemotherapy and Avastin.

### **Side effects**

In general, research has found the side effects of antiangiogenesis agents to be mostly minimal. The side effects most likely to be associated with bevacizumab include:

- hypertension
- thromboembolic events
- venous thrombus/embolus
- delayed wound healing
- dizziness
- pain
- headache
- abdominal pain
- vomiting, anorexia, constipation, diarrhea, stomatitis
- weakness
- upper respiratory tract infection
- increased protein in the urine

### **Interactions**

The manufacturer of bevacizumab is not reporting any significant interactions associated with the drug as of July 2010. There is the potential for bevacizumab to interact unfavorably with other drugs used to treat cancer. For example, bevacizumab may increase the cardiac toxicities associated with anthracycline chemotherapy agents. It may also increase the adverse/toxic effects of the drug irinotecan (Camptosar). Bevacizumab may interact with the drug sorafenib (Nexavar) to increase the likelihood of hand-foot skin reaction. Bevacizumab given concurrently with sunitinib (Sutent) increases the risk for microangiopathic **hemolytic anemia** and may increase the hypertensive effect of sunitinib.

### **Resources**

#### **BOOKS**

Cooke, Robert. *Dr. Folkman's War: Angiogenesis and the Struggle to Defeat Cancer*. Collingdale, PA: Diane Publishing Co., 2003.

#### **PERIODICALS**

Bergers, G., and D. Hanahan. "Modes of Resistance to Anti-Angiogenic Therapy." *Nature Reviews Cancer* 8, no. 8 (2008): 592–603.

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Izzedine, H., et al. "Management of Hypertension in Angiogenesis Inhibitor-Treated Patients." *Annals of Oncology* 20, no. 5 (2009): 807–815, <http://www.medscape.com/viewarticle/703313> (accessed July 24, 2010).

#### **ORGANIZATIONS**

The Angiogenesis Foundation, P.O. Box 382111, Cambridge, MA, 02238 (617) 576-5708 (617) 401-3782, [patienthelp@angio.org](mailto:patienthelp@angio.org), <http://www.angio.org>.

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## **Antianxiety drugs**

### **Definition**

Antianxiety drugs are medicines that calm and relax people with excessive **anxiety**, nervousness, or tension, or for short-term control of social phobia

Antianxiety drugs	
Brand name (generic name)	Possible side effects*
Atarax (hydroxyzine hydrochloride)	Chest congestion, headache, skin reddening
Ativan (lorazepam)	Diarrhea, restlessness, weakness
BuSpar, Buspirone (buspirone hydrochloride)	Constipation, insomnia, nervousness, numbness, vomiting
Librium, Libritabs (chlordiazepoxide)	Constipation, diarrhea, restlessness, weakness
Serax (oxazepam)	Decreased coordination, fainting, headache, liver problems, swelling, vertigo
Stelazine (trifluoperazine hydrochloride)	Abnormal glucose in urine, allergic reactions, blurred vision, constipation, eye spasms, fluid retention, swelling
Tranxene, Tranxene-SD (clorazepate dipotassium)	Confusion, decreased coordination, headache, nervousness, tremors
Valium (diazepam)	Blurred vision, constipation, restlessness, weakness
Xanax (alprazolam)	Change in libido, difficulty urinating, increased salivation, irritability, weight fluctuation

\*Common side effects of all of these medications include changes in appetite, dizziness, drowsiness, dry mouth, fatigue, and upset stomach or nausea. Most of these drugs also share the other possible side effects listed.

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disorder, longer-term control of general anxiety disorder or another specific phobia.

### Purpose

Antianxiety agents, also called anxiolytics, may be used to treat mild transient bouts of anxiety as well as more pronounced episodes of social phobia, general anxiety disorder, or another specific phobia. Many drugs that treat anxiety disorder are also used to treat **panic disorder** and post-traumatic stress syndrome. Some are also used to treat depression. Clinically significant anxiety, or general anxiety disorder, is marked by several symptoms such as marked or persistent fear of one or more social or performance situations in which he or she is exposed to unfamiliar people or possible scrutiny by others and may react in a humiliating or embarrassing way. The exposure to the feared situation produces an anxiety attack. Fear of these episodes of anxiety leads to avoidance behavior that interferes with normal social functioning, including working or attending classes. The patient is aware that these fears are unjustified.

### Description

In psychiatric practice, treatment of anxiety has largely turned from traditional antianxiety agents to antidepressant therapies. In current use, the **benzodiazepines**, the best-known class of antianxiety drugs, have been largely supplanted by or supplemented by **selective serotonin reuptake inhibitors** (SSRIs), which are also used to treat major depression. Among the preferred SSRIs for **generalized anxiety disorder** are paroxetine (Paxil, Seroxat, Aropax, Deroxat, Rextin, Xetanor, Paroxat), escitalopram (Lexapro, Cipralex, Esertia), and venlafaxine (Effexor), which is not an SSRI, but is closely related to that class of drugs. Other SSRIs are fluoxetine (Prozac, Fontex, Seromex, Seronil, Fluctin, Fluox) and sertraline (Zoloft, Lustral, Serlan). Venlafaxine and paroxetine have been shown particularly effective in relieving symptoms of social anxiety.

Nevertheless, traditional antianxiety drugs remain useful for patients who need a rapid onset of action or whose frequency of exposure to anxiety provoking stimuli is low enough to eliminate the need for continued treatment. While SSRIs may require three to five weeks to show any effects and must be taken continuously, benzodiazepines such as Ativan, Centrax, Dalmane, Klonopin, Librium, Paxipan, Restoril, Serax, Tranxene, Valium, and Xanax, may produce a response within 30 minutes. These may be taken on an as-needed basis rather than continuously.

The intermediate action benzodiazepines, alprazolam (Xanax), and lorazepam (Ativan) often are the appropriate choice for treatment of mild anxiety and social phobia. Diazepam (Valium) is still widely used for anxiety, but its active metabolite, desmethyl diazepam, which has a long half-life, may make this a poorer choice than other drugs in its class. There is considerable variation among individuals in the metabolism of benzodiazepines, so patient response may not be predictable. As a class, benzodiazepines are used not only as to treat anxiety, but also as sedatives, **muscle relaxants**, and in treatment of **epilepsy** and **alcoholism**. The distinctions between these uses are largely determined by onset and duration of action and route of administration.

Buspirone (BuSpar), which is not chemically related to other classes of central nervous system (CNS) drugs, is also a traditional antianxiety drug, although it is now used most often either after the patient has failed to respond to treatment with SSRIs and benzodiazepines. It can also be used in conjunction with other antianxiety drugs. It is appropriate for

## KEY TERMS

**Anxiety**—Worry or tension in response to real or imagined stress, danger, or dreaded situations. Physical reactions, such as fast pulse, sweating, trembling, fatigue, and weakness may accompany anxiety.

**Epilepsy**—A brain disorder with symptoms that include seizures.

**Glaucoma**—An eye disorder caused by damage to the optic nerve resulting in vision loss. Glaucoma is usually accompanied by inflammation and increased pressure in the eye (intraocular pressure). There are several types that may develop suddenly or gradually.

**Panic disorder**—An disorder in which people have sudden and intense attacks of anxiety in certain

situations. Symptoms such as shortness of breath, sweating, dizziness, chest pain, and extreme fear often accompany the attacks.

**Phobia**—An intense, abnormal, or illogical fear of something specific, such as heights or open spaces.

**Pregnancy category B**—Animal studies indicate no fetal risk, but no human studies, or adverse effects in animals, but not in well-controlled human studies.

**Pregnancy category C**—No adequate human or animal studies, or adverse fetal effects in animal studies, but no available human data.

**Seizure**—A sudden attack, spasm, or convulsion.

use in patients who have either failed trials of other treatments or who should not receive benzodiazepines because of a history of **substance abuse** problems. Buspirone, in common with antidepressants, requires a two to three week period before there is clinical evidence of improvement, and must be continuously dosed to maintain its effects. Benzodiazepines are controlled drugs under federal law and are subject to frequent abuse. Buspirone is not a controlled substance and has no established abuse potential.

### Recommended dosage

Benzodiazepines should be administered 30 to 60 minutes before exposure to the anticipated stress. Dosage should be individualized to minimize **sedation**. The normal dose of alprazolam is 0.25–0.5 mg. The usual dose of lorazepam is 2–3 mg. Doses may be repeated if necessary.

Buspirone is initially dosed at 5 mg three times a day. Patients may be directed to increase the dosage 5 mg/day, at intervals of two to three days, as needed and should not exceed 60 mg/day. Two to three weeks may be required before a satisfactory response is seen.

### Precautions

Benzodiazepines should not be used in patients with **psychosis**, acute narrow angle glaucoma, or **liver disease**. The drugs can act as respiratory depressants and should be avoided in patients with respiratory conditions. Benzodiazepines are potentially addictive and should not be administered to patients with substance abuse disorders. Because benzodiazepines are

sedative, they should be avoided in patients who must remain alert. Their use for periods over four months has not been documented. These drugs should not be used during the second and third trimester of **pregnancy**, although use during the first trimester appears to be safe. They should not be taken while **breastfeeding**. Physicians and pharmacists should be consulted about use in children.

Buspirone is metabolized by the liver and excreted by the kidney, and should be used with care in patients with hepatic or renal disease. The drug is classified as schedule B during pregnancy, but should not be taken during breastfeeding. Its use in children under the age of 18 years has not been studied.

In October 2004, the United States Food and Drug Administration (FDA) issued a warning that treating children and adolescents with SSRIs increased the risk of suicidal thoughts and behaviors. In a review of 2,200 children treated with SSRIs, the FDA found no completed suicides, but did find a 4% increase in suicidal thinking or behavior, including **suicide** attempts. In 2006, this warning was extended to include all people under age 25. However, in April 2007, a comprehensive review of SSRI treatment in children, adolescents, and adults under age 25 that was published in the *Journal of the American Medical Society* indicated that the benefits of treating these patients with SSRIs generally outweighed the risks. To reduce the risks of suicide, SSRIs should only be prescribed by a psychiatrist, not a family physician, and parents and caregivers should be alert for any of the signs of potential suicidal behavior found below.

## Side effects

The most common side effects of benzodiazepines are secondary to their CNS effects and include sedation and sleepiness, depression, lethargy, apathy, **fatigue**, hypoactivity, lightheadedness, memory impairment, disorientation, anterograde **amnesia**, restlessness, confusion, crying or sobbing, **delirium**, **headache**, slurred speech, aphonia, dysarthria, stupor, seizures, **coma**, syncope, rigidity, tremor, dystonia, vertigo, **dizziness**, euphoria, nervousness, irritability, difficulty in concentration, agitation, inability to perform complex mental functions, akathisia, hemiparesis, hypotonia, unsteadiness, ataxia, incoordination, weakness, vivid dreams, psychomotor retardation, “glassy-eyed” appearance, extrapyramidal symptoms, paradoxical reactions. Other reactions include changes in heart rate and blood pressure, changes in bowel function, severe skin rash and changes in genitourinary function. Other adverse effects have been reported.

Buspirone has a low incidence of side effects. Dizziness and drowsiness are the most commonly reported adverse effects. Other CNS effects include dream disturbances, depersonalization, dysphoria, noise intolerance, euphoria, akathisia, fearfulness, loss of interest, disassociative reaction, **hallucinations**, suicidal ideation, seizures, feelings of claustrophobia, cold intolerance, stupor and slurred speech, psychosis. Rarely, heart problems, including congestive **heart failure** and myocardial infarction, have been reported. Other adverse effects have been reported.

The most common side effects of SSRIs include:

- dry mouth
- dizziness
- sour or acid stomach or gas
- heartburn
- decreased appetite
- stomach upset
- nausea
- diarrhea
- sweating
- headache
- weakness or fatigue
- drowsiness
- insomnia
- nervousness or anxiety
- tremors
- sexual problems

For additional information on less common side effects and side effects of SSRIs on children, see the entry on **antidepressant drugs, SSRI**.

## Interactions

The metabolism of alprazolam may be increased by: cimetidine, **oral contraceptives**, disulfiram, fluoxetine, isoniazid, ketoconazole, metoprolol, propoxyphene, propranolol and valproic acid. The absorption of all benzodiazepines is inhibited by concomitant use of **antacids**. Benzodiazepines may increase blood levels of **digoxin**, and reduce the efficacy of levodopa. Other **drug interactions** have been reported.

Buspirone levels will be increased by concomitant use of erythromycin, itraconazole, and nefazadone. Doses should be adjusted based on clinical response. Use of buspirone at the same time as monoamine oxidase inhibitors (MAOIs, phenelzine, tranylcypromine) may cause severe blood pressure elevations. Use of buspirone with monoamine oxidase inhibitors (MAOIs) should be avoided.

SSRIs interact with many other drugs and herbal remedies especially other drugs that affect mood. Alcohol may increase SSRI-induced drowsiness and should not be used when taking some SSRIs.

The interaction of SSRIs with **monoamine oxidase inhibitors** (MAOIs), an older class of antidepressants, can be fatal. In addition to antidepressant MAOIs, the antibiotic linezolid (Zyvox) is an MAOI. There must be at minimum a two-week interval between stopping one drug and starting the other drug. There should be at least a three-week interval between an MAOI and either paroxetine hydrochloride or sertraline, if either type of antidepressant was taken for more than three months. Because of its long half-life in the body, it is necessary to wait five to six weeks after stopping fluoxetine before starting on an MAOI. For a more extensive list of SSRI drug interactions, please see the entry on antidepressant drugs, SSRI.

## Resources

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## ORGANIZATIONS

American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Ave. NW, Washington, DC, 20013-3007, (202) 966-7300, (202) 966-2891, [communications@aacap.org](mailto:communications@aacap.org), <http://www.aacap.org/>.

American Psychiatric Association (APA), 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (888) 357-7924, [apa@psych.org](mailto:apa@psych.org), <http://www.psych.org>.

National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD, 20892-9663 <http://www.nimh.nih.gov/site-info/contact-nimh.shtml>.

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## Description

Antiarrhythmic drugs are available only with a physician's prescription and are sold in capsule (regular and extended release), tablet (regular and extended-release), and injectable forms. Commonly used antiarrhythmic drugs are disopyramide (Norpace, Norpace CR), procainamide (Procan SR, Pronestyl, Pronestyl-SR), and quinidine (Cardioquin, Duraquin, Quinidex, and other brands). *Do not confuse quinidine with quinine, which is a related medicine with different uses, such as relieving leg cramps.* Anti-coagulant (blood thinning) drugs such as warfarin (Coumadin) are often given at the same time as anti-arrhythmic drugs because irregular heart rhythms increase the chance of developing **blood clots**.

## Recommended dosage

The recommended dosage depends on the type of antiarrhythmic drug and other factors. Doses may be different for different patients. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Always take antiarrhythmic drugs exactly as directed. Never take larger or more frequent doses.

Do not stop taking this medicine without checking with the physician who prescribed it. Stopping it suddenly could lead to a serious change in heart function.

Antiarrhythmic drugs work best when they are at constant levels in the blood. To help keep levels constant, take the medicine in doses spaced evenly through the day and night. Do not miss any doses. If taking medicine at night interferes with sleep, or if it is difficult to remember to take the medicine during the day, check with a health care professional for suggestions.

## Precautions

Persons who take these drugs should see their physician regularly. The physician will check to make sure the medicine is working as it should and will note any unwanted side effects.

Some people feel dizzy, lightheaded, or faint when using these drugs, especially when they get up after sitting or lying down. To lessen the problem, get up gradually and hold onto something for support if possible.

This medicine may cause blurred vision or other vision problems. Because of these possible problems, anyone who takes these drugs should not drive, use

# Antiarrhythmic drugs

## Definition

Antiarrhythmic drugs are medicines that correct irregular heartbeats and slow down hearts that beat too fast.

## Purpose

Normally, the heart beats at a steady, even pace. The pace is controlled by electrical signals that begin near the top of the heart and quickly spread through the whole heart. If something goes wrong with this control system, the result may be an irregular heartbeat, or arrhythmia. Antiarrhythmic drugs correct irregular heartbeats and restore the normal rhythm. If the heart is beating too fast, these drugs will slow it down. By correcting these problems, antiarrhythmic drugs reduce stress on the heart and help it work more efficiently.

## KEY TERMS

**Anxiety**—Worry or tension in response to real or imagined stress, danger, or dreaded situations. Physical reactions, such as fast pulse, sweating, trembling, fatigue, and weakness may accompany anxiety.

**Arrhythmia**—Abnormal heart rhythm.

**Asthma**—A disease in which the air passages of the lungs become inflamed and narrowed.

**Emphysema**—A lung disease in which breathing becomes difficult.

**Glaucoma**—A condition in which pressure in the eye is abnormally high. If not treated, glaucoma may lead to blindness.

**Hallucination**—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

**Heat stroke**—A severe condition caused by prolonged exposure to high heat. Heat stroke interferes with the body's temperature regulating abilities and can lead to collapse and coma.

**Inflammation**—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

**Myasthenia gravis**—A chronic disease with symptoms that include muscle weakness and sometimes paralysis.

**Palpitation**—Rapid, forceful, throbbing, or fluttering heartbeat.

**Prostate**—A donut-shaped gland below the bladder in men that contributes to the production of semen.

**Psoriasis**—A skin disease in which people have itchy, scaly, red patches on the skin.

**Systemic lupus erythematosus (SLE)**—A chronic disease that affects the skin, joints, and certain internal organs.

**Tourette syndrome**—A condition in which a person has tics and other involuntary behavior, such as barking, sniffing, swearing, grunting, and making uncontrollable movements.

**Tremor**—Shakiness or trembling.

machines, or do anything else that might be dangerous until they have found out how the drugs affect them. If the medicine does cause vision problems, wait until vision is clear before driving or engaging in other activities that require normal vision.

Antiarrhythmic drugs make some people feel lightheaded, dizzy, or faint.

Anyone taking this medicine should not drink alcohol without his or her physician's approval.

Some antiarrhythmic drugs may change the results of certain medical tests. Before having medical tests, anyone taking this medicine should alert the health care professional in charge.

Anyone who is taking antiarrhythmic drugs should be sure to tell the health care professional in charge before having any surgical or dental procedures or receiving emergency treatment.

Antiarrhythmic drugs may cause low blood sugar in some people. Anyone who experiences symptoms of low blood sugar should eat or drink a food that contains sugar and call a physician immediately. Signs of low blood sugar are:

- anxiety
- confusion

- nervousness
- shakiness
- unsteady walk
- extreme hunger
- headache
- nausea
- drowsiness
- unusual tiredness or weakness
- fast heartbeat
- pale, cool skin
- chills
- cold sweats

Antiarrhythmic drugs may cause **dry mouth**. To temporarily relieve the discomfort, chew sugarless gum, suck on sugarless candy or ice chips, or use saliva substitutes, which come in liquid and tablet forms and are available without a prescription. If the problem continues for more than 2 weeks, check with a physician or dentist. Mouth dryness that continues over a long time may contribute to **tooth decay** and other dental problems.

People taking antiarrhythmic drugs may sweat less, which can cause the body temperature to rise. Anyone who takes this medicine should be careful

not to become overheated during **exercise** or hot weather and should avoid hot baths, hot tubs, and saunas. Overheating could lead to heat stroke.

Older people may be especially sensitive to the effects of antiarrhythmic drugs. This may increase the risk of certain side effects, such as dry mouth, difficult urination, and **dizziness** or lightheadedness.

The antiarrhythmic drug procainamide can cause serious blood disorders. Anyone taking this medicine should have regular blood counts and should check with a physician if any of the following symptoms occur:

- joint or muscle pain
- muscle weakness
- pain in the chest or abdomen
- tremors
- wheezing
- cough
- palpitations
- rash, sores, or pain in the mouth
- sore throat
- fever and chills
- loss of appetite
- diarrhea
- dark urine
- yellow skin or eyes
- unusual bleeding or bruising
- dizziness
- hallucinations
- depression

### *Special conditions*

People with certain medical conditions or who are taking certain other medicines may have problems if they take antiarrhythmic drugs. Before taking these drugs, be sure to let the physician know about any other medical conditions.

**ALLERGIES.** Anyone who has had unusual reactions to an antiarrhythmic drug in the past should let his or her physician know before taking this type of medicine again. Patients taking procainamide should let their physicians know if they have ever had an unusual or allergic reaction to procaine or any other “caine-type” medicine, such as xylocaine or lidocaine. Patients taking quinidine should mention any previous reactions to quinine. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

**CONGESTIVE HEART DISEASE.** Antiarrhythmic drugs may cause low blood sugar, which can be a particular problem for people with congestive heart disease. Anyone with congestive heart disease should be familiar with the signs of low blood sugar (listed above) and should check with his or her physician about what to do if such symptoms occur.

**DIABETES.** Antiarrhythmic drugs may cause low blood sugar, which can be a particular problem for people with diabetes. Anyone with diabetes should be familiar with the signs of low blood sugar (listed above) and should check with his or her physician about what to do if such symptoms occur.

**PREGNANCY.** The effects of taking antiarrhythmic drugs in **pregnancy** have not been studied in humans. In studies of laboratory animals, this medicine increased the risk of **miscarriage**. In addition, some women who have taken these drugs while pregnant have had contractions of the uterus (womb). Women who are pregnant or who may become pregnant should check with their physicians before taking this medicine. Women who become pregnant while taking this medicine should let their physicians know right away.

**BREASTFEEDING.** Antiarrhythmic drugs pass into breast milk. Women who are **breastfeeding** should check with their physicians before taking this medicine.

**OTHER MEDICAL CONDITIONS.** Before using antiarrhythmic drugs, people with any of these medical problems should make sure their physicians are aware of their conditions:

- heart disorders such as structural heart disease or inflammation of the heart muscle
- congestive heart failure
- kidney disease
- liver disease
- diseases of the blood
- asthma or emphysema
- enlarged prostate or difficulty urinating
- overactive thyroid
- low blood sugar
- psoriasis
- glaucoma
- myasthenia gravis
- systemic lupus erythematosus

### *Side effects*

The most common side effects are dry mouth and throat, **diarrhea**, and loss of appetite. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side

effects, such as dizziness, lightheadedness, blurred vision, dry eyes and nose, frequent urge to urinate, bloating, **constipation**, stomach **pain**, and decreased sexual ability, also may occur and do not need medical attention unless they do not go away or they interfere with normal activities.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine as soon as possible:

- fever and chills
- difficult urination
- swollen or painful joints
- pain when breathing
- skin rash or itching

People who are especially sensitive to quinidine may have a reaction to the first dose or doses. If any of these side effects occur after taking quinidine, check with a physician immediately:

- dizziness
- ringing in the ears
- breathing problems
- vision changes
- fever
- headache
- skin rash

Other rare side effects may occur with any antiarrhythmic drug. Anyone who has unusual symptoms after taking antiarrhythmic drugs should get in touch with his or her physician.

## Interactions

Antiarrhythmic drugs may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes antiarrhythmic drugs should let the physician know all other medicines he or she is taking. Among the drugs that may interact with antiarrhythmic drugs are:

- other heart medicines, including other antiarrhythmic drugs
- blood pressure medicine
- blood thinners
- pimozide (Orap), used to treat Tourette syndrome

The list above does not include every drug that may interact with antiarrhythmic drugs. Be sure to check with a physician or pharmacist before combining antiarrhythmic drugs with any other prescription or nonprescription (over-the-counter) medicine.

## Resources

### BOOKS

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### ORGANIZATIONS

American College of Cardiology, Heart House, 2400 N Street NW, Washington, DC, 20037, (202) 375-6000, ext 5603, (202) 375-7000, (800) 223-4636, ext. 5603, [resource@acc.org](mailto:resource@acc.org), <http://www.acc.org>.

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, [Review.personal.info@heart.org](mailto:Review.personal.info@heart.org).

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, <http://www.nhlbi.nih.gov>.

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## Antiasthmatic drugs

### Definition

Antiasthmatic drugs are medicines that treat or prevent **asthma** attacks.

## KEY TERMS

**Asthma**—A disease in which the air passages of the lungs become inflamed and narrowed.

**Inflammation**—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

**Inhalant**—Medicine that is breathed into the lungs.

**Mucus**—Thick fluid produced by the moist membranes that line many body cavities and structures.

## Purpose

For people with asthma, the simple act of breathing can be a struggle. Their airways become inflamed and blocked with mucus during asthma attacks, narrowing the opening through which air passes. This is not such a problem when the person breathes in, because the airways naturally expand when a person takes a breath. The real problem arises when the person with asthma tries to breathe out. The air cannot get out through the blocked airways, so it stays trapped in the lungs. With each new breath, the person can take in only a little more air, so breathing becomes shallow and takes more and more effort.

Asthma attacks can be caused by **allergies** to pollen, dust, pets, or other things, but people without known allergies may also have asthma. **Exercise, stress, intense emotions, exposure to cold, certain medicines, and some medical conditions** can bring on attacks.

The two main approaches to dealing with asthma are avoiding substances and situations that trigger attacks and using medicines that treat or prevent the symptoms. With a combination of the two, most people with asthma can find relief and live normal lives.

## Description

Three types of drugs are used in treating and preventing asthma attacks:

- Bronchodilators relax the smooth muscles that line the airway. This makes the airways open wider, letting more air pass through them. These drugs are used mainly to relieve sudden asthma attacks or to prevent attacks that might come on after exercise. They may be taken by mouth, injected, or inhaled. Bronchodilators can be taken in pill or liquid form, but normally are used as inhalers. The drug is breathed in metered doses and goes directly into the airways. This results in prompt response and fewer side effects. Albuterol (Accuneb, Proair, Proventil, Ventolin) is a common short-acting bronchodilator

Salmeterol (Serevent), another inhaled drug, is only prescribed when other drugs fail to control asthma, as it has a higher percentage of fatal complications than other antiasthmaic drugs.

- Corticosteroids block the inflammation that narrows the airways. Used regularly, these drugs will help prevent asthma attacks. Those attacks that do occur will be less severe. However, corticosteroids cannot stop an attack that is already underway. These drugs may be taken by mouth, injected, or inhaled. Examples of common corticosteroids used in the treatment of asthma include beclomethasone (Beconase), budesonide (Entocort, Pulmicort), flunisolide (Nasalide), fluticasone (Flonase), and triamcinolone (Azmacort, Kenalog).
- Leukotriene modifiers are a newer type of drug that can be used in place of steroids for older children or adults who have a mild degree of asthma that persists. They work by counteracting leukotrienes, which are substances released by white blood cells in the lung that cause the air passages to constrict and promote mucus secretion. Leukotriene modifiers also fight off some forms of rhinitis, an added bonus for people with asthma. However, they are not proven effective in fighting seasonal allergies. Leukotriene modifiers include montelukast (Singulair), zafirlukast (Accolate), and zileuton (Zyflo, Filmtab). However, in March 2008, the United States Food and Drug Administration (FDA) began investigating a link between montelukast (Singulair) and changes in mood and behavior, increased suicidal thinking, and increased the risk of suicide. Check with a physician or pharmacist for the most recent information on this investigation.
- Cromolyn (Intal) and nedocromil (Tilade) are mast cell inhibitors. Mast cells are cells that are involved in the production of allergy symptoms. These drugs may be taken regularly to help prevent asthma attacks and may be used alone or with other asthma medicines. They cannot stop an attack that already has started. These drugs work by preventing certain mast cells from releasing substances that cause allergic reactions or asthma symptoms.

## Precautions

Using antiasthmatic drugs properly is important. Because **bronchodilators** provide quick relief, some people may be tempted to overuse them. However, with some kinds of bronchodilators, this can lead to serious and possibly life-threatening complications. Patients benefit most by using bronchodilators only as directed and also routinely using other drugs that over time will reduce their need for bronchodilators. Research has also shown that people with asthma who

work closely with their physicians to self-manage their asthma have fewer attacks and less need for bronchodilators. Carefully managing asthma also reduces visits to the emergency department and hospitalizations.

As noted above, people using Salmeterol (Serevent) have an increased risk of fatal asthma attacks. This drug should be used only when asthma cannot be controlled by other means.

**Corticosteroids** are powerful drugs that may cause serious side effects when used over a long time. However, these problems are much less likely with the inhalant forms than with the oral and injected forms. While the oral and injected forms generally should be used only for one to two weeks, the inhalant forms may be used for longer periods.

It is important to remember that leukotriene modifiers are used to prevent and manage asthma, not to stop an attack. A physician or pharmacist can advise patients on possible interactions with other drugs. Note that as of 2008 an investigation was underway to examine a suspected connection between montelukast (Singulair) and increased suicidal thoughts and behavior.

Patients who are using their antiasthmatic drugs correctly but feel their asthma is not under control should see their physicians. The physician can either increase the dose, switch to another drug or add another drug to the regimen. A 2004 survey showed that 70% of people with mild to moderate asthma were not taking the correct dose of asthma medication.

When used to prevent asthma attacks, cromolyn must be taken as directed every day. The drug may take as long as four weeks to start working. Unless told to do so by a physician, patients should not stop taking the drug just because it does not seem to be working. When symptoms do begin to improve, patients should continue taking all medicines that have been prescribed, unless a physician directs otherwise.

### Side effects

Inhalant forms of antiasthmatic drugs may cause dryness or irritation in the throat, **dry mouth**, or an unpleasant taste in the mouth. To help prevent these problems, gargling and rinsing the mouth or taking a sip of water after each dose is recommended.

More serious side effects are not common when these medicines are used properly. However, anyone who has unusual or bothersome symptoms after taking an antiasthmatic drug should get in touch with a physician and discuss altering the medication regimen.

### Interactions

A physician or pharmacist should be consulted before combining antiasthmatic drugs with any other prescription, nonprescription (over-the-counter) medicine, or herbal remedy.

### Resources

#### OTHER

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#### ORGANIZATIONS

Asthma and Allergy Foundation of America, 8201 Corporate Drive, Suite 1000, Landover, MD, 20785, (800) 727-8462, [info@aafa.org](mailto:info@aafa.org), <http://www.aafa.org/>.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, <http://www.nhlbi.nih.gov>.

National Institute of Allergies and Infectious Diseases, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612, (301) 496-5717, (301) 402-3573, (866) 284-4107, [ocpostoffice@niaid.nih.gov](mailto:ocpostoffice@niaid.nih.gov), <http://www.niaid.nih.gov>.

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Antibacterial bath see **Therapeutic baths**

## Antibiotic-associated colitis

### Definition

Antibiotic-associated **colitis** is an inflammation of the intestines that sometimes occurs following antibiotic treatment and is caused by toxins produced by the bacterium *Clostridium difficile*.

### Description

Antibiotic-associated colitis, also called antibiotic-associated enterocolitis, can occur following antibiotic treatment. The bacteria *Clostridia difficile* are normally found in the intestines of 5% of healthy adults, but people can also pick up the bacteria while they are in a hospital or nursing home. In a healthy

## KEY TERMS

**Colitis**—Inflammation of the colon.

**Edema**—Fluid accumulation in a tissue.

**Endoscopy**—A procedure in which a thin, lighted instrument is inserted into the interior of a hollow organ, such as the rectum and used to visually inspect the inner intestinal lining.

**Fibrin**—A fibrous blood protein vital to coagulation and blood clot formation.

**Rectum**—The last part of the intestine. Stool passes through the rectum and out through the anal opening.

**Toxic megacolon**—Acute enlargement or dilation of the large intestine.

person, harmless resident intestinal bacteria compete with each other for food and places to “sit” along the inner intestinal wall. When **antibiotics** are given, most of the resident bacteria are killed. With fewer bacteria to compete with, the normally harmless *Clostridium difficile* grow rapidly and produce toxins. These toxins damage the inner wall of the intestines and cause inflammation and **diarrhea**.

Although all antibiotics can cause this disease, it is most commonly caused by clindamycin (Cleocin), ampicillin (Omnipen), amoxicillin (Amoxil, Augmentin, or Wymox), and any in the cephalosporin class (such as cefazolin or cephalexin). Symptoms of the condition can occur during antibiotic treatment or within four weeks after the treatment has stopped.

In approximately half of cases of antibiotic-associated colitis, the condition progresses to a more severe form of colitis called pseudomembranous enterocolitis in which pseudomembranes are excreted in the stools. Pseudomembranes are membrane-like collections of white blood cells, mucus, and the protein that causes blood to clot (fibrin) that are released by the damaged intestinal wall.

### Causes and symptoms

Antibiotic-associated colitis is caused by toxins produced by the bacterium *Clostridium difficile* after treatment with antibiotics. When most of the other intestinal bacteria have been killed, *Clostridium difficile* grows rapidly and releases toxins that damage the intestinal wall. The disease and symptoms are caused by these toxins, not by the bacterium itself.

Symptoms of antibiotic-associated colitis usually begin four to ten days after antibiotic treatment has begun. The early signs and symptoms of this disease include lower abdominal cramps, an increased need to pass stool, and watery diarrhea. As the disease progresses, the patient may experience a general ill feeling, **fatigue**, abdominal **pain**, and **fever**. If the disease proceeds to pseudomembranous enterocolitis, the patient may also experience **nausea**, **vomiting**, large amounts of watery diarrhea, and a very high fever (104–105 °F/40–40.5 °C). Complications of antibiotic-associated colitis include severe **dehydration**, imbalances in blood **minerals**, low blood pressure, fluid accumulation in deep skin (**edema**), enlargement of the large intestine (toxic megacolon), and the formation of a tear (perforation) in the wall of the large intestine.

The *Clostridium difficile* toxin is found in the stools of persons older than 60 years of age 20–100 times more frequently than in the stools of persons who are 10–20 years old. As a result, the elderly are much more prone to developing antibiotic-associated colitis than younger individuals.

### Diagnosis

Antibiotic-associated colitis can be diagnosed by the symptoms and recent medical history of the patient, by a laboratory test for the bacterial toxin, and/or by using a procedure called **endoscopy**.

If the diarrhea and related symptoms occurred after the patient received antibiotics, antibiotic-associated colitis may be suspected. A stool sample may be analyzed for the presence of the *Clostridium difficile* toxin. This toxin test is the preferred diagnostic test for antibiotic-associated colitis. One frequently used test for the toxin involves adding the processed stool sample to a human cell culture. If the toxin is present in the stool sample, the cells die. It may take up to two days to get the results from this test. A simpler test, which provides results in two to three hours, is also available. Symptoms and toxin test results are usually enough to diagnose the disease.

Another tool that may be useful in the diagnosis of antibiotic-associated colitis, however, is a procedure called an endoscopy that involves inserting a thin, lighted tube into the rectum to visually inspect the intestinal lining. Two different types of endoscopy procedures, the **sigmoidoscopy** and the **colonoscopy**, are used to view different parts of the large intestine. These procedures are performed in a hospital or doctor’s office. Patients are sedated during the procedure to make them more comfortable and are allowed to go home after recovering from the **sedation**.

## Treatment

Diarrhea, regardless of the cause, is always treated by encouraging the individual to replace lost fluids and prevent dehydration. One method to treat antibiotic-associated colitis is to simply stop taking the antibiotic that caused the disease. This allows the normal intestinal bacteria to repopulate the intestines and inhibits the overgrowth of *Clostridium difficile*. Many patients with mild disease respond well to this and are free from diarrhea within two weeks. It is important, however, to make sure that the original disease for which the antibiotics were prescribed is treated.

Because of the potential seriousness of this disease, most patients are given another antibiotic to control the growth of the *Clostridium difficile*, usually vancomycin (Vancocin) or metronidazole (Flagyl or Protostat). Both are designed to be taken orally four times a day for 10-14 days. Upon finishing antibiotic treatment, approximately 15-20% of patients will experience a relapse of diarrhea within one to five weeks. Mild relapses can go untreated with great success, however, severe relapses of diarrhea require another round of antibiotic treatment. Instead of further antibiotic treatment, a cholestyramine resin (Questran or Prevalite) may be given. The bacterial toxins produced in the intestine stick to the resin and are passed out with the resin in the stool. Unfortunately, however, vancomycin also sticks to the resin, so these two drugs cannot be taken at the same time. Serious disease may require hospitalization so that the patient can be monitored, treated, and rehydrated.

## Alternative treatment

The goal of alternative treatment for antibiotic-associated enterocolitis is to repopulate the intestinal environment with microorganisms that are normal and healthy for the intestinal tract. These microorganisms then compete for space and keep the *Clostridium difficile* from over-populating.

Several types of supplements can be used. Supplements containing *Lactobacillus acidophilus*, the bacteria commonly found in yogurt and some types of milk, *Lactobacillus bifidus*, and *Streptococcus faecium*, are available in many stores in powder, capsule, tablet, and liquid form. *Acidophilus* also acts as a mild antibiotic, which helps it to reestablish itself in the intestine, and all may aid in the production of some B **vitamins** and vitamin K. These supplements can be taken individually and alternated weekly or together following one or more courses of antibiotics.

## Prognosis

With appropriate treatment and replenishment of fluids, the prognosis is generally excellent. One or more relapses can occur. Very severe colitis can cause a tear (perforation) in the wall of the large intestine that would require major surgery. Perforation of the intestine can cause a serious abdominal infection. Antibiotic-associated colitis can be fatal in people who are elderly and/or have a serious underlying illness, such as **cancer**.

## Prevention

There are no specific preventative measures for this disease. Good general health can reduce the chance of developing a bacterial infection that would require antibiotic treatment and the chance of picking up the *Clostridia* bacteria. Maintaining good general health can also reduce the seriousness and length of the condition, should it develop following antibiotic therapy.

## Resources

### OTHER

*"Clostridium-difficile-Induced Colitis."* Merck Manual Online. <http://www.merckmanuals.com/home/sec09/ch127/ch127a.html> (accessed November 22, 2010).

### ORGANIZATIONS

Crohn's & Colitis Foundation of America, 386 Park Ave. S, 17th Fl., New York, NY, 10016, (800) 932-2423, [info@ccfa.org](mailto:info@ccfa.org), <http://ccfa.org>.

Antibiotic prophylaxis see **Prophylaxis**

## Antibiotics

### Definition

Antibiotics are drugs that treat infections caused by bacteria. Some antibiotics may have secondary uses, such as the use of demeclocycline (Declomycin, a tetracycline derivative) to treat the syndrome of inappropriate antidiuretic hormone (SIADH) secretion. Other antibiotics may be useful in treating protozoal (another type of single-celled organism) infections.

### Purpose

Antibiotics are used for treatment or prevention of bacterial infection. Different antibiotics are effective in killing different species of bacteria.

<b>Antibiotics</b>	
<b>Brand name</b>	<b>Generic name</b>
<b>Aminoglycosides</b>	
Amikin	amikacin
AK-Tob, Tobi, Tobrex	tobramycin
Capastat Sulfate	capreomycin sulfate
Garamycin, Gentak, Pred-G	gentamicin
Kantrex	kanamycin
Netromycin	netilmicin
<b>Cephalosporins</b>	
Ancef	cefazolin
Ceclor	cefaclor
Cedax	ceftibuten
Ceftin, Zinacef	cefoxime
Cefzil	cefprozil
Duricef	cefadroxil
Fortaz, Tazicef	ceftazidime
Keflex	cephalexin
Mefoxin	cefoxitin
Omnicef	cefdinir
Rocephin	ceftrioxone
Spectracef	cefditoren
Suprax	cefixime
Vantin	cefpodoxime
<b>Macrolides</b>	
Biaxin, Biaxin XL	clarithromycin
ERYC, Ery-Tab, EryDerm, EryGel, PCE	erythromycin
Zithromax	azithromycin
<b>Penicillins</b>	
Amoxil, Trimox	amoxicillin
Bactocill	oxacillin
Dicloxacillin Sodium	dicloxacillin sodium
Pfizerpen	penicillin G
Principen	ampicillin
Timentin	ticarcillin (and clavulanate)
Unipen	nafcillin
V-Cillin K, Veetids	penicillin V
Zosyn	piperacillin (and tazobactam)
<b>Tetracyclines</b>	
Declomycin	demeclocycline
Doryx, Monodox, Vibramycin, Vibra-Tabs	doxycycline hyclate
Dynacin, Minocin	minocycline hydrochloride
Sumycin	tetracycline hydrochloride
Terramycin	oxytetracycline
<b>Miscellaneous</b>	
Chloramphenicol	chloramphenicol
Cleocin, Cleocin T, Clinda-Derm, Clindagel, Clindets, Clindesse	clindamycin
Coly-Mycin M	colistimethate
Flagyl, Flagyl ER, Flagyl I.V., Noritate, Metrogel	metronidazole
Furadantin, Macrobid	nitrofurantoin
Monurol	fosfomycin tromethamine
Myambutol	ethambutol
Nydrazid	isoniazid
Pyrazinamide	pyrazinamide
Synercid	quinupristin/dalfopristin
Trobicin	spectinomycin hydrochloride
Vancocin	vancomycin hydrochloride

(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

## Description

There are a very large number of antibiotics approved for use in the United States and Canada sold under a variety of brand names.

There are several classification schemes for antibiotics. The most useful is based on chemical structure. Antibiotics within a structural class will generally show similar patterns of effectiveness, toxicity, and allergic potential. Additional classification schemes are based on:

- bacterial spectrum—broad spectrum can kill many types of bacteria, whereas narrow spectrum antibiotics specifically target a single class of bacteria
- route of administration—injectable, oral, or topical
- type of activity—bactericidal drugs kill bacteria outright whereas bacteriostatic drugs inhibit bacterial growth

### *Penicillins*

The **penicillins** are the oldest class of antibiotics. They have a common chemical structure that they share with the cephalosporins. The two groups are classed as beta-lactam antibiotics, and are generally bacteriocidal—that is, they kill bacteria rather than inhibiting growth. Penicillins are sold under a variety of generic and brand names.

The penicillins can be further subdivided. Natural penicillins are based on the original penicillin G structure; penicillinase-resistant penicillins, notably methicillin and oxacillin, are active even in the presence of the bacterial enzyme that inactivates most natural penicillins. Aminopenicillins such as ampicillin and amoxicillin have an extended spectrum of action compared with natural penicillins. Extended spectrum penicillins are effective against a wider range of bacteria. These generally include coverage for *Pseudomonas aeruginosa*. The penicillin may be used in combination with a penicillinase inhibitor.

### *Cephalosporins*

**Cephalosporins** and the closely related cephamy- cins and carbapenems are the most widely prescribed class of antibiotics in the United States. They were discovered in Italy in 1948 and were first manufactured commercially in the United States in 1964. Like the penicillins, cephalosporins contain a beta-lactam chemical structure. Consequently, bacteria resistant to penicillins are also likely to be resistant to cephalosporins, and people allergic to penicillins are likely to be allergic to cephalosporins.



**A penicillin culture.** (Custom Medical Stock Photo, Inc.  
Reproduced by permission.)

The “cepha” drugs are among the most diverse class of antibiotics and are themselves subgrouped into first, second, third, and fourth generation drugs. Each generation has a broader spectrum of activity than the one before. In addition, cefoxitin, a cephamycin, is highly active against anaerobic bacteria, which makes them a good choice in the treatment of abdominal infections. The fourth generation cephalosporins (cefepime, ceftazidime, cefozopran, cefpirone, cefquinome) cross the blood-brain barrier and may be used to treat **meningitis** and **encephalitis**.

### Fluoroquinolones

The **fluoroquinolones** are synthetic antibacterial agents, and not derived from bacteria. A related class of antibacterial agents developed earlier, the quinolones, were not well absorbed and could be used only to treat urinary tract infections. The fluoroquinolones, which are based on the older group, are broad-spectrum bactericidal drugs that are chemically unrelated to the penicillins or the cephalosporins. They are well distributed into bone tissue, and so well absorbed that in general they are as effective when given by mouth as by intravenous infusion. Cipro is the brand name of the best-known fluoroquinolone sold in the United States.

### Tetracyclines

**Tetracyclines** got their name because they share a chemical structure that has four rings. They are

derived from a species of *Streptomyces* bacteria. As broad-spectrum bacteriostatic agents, the tetracyclines may be effective against a wide variety of microorganisms, including rickettsia and amoebic parasites.

### Macrolides

The **macrolide antibiotics** are derived from *Streptomyces* bacteria, and got their name because they all have a macrocyclic lactone chemical structure. Erythromycin, the prototype of this class, has a spectrum and use similar to penicillin. Newer members of the group, azithromycin (Zithromax) and clarithromycin (Biaxin), are particularly useful for their high level of lung penetration. Clarithromycin has been widely used to treat *Helicobacter pylori* infections that cause stomach ulcers.

### Others

Other classes of antibiotics include the **aminoglycosides**, which are particularly useful for their effectiveness in treating *Pseudomonas aeruginosa* infections. Gentamycin (garamycin), polymyxin B sulfate/trimethoprim (Polytrim), and tobramycin (Tobrex) fall into this category. The lincosamides include clindamycin (Cleocin) and lincomycin (Lincocin), which are highly active against anaerobic pathogens. The **sulfonamides** include co-trimoxazole (Bactrim) and trimethoprim (Proloprim). There are other individual drugs that have also been useful in treating specific infections.

### Recommended dosage

Dosage varies with drug, route of administration, pathogen, site of infection, and severity. Additional considerations include renal function, age of patient, and other factors. Consult manufacturers' recommendations for dose and route.

### Precautions

To minimize risk of adverse reactions and development of resistant strains of bacteria, antibiotics should be restricted to use in cases where there is either known or a reasonable presumption of bacterial infection. The use of antibiotics in viral infections such as the **common cold** is to be avoided. Avoid use of fluoroquinolones for trivial infections. Use antibiotics as often as directed and for as long as directed. Although the symptoms may have disappeared, the infection may not clear up completely if the drug is stopped too soon.

## KEY TERMS

**Anaerobic bacteria**—Bacteria that grow and reproduce in an oxygen-free environment, such as the bacterium that causes tetanus.

**Bacteria**—Tiny, one-celled forms of life that cause many diseases and infections.

**Blood-brain barrier**—A specialized, semi-permeable layer of cells around the blood vessels in the brain that controls which substances can leave the circulatory system and enter the brain.

**Inflammation**—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

**Meningitis**—Inflammation of tissues that surround the brain and spinal cord.

**Microorganism**—An organism that is too small to be seen with the naked eye.

**Myasthenia gravis**—A muscle weakness that occurs because the body makes antibodies to the natural chemical that facilitates transmission of impulses between the nerve and the muscle.

**Pregnancy category**—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

In severe infections, therapy with a broad-spectrum antibiotic such as a third or fourth generation cephalosporin may be appropriate. Treatment should be changed to a narrow spectrum agent as soon as the disease-causing bacterium has been identified. After 48 hours of treatment, if there is clinical improvement, an oral antibiotic should be considered.

### Side effects

Due to the various types of antibiotics available, there are a variety of side effects possible. The most common problems associated with each type are:

- Penicillins: Allergic reactions may be common, and cross allergenicity with cephalosporins has been reported. Penicillins are classed as category B during pregnancy.
- Cephalosporins: Several cephalosporins and related compounds have been associated with seizures. Cefoperazone (Cefobid), cefotetan (Cefotan), and ceftriaxone (Rocephin) may be associated with a decrease in the ability of the blood to clot and other coagulation abnormalities. Some forms of colitis (a serious infection of the large intestine) have been reported with cephalosporins and other broad-spectrum antibiotic use. Some drugs in this class may cause kidney damage. Pregnancy category B.
- Fluoroquinolones: Lomefloxacin (Maxaquin) has been associated with increased photosensitivity. All drugs in this class have been associated with convulsions. Pregnancy category C.

- Tetracyclines: Demeclocycline (Declomycin) may cause increased photosensitivity. Minocycline (Dynacin) may cause dizziness. Oral tetracyclines bind to anions such as calcium and iron. Although doxycycline and minocycline may be taken with meals, patients should take other tetracycline antibiotics on an empty stomach, and should not take the drugs with milk or other calcium-rich foods. Expired tetracycline should never be administered. Pregnancy category D.
- Macrolides: Erythromycin may aggravate the weakness of patients with myasthenia gravis. Azithromycin has rarely been associated with allergic reactions, including angioedema, anaphylaxis (life-threatening shock), and skin reactions, including Stevens-Johnson syndrome and toxic epidermal necrolysis. Oral erythromycin may be highly irritating to the stomach and when given by injection may cause severe phlebitis. These drugs should be used with caution in patients with liver dysfunction. Pregnancy category B: Azithromycin, erythromycin. Pregnancy category C: Clarithromycin, dirithromycin, troleandomycin.
- Aminoglycosides: This class of drugs causes kidney damage and damage to the organs of the inner ear. These problems can occur even with normal doses. Dosing should be based on kidney (renal) function, with periodic testing of both kidney function and hearing. Pregnancy category D.

### Pediatric

Tetracyclines should not be prescribed for children under the age of eight. They should specifically

be avoided during periods of tooth development. In children, these drugs can cause permanent tooth discoloration.

### *Geriatric*

Older patients are more sensitive to the side effects of antibiotics. Since these patients often take multiple medications, their use and possible **drug interactions** should be carefully monitored by a physician and pharmacist.

### *Pregnant or breastfeeding*

Several antibiotics may impair fetal development. Their use during **pregnancy** should be discussed with a physician and closely monitored. Generally, **breastfeeding** is not recommended while taking antibiotics due to the risk of upsetting the balance of the infant's intestinal bacteria and risk of masking infection in the infant.

The use of tetracyclines should be avoided during pregnancy as it may cause alterations in bone development.

### *Other conditions and allergies*

All antibiotics cause risk of overgrowth by non-susceptible bacteria. Manufacturers list other major hazards by class; however, the health care provider should review each drug individually to assess the degree of risk.

Excessive or inappropriate use of any antibiotic may lead to the development of antibiotic resistant strains of bacteria. This has become an increasing concern as antibiotics are routinely added to animal feed and some household cleaning products. A strain that is considered resistant is one that can no longer be treated effectively using the antibiotics commonly prescribed for that type of infection.

Methicillin-resistant *Staphylococcus aureus* (MRSA) is a strain of staphylococcal bacteria that is resistant to the antibiotic methicillin and other common antibiotics that normally control staph infections. Although this strain of staph has existed in hospitals for years, in the 1990s, MRSA began appearing in places other than hospitals. By 2007, two forms of MRSA were recognized, hospital-acquired MRSA (HA-MRSA) and community-acquired MRSA (CA-MRSA). Symptoms of a MRSA infection are similar to other staph infection symptoms, only MRSA is much more dangerous and has a much higher mortality rate because treatment with common antibiotics does not kill the bacterium.

## Interactions

The potential for interactions with other drugs and with foods is pronounced with the antibiotic drug group as a whole. Patients should request verbal and written information about the potential of these interactions for every antibiotic they are prescribed.

## Resources

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### ORGANIZATIONS

Alliance for the Prudent Use of Antibiotics (APUA), 75 Kneeland Street, Boston, MA, 02111-1901 (617) 636-0966 (617) 636-3999, <http://www.tufts.edu/med/apua>.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333 (800) 232-4636, <http://www.cdc.gov>.

United States Food and Drug Administration, 10903 New Hampshire Avenue, Silver Spring, MD, 20993 (888) INFO-FDA (463-6332), <http://www.fda.gov>.

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## Antibiotics, ophthalmic

### Definition

Ophthalmic **antibiotics** are medicines used in the eye that kill bacteria that cause eye infections. However, not all eye inflammation is caused by bacteria, and these drugs do not treat viruses.

## KEY TERMS

**Bacteria**—Tiny, one-celled forms of life that cause many diseases and infections.

**Inflammation**—The body's response to tissue damage. Includes warmth, swelling, redness, and pain in the affected part.

**Ointment**—A thick, spreadable substance that contains medicine and is meant to be used on the skin, or, if it is specifically an ophthalmic, or "eye" ointment, in the eye

### Purpose

Ophthalmic antibiotics are applied to the eye or under the eyelid to treat eye infections caused by bacteria.

### Description

Ophthalmic antibiotics come in the form of eye drops or ointment. Tobramycin (Tobrex), gatifloxacin ophthalmic (Zymar), and polymyxin B sulfate/trimethoprim (Polytrim) come as eye drops. Triple ophthalmic antibiotic ointment is sold under about a dozen brand names including Ak-Spore, Neocidin Ophthalmic Ointment, Ocusporin, Spectro-Sporin, and Triple Antibiotic. It is a combination of three antibiotics: neomycin, polymyxin B, and bacitracin. All ophthalmic antibiotics are available only with a physician's prescription.

### Recommended dosage

The dosages given here are typical. Physicians may adjust the number of doses per day, the time between doses, and the length of treatment with the medicine, depending on the patient's particular medical problem. If the physician's directions are different from those given here, follow the physician's directions.

#### Adults

**EYE DROPS.** For mild to moderate infections, use one to two drops in the affected eye or eyes every four hours.

For severe infections, use two drops in the affected eye or eyes every two hours until the condition improves. At that time, the physician will determine how much to use until the infection is completely cleared up.

**OINTMENT.** For mild to moderate infections, squeeze a half-inch ribbon of ointment into the affected eye or eyes two or three times a day. Do not let the tip of the ointment tube touch the eye.

For severe infections, squeeze a half-inch ribbon of ointment into the affected eye or eyes every three to four hours until the condition improves. At that time, the physician will determine how much to use until the infection is completely cleared up.

### Children

The child's physician should determine the proper dose.

### Precautions

Use these drugs as often as directed, for as long as directed. Although the symptoms may have disappeared, the infection may not clear up completely if the drug is stopped too soon. Therefore, the medication may be prescribed for several days after the infection appears to have cleared. However, it is just as important to use the drug for *only* as long as directed. Using it for too long may lead to the growth of bacteria that do not respond to the drug. These bacteria may then cause infections that can be very difficult to treat. Make sure the physician or pharmacist specifies how long the medication is to be used.

Anyone who has had an allergic reaction to the prescribed drug or to any of the ingredients in it should not use the medicine. If an apparent allergic reaction occurs, the individual should stop using the medicine immediately and call his or her physician.

Women who are pregnant or **breastfeeding** or who plan to become pregnant should check with their physicians before using ophthalmic antibiotics. Generally, these drugs are not known to cause problems for the developing fetus or infant.

### Side effects

The main side effects of these drugs are **itching**, redness, and swelling of the eye or eyelid. Allergic reactions also are possible. If any of these symptoms occur, call the physician who prescribed the medicine.

### Interactions

Patients who are using any other prescription or nonprescription (over-the-counter) medicines in their eyes should check with their physicians before using any ophthalmic antibiotic.

### Resources

#### BOOKS

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**ORGANIZATIONS**

- Alliance for the Prudent Use of Antibiotics (APUA), 75 Kneeland Street, Boston, MA, 02111-1901, (617) 636-0966, (617) 636-3999, [apua@tufts.edu](mailto:apua@tufts.edu), <http://www.tufts.edu/med/apua>.
- Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, [cdcinfo@cdc.gov](mailto:cdcinfo@cdc.gov), <http://www.cdc.gov>.
- EyeCare America The Foundation of the American Academy of Ophthalmology, P. O. Box 429098, San Francisco, CA, 94142-9098, (415) 561-8567, (877) 887-6327, <http://www.eyecareamerica.org>.
- United States Food and Drug Administration (FDA), 10903 New Hampshire Ave., Silver Spring, MD, 02993-0002, (888) 463-6332, <http://www.fda.gov>.

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## Antibiotics, topical

### Definition

Topical **antibiotics** are medicines applied to the skin to kill bacteria.

### Purpose

Topical antibiotics help to prevent infections caused by bacteria that get into minor cuts, scrapes, and **burns**. Treating minor **wounds** with antibiotics allows quicker healing. If the wounds are left untreated, the bacteria will multiply, causing **pain**, redness, swelling, **itching**, and oozing. Untreated infections can eventually spread and become much more serious. Occasionally topical antibiotics are also used to treat **eczema** or other skin conditions that have become infected. Some newer acne preparations combine benzoyl peroxide with antibiotics.

### KEY TERMS

**Bacteria**—Tiny, one-celled forms of life that cause many diseases and infections.

**Eczema**—A disease in which the skin becomes dry, red, itchy, and thickened.

**Fungus**—A member of a group of simple organisms that are related to yeast and molds.

**Incontinence**—The inability to control the bladder or bowel.

**Inflammation**—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

One topical combination of benzoyl peroxide with clindamycin is sold under the trade name BenzaClin.

When treating a wound, it is not enough to simply apply a topical antibiotic. The wound must first be cleaned with soap and water and patted dry. After the antibiotic is applied, the wound should be covered with a dressing, such as a bandage or a protective gel or spray. For many years, it was thought that wounds heal best when exposed to the air. But now most experts say it is best to keep wounds clean and moist while they heal. The covering should still allow some air to reach the wound, however.

### Description

Different kinds of topical antibiotics kill different kinds of bacteria. Many antibiotic first-aid products contain combinations of antibiotics to make them effective against a broad range of bacteria. The most common antibiotics found in topical antibiotics are mupirocin, bacitracin, polymyxin B, and neomycin. Triple antibiotic ointment (TAO) is sold under about a dozen brand names including Ak-Spore, Spectro-Sporin, and Triple Antibiotic. It contains three antibiotics: neomycin, polymyxin B, and bacitracin. Some antibacterial ointments (e.g., Neosporin, Polysporin) are available without a prescription, while others are prescription drugs.

### Recommended dosage

The recommended dosage depends on the type of topical antibiotic. Follow the directions on the package label or ask a pharmacist for directions.

In general, topical antibiotics should be applied within four hours after injury. Do not use more than the recommended amount and do not apply it more

often than three times a day. Do not apply the medicine over large areas of skin or on open wounds.

## Precautions

Excessive or inappropriate use of any antibiotic may lead to the development of antibiotic resistant strains of bacteria. This has become of increasing concern as antibiotics are routinely added to animal feed and some household cleaning products. A strain that is considered resistant is one that can no longer be treated effectively using the antibiotics that are commonly prescribed for that type of infection.

Although use of topical antibiotics are of less concern than widespread and indiscriminate use of systemic antibiotics, to help control the development of antibiotic resistant bacteria, many public health experts advise people to use topical antibiotics only for short periods, that is, until the wound heals, and only as directed. For the topical antibiotic to work best, it should be used only to prevent infection in a fresh wound, not to treat an infection that has already started. Wounds that are not fresh may need the attention of a physician to prevent complications such as blood poisoning.

Topical antibiotics are meant to be used only on the skin and only for only a few days at a time. If the wound has not healed in five days, stop using the antibiotic and call a doctor.

Do not use topical antibiotics on large areas of skin or on open wounds. These products should not be used to treat **diaper rash** in infants or incontinence rash in adults.

Only minor cuts, scrapes, and burns should be treated with topical antibiotics. Certain kinds of injuries may need medical care and should not be self-treated with topical antibiotics. These include:

- large wounds
- deep cuts
- cuts that continue bleeding
- cuts that may need stitches
- burns any larger than a few inches in diameter
- scrapes imbedded with particles that will not wash away
- animal bites
- deep puncture wounds
- eye injuries

Never use regular topical antibiotics in the eyes. Special antibiotic products are available for treating eye infections. (See entry on **antibiotics, ophthalmic** for additional information.)

Although topical antibiotics control infections caused by bacteria, they may allow fungal infections to develop. The use of other, different drugs to treat the fungal infections may be necessary. Check with the physician or pharmacist.

Some people may be allergic to one or more ingredients in a topical antibiotic product. If an allergic reaction develops, stop using the product immediately and call a physician.

No harmful or abnormal effects have been reported in babies whose mothers used topical antibiotics while pregnant or nursing. However, pregnant or **breastfeeding** women are advised not to use any prescription, nonprescription or herbal drugs or remedies without first checking with her physician.

Unless a physician says to do so, do not use topical antibiotics on children under two years of age.

## Side effects

The most common minor side effects are itching or burning. These problems usually do not require medical treatment unless they do not go away or they interfere with normal activities.

If any of the following side effects occur, check with a doctor as soon as possible:

- rash
- swelling of the lips and face
- sweating
- tightness or discomfort in the chest
- breathing problems
- fainting or dizziness
- low blood pressure
- nausea
- diarrhea
- hearing loss or ringing in the ears

Other rare side effects may occur. Anyone who has unusual symptoms after using a topical antibiotic should get in touch with the physician who prescribed or the pharmacist who recommended the medication.

## Interactions

Using certain topical antibiotics at the same time as hydrocortisone (a topical corticosteroid used to treat inflammation) may hide signs of infection or allergic reaction. Do not use these two medicines at the same time unless told to do so by a health care provider.

Anyone who is using any other type of prescription or nonprescription (over-the-counter) medicine or herbal treatment on the skin should check with a doctor before using a topical antibiotic.

## Resources

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### ORGANIZATIONS

Alliance for the Prudent Use of Antibiotics (APUA), 75 Kneeland Street, Boston, MA, 02111-1901, (617) 636-0966, (617) 636-3999, [apua@tufts.edu](mailto:apua@tufts.edu), <http://www.tufts.edu/med/apua>.

American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, (847) 240-1859, (866) 503-SKIN (7546), <http://www.aad.org>.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, [cdclinfo@cdc.gov](mailto:cdclinfo@cdc.gov), <http://www.cdc.gov>.

United States Food and Drug Administration (FDA), 10903 New Hampshire Ave., Silver Spring, MD, 02993-0002, (888) 463-6332, <http://www.fda.gov>.

Nancy Ross-Flanigan  
Tish Davidson A. M.

Antibody screening see **Blood typing and crossmatching**

## Anti-cancer diet

### Definition

The phrase *cancer diet* can be used to refer to several different approaches to the associations between **cancer** and **nutrition**. Some people think of a cancer

diet as a preventive approach to cancer or a way to lower one's risk of cancer by avoiding foods associated with specific types of cancer. *Cancer diet* may also refer to the special **diets** or nutritional therapy prescribed for cancer patients to prevent them from developing **malnutrition** as a side effect of their cancer therapy. Last, *cancer diet* is sometimes used to refer to complementary and alternative (CAM) approaches to cancer that involve the use of special diets and **nutritional supplements**. The best-known of these are the macrobiotic diet, a largely vegetarian diet that originated in Japan; and the Gonzalez regimen, an alternative therapy for pancreatic cancer. The Gonzalez regimen includes a special diet, nutritional supplements, pancreatic enzymes in capsule form, and coffee **enemas**.

### Purpose

The purpose of preventive cancer diets is to lower an individual's risk of cancer, particularly cancers of the digestive system. The purpose of nutritional therapy for cancer is to minimize loss of appetite, tissue wasting, and other symptoms of the disease or side effects of treatment; to help the patient tolerate cancer treatment; to protect the functioning of his or her immune system; and to maintain or improve the patient's quality of life. The purpose of the Gonzalez regimen and other CAM dietary therapies for cancer is to treat the disease itself rather than its symptoms or the side effects of mainstream cancer therapies.

### Demographics

As of 2009, the evidence indicates that diet is second only to tobacco as a preventable cause of cancer. The World Health Organization (WHO) and the National Cancer Institute (NCI) both estimate that between 30% and 40% of all cancers in developed countries and 20% of all cancers in the developing countries are related to dietary factors. Diet has been linked not only to cancers of the mouth, esophagus, stomach, intestines, and rectum, but also to cancers of the prostate, breast, kidney, liver, and pancreas.

Cancer accounts for 7.1 million deaths worldwide each year, or 12.5% of the global total. About 20 million people around the world are presently living with cancer; this figure is expected to rise to 30 million by 2020. More than half of all new cancers occur in the developing countries. The greatest single risk factor for cancers related to diet is not race or sex but socioeconomic status (SES); cancer risk factors are highest and survival rates are lowest in groups with the least education.

## Cancer-fighting foods

Foods	Effects on cancer
Avocados	May attack free radicals in the body by blocking intestinal absorption of certain fats; may be useful in treating viral hepatitis (a cause of liver cancer)
Beans	May prevent or slow genetic damage to cells, prevent prostate cancer, and lower the risk of digestive cancers
Berries	May help prevent skin, bladder, lung, and breast cancers and slow the reproduction of cancer cells
Cabbage and cauliflower	May slow cancer growth and development and help to reduce the risk of lung, prostate, and bladder cancers
Broccoli	May prevent some types of cancer, including stomach, colon and rectal
Carrots	May reduce a wide range of cancers including lung, mouth, throat, stomach, intestine, bladder, prostate and breast
Chili peppers and jalapeños	May prevent cancers such as stomach cancer
Cruciferous vegetables (broccoli, cauliflower, kale, Brussels sprouts, and cabbage)	May help decrease prostate and other cancers
Dark green leafy vegetables	May reduce the risk of lung and breast cancer
Figs	May shrink tumors
Flax	May reduce the risk of breast, skin, and lung cancer
Garlic	May increase the activity of immune cells that fight cancer and indirectly help break down cancer causing substances. May help block carcinogens from entering cells and slow tumor development. May render carcinogens in the liver inactive
Grapefruits	May lower risk of a variety of cancers including stomach, colon, lung and skin
Grapes	May prevent cancer by sweeping carcinogens out of the body and inhibit the proliferation of breast-cancer cells in vitro
Kale	May inhibit the enzymes that can stimulate cancer-cell growth and suppress immune response
Licorice root	May help stop the conversion of certain lesions to cancerous cells in estrogen-sensitive tissues, suppress tumor growth, and block cancer-causing substances from reaching their targets
Mushrooms	May prevent the growth of prostate cancer
Nuts	May help the body fight cancer and build the immune system
Oranges and lemons	May suppress the growth of cancers
Papayas	May stimulate cancer-killing immune cells like lymphocytes that may function in breaking down cancer-causing substances
Red wine	May reduce absorption of cancer-causing nitrosamines from the soil or processed foods. May minimize cervical dysplasia and certain cancers
Rosemary	May reduce cell proliferation and help prevent cancer
Seaweed and other sea vegetables	May inhibit the development of breast and skin tumors
Soy products like tofu	May help in the fight against breast cancer
Sweet potatoes	May help to prevent breast and prostate cancer by blocking and suppressing cancerous changes
Tomatoes	May prevent cancer cells from dividing, reduce the risk of cancer of the stomach, lung, colon, rectum, liver and pancreas, and protect against various types of cancer
Tumeric	May combat prostate cancer and protect against breast, lung, mouth, stomach, and pancreatic cancer. May reduce risk of breast, prostate, pancreas and colorectal cancer. May prevent cellular damage that leads to cancer.
Whole grains	May inhibit the production of the inflammation-related enzyme cyclo-oxygenase 2 (COX-2), which reaches abnormally high levels in certain inflammatory diseases and cancers, especially bowel and colon cancer
	May help decrease the risk of developing most types of cancer

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## Precautions

People concerned to lower their individual risk of cancer by changing their diet should consult their primary care physician, or a reliable source like the American Cancer Society (ACS), the National Cancer Institute (NCI), or the World Health Organization (WHO) to be sure that they have up-to-date information about the relationships between cancer and

nutrition. Patients being treated with nutritional therapy as part of cancer treatment should follow the recommendations of their doctors and dietitians. People considering CAM therapies for cancer should find out as much as they can about these approaches and talk to their primary care doctor before using them. They should not use CAM therapies as substitutes for mainstream cancer treatments.

## Description

### *Diet as a cancer preventive*

Dietary changes as a preventive measure for lowering an individual's risk of cancer are sometimes called an anticancer diet, although this term does not have a precise definition. Most recommendations for lowering one's risk of cancer through changing one's eating patterns include the following:

- Eat less total fat and avoid hydrogenated fats—the type of fats often used to prepare fast foods.
- Choose foods that are high in fiber, such as wheat bran, kidney beans, garbanzo beans, navy beans, whole wheat, whole grains, legumes, whole-grain bread, and prunes.
- Eat large amounts of fresh fruits and vegetables, particularly the cruciferous vegetables (broccoli, cabbage, Brussels sprouts, mustard greens, kale, and cauliflower).
- Switch from red meat to fish; if possible, move from a meat-based to a vegetarian diet.
- Use olive oil rather than oils containing saturated fats when cooking.
- Choose foods that are high in calcium.
- Drink less alcohol.
- Consider using dietary supplements or foods reported to reduce cancer risk. These include vitamin D, selenium, green tea, and garlic.

One mainstream approach to diet that is often recommended as a way to lower cancer risk is the **Mediterranean diet**. The Mediterranean diet is better described as a nutritional model or pattern of food consumption rather than a diet in the usual sense of the word. There is more than one Mediterranean diet, if the phrase is understood to refer to the traditional foods and eating patterns found in the countries bordering the Mediterranean Sea. In general, however, Mediterranean diets have five major characteristics:

- High levels of fruits and vegetables, breads and other cereals, potatoes, beans, nuts, and seeds.
- Olive oil as the principal or only source of fat in the diet.
- Low to moderate amounts of dairy products, fish, and poultry; little use of red meat.
- Eggs used no more than 4 times weekly.
- Wine consumed in moderate amounts—two glasses per day for men, one glass for women.

These characteristics are in line with most of the recommendations of so-called anticancer diets.

It is important to remember, however, that diet is not the only risk factor for certain types of cancer. Occupation, environmental factors, and heredity also influence a given individual's risk of developing cancer. Thus changing one's diet to reduce the intake of high-risk foods and eating more foods associated with lowering one's cancer risk is not a guarantee that one will never develop cancer.

### *Nutritional therapy for cancer*

Nutritional therapy for cancer patients is intended to help them maintain normal energy levels and avoid malnutrition. Appetite, taste, smell, and the ability to eat enough food or absorb the nutrients from food may be affected by the symptoms of the disease itself or by the side effects of treatment. Cancer patients frequently experience such symptoms as loss of appetite, **nausea and vomiting**, **constipation**, **diarrhea**, sore mouth, trouble swallowing, and depression. The most common nutritional problems in cancer patients are failure to eat enough high-protein foods and failure to take in enough overall calories.

The most common cause of malnutrition in cancer patients is anorexia, or loss of appetite. It may appear together with cachexia, a wasting syndrome in which the person loses weight, muscle, and fat tissue. Cachexia is not the same as **starvation**. A healthy person's body can adjust to starvation by slowing down its use of nutrients, but the body cannot adjust in this fashion in cancer patients with cachexia.

Nutrition therapy for cancer patients may be very different from standard guidelines for healthful eating. It is tailored to each patient's individual nutritional needs, response to cancer treatment, and personal food preferences. Patients who cannot take foods by mouth may require enteral nutrition (tube feeding) or parenteral nutrition (nutrients infused directly into the bloodstream through a catheter). Those who can take foods by mouth may need to change their eating habits by having several small meals a day rather than one large one; by taking medications for such problems as **nausea**, **vomiting**, constipation, or diarrhea; by drinking extra fluids to cope with such problems as **dry mouth** or changes in the sense of taste; and by adding as many high-protein, high-calorie foods to the diet as possible. Good choices include cheese and crackers, puddings, muffins, nutritional supplements, milk shakes, yogurt, ice cream, and chocolate.

### *CAM dietary therapies*

**GONZALEZ REGIMEN.** The Gonzalez regimen is an alternative dietary therapy for pancreatic cancer

developed by Nicholas Gonzalez, a physician in New York City. It is a complex combination of dietary changes, various nutritional supplements, and **detoxification** procedures.

- Diet. In general, the diet in the Gonzalez regimen requires the patient to consume mostly organic foods, and avoid such synthetic and refined foods as white flour and white sugar. The diet is, however, tailored to each patient. There are ten basic diets with 90 variations, ranging from nearly vegetarian diets to diets high in meat and fat.
- Supplements. These may include vitamins, minerals, trace elements, antioxidants, animal glandular concentrates and other food concentrates. Like the diet, the combination of supplements is also customized for the individual patient.
- Proteolytic enzymes made from pig pancreas. The basic theory underlying the Gonzalez regimen is that toxins from processed foods and environmental sources are responsible for cancers in humans, and that the pancreas is the organ primarily responsible for detoxifying the body. Gonzalez maintains that these pancreatic enzymes, taken in capsule form, enter the bloodstream and help the body eliminate and destroy malignant cells, waste material, and abnormal proteins that are toxic to the body. Overall, a cancer patient on the Gonzalez regimen will take between 150 and 175 capsules per day of nutrient supplements and pancreatic enzymes.
- Coffee enemas, taken twice daily. Gonzalez maintains that these enemas serve to detoxify the body by improving liver function and stimulate the gallbladder to empty, thereby speeding up the elimination of toxins and waste products.

**MACROBIOTIC DIET.** The macrobiotic diet is a diet based on heavy consumption of whole grains, vegetables, soy products, seaweed, beans and bean products, mild flavorings, fruit, fish, nuts, and seeds. All products used should be locally grown whenever possible and processed as little as possible. The specific foods are selected according to the time of year, the climate, the person's sex, age, and activity level, and their overall health status. The macrobiotic diet developed in Japan from traditional folk medicine. It was given the name "macrobiotic" in the 1950s by George Ohsawa (1893–1966) and brought to the West in the late 1950s.

The macrobiotic diet was first touted as a cure for cancer by one of Ohsawa's disciples, Michio Kushi (1926– ). Kushi wrote a book about the macrobiotic diet as a cancer preventive and treatment, titled *The Cancer Prevention Diet: The Macrobiotic Approach to Preventing and Relieving Cancer* and first published in

## KEY TERMS

**Aflatoxins**—A group of naturally occurring toxins produced by fungi of the genus *Aspergillus*.

**Cachexia**—Unintentional loss of body weight and muscle mass, and weakness that may occur in patients with cancer, AIDS, or other chronic diseases.

**Enteral nutrition**—The medical term for tube feeding.

**Gonzalez regimen**—An alternative therapy for pancreatic cancer that includes a special diet, nutritional supplements, pancreatic enzymes, and coffee enemas.

**Macrobiotic diet**—A diet based primarily on whole grains, vegetables, and beans, and avoiding refined or processed foods. It is sometimes recommended by practitioners of alternative medicine as a preventive for cancer.

**Parenteral nutrition**—Providing a person with necessary nutrients through intravenous feeding.

1993. The website of the Kushi Institute includes personal testimonials from people who maintain that their cancers, ranging from uterine and pancreatic cancers to leukemia and brain tumors, were cured by following the macrobiotic diet.

### Origins

The Gonzalez regimen is based on the theories of William Donald Kelley (1925–2005), an orthodontist who developed pancreatic cancer in 1962 and claimed to have cured himself by a combination of dietary changes along with pancreatic enzymes, an individualized diet of **vitamins**, **minerals**, and other nutrients, and detoxification by means of coffee enemas. Kelley's theories were rejected by mainstream physicians, and his dental license was revoked in 1976.

The origins of the macrobiotic diet have been outlined in the previous section.

### Risks

There are no known risks to eating a healthful diet in order to reduce one's risk of cancer nor in following the nutritional recommendations of one's treatment team if one is being treated for cancer.

Gonzalez notes that patients on his dietary regimen frequently experience muscle aches and pains,

low-grade fevers, skin **rashes**, and other flu-like symptoms. He attributes these to the body's reaction to detoxification. Other reported side effects include bloating, gassiness, and **indigestion**.

The primary risk of following the macrobiotic diet is using it as a therapy for cancer instead of mainstream cancer treatment. Other people who have used it as a preventive diet to lower their risk of cancer have developed mild forms of malnutrition by failing to supplement the diet with vitamin D and vitamin B<sub>12</sub>, which are not available in sufficient amounts in the foods that are the mainstays of the macrobiotic diet.

### Health care team roles

Dietary changes as a cancer preventive for individual patients should be overseen and monitored by a primary care physician and a dietitian. Dietary therapy for cancer patients is usually designed and modified by a treatment team that includes a dietitian as well as doctors and nurses.

Patients with pancreatic cancer who are interested in the Gonzalez regimen should consult their present treatment team before contacting Dr. Gonzalez. Similarly, patients already diagnosed with cancer should consult their treatment team before using a macrobiotic diet as cancer therapy. The ACS "strongly urges individuals with cancer not to use a dietary program as an exclusive or primary means of treatment."

### Research & general acceptance

The World Health Organization (WHO) has summarized recent findings about the relationship between lifestyle and dietary factors and cancer as follows:

- Convincing evidence for lowering cancer risk: Regular physical activity.
- Convincing evidence for increasing cancer risk: Overweight and obesity.
- Probable evidence for lowering cancer risk: High consumption of fresh fruits and vegetables.
- Probable evidence for increasing cancer risk: Excessive alcohol consumption; salted and preserved meats; highly cooked rather than rare or raw meats; fermented fish; very hot (temperature) drinks and food; and aflatoxins (toxins produced by fungi sometimes found in peanuts, grains, and tree nuts).
- Possible or insufficient evidence for lowering cancer risk: Plant fiber, soya, fish, omega-3 fatty acids, carotenoids, vitamins B<sub>2</sub>, B<sub>6</sub>, folate, B<sub>12</sub>, C, D, E,

calcium, zinc, selenium, and non-nutrient plant constituents.

- Possible or insufficient evidence for increasing cancer risk: Animal fats, heterocyclic amines (chemicals found in well-cooked meat), polycyclic aromatic hydrocarbons, and nitrosamines.

Evidence for CAM dietary therapies for cancer is considerably lower than that for preventive dietary modifications. The NCI's summary of the Gonzalez regimen states that "Existing clinical data concerning the effectiveness of the Gonzalez regimen as a treatment for cancer are limited and inconclusive," primarily because of the small size of the subject groups and the lack of a control group. In August 2009 a group of researchers in New York and Boston reported that patients following the Gonzalez regimen survived only a third as long as those receiving conventional **chemotherapy** and had a lower quality of life. There are no data as of 2009 regarding the effectiveness of the Gonzalez regimen in treating other types of cancer. There is one clinical trial of the Gonzalez regimen underway as of early 2010.

The macrobiotic diet is generally considered ineffective as a treatment for cancer. The ACS states, "After studying the literature and other available information, the American Cancer Society has found no evidence that macrobiotic diet is useful as a cure for cancer in humans." This position was reinforced by the fact that the wife and daughter of Michio Kushi both died of cancer (as did two physicians who claimed to have cured themselves of cancer by following the macrobiotic diet) and that Kushi himself had a cancerous tumor removed from his intestines in 2004. There are no clinical trials of the macrobiotic diet as cancer therapy as of 2009.

### Caregiver concerns

Caregiver concerns include making sure that a cancer patient receiving nutritional therapy at home is following his or her dietary guidelines, and consulting the patient's doctor if the patient expresses interest in CAM dietary therapies.

### Resources

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## ORGANIZATIONS

- American Cancer Society, 250 Williams Street NW, Atlanta, GA, 30303 800-ACS-2345 (227-2345), [www.cancer.org](http://www.cancer.org).
- American Dietetic Association, 120 South Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995 800-877-1600, <http://www.eatright.org/cps/rde/xchg/ada/hs.xsl/index.html>.
- Dr. Gonzalez.com: Individualized Nutritional Protocols, 36A East 36th Street, Suite 204, New York, NY, 10016 212-213-3337 212-213-3414, <http://www.dr-gonzalez.com/index.htm>.
- Kushi Institute, 198 Leland Road, Becket, MA, 01223 413-623-5741 800-975-8744 413-623-8827, <http://www.kushiinstitute.org>.
- National Cancer Institute, 6116 Executive Blvd., Room 3036A, Bethesda, MD, 20892-8322 800-422-6237, [cancer.govstaff@mail.nih.gov](mailto:cancer.govstaff@mail.nih.gov), [www.cancer.gov](http://www.cancer.gov).
- National Center for Complementary and Alternative Medicine (NCCAM), 9000 Rockville Pike, Bethesda, MD, 20892, [info@nccam.nih.gov](mailto:info@nccam.nih.gov), <http://nccam.nih.gov>.
- World Health Organization (WHO), Avenue Appia 20, 1211 Geneva 27, Switzerland + 41 22 791 21 11 + 41 22 791 31 11, [info@who.int](mailto:info@who.int), <http://www.who.int/en>.

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## Anticancer drugs

### Definition

Anticancer drugs, also called antineoplastic drugs, are used to treat malignancies, or cancerous growths. Drug therapy may be used alone, or in combination with other treatments such as surgery or **radiation therapy**.

**Anticancer drugs\***

Generic (brand name)	Clinical uses	Possible side effects**
Altretamine (Hexalen)	Treatment of advanced ovarian cancer	Bone marrow depression, nausea and vomiting
Bevacizumab (Avastin)	Colon or rectal cancer	Bleeding gums, dizziness, mouth sores, nosebleeds
Bleomycin (Blenoxane)	Hodgkin's lymphoma, squamous cell carcinoma, testicular cancer	Hair loss, hyperpigmentation of skin, pulmonary toxicity, stomatitis
Capecitabine (Xeloda)	Metastatic breast or colorectal cancer	Dehydration, dry skin, insomnia, nausea and vomiting, weakness
Carboplatin (Paraplatin)	Palliation of ovarian cancer	Bone marrow depression, nausea and vomiting
Cisplatin (Platinol)	Treatment of bladder, head and neck, ovarian, testicular, and uterine cancers	Renal toxicity and ototoxicity
Cyclophosphamide (Cytoxan)	Breast and ovarian cancer, leukemias, lymphomas, multiple myeloma, neuroblastoma, retinoblastoma	Bladder inflammation, bone marrow depression, hair loss, nausea and vomiting
Cytarabine (Cytosar-U)	Leukemias	Bone marrow depression, diarrhea, nausea and vomiting, stomatitis
Dacarbazine (DTIC-Dome)	Hodgkin's lymphoma, malignant melanoma	Bone marrow depression, nausea and vomiting
Docetaxel (Taxotere)	Certain types of breast, head and neck, lung, prostate, and stomach cancers	Mouth sores, muscle or joint pain, nausea and vomiting, sensitivity at injection site
Doxorubicin HCL (Adriamycin)	Many cancers, including breast, ovarian, and thyroid cancer; leukemias; lymphomas; and Wilms' tumor	Bone marrow depression, nausea and vomiting, swelling or pain on palms or soles of feet, thinning hair, trouble swallowing
Etoposide (VePesid)	Acute leukemias, lymphomas, testicular cancer	Bone marrow depression, hair loss, nausea and vomiting
Gemcitabine (Gemzar)	Pancreatic cancer	Diarrhea, loss of appetite, nausea and vomiting, thinning hair
Imatinib mesylate (Gleevec)	Leukemias	Anxiety or depression, joint pain, night sweats, stomach upset
Lapatinib (Tykerb)	Advanced breast cancer	Decreased appetite, difficulty sleeping, nausea and vomiting, pain

continued

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**Anticancer drugs\* [CONTINUED]**

Generic (brand name)	Clinical uses	Possible side effects**
Oxaliplatin (Eloxatin)	Colorectal cancer	Hair loss, increased sensitivity to cold, numbness or tingling in extremities and mouth and throat
Paclitaxel (Taxol)	Advanced ovarian cancer	Bone marrow depression, hair loss, hypotension, muscle and joint pain, nausea and vomiting
Procarbazine (Matulane)	Hodgkin's lymphoma	Bone marrow depression, nausea and vomiting
Rituximab (Rituxan)	Non-Hodgkin's lymphoma	Back pain, flushing, heartburn, weight gain
Sipuleucel-T (Provenge)	Metastatic prostate cancer	Chills, fatigue, fever, headache, nausea, pain
Thalidomide (Thalomid)	Multiple myeloma	Birth defects (in pregnant women), blood clots, confusion, depression, joint pain, swelling of extremities
Topotecan (Hycamtin)	Small cell lung cancer	Bone marrow depression, diarrhea, hair loss, nausea and vomiting
Trastuzumab (Herceptin)	HER2-positive breast cancer	Acne, depression, hot flashes, joint pain, upset stomach
Tretinoin (ATRA)	Acute promyelocytic leukemia	Birth defects (in pregnant women), bone pain, hallucinations, increase in white blood cells, shivers
Vinblastine (Velban)	Breast cancer, Hodgkin's lymphoma, metastatic testicular cancer	Bone marrow depression, neurotoxicity
Vincristine (Oncovin)	Acute leukemia, Hodgkin's lymphoma	Constipation, neurotoxicity, possible tissue necrosis
Vinorelbine (Navelbine)	Non-small cell lung cancer	Bone marrow depression, fatigue, nausea and vomiting, thinning hair

\*Includes antineoplastic drugs as well as newer drug classes, such as antimetabolites, monoclonal antibodies [immunotherapy drugs], topoisomerase inhibitors, and alkylating agents.

\*\*While this chart lists some common side effects or risks, all of the drugs listed are also associated with additional and more severe side effects, so be sure to contact your doctor right away if these or any other symptoms occur.

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**Purpose**

Cancers are malignant growths. **Cancer** is commonly defined as the uncontrolled growth of cells with loss of differentiation and commonly with metastasis.

Anticancer drugs are used to kill cancer cells or limit their growth in order to prolong life or relieve symptoms so that the quality of life is improved. In contrast, benign growths remain encapsulated and grow within a well-defined area. Although benign tumors may be fatal if untreated, due to pressure on essential organs, as in the case of a benign **brain tumor**, surgery or radiation are the preferred methods of treating growths which have a well defined location. Drug therapy is used when the tumor has spread, or may spread, to other areas of the body.

Several classes of drugs may be used in cancer treatment, depending on the nature of the cancer involved. Often two or more drugs are used together to most effectively control the cancer. Classes of cancer drugs include:

- alkylating agents. These agents cause direct damage to DNA (deoxyribonucleic acid, the genetic material in the nucleus of the cell) and prevent cells from reproducing. Alkylating agents include the following: nitrogen mustards (for example, mechlorethamine, chlorambucil, cyclophosphamide, ifosfamide, melphalan); nitrosoureas (streptozocin, carmustine, lomustine); alkyl sulfonates (busulfan); triazines (dacarbazine, temozolamide; and ethylenimines (thiotepa, altretamine). The most serious side effect of these drugs is that they can cause damage to the bone marrow that results in leukemia often 5–10 years after treatment.
- platinum drugs (for example, cisplatin, carboplatin, and oxaplatin). These drugs also damage DNA but have less chance of causing leukemia than alkylating agents.
- antimetabolites (5-fluorouracil, capecitabine, 6-mercaptopurine, methotrexate, gemcitabine, cytarabine, fludarabine, pemetrexed). These drugs damage DNA and RNA (ribonucleic acid, used in protein synthesis) by substituting incorrect compounds into the DNA and RNA when they reproduce. They are used most often to treat leukemias, breast cancer, ovarian cancer and intestinal cancer.
- antitumor antibiotics. Anthracyclines (daunorubicin, doxorubicin, epirubicin, idarubicin) are antibiotics that interfere with the synthesis of enzymes needed to duplicate DNA. These drugs are used to treat many types of cancer but have the potential to damage the heart if given in high doses. Other antitumor antibiotics include actinomycin-D, bleomycin, mitomycin-C and mitoxantrone.
- topoisomerase inhibitors (topotecan, irinotecan). These drugs also interfere with enzymes that control the reproduction of DNA.
- mitotic inhibitors (paclitaxel, docetaxel, ixabepilone, vinblastine, vincristine, vinorelbine, estramustine). Mitosis is the process of cell division. These drugs prevent cells from dividing.
- corticosteroids (prednisone, methylprednisolone, dexamethasone). These drugs are related to sex hormones. They have many uses outside of cancer treatment, but when used in patients with cancer they slow cell growth and prevent nausea and vomiting caused by other anticancer drugs.
- hormone therapy drugs include several categories including: anti-estrogen drugs (ulvestrant, tamoxifen, toremifene); aromatase inhibitors (anastrozole, exemestane, letrozole); progestins (megestrol acetate); estrogens; anti-androgens (calutamide, flutamide, nilutamide); LHRH agonists (leuprolide, goserelin). These drugs work against hormones that stimulate the growth of cancer cells. For example, breast cancers are commonly stimulated by estrogens, and may be treated with drugs that inactivate the female sex hormones. Similarly, prostate cancer may be treated with drugs that inactivate androgens, the male sex hormone.
- immunotherapy drugs. These drugs enhance or stimulate the body's immune system. They include monoclonal antibody therapy (for example rituximab, alemtuzumab), where laboratory-made antibodies are injected into the body, immunostimulating drugs (interleukin -2, interferon-alpha) that non-specifically stimulate the body's immune response, and immunomodulating drugs (thalidomide, lenalidomide) that alter the immune response

The majority of antineoplastic drugs act by interfering with cell growth. Since cancerous cells grow more rapidly than most other cells, the drugs are most effective in stopping cancer cell growth. Nevertheless, antineoplastic drugs affect not only the cancerous cells, but others cells that reproduce quickly, including cells in the hair follicles, ovaries, testes, and the blood-forming organs.

Newer methods of antineoplastic drug therapy have taken different approaches, including angiogenesis—the inhibition of formation of blood vessels feeding the tumor and contributing to tumor growth. The idea behind this approach is that if a tumor is deprived of blood, an the oxygen and food carried in blood, it will be unable to grow larger.

Many new cancer drugs are being explored on an experimental basis. Individuals who are interested in participating in a clinical trial of a new cancer drug can find a list of current trials at <http://www.clinicaltrials.gov>.

## KEY TERMS

**Cataract**—Clouding of the lens of the eye, leading to poor vision or blindness.

**Enzyme**—a protein that changes the rate of a chemical reaction within the body without themselves being used up in the reaction

**Impotent**—Unable to achieve or maintain an erection of the penis.

**Leukemia**—A cancer of the blood.

**Metastasis**—The spread of cancer from its initial site to another part of the body.

antinausea medications to reduce **nausea and vomiting**, maintaining fluid levels to reduce drug toxicity, particularly to the kidneys, or application of a scalp tourniquet to reduce blood flow to the scalp and minimize hair loss due to drug therapy.

Patients receiving chemotherapy also are at risk of infections due to reduced white blood counts. While prophylactic **antibiotics** may be useful, the health care professional should also be sure to use standard precautions, including gowns and gloves when appropriate. Patients should be alerted to avoid risks of viral contamination, and live virus immunizations are contraindicated until the patient has fully recovered from the effects of chemotherapy. Similarly, the patient should avoid contact with other people who have recently had live virus immunizations.

Other precautions that should be emphasized are the risks to pregnant or nursing women. Because antineoplastic drugs are commonly harmful to the fetus, women of childbearing potential should be cautioned to use two effective methods of birth control while receiving cancer chemotherapy. This also applies if the woman's male partner is receiving chemotherapy. **Breastfeeding** should be avoided while the mother is being treated.

Before prescribing or administering anticancer drugs, health care providers should inquire whether the patient has any of the following conditions:

- chickenpox or recent exposure to someone with chickenpox
- shingles (Herpes zoster)
- mouth sores
- current or past seizures
- head injury
- nerve or muscle disease
- hearing problems
- infection of any kind
- gout
- colitis
- intestine blockage
- stomach ulcer
- kidney stones
- kidney disease
- liver disease
- current or past alcohol abuse
- immune system disease
- cataracts or other eye problems
- high cholesterol

gov. There is no charge to the patient to participate in a clinical trial.

### Precautions

Because antineoplastic agents target all cells and not just cancer cells, they have a number of common adverse side effects. Hair loss is common due to the effects of these drugs on hair follicles, and anemia, immune system impairment, and blood-clotting problems are caused by destruction of the blood-forming organs, leading to a reduction in the number of red cells, white cells, and platelets. Because of the frequency and severity of these side effects, it is common to administer anticancer drugs in cycles, allowing time for recovery from the drug effects before administering the next dose. Doses are often calculated, not on the basis of weight, but rather based on blood counts, in order to avoid dangerous levels of anemia (red cell depletion), **neutropenia** (white cell deficiency), or **thrombocytopenia** (platelet deficiency.)

The health professional has many responsibilities in dealing with patients undergoing **chemotherapy**. The patient must be well informed of the risks and benefits of chemotherapy, and must be emotionally prepared for the side effects. These may be permanent, and younger patients should be aware of the high risk of sterility after chemotherapy.

The patient must also know which side effects should be reported to the practitioner, since many adverse effects do not appear until several days after a dose of chemotherapy. When chemotherapy is self-administered, the patient must be familiar with proper use of the drugs, including dose scheduling and avoidance of drug-drug and food-drug interactions.

Appropriate steps should be taken to minimize side effects. These may include administration of

The anticancer drug methotrexate has additional precautions. Patients should be given advice on the effects of sun exposure and the use of alcohol and **pain** relievers.

## Side effects

### *Tamoxifen*

The anticancer drug tamoxifen (Nolvadex) increases the risk of cancer of the uterus in some women. It also causes **cataracts** and other eye problems. Women taking this drug may have hot flashes, menstrual changes, genital **itching**, vaginal discharge, and weight gain. Men who take tamoxifen may lose interest in sex or become impotent. Health care providers should keep in close contact with patients to assess the individual risks associated with taking this powerful drug.

### *Other anticancer drugs*

These side effects are not common, but could be a sign of a serious problem. Health care providers should immediately be consulted if any of the following occur:

- black, tarry, or bloody stools
- blood in the urine
- diarrhea
- fever or chills
- cough or hoarseness
- wheezing or shortness of breath
- sores in the mouth or on the lips
- unusual bleeding or bruising
- swelling of the face
- red “pinpoint” spots on the skin
- redness, pain, or swelling at the point where an injectable anticancer drug is given
- pain in the side or lower back
- problems urinating or painful urination
- dizziness or faintness
- fast or irregular heartbeat

Other side effects do not need immediate care, but should have medical attention. They are:

- joint pain
- skin rash
- hearing problems or ringing in the ears
- numbness or tingling in the fingers or toes
- trouble walking or balance problems
- swelling of the feet or lower legs
- unusual tiredness or weakness

- loss of taste
- seizures
- dizziness
- confusion
- agitation
- headache
- dark urine
- yellow eyes or skin
- flushing of the face

In addition, there are other possible side effects that do not need medical attention unless they persist or interfere with normal activities. These include changes in menstrual period, itchy skin, **nausea** and **vomiting**, and loss of appetite.

Other rare side effects may occur. Anyone who has unusual symptoms after taking anticancer drugs should contact the physician who prescribed the medication.

## Interactions

Anticancer drugs may interact with a number of other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. The health care provider should be aware of all other prescription or non-prescription (over-the-counter) medicines and herbal remedies a patient is taking. The primary care provider should also be told if the patient has been treated with radiation or has taken other anticancer drugs.

## Resources

### BOOKS

Lyss, Alan P. *Chemotherapy and Radiation For Dummies*. Hoboken, NJ: Wiley, 2005.

Nathan, David G. *The Cancer Treatment Revolution: How Smart Drugs and Other New Therapies are Renewing Our Hope and Changing the Face of Medicine*. Hoboken, NJ: John Wiley & Sons, 2007.

Thurston, David E. *Chemistry and Pharmacology of Anticancer Drugs*. Boca Raton, FL: CRC Press/Taylor & Francis, 2007.

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“Anticancer Drugs.” *University of Maryland Medical Center*. 2008 [cited June 12, 2008]. <http://www.umm.edu/altmed/articles/anticancer-drugs-002712.htm>.

“Cancer Center.” *Drugs.com*. May 19, 2008 [cited June 12, 2008]. <http://www.drugs.com/cancer.html>.

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"Chemotherapy: Drug Treatment Uses Chemicals to Kill Cancer Cells." *MayoClinic.com*. February 8, 2008 [cited June 12, 2008]. <http://www.mayoclinic.com/health/chemotherapy/CA00029>.

## ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, <http://www.cancer.org>.

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), [cancergovstaff@mail.nih.gov](mailto:cancergovstaff@mail.nih.gov), <http://www.cancer.gov/>.

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Anticholinergic drugs see **Antiparkinson drugs**

Anticlotting drugs see **Anticoagulant and antiplatelet drugs**

## Anticoagulant and antiplatelet drugs

### Definition

Anticoagulants, also called anticlotting drugs or blood thinners, are drugs used to prevent blood clot formation or to prevent a clot that has formed from enlarging. They inhibit clot formation by blocking the action of clotting factors or platelets. Anticoagulant drugs fall into three categories: inhibitors of clotting factor synthesis, inhibitors of thrombin, and antiplatelet drugs.

### Purpose

Anticoagulant drugs reduce the ability of the blood to form clots. Although blood clotting is essential to prevent serious bleeding in the case of skin cuts, clots inside the blood vessels block the flow of blood to major organs and cause heart attacks and strokes. Although these drugs are sometimes called blood thinners, they do not actually thin the blood. Furthermore, this type of medication will not dissolve clots that already have formed, although the drug stops an existing clot from worsening. However, another type of drug, used in **thrombolytic therapy**, will dissolve existing clots.

Anticoagulant drugs are used for a number of conditions. For example, they may be given to prevent **blood clots** from forming after the replacement of a heart valve or to reduce the risk of a **stroke** or another **heart attack** after a first heart attack. They are also used to reduce the chance of blood clots forming during open-heart surgery or bypass surgery. Low doses of these drugs may be given to prevent blood clots in patients who have heart **arrhythmias**, as well as those who must stay in bed for a long time after certain types of surgery.

Because anticoagulants affect the blood's ability to clot, they can increase the risk of severe bleeding and heavy blood loss. It is thus essential to take these drugs exactly as directed and to see a physician regularly as long as they are prescribed.

### Description

Anticoagulant drugs are available only with a physician's prescription. They come in tablet and injectable forms. They fall into three groups:

- Inhibitors of clotting factor synthesis. These anticoagulants inhibit the production of certain clotting factors in the liver. One example is warfarin (Coumadin).
- Inhibitors of thrombin. Thrombin inhibitors interfere with blood clotting by blocking the activity of thrombin, a protein needed for blood clotting. They include heparin, enoxaparin (Lovenox), dalteparin (Fragmin), ardeparin (Normiflo), and lepirudin (Refludan).
- Antiplatelet drugs. Antiplatelet drugs interact with platelets, which is a type of blood cell, to block platelets from aggregating into harmful clots. They include: aspirin, ticlopidine (Ticlid), clopidogrel (Plavix), tirofiban (Aggrastat), eptifibatide (Integri-lin) dipyridamole (Persantine), and abciximab (ReoPro).

### Recommended dosage

The recommended dosage depends on the type of anticoagulant drug and the medical condition for which it is prescribed. The prescribing physician or the pharmacist who filled the prescription can provide information concerning the correct dosage. Usually, the physician will adjust the dose after checking the patient's clotting time.

Anticoagulant and antiplatelet drugs must be taken exactly as directed by the physician. Larger or more frequent doses should not be taken, and the drug should not be taken for longer than prescribed. Taking

## KEY TERMS

**Anticoagulant**—Drug used to prevent clot formation or to prevent a clot that has formed from enlarging. Anticoagulant drugs inhibit clot formation by blocking the action of clotting factors or platelets. Anticoagulant drugs fall into three groups: inhibitors of clotting factor synthesis, inhibitors of thrombin and antiplatelet drugs.

**Antiplatelet drug**—Drug that inhibits platelets from aggregating to form a plug. They are used to prevent clotting and alter the natural course of atherosclerosis.

**Arrhythmia**—An abnormal heart rhythm.

**Atherosclerosis**—Condition characterized by deposits of fatty plaque in the arteries.

**Clot**—A soft, semi-solid mass that forms when blood gels.

**Platelet**—A small, disk-shaped body in the blood that has an important role in blood clotting: they form the initial plug at the rupture site of a blood vessel.

**Thrombin**—Thrombin is a protein produced by the body. It is a specific clotting factor that plays an important role in the blood clotting process.

**Thrombin inhibitor**—Thrombin inhibitors are one type of anticoagulant medication, used to help prevent formation of harmful blood clots in the body by blocking the activity of thrombin.

too much of this medication can cause severe bleeding. Anticoagulants should also be taken on schedule. A record of each dose should be kept as it is taken. If a dose is missed, it should be taken as soon as possible followed by the regular dose schedule. However, a patient who forgets to take a missed dose until the next day should not take the missed dose at all and should not double the next dose, as this could lead to bleeding. A record of all missed doses should be kept for the prescribing physician who should be informed at the scheduled visits.

### Precautions

People who take anticoagulants should see a physician regularly while taking these drugs, particularly at the beginning of therapy. The physician will order periodic blood tests to check the blood's clotting ability. The results of these tests will help the physician determine the proper amount of medication to be taken each day.

Time is required for normal clotting ability to return after anticoagulant treatment. During this period, patients must observe the same precautions they observed while taking the drug. The length of time needed for the blood to return to normal depends on the type of anticoagulant drug that was taken. The prescribing physician will advise as to how long the precautions should be observed.

People who are taking anticoagulant drugs should tell all physicians, dentists, pharmacists, and other medical professionals who provide medical treatments or services to them that they are taking such a

medication. They should also carry identification stating that they are using an anticoagulant drug.

Other prescription drugs, over-the-counter medicines, especially **aspirin**, should be not be taken without the prescribing physician being informed. Certain herbal remedies can enhance or diminish the effect of these drugs. Be sure to tell the prescribing physician about any herbal medicines or dietary supplements being taken.

Because of the risk of heavy bleeding, anyone who takes an anticoagulant drug must take care to avoid injuries. Sports and other potentially hazardous activities should be avoided. Any falls, blows to the body or head, or other injuries should be reported to a physician, as internal bleeding may occur without any obvious symptoms. Special care should be taken in shaving and in brushing and flossing the teeth. Soft toothbrushes should be used and the flossing should be very gentle. Electric razors should be used instead of a blade.

Alcohol can change the way anticoagulant drugs affect the body. Anyone who takes this medicine should not have more than one to two drinks at any time and should not drink alcohol every day.

### Special conditions

People with specific medical conditions or who are taking certain other medicines can have problems if they take anticoagulant drugs. Before taking these drugs, the prescribing physician should be informed about any of these conditions:

**ALLERGIES.** Anyone who has had unusual reactions to anticoagulants in the past should let his or

her physician know before taking the drugs again. The physician should also be told about any **allergies** to beef, pork, or other foods; dyes; preservatives; or other substances.

**PREGNANCY.** Anticoagulants may cause many serious problems if taken during **pregnancy**. **Birth defects**, severe bleeding in the fetus, and other problems that affect the physical or mental development of the fetus or newborn are possible. The mother may also experience severe bleeding if she takes anticoagulants during pregnancy, during delivery, or even shortly after delivery. Women should not start taking anticoagulants during pregnancy and should not become pregnant while taking it. Any woman who becomes pregnant or suspects that she has become pregnant while taking an anticoagulant should check with her physician immediately.

**BREASTFEEDING.** Some anticoagulant drugs may pass into breast milk. Blood tests can be done on nursing babies to see whether the drug is causing any problems. If it is, other medication may be prescribed to counteract the effects of the anticoagulant drug.

**OTHER MEDICAL CONDITIONS.** Before using anticoagulant drugs, people should inform their physician about *any* medical problems they have. They should also let the physician who prescribed the medicine know if they are being treated by any other medical physician or dentist. In addition, people who will be taking anticoagulant drugs should let their physician know if they have recently had any of the following:

- fever lasting more than one to two days
- severe or continuing diarrhea
- childbirth
- heavy or unusual menstrual bleeding
- insertion of an intrauterine contraceptive device (IUD)
- falls, injuries, or blows to the body or head
- any type of surgery, including dental surgery
- spinal anesthesia
- radiation treatment

**USE OF CERTAIN FOODS AND MEDICINES.** Many foods and drugs may affect the way the anticoagulant drugs work or may increase the risk of side effects. Leafy green vegetables, in particular, interact with some of these drugs. The prescribing physician should provide a list of foods that interact with anticoagulant drugs. These foods do not necessarily need to be avoided, but should be eaten in reasonably consistent amounts so that their effects can be compensated for in the prescribed dosage.

## Side effects

The most common minor side effects are bloating or gas. These problems usually go away as the body adjusts to the drug and do not require medical treatment.

More serious side effects may occur, especially if excessive anticoagulant is taken. If any of the following side effects occur, a physician should be notified immediately:

- bleeding gums
- sores or white spots in the mouth or throat
- unusual bruises or purplish areas on the skin
- unexplained nosebleeds
- unusually heavy bleeding or oozing from wounds
- unexpected or unusual menstrual bleeding
- blood in the urine
- cloudy or dark urine
- painful or difficult urination or sudden decrease in amount of urine
- black, tarry, or bloody stools
- coughing up blood
- vomiting blood or something that looks like coffee grounds
- constipation
- pain or swelling in the stomach or abdomen
- back pain
- stiff, swollen, or painful joints
- painful, bluish or purplish fingers or toes
- puffy or swollen eyelids, face, feet, or lower legs
- changes in the color of the face
- skin rash, itching, or hives
- yellow eyes or skin
- severe or continuing headache
- sore throat and fever, with or without chills
- breathing problems or wheezing
- tightness in the chest
- dizziness
- unusual tiredness or weakness
- weight gain.

In addition, patients taking anticoagulant drugs should check with their physicians as soon as possible if any of these side effects occur:

- nausea or vomiting
- diarrhea
- stomach pain or cramps.

Other side effects may occur. Anyone who has unusual symptoms while taking anticoagulant drugs should get in touch with his or her physician.

## Interactions

Anticoagulants may interact with many other medications. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be increased. Anyone who takes anticoagulants should inform the prescribing physician about other prescription or nonprescription (over-the-counter medicines) he or she is taking, even aspirin, **laxatives**, **vitamins**, herbals, or **antacids**.

Diet also affects the way anticoagulant drugs work in the body. A normal, balanced diet should be followed every day while taking such medication. No dietary changes should be made without informing first the prescribing physician, who should also be told of any illness or other condition interfering with the ability to eat normally. Diet is a very important consideration because the amount of vitamin K in the body affects how anticoagulant drugs work.

Dicoumarol and warfarin act by reducing the effects of vitamin K. Vitamin K is found in meats, dairy products, leafy, green vegetables, and some multiple vitamins and **nutritional supplements**. For the drugs to work properly, it is best to have the same amount of vitamin K in the body all the time. Foods containing vitamin K in the diet should not be increased or decreased without consulting with the prescribing physician. If the patient takes vitamin supplements, he or she should check the label to see if it contains vitamin K. Because vitamin K is also produced by intestinal bacteria, a severe case of **diarrhea** or the use of laxatives may also alter a person's vitamin K levels.

## Resources

### OTHER

- “Anticoagulation.” *American Heart Association*. 2007 [cited June 12, 2008]. <http://www.americanheart.org/presenter.jhtml?identifier=11079>.
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- Walter, Uwe, Friedhelm Sandbrink, and Reiner Benecke. “Stroke Anticoagulation and Prophylaxis.” May 9, 2007 [cited June 12, 2008]. <http://www.emedicine.com/neuro/TOPIC18.HTM>.

2007 [cited June 12, 2008]. <http://www.emedicine.com/neuro/TOPIC18.HTM>.

## ORGANIZATIONS

- American College of Cardiology, Heart House, 2400 N Street NW, Washington, DC, 20037, (202) 375-6000, ext 5603, (202) 375-7000, (800) 223-4636, ext. 5603, [resource@acc.org](mailto:resource@acc.org), <http://www.acc.org>.
- American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, [Review.personal.info@heart.org](mailto:Review.personal.info@heart.org).
- American Society of Hematology, 2021 L St. NW, Suite 900, Washington, DC, 20036, (202) 776-0544, (202) 776-0545, <http://www.hematology.org>.
- National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, <http://www.nhlbi.nih.gov>.

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## Anticonvulsant drugs

### Definition

Anticonvulsant drugs are medicines used to prevent or treat convulsions (seizures).

### Purpose

Anticonvulsant drugs are used to control seizures in people with **epilepsy**. Epilepsy is not a single disease—it is a set of symptoms that may have different causes in different people. The common thread is an imbalance in the brain's electrical activity. This imbalance causes seizures that may affect part or all of the body and may or may not cause a loss of consciousness. Anticonvulsant drugs act on the brain to reduce the frequency and severity of seizures.

Some cases of epilepsy are brought on by head injuries, brain tumors or infections, or metabolic problems such as low blood sugar. But in some people with epilepsy, the cause is not clear.

Anticonvulsant drugs are an important part of the treatment program for epilepsy. Different kinds of drugs may be prescribed for different types of seizures. In addition to taking medicine, patients with epilepsy should get enough rest, avoid **stress**, and practice good health habits.

Some physicians believe that giving the drugs to children with epilepsy may prevent the condition from getting worse in later life. However, others say the

## KEY TERMS

**Chronic**—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

**Epilepsy**—A brain disorder with symptoms that include seizures.

**Glaucoma**—A condition in which pressure in the eye is abnormally high. If not treated, glaucoma may lead to blindness.

**Porphyria**—A disorder in which porphyrins build up in the blood and urine.

**Porphyrin**—A type of pigment found in living things, such as chlorophyll which makes

plants green or hemoglobin which makes blood red.

**Seizure**—A sudden attack, spasm, or convulsion.

**Systemic lupus erythematosus (SLE)**—A chronic disease with many symptoms, including weakness, fatigue, joint pain, sores on the skin, and problems with the kidneys, spleen, and other organs.

**Withdrawal symptoms**—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug to which he or she has become dependent.

effects are the same, whether treatment is started early or later in life. Determining when treatment begins depends on the physician and his assessment of the patient's symptoms.

Physicians also prescribe certain anticonvulsant drugs for other conditions, including **bipolar disorder** and migraine headaches.

### Description

Anticonvulsant drugs may be divided into several classes. The hydantoins include phenytoin (Dilantin) and mephenytoin (Mesantoin.) The succimides include ethosuximide (Zarontin) and methsucimide (Celon-tin.) The **benzodiazepines**, which are better known for their use as tranquilizers and sedatives, include clonazepam (Klonopin), clorazepate (Tranxene) and diazepam (Valium.) There are also a large number of other drugs which are not related to larger groups. These include carbamazepine (Tegretol), valproic acid (Depakote, Depakene) gabapentin (Neurontin), topiramate (Topamax), felbamate (Felbatol) and several others. Phenobarbital has been used as an anticonvulsant, and is still useful for some patients. The drugs are available only with a physician's prescription and come in tablet, capsule, liquid, and "sprinkle" forms.

### Recommended dosage

The recommended dosage depends on the type of anticonvulsant, its strength, and the type of seizures for which it is being taken. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Do not stop taking this medicine suddenly after taking it for several weeks or more. Gradually

tapering the dose may reduce the chance of withdrawal effects.

Do not change brands or dosage forms of this medicine without checking with a pharmacist or physician. If a prescription refill does not look like the original medicine, check with the pharmacist who filled the prescription.

### Precautions

Patients on anticonvulsant drugs should see a physician regularly while on therapy, especially during the first few months. The physician will check to make sure the medicine is working as it should and will note unwanted side effects. The physician may also need to adjust the dosage during this period.

Valproic acid can cause serious liver damage, especially in the first 6 months of treatment. Children are particularly at risk, but anyone taking this medicine should see their physician regularly for tests of liver function and should be alert to symptoms of liver damage, such as yellow skin and eyes, facial swelling, loss of appetite, general feeling of illness, loss of appetite, and **vomiting**. If liver problems are suspected, call a physician immediately.

Felbatol has caused serious liver damage and **aplastic anemia**, a condition in which the bone marrow stops producing blood cells. Patients taking this drug should have regular blood counts, and should stop taking the drug if there are too few red blood cells.

While taking anticonvulsant drugs, do not start or stop taking any other medicines without checking with a physician. The other medicines may affect the way the anticonvulsant medicine works.

Because anticonvulsant drugs work on the central nervous system, they may add to the effects of alcohol and other drugs that slow down the central nervous system, such as **antihistamines**, cold medicine, allergy medicine, sleep aids, other medicine for seizures, tranquilizers, some **pain** relievers, and **muscle relaxants**. Anyone taking anticonvulsant drugs should check with his or her physician before drinking alcohol or taking any medicines that slow the central nervous system.

Anticonvulsant drugs may interact with medicines used during surgery, dental procedures, or emergency treatment. These interactions could increase the chance of side effects. Anyone who is taking anticonvulsant drugs should be sure to tell the health care professional in charge before having any surgical or dental procedures or receiving emergency treatment.

Some people feel drowsy, dizzy, lightheaded, or less alert when using these drugs, especially when they first begin taking them or when their dosage is increased. Anyone who takes anticonvulsant drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

Anticonvulsant drugs may affect the results of certain medical tests. Before having medical tests, people who take anticonvulsant drugs should make sure that the medical professional in charge knows what they are taking.

Children may be more likely to have certain side effects from anticonvulsant drugs, such as behavior changes; tender, bleeding, or swollen gums; enlarged facial features; and excessive hair growth. Problems with the gums may be prevented by regularly brushing and flossing, massaging the gums, and having the teeth cleaned every 3 months whether the patient is a child or an adult.

Children who take high doses of this medicine for a long time may have problems in school.

Older people may be more sensitive to the effects of anticonvulsant drugs. This may increase the chance of side effects and overdoses.

### *Special conditions*

People with certain medical conditions or who are taking certain other medicines can have problems if they take anticonvulsant drugs. Before taking these drugs, be sure to let the physician know about any of these conditions:

**ALLERGIES.** Anyone who has had unusual reactions to anticonvulsant drugs or to **tricyclic**

**antidepressants** such as imipramine (Tofranil) or desipramine (Norpramin) in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

**PREGNANCY.** Some anticonvulsant drugs taken during **pregnancy** may cause bleeding problems in the mother during delivery and in the baby after delivery. This problem can be avoided by giving vitamin K to the mother during delivery and to the baby after birth.

Pregnancy may affect the way the body absorbs anticonvulsant drugs. Women who are prone to seizures may have more seizures during pregnancy, even though they are taking their medicine regularly. If this happens, they should check with their physicians about whether the dose needs to be increased.

**BREASTFEEDING.** Some anticonvulsant drugs pass into breast milk and may cause unwanted effects in babies whose mothers take the medicine. Women who are **breastfeeding** should check with their physicians about the benefits and risks of using anticonvulsant drugs.

**DIABETES.** Anticonvulsant drugs may affect blood sugar levels. Patients with diabetes who notice changes in the results of their urine or blood tests should check with their physicians.

**OTHER MEDICAL CONDITIONS.** Before using anticonvulsant drugs, people with any of these medical problems should make sure their physicians are aware of their conditions:

- liver disease
- kidney disease
- thyroid disease
- heart or blood vessel disease
- blood disease
- brain disease
- problems with urination
- current or past alcohol abuse
- behavior problems
- diabetes mellitus
- glaucoma
- porphyria
- systemic lupus erythematosus
- fever higher than 101 °F (38.3 °C) for more than 24 hours

**USE OF CERTAIN MEDICINES.** Taking anticonvulsant drugs with certain other drugs may affect the

way the drugs work or may increase the chance of side effects.

### Side effects

The most common side effects are **constipation**, mild **nausea** or **vomiting**, and mild **dizziness**, drowsiness, or lightheadedness. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side effects, such as **diarrhea**, sleep problems, aching joints or muscles, increased sensitivity to sunlight, increased sweating, hair loss, enlargement of facial features, excessive hair growth, muscle twitching, and breast enlargement in males also may occur and do not need medical attention unless they persist or are troublesome.

Other side effects may need medical attention. If any of these side effects occur, check with a physician as soon as possible:

- clumsiness or unsteadiness
- slurred speech or stuttering
- trembling
- unusual excitement, irritability, or nervousness
- uncontrolled eye movements
- blurred or double vision
- mood or mental changes
- confusion
- increase in seizures
- bleeding, tender, or swollen gums
- skin rash or itching
- enlarged glands in neck or armpits
- muscle weakness or pain
- fever

Other side effects are possible. Anyone who has unusual symptoms after taking anticonvulsant drugs should get in touch with his or her physician.

### Interactions

Some anticonvulsant drugs should not be taken within two to three hours of taking **antacids** or medicine for diarrhea. These medicines may make the anticonvulsant drugs less effective. Ask the pharmacist or physician for more information.

Birth control pills may not work properly when anticonvulsant drugs are being taken. To prevent pregnancy, ask the physician or pharmacist if additional methods of birth control should be used while taking anticonvulsant drugs.

Anticonvulsant drugs may interact with many other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes anticonvulsant drugs should let the physician know all other medicines he or she is taking. Among the drugs that may interact with certain anticonvulsant drugs are:

- airway opening drugs (bronchodilators) such as aminophylline, theophylline (Theo-Dur and other brands), and oxtriphylline (Choledyl and other brands)
- medicines that contain calcium, such as antacids and calcium supplements
- blood thinning drugs
- caffeine
- antibiotics such as clarithromycin (Biaxin), erythromycins, and sulfonamides (sulfa drugs)
- disulfiram (Antabuse), used to treat alcohol abuse
- fluoxetine (Prozac)
- monoamine oxidase inhibitors (MAO inhibitors) such as phenelzine (Nardil) or tranylcypromine (Parnate), used to treat conditions including depression and Parkinson's disease
- tricyclic antidepressants such as imipramine (Tofranil) or desipramine (Norpramin)
- corticosteroids
- acetaminophen (Tylenol)
- aspirin
- female hormones (estrogens)
- male hormones (androgens)
- cimetidine (Tagamet)
- central nervous system (CNS) depressants such as medicine for allergies, colds, hay fever, and asthma; sedatives; tranquilizers; prescription pain medicine; muscle relaxants; medicine for seizures; sleep aids; barbiturates; and anesthetics
- alcohol
- other anticonvulsant drugs

The list above does not include every drug that may interact with anticonvulsant drugs. Be sure to check with a physician or pharmacist before combining anticonvulsant drugs with any other prescription or nonprescription (over-the-counter) medicine.

### ORGANIZATIONS

American Epilepsy Society (AES), 342 North Main Street, West Hartford, CT, 06117-2507, (860) 586-7505, (860) 586-7550, <http://www.aesnet.org/>.

Epilepsy Foundation of America, 8301 Professional Place, Landover, MD, 20785-7223, (301) 577-2684, (800) 332-1000, info@efa.org, <http://www.epilepsy.org>.  
 National Institute of Neurological Disorders and Stroke (NINDS), NIH Neurological Institute, P. O. Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, <http://www.ninds.nih.gov/>.

Nancy Ross-Flanigan

## Antidepressant drugs

### Definition

Antidepressant drugs are medicines that reduce symptoms such as extreme sadness, hopelessness, and lack of energy that characterize **depressive disorders**.

### Purpose

Depressive disorders may either be unipolar (depression alone) or bipolar (depression alternating with periods of extreme excitement or **mania**). The formal diagnosis requires a cluster of symptoms, lasting at least two weeks. These symptoms include, but are not limited to, mood changes, **insomnia** or hypersomnia (excessive sleeping), and diminished interest in daily activities formerly found enjoyable. The symptoms are not caused by any medical condition, drug side effect, or adverse life event. The condition is severe enough to cause clinically significant distress or impairment in social, occupational, or other important areas of functioning.

Secondary depression, or depression caused by unfavorable life events such as the **death** of a loved one is normally self limiting, and may best be treated with cognitive/behavioral therapy rather than drugs.

### Description

Antidepressant agents act by increasing the levels of excitatory neurotransmitters, or nerve cell chemicals that act as messengers in the brain's nervous system. The neurotransmitters most commonly affected by antidepressant drugs are serotonin, dopamine, and norepinephrine. Antidepressant drugs may be prescribed as a first-line treatment for depression, or in conjunction with other methods of controlling depression, such as behavioral therapy and **exercise**.

The main types of antidepressant drugs in use today are listed below.

- tricyclic antidepressants, such as amitriptyline (Elavil), desipramine (Norpramin), doxepin (Sinequan),

imipramine (Tofranil), nortriptyline (Pamelor), protriptyline (Vivactil), and trimipramine (Surmontil)

- selective serotonin reuptake inhibitors (SSRIs), such as citalopram hydrobromide (Celexa, Emocal, Sepram, Seropram), escitalopram oxalate (Lexapro, Cipralex, Esertia), fluvoxamine (Luvox, Faverin, Demyrox), paroxetine hydrochloride (Paxil, Seroxat, Aropax, Deroxat, Rextin, Xetanor, Paroxat), fluoxetine (Prozac, Fontex, Seromex, Seronil, Fluctin, Fluox), and sertraline (Zoloft, Lustral, Serlan).
- monoamine oxidase inhibitors (MAO inhibitors), such as phenelzine (Nardil), and tranylcypromine (Parnate)
- tetracyclic compounds and atypical antidepressants that do not fall into any of the above categories

**Selective serotonin reuptake inhibitors** maintain levels of the excitatory neurohormone serotonin in the brain. They do not alter levels of norepinephrine. These have become the drugs of choice for a variety of psychiatric disorders, primarily because of their low incidence of severe side effects as compared with other drugs in this therapeutic class. SSRIs show similar actions and side effect profiles, but may vary in individual response and duration of action.

Tricyclic compounds, identified by their chemical structure containing three carbon rings, are an older class of antidepressants. Although generally effective, they have a high incidence certain side effects, notably **dry mouth** and dry eyes, which can cause discomfort. They also cause cardiac **arrhythmias**. Because tricyclics act on both serotonin and norepinephrine, they may have some value in treatment of patients who fail to respond to SSRIs. Drugs in this class often are available at low prices, which may be significant when cost is a major factor in treatment. They also have been found useful in control of some neurologic **pain** syndromes.

**Tricyclic antidepressants** are similar, but may vary in severity of side effects, most notably the degree of **sedation** and the extent of the anticholinergic effects.

Tetracyclic compounds and atypical antidepressants are chemically distinct from both the major groups and each other. Although maprotilene (no brand name, marketed in generic form only) and mirtazepine (Remeron) are similar in chemical structures, they differ in their balance of activity on serotonin and norepinephrine levels. Bupropion (Wellbutrin, Zyban) is another atypical antidepressant. It inhibits norepinephrine and dopamine uptake.

**Monoamine oxidase inhibitors** (phenelzine [Nardil], tranylcypromine [Parnate]) have largely been supplanted in therapy because of their high risk of severe

## KEY TERMS

**Cognitive behavioral therapy**—A type of psychotherapy in which people learn to recognize and change negative and self-defeating patterns of thinking and behavior.

**Depression**—A mental condition in which people feel extremely sad and lose interest in life. People with depression also may have sleep problems and loss of appetite and may have trouble concentrating and carrying out everyday activities.

**Dopamine**—A neurotransmitter and the precursor of norepinephrine.

**Neurotransmitter**—One of a group of chemicals secreted by a nerve cell (neuron) to carry a chemical

message to another nerve cell, often as a way of transmitting a nerve impulse. Examples of neurotransmitters include acetylcholine, dopamine, serotonin, and norepinephrine.

**Norepinephrine**—A hormone released by nerve cells and the adrenal medulla that causes constriction of blood vessels. Norepinephrine also functions as a neurotransmitter.

**Serotonin**—5-Hydroxytryptamine; a substance that occurs throughout the body with numerous effects including neurotransmission. Inadequate amounts of serotonin are implicated in some forms of depression.

adverse effects, most notably severe **hypertension**. They act by inhibiting the enzyme monoamine oxidase, which is responsible for the metabolism of the stimulatory neurohormones norepinephrine, epinephrine, dopamine, and serotonin. The MAOIs are normally reserved for patients who are resistant to safer drugs. Two drugs, eldepryl (Carbex, used in treatment of **Parkinson's disease**) and the herb, **St. John's wort**, have some action against monoamine oxidase B, and have shown some value as antidepressants. They do not share the same risks as the non-selective MAO inhibitors.

All antidepressant agents, regardless of their structure, have a slow onset of action, typically three to five weeks. Although adverse effects may be seen as early as the first dose, significant therapeutic improvement is always delayed. Similarly, the effects of antidepressants will continue for a period after the drugs have been discontinued.

### Recommended dosage

Dose varies with the specific drug and patient. Specialized references or a physician should be consulted.

### Precautions

Antidepressants have many significant cautions and adverse effects. Although a few are listed here, specific references should be consulted for more complete information.

In October 2004, the FDA issued a warning that treating children and adolescents with SSRIs increased the risk of suicidal thoughts and behaviors.

In a review of 2,200 children treated with SSRIs, the FDA found no completed suicides, but did find a 4% increase in suicidal thinking or behavior, including **suicide attempts**. In 2006, this warning was extended to include all people under age 25. However, in April 2007, a comprehensive review of SSRI treatment in children, adolescents, and adults under age 25 that was published in the *Journal of the American Medical Society* indicated that the benefits of treating these patients with SSRIs generally outweighed the risks. To reduce the risks of suicide, SSRIs should only be prescribed by a psychiatrist, not a family physician, and parents and caregivers should be alert for any of the signs of potential suicidal or self-harm behaviors.

SSRI use during **pregnancy** may not be safe, particularly during the third trimester. Exposure of fetuses to citalopram hydrobromide and other SSRIs during the late third trimester have led to very serious complications, including serotonin syndrome—a condition in which high serotonin levels cause severe problems. Symptoms in a newborn may be the result of a direct toxic effect of the SSRI or withdrawal from the drug. SSRIs pass into breast milk and may negatively affect a baby.

The most common side effects of SSRIs include:

- dry mouth
- dizziness
- sour or acid stomach or gas
- heartburn
- decreased appetite
- stomach upset
- nausea

- diarrhea
- sweating
- headache
- weakness or fatigue
- drowsiness
- insomnia
- nervousness or anxiety
- tremors
- sexual problems

Additional information on precautions and side effects of SSRIs can be found in the entry, **antidepressant drugs, SSRI**.

Tricyclic antidepressants. Amoxepine (not marketed by brand, generic available), although a tricyclic antidepressant rather than a neuroleptic (major tranquilizer), displays some of the more serious effects of the neuroleptics, including tardive dyskinesias (drug induced involuntary movements) and neuroleptic malignant syndrome, a potentially fatal syndrome with symptoms including high **fever**, altered mental status, irregular pulse or blood pressure, and changes in heart rate. These adverse effects have not been reported with other tricyclic antidepressants.

The most common side effects are **dizziness**, drowsiness, dry mouth, unpleasant taste, **headache**, **nausea**, mild tiredness or weakness, increased appetite or craving for sweets, and weight gain. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side effects, such as **diarrhea**, **vomiting**, sleep problems, sweating, and **heartburn** also may occur and do not need medical attention unless they do not go away or they interfere with normal activities.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine as soon as possible:

- blurred vision
- eye pain
- confusion
- hallucinations
- fainting
- loss of balance
- swallowing problems
- difficulty speaking
- mask-like face
- shakiness or trembling
- nervousness or restlessness

- movement problems, such as shuffling walk, stiff arms and legs, or slow movement
- decreased sexual ability
- fast or irregular heartbeat
- constipation
- problems urinating

Problems have been reported in babies whose mothers took tricyclic antidepressants just before delivery. Women who are pregnant or who may become pregnant should check with their physicians about the safety of using tricyclic antidepressants.

Tricyclic antidepressants pass into breast milk and may cause drowsiness in nursing babies whose mothers take the drugs. Women who are **breastfeeding** should check with their physicians before using tricyclic antidepressants.

Because tricyclic antidepressants work on the central nervous system, they may add to the effects of alcohol and other drugs that cause drowsiness, such as **antihistamines**, cold medicine, allergy medicine, sleep aids, medicine for seizures, tranquilizers, some pain relievers, and **muscle relaxants**. Anyone taking tricyclic antidepressants should check with his or her physician before drinking alcohol or taking any drugs that cause drowsiness.

These drugs may also change the results of medical tests. Before having medical tests, anyone taking this medicine should alert the health care professional in charge.

For additional information on precautions and side effects of tricyclic antidepressants, see the entry **antidepressant drugs, tricyclic**.

Monoamine oxidase inhibitors (MAOIs). The greatest risk associated with these drugs is a hypertensive (high blood pressure) crisis that may be fatal and most often occurs when the drugs are taken with interacting foods or drugs. More common adverse reactions may include low blood pressure and slowing of heart beat. Sedation and gastrointestinal disturbances also are common. MAOIs are in pregnancy category C. Safety in breast feeding has not been established.

Tetracyclines and atypicals. Because these drugs are individual, there are no group patterns of adverse reactions. Specific references should be consulted.

## Interactions

Antidepressants have many **drug interactions**, some severe. Although a few are listed here, specific references should be consulted for more complete

information. Before beginning any antidepressant, the patient should review with his or her physician and pharmacist all prescription, nonprescription, and herbal medicines being taken as well as any dietary supplements.

The interaction of SSRIs or tricyclic antidepressants with MAOIs can be fatal. In addition to antidepressant MAOIs, the antibiotic linezolid (Zyvox) is an MAOI. There must be at minimum a two-week interval between stopping one drug and starting the other drug. There should be at least a three-week interval between an MAOI and either paroxetine hydrochloride or sertraline, if either type of antidepressant was taken for more than three months. Because of its long half-life in the body, it is necessary to wait five to six weeks after stopping fluoxetine before starting on an MAOI.

Tricyclic compounds have many interactions, and specialized references should be consulted. Specifically, it is best to avoid other drugs with anticholinergic (drying) effects. Tricyclics should not be taken with the **antibiotics** grepafloxacin and sparfloxacin, since the combination may cause serious heart arrhythmias.

Tricyclic compounds should not be taken with the gastric acid inhibitor cimetidine (Tagamet), since this increases the blood levels of the tricyclic compound. Other acid inhibiting drugs do not share this interaction.

SSRIs interact with a number of other drugs that act on the central nervous system. Care should be used in combining these drugs with major or minor tranquilizers, or with anti-epileptic agents such as phenytoin (Dilantin) or carbamazepine (Tegretol).

## ORGANIZATIONS

American Academy of Child and Adolescent

Psychiatry (AACAP), 3615 Wisconsin Ave. NW, Washington, DC, 20013-3007, (202) 966-7300, (202) 966-2891, [communications@aacap.org](mailto:communications@aacap.org), <http://www.aacap.org/>.

American Psychiatric Association (APA), 1000

Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (888) 357-7924, [apa@psych.org](mailto:apa@psych.org), <http://www.psych.org>.

National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Room 8184, MSC 9shtml663, Bethesda, MD, 20892-9663, <http://www.nimh.nih.gov/site-info/contact-nimh.shtml>.

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# Antidepressant drugs, SSRI

## Definition

SSRI or selective serotonin reuptake inhibitor drugs are prescribed primarily to treat mental depression. In people with depression, these drugs slow the reabsorption of the neurotransmitter serotonin into nerve cells in the brain, making more serotonin available.

## Purpose

Because they are as effective as other types of antidepressants and have less serious side effects, SSRIs have become some of the most commonly prescribed antidepressants. In addition to treating depression, some SSRIs have been approved by the United States Food and Drug Administration (FDA) for the treatment of other psychiatric disorders including:

- obsessive-compulsive disorder (OCD)
- generalized anxiety disorder
- panic disorder
- social anxiety disorder or social phobia
- premenstrual dysphoric disorder (PMDD) or premenstrual syndrome (PMS)
- post-traumatic stress disorder (PTSD)
- bulimia nervosa, an eating disorder.

SSRIs often are prescribed for other off-label uses including:

- various mental disorders including schizophrenia
- mania
- menopause-related symptoms such as hot flashes
- geriatric depression
- loss of mental abilities in the elderly
- nicotine withdrawal
- alcoholism
- premature ejaculation
- irritable bowel syndrome

The advantages of SSRIs over other types of antidepressants include:

- Most SSRIs can be taken in one daily dose as compared with multiple daily pills.
- Because they lessen cravings for carbohydrates, SSRIs are less likely to cause weight gain.
- Since SSRIs do not appear to affect the cardiovascular system, they can be prescribed for people with high blood pressure or heart conditions.

## KEY TERMS

**Citalopram hydrobromide**—An SSRI that is highly specific for serotonin reuptake.

**Dopamine**—A neurotransmitter and the precursor of norepinephrine.

**Escitalopram oxalate**—An SSRI that is very similar to citalopram hydrobromide.

**Fluoxetine**—The first SSRI; marketed as Sarafem for treating PMDD.

**Fluvoxamine**—An SSRI that is used to treat obsessive-compulsive disorder as well as other conditions.

**Monoamine oxidase inhibitor (MAOI)**—An older class of antidepressants.

**Neurotransmitter**—One of a group of chemicals secreted by a nerve cell (neuron) to carry a chemical message to another nerve cell, often as a way of transmitting a nerve impulse. Examples of neurotransmitters include acetylcholine, dopamine, serotonin, and norepinephrine.

**Norepinephrine**—A hormone released by nerve cells and the adrenal medulla that causes constriction of blood vessels. Norepinephrine also functions as a neurotransmitter.

**Obsessive-compulsive disorder (OCD)**—An anxiety disorder characterized by obsessions, such as

recurring thoughts or impulses, and compulsions, such as repetitive behaviors.

**Off-label use**—Drugs in the United States are approved by the Food and Drug Administration (FDA) for specific uses, periods of time, or dosages based on the results of clinical trials. However, it is legal for physicians to administer these drugs for other “off-label” or non-approved uses. It is not legal for pharmaceutical companies to advertise drugs for off-label uses.

**Paroxetine hydrochloride**—An SSRI that is used to treat mental depression, OCD, anxiety, and various other disorders.

**Premenstrual dysphoric disorder (PMDD)**—Premenstrual syndrome (PMS); symptoms including back and abdominal pain, nervousness and irritability, headache, and breast tenderness that occur the week before menstruation.

**Serotonin**—5-Hydroxytryptamine; a substance that occurs throughout the body with numerous effects including neurotransmission. Inadequate amounts of serotonin are implicated in some forms of depression.

**Serotonin syndrome**—A group of symptoms caused by severely elevated serotonin levels in the body.

**Sertraline**—An SSRI that is used to treat mental depression and a variety of other disorders.

- Since SSRIs are not particularly dangerous even in high doses and are unlikely to cause permanent damage if misused.

SSRIs are mood enhancers only in depressed individuals. They have little effect on people who are not clinically depressed. However some experts believe that SSRIs are over-prescribed and should be reserved for those with major disabling depression, especially in children and adolescents.

In October 2004, the FDA issued a warning that treating children and adolescents with SSRIs increased the risk of suicidal thoughts and behaviors. In a review of 2,200 children treated with SSRIs, the FDA found no completed suicides, but did find a 4% increase in suicidal thinking or behavior, including **suicide** attempts. In 2006, this warning was extended to include all people under age 25. However, in April 2007, a comprehensive review of SSRI treatment in children, adolescents, and adults under age 25 that was published in the *Journal of the American Medical Society* indicated that the benefits of treating these patients

with SSRIs generally outweighed the risks. To reduce the risks of suicide, SSRIs should only be prescribed by a psychiatrist, not a family physician, and parents and caregivers should be alert for any of the signs of potential suicidal behavior found below.

### Description

#### *Types of SSRIs*

Many brand-name SSRIs and their generic equivalents are available. Some are preferred over others for treating certain disorder, although individual response varies. Some of the more widely used include:

- citalopram hydrobromide (Celexa, Emocal, Sepram, Seropram) for treating depression
- escitalopram oxalate (Lexapro, Cipralex, Esertia) for treating depression and generalized anxiety disorder
- fluvoxamine (Luvox, Faverin, Dumyrox) for treating OCD
- paroxetine hydrochloride (Paxil, Seroxat, Aropax, Deroxat, Rextin, Xetanor, Paroxat) for treating

depression, generalized anxiety disorder, OCD, panic disorder, social anxiety disorder, PMDD, and PTSD

- fluoxetine (Prozac, Fontex, Seromex, Seronil, Fluctin, Fluox) for treating depression, OCD, and bulimia nervosa; marketed as Sarafem for treating PMDD
- sertraline (Zoloft, Lustral, Serlan) for treating depression, OCD, panic disorder, social anxiety disorder, PMDD, and PTSD

When fluoxetine first became available in 1988, it was hailed as a new wonder drug and quickly became the most popular antidepressant ever prescribed. Many millions of Americans have taken fluoxetine and more than 70% of them claim to have benefited from it.

Citalopram hydrobromide and escitalopram oxalate are very similar, with chemical structures unrelated to other SSRIs. Citalopram hydrobromide is a mixture of two isomers—forms of the same chemical—whereas escitalopram oxalate is the active isomer alone. They appear to be highly selective for serotonin, only minimally inhibiting the reuptake of the neurotransmitters norepinephrine and dopamine.

Paroxetine hydrochloride is structurally unrelated to other SSRIs and is more selective for serotonin than fluvoxamine, fluoxetine, or sertraline, but less selective than citalopram hydrobromide and escitalopram oxalate. Paroxetine hydrochloride becomes distributed widely throughout body tissues and the central nervous system with only 1% remaining in the circulatory system.

### *Mode of action*

Mental depression is believed to be related to the low activity of one or more neurotransmitters in the brain. Neurotransmitters are chemical messengers that cross the gap or synapse between nerve cells. Although it is not understood exactly how most SSRIs work, they are designed to increase the level of serotonin in the brain. This can reduce the symptoms of depression and other psychological disorders.

Serotonin is released by nerve cells and then, in a process called reuptake, is reabsorbed by the cells to be used again. SSRIs interfere with reuptake by blocking the serotonin reabsorption sites on the surfaces of nerve cells, thereby making more serotonin available for brain activity. Paroxetine hydrochloride inhibits the transporter molecule that moves serotonin back into the cell. SSRIs are said to selectively interfere with the reuptake of serotonin, without affecting the uptake or activities of other neurotransmitters. In

contrast, older antidepressants, such as **tricyclic antidepressants** and **monoamine oxidase inhibitors** (MAOIs), affect many different neurotransmitters, brain cell receptors, and brain processes, thus increasing the likelihood of serious side effects.

Nevertheless, it is becoming clear that the serotonin neurotransmitter system is far more complex and widespread throughout the body than was originally thought. Although serotonin receptors are particularly common in areas of the brain that control emotion, it is now known that there are at least six different types of serotonin receptors that send different signals to different parts of the brain. Serotonin also appears to affect other neurotransmitter systems to some extent. As a result, increasing the levels of serotonin may not be the only reason why SSRIs relieve depression.

### *Effectiveness*

SSRIs are not effective for treating **anxiety** or depression in 20–40% of patients. Other **antidepressant drugs** may be effective in people who do not respond to SSRIs. However, some research suggests that the use of SSRIs in the early stages of depression can prevent major **depressive disorders**.

Individuals respond differently to different SSRIs, and side effects may vary. Finding the best SSRI for an individual may be a matter of trial-and-error. It usually takes two to four weeks after starting an SSRI before symptoms begin to improve. Fluvoxamine may take one to two months for noticeable improvement. Paroxetine hydrochloride may take as long as several months, although sleep often improves within one or two weeks of beginning the medication. If there is no response after a few weeks or if side effects occur, the patient may be switched to another SSRI.

Although fluvoxamine approved for treating OCD in children and fluoxetine is the only SSRI that is FDA-approved for treating depression in children over age 8, thousands of young people have been treated by off-label use of a variety of SSRIs for:

- depression
- anxiety
- OCD
- panic
- attention deficit/hyperactivity disorder (ADHD)

SSRIs sometimes are prescribed to relieve depression accompanying **alcoholism**. A recent study found that, although type A alcoholics responded to Sertraline in conjunction with a 12-step individual therapy program, type B alcoholics (those with the most severe

drinking problems) did not benefit from sertraline and, in some cases, increased their alcohol intake.

### Recommended dosage

Usually SSRIs are started with a low dosage that may be gradually increased. In older adults, SSRIs remain in the body longer than in younger adults. The blood levels of paroxetine hydrochloride can be 70–80% higher in the elderly as compared with younger patients. Therefore, lower doses usually are prescribed for older people. Older patients with other medical conditions or who are taking many different drugs also may need smaller or less frequent doses. The dosage of an SSRI also varies according to the individual and the condition that is being treated. SSRIs may be taken with or without food, on a full or empty stomach. However taking SSRIs with food or drink may lessen side effects such as stomach upset or **nausea**.

Citalopram hydrobromide is supplied as tablets or as an oral solution equivalent to 2 mg per mL (0.03 oz.), taken once per day in the morning or evening:

- adults: 20 mg per day, increasing to 40 mg if necessary, to a maximum of 60 mg per day
- older adults: 20 mg per day to a maximum of 40 mg

Escitalopram oxalate is supplied as 5-, 10-, or 20-mg tablets or as a 1 mg per mL (0.03 oz.) liquid. The recommended dose is 10 mg per day, with a possible increase to 20 mg per day after at least one week.

Average dosages of fluvoxamine for treating OCD and depression are:

- adults: one 50-mg tablet at bedtime; may be increased up to a maximum of 300 mg daily; dosages of more than 100 mg per day should be divided into two doses, one taken in the evening and one in the morning
- children aged 8–17: initially one 25-mg tablet at bedtime; may be gradually increased by 25 mg per day every four to seven days, up to a maximum of 200 mg per day; daily dosages of more than 50 mg should be divided into two daily doses.

Average doses of paroxetine hydrochloride for treating depression are:

- adults: 20 mg (10 mL, 0.3 oz.) of oral suspension, one 20-mg tablet, or one 25-mg extended-release tablet, once a day in the morning, increased by 10 mg per week to a maximum of 50 mg—25 mL (0.75 oz.) of oral suspension—or a 62.5-mg extended-release tablet

- older adults: 10 mg (5 mL, 0.15 oz.) of oral suspension or a 10-mg tablet daily, increased to a maximum of 40 mg (20 mL, 0.6 oz.); one 12.5-mg extended-release tablet daily, increased to a maximum of 50 mg

Because of its sedating effect, paroxetine hydrochloride may be taken in the evening rather than in the morning as usually recommended. Oral suspensions need to be shaken well before measuring with a small measuring cup or measuring spoon. Extended-release tablets should be swallowed whole, not broken or chewed. Dosages may be different for treating disorders other than depression.

Typical dosages of fluoxetine are:

- one 10–20-mg daily capsule or solution taken in the morning; increased up to as much as 40 mg daily if there is no improvement in one month, up to an 80-mg maximum
- one 20-mg capsule of Sarafem per day, taken in the morning, every day or for only 14 days of a menstrual cycle; maximum of 80 mg per day; Sarafem is supplied in seven-day blister packs to help keep track of the days
- children: initially one 5–10-mg capsule or solution per day.

Sertraline is available as capsules, oral solutions, or tablets:

- adults: 50 mg daily, taken in the morning or evening, up to a maximum of 200 mg daily for severely depressed individuals
- older adults: 12.5–25 mg per day, taken in the morning or evening; may be increased gradually
- for treating OCD in children aged 6–12: 25 mg per day, taken in the morning or evening; may be increased gradually to a maximum of 200 mg per day
- children aged 13–17: initially 50 mg per day, in the morning or evening, may be increased gradually to a maximum of 200 mg per day.

Sertraline oral concentrate should be mixed with 4 oz (133 mL) of water, ginger ale, lemon-lime soda, lemonade, or orange juice and taken immediately.

Missed doses of SSRIs are handled differently depending on the SSRI and the number of doses per day. An effective SSRI may be prescribed for six months or more. Some experts recommend continuing on the SSRI indefinitely to prevent the recurrence of depression.

## Precautions

### *Medical conditions*

Medical conditions that may affect the use or dosage of at least some SSRIs include:

- drug allergies or allergies to other substances in medications
- mania
- manic-depressive (bipolar) disorder
- brain disease or mental retardation
- seizures or epilepsy
- Parkinson's disease
- liver or severe kidney disease
- abnormal bleeding problems
- diabetes mellitus
- heart disease
- a recent heart attack
- glaucoma

SSRI use during **pregnancy** may not be safe, particularly during the third trimester. Exposure of fetuses to citalopram hydrobromide and other SSRIs during the late third trimester have led to very serious complications, including serotonin syndrome—a condition in which high serotonin levels cause severe problems. Symptoms in a newborn may be the result of a direct toxic effect of the SSRI or withdrawal from the drug. SSRIs pass into breast milk and may negatively affect a baby.

### *Suicidal tendencies*

As discussed above, concern about a link between SSRIs and suicidal thoughts and behaviors, including suicide attempts in depressed children has led to warnings about prescribing these drugs for people under age 25. A link between SSRIs and suicidal thoughts and behaviors in adults over age 25 remains controversial as studies have produced mixed or inconclusive results.

Symptoms that may indicate suicidal tendencies can develop very suddenly in children and adolescents taking SSRIs. Parents and caregivers should be alert to the following changes:

- new or worsening depression
- severe worrying
- irritability
- agitation
- extreme restlessness
- frenzied excitement
- panic attacks
- insomnia

- impulsive behavior
- aggressive behavior
- thinking about, planning, or attempting to harm one's self

### *Withdrawal*

SSRIs remain in the body for some time after the medication is stopped:

- Citalopram hydrobromide for at least three days
- Fluvoxamine for at least 32 hours
- Paroxetine hydrochloride for at least 42 hours
- Fluoxetine for up to five weeks
- Sertraline for at least three to five days

SSRIs can cause what the manufacturers refer to as "discontinuation syndrome" when the medication is stopped. Since this occurs most often when the drug is stopped abruptly, the normal method of stopping the drug is to gradually decrease the dose before stopping the drug completely. The occurrence of discontinuation syndrome depends on the SSRI, the dosage, and the length of time that the drug was used and the individual's body chemistry. Paroxetine hydrochloride appears to induce more serious withdrawal symptoms than other SSRIs. Symptoms of Paroxetine hydrochloride withdrawal appear within 1–10 days of stopping the drug. Because of its long half-life in the body, fluoxetine rarely causes withdrawal symptoms, although symptoms have been known to appear within 5 to 42 days of stopping Fluoxetine.

Withdrawal symptoms may include:

- generally feeling sick
- dry mouth
- runny nose
- dizziness or lightheadedness
- nausea and vomiting
- diarrhea
- headache
- sweating
- muscle pain
- weakness or fatigue
- nervousness or anxiety
- restlessness or agitation
- trembling or shaking
- insomnia
- fast heart rate
- breathing difficulties
- chest pain
- confusion

Although withdrawal symptoms usually disappear after a short time, in some patients some symptoms appear to continue indefinitely.

### ***Other precautions***

Other precautions concerning SSRIs include:

- a 50% chance that an episode of depression will recur at some point after stopping the drug
- a 90% risk of recurrence following two episodes of depression
- reports of patients developing tolerance to an SSRI, requiring increased dosages for effectiveness
- the long-term effects of SSRIs are unknown
- SSRIs are expensive and some insurance plans do not cover mental health medications.

### ***Side effects***

#### ***Common side effects***

The most common side effects of SSRIs include:

- dry mouth
- dizziness
- sour or acid stomach or gas
- heartburn
- decreased appetite
- stomach upset
- nausea
- diarrhea
- sweating
- headache
- weakness or fatigue
- drowsiness
- insomnia
- nervousness or anxiety
- tremors
- sexual problems

Most common side effects disappear as the body adjusts to the drug. Nausea may be relieved by taking the medication with meals or temporarily dividing the dose in half.

Certain side effects occur more frequently depending on the SSRI:

- Side effects of citalopram hydrobromide usually are mild and disappear as the body adjusts.
- Fluvoxamine and sertraline are more likely to cause gastrointestinal upset, including stomach irritation, nausea, and diarrhea.

- Paroxetine hydrochloride is more likely to cause dry mouth, constipation, and drowsiness. Paroxetine hydrochloride is significantly more sedating than other SSRIs, which may benefit patients with insomnia.
- The most common side effect of fluoxetine is nausea during the first two weeks on the drug; nervousness and anxiety also are common with fluoxetine.
- Paroxetine hydrochloride, fluoxetine, and sertraline often reduce appetite.
- Up to 30% of those people taking sertraline experience headaches and 20% experience insomnia.

Studies with fluvoxamine have found that children may experience different side effects than adults, the most common being:

- dry mouth
- a stuffy or bloody nose
- sweating
- drowsiness
- restlessness
- muscle twitching or tics
- tremors
- thinning hair
- abnormal thinking

#### ***Sexual side effects***

Any SSRI can affect sexual interest or performance. Side effects include increased or, more often, decreased sexual interest, difficulty reaching orgasm or ejaculation, and **impotence**.

Although manufacturers initially reported that sexual problems were very rare side effects of SSRIs, most patients in clinical trials were never asked specifically about sex and were reluctant to raise the issue. After a few years it became apparent that sexual problems were commonplace among SSRI users, affecting as many as 70%. Among men taking Paroxetine hydrochloride, 23% report problems with ejaculation. Between 40% and 70% of those taking Fluoxetine report negative sexual side effects, especially loss of interest.

#### ***Less common or rare side effects***

Less common—but potentially serious—side effects of at least some SSRIs may include:

- flu-like symptoms
- sneezing
- nasal congestion or a runny nose
- sore throat

- skin rash
- itching or tingling, burning, or prickling of the skin
- fever
- chills
- body aches or pain
- muscle or joint pain
- abdominal cramps or pain
- vomiting
- decreased or increased appetite
- weight loss
- weight gain, especially after a year on an SSRI
- mouth watering
- increased frequency or amount of urination
- constipation
- menstrual changes or pain
- chest congestion or pain
- difficulty breathing
- taste changes, including a metallic taste in the mouth
- blurred vision or other visual changes
- loss of voice
- teeth grinding
- trembling or shaking
- hair loss
- sensitivity to sunlight
- anxiety or agitation
- abnormal dreams
- confusion
- lack of emotion, apathy
- memory loss

Rare side effects that may occur with some SSRIs include:

- symptoms of low blood sugar or sodium
- bleeding gums or nosebleeds
- unusual bruising
- irregular or slow heartbeat (less than 50 beats per minute)
- fainting
- painful urination or other difficulties with urination
- purple or red spots on the skin
- skin conditions
- red or irritated eyes
- inability to move the eyes
- swelling of the face, ankles, or hands
- increased or decreased body movements
- clumsiness

- tics or other sudden or unusual body or facial movements or postures
- changes in the breasts, including leakage of milk
- seizures
- irritability
- increased depression
- mood or mental changes
- abnormal behaviors
- difficulty concentrating
- lethargy or stupor
- hallucinations
- suicidal thoughts or tendencies

Various other SSRI side effects have been observed in clinical practice although their incidence is not known.

#### *Symptoms of overdose*

Although SSRIs are generally safe and overdose rarely occurs, symptoms of overdose include two or more severe side effects occurring together. More common symptoms of SSRI overdose include:

- flushing of the face
- enlarged pupils
- fast heart rate
- upset stomach
- nausea and vomiting
- sweating
- dizziness
- irritability
- drowsiness
- insomnia
- trembling or shaking

#### *Rare symptoms of SSRI overdose include:*

- deep or fast breathing with dizziness
- fainting
- muscle pain
- weakness
- difficulty urinating
- bluish skin or lips
- fast, slow, or irregular heartbeat
- low blood pressure
- confusion
- memory loss
- seizures
- coma

## Interactions

SSRIs interact with many other drugs and herbal remedies especially other drugs that affect mood. Alcohol may increase SSRI-induced drowsiness and should not be used when taking some SSRIs. Fluvoxamine appears to cause the most serious **drug interactions**, whereas citalopram hydrobromide has relatively few interactions. A combination of fluvoxamine and clozapine (Clozaril) can cause low blood pressure and seizures.

The interaction of SSRIs with MAOIs can be fatal. In addition to antidepressant MAOIs, the antibiotic linezolid (Zyvox) is an MAOI. There must be at minimum a two-week interval between stopping one drug and starting the other drug. There should be at least a three-week interval between an MAOI and either paroxetine hydrochloride or sertraline, if either type of antidepressant was taken for more than three months. Because of its long half-life in the body, it is necessary to wait five to six weeks after stopping fluoxetine before starting on an MAOI.

Some of the drugs and herbal remedies that can interact negatively with SSRIs include:

- other antidepressants
- antihistamines
- various medications for anxiety, mental illness, or seizures
- sedatives and tranquilizers
- sleeping pills
- St. John's wort

Drugs that may cause severe heart problems if taken in conjunction with some SSRIs include:

- astemizole (Hismanal)
- cisapride (Propulsid)
- terfenadine (Seldane)
- thioridazine (Mellaril), which should not be taken for at least five weeks after stopping fluoxetine

Drugs that may affect the blood levels of an SSRI or the length of time that an SSRI remains in the body include:

- antifungal drugs
- cimetidine (Tagamet)
- erythromycin
- tricyclic antidepressants
- Dilantin and phenobarbital, which may decrease the blood levels of Paroxetine hydrochloride

Some SSRIs may cause higher blood levels of other medications including:

- alprazolam (Xanax and others)
- anticoagulants or blood-thinners such as warfarin (Coumadin)—SSRIs can increase warfarin blood levels dramatically
- aspirin and other nonsteroidal anti-inflammatory drugs (NSAIDs) including ibuprofen and naproxen
- caffeine
- carbamazepine (Tegretol)
- diazepam (Valium)
- digitalis glycosides (heart medicines)
- lithium
- methadone
- phenytoin (Dilantin and others)
- propantheline (Ineral and others)
- theophylline or theophylline-containing drugs
- triazolam (Halcion and others)
- tricyclic antidepressants

This list is not complete. Before taking any antidepressant, patients should review all their medications—prescription, nonprescription, and herbal—with the prescribing physician and their pharmacist.

### *Serotonin syndrome*

Rarely, some drugs may interact with an SSRI to cause excessively high levels of serotonin, a condition known as serotonin syndrome. Drug interactions most likely to cause serotonin syndrome include:

- buspirone (BuSpar)
- bromocriptine (Parlodel)
- dextromethorphan (cough medicine such as Robitussin DM)
- levodopa (Sinemet)
- lithium (Eskalith)
- meperidine (Demerol)
- moclobemide (Manerex)
- nefazodone (Serzone)
- pentazocine (Talwin)
- other SSRIs
- street drugs
- sumatriptan (Imitrex)
- tramadol (Ultram)
- trazodone (Desyrel)
- tryptophan
- venlafaxine (Effexor)

Serotonin syndrome may occur shortly after the dose of a drug is increased, when symptoms have not been present at a lower dosage.

Serotonin syndrome may be suspected when at least three of the following symptoms occur together:

- diarrhea
- fever
- shivering
- sweating
- restlessness
- agitation
- uncontrollable excitement
- poor coordination
- twitching
- trembling or shaking
- rigidity
- confusion
- mental changes
- fluctuating vital signs

### *Combined treatments*

Increasingly physicians are combining an SSRI with other medications, either to increase effectiveness or to counteract side effects. Certain SSRIs are sometimes prescribed along with:

- an anti-anxiety drug such as diazepam (Valium)
- trazodone (Desyrel, Molipaxin, Trittico, Thombran, Trialodine), a different type of antidepressant, for patients with insomnia
- lithium

### Resources

#### OTHER

"Antidepressants." *MedlinePlus*. June 4, 2008 [cited June 9, 2008]. <http://www.nlm.nih.gov/medlineplus/antidepressants.html>.

"Depression." *MedlinePlus*. June 4, 2008 [cited June 9, 2008]. <http://www.nlm.nih.gov/medlineplus/depression.html>.

#### ORGANIZATIONS

American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Ave. NW, Washington, DC, 20013-3007, (202) 966-7300, (202) 966-2891, [communications@aacap.org](mailto:communications@aacap.org), <http://www.aacap.org/>.

American Psychiatric Association (APA), 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (888) 357-7924, [apa@psych.org](mailto:apa@psych.org), <http://www.psych.org>.

National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD, 20892-9663, <http://www.nimh.nih.gov/site-info/contact-nimh.shtml>.

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## Antidepressant drugs, tricyclic

### Definition

Tricyclic antidepressants are medicines that relieve mental depression.

### Purpose

Since their discovery in the 1950s, tricyclic antidepressants have been used to treat mental depression. The name tricyclic refers to their molecular structure. Like other **antidepressant drugs**, they reduce symptoms such as extreme sadness, hopelessness, and lack of energy. Some tricyclic antidepressants are also used to treat bulimia, **cocaine withdrawal**, **panic disorder**, obsessive-compulsive disorders, certain types of chronic **pain**, and bed-wetting in children. Newer antidepressant drugs called **selective serotonin reuptake inhibitors** (SSRIs) are often used in place of the older tricyclic antidepressants because SSRIs generally have fewer side effects.

### Description

Named for their three-ring chemical structure, tricyclic antidepressants work by correcting chemical imbalances in the brain. But because they also affect other chemicals throughout the body, these drugs may produce many unwanted side effects.

Tricyclic antidepressants are available only with a physician's prescription and are sold in tablet, capsule, liquid, and injectable forms. Some commonly used tricyclic antidepressants are amitriptyline (Elavil), desipramine (Norpramin), doxepin (Sinequan), imipramine (Tofranil), nortriptyline (Pamelor), protriptyline (Vivactil), and trimipramine (Surmontil). Different drugs in this family have different effects, and physicians can choose the drug that best fits the patient's symptoms. For example, a physician might prescribe Elavil for a person with depression who has trouble sleeping, because this drug is more likely to make people feel calm and sleepy. Other tricyclic antidepressants might be more appropriate for depressed people with low energy.

### Recommended dosage

The recommended dosage depends on many factors, including the patient's age, weight, general health, and symptoms. The type of tricyclic antidepressant and its strength also must be considered, as well as whether the antidepressant will interact with other drugs the patient is taking. Check with the

## KEY TERMS

**Asthma**—A disease in which the air passages of the lungs become inflamed and narrowed.

**Bulimia**—An eating disorder in which a person binges on food and then induces vomiting, uses laxatives, or goes without food for some time.

**Chronic**—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

**Delusion**—An abnormal mental state characterized by the acceptance of something as true that is actually false or unreal, such as the belief that one is Jesus Christ.

**Depression**—A mental condition in which a person feels extremely sad and loses interest in life. A person with depression may also have sleep problems and loss of appetite and may have trouble concentrating and carrying out everyday activities.

**Glaucoma**—A condition in which pressure in the eye is abnormally high. If not treated, glaucoma may lead to blindness.

**Hallucination**—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

**Obsessive-compulsive disorder**—An anxiety disorder in which a person cannot prevent himself or herself from dwelling on unwanted thoughts, acting on urges, or performing repetitious rituals, such as washing his hands or checking to make sure he or she turned off the lights.

**Panic disorder**—An disorder in which a person has sudden and intense attacks of anxiety in certain situations. Symptoms such as shortness of breath, sweating, dizziness, chest pain, and extreme fear often accompany the attacks.

**Prostate**—A donut-shaped gland in males below the bladder that contributes to the production of semen.

**Schizophrenia**—A severe mental disorder in which a person loses touch with reality and may have illogical thoughts, delusions, hallucinations, behavioral problems and other disturbances.

**Seizure**—A sudden attack, spasm, or convulsion.

**Serotonin**—A natural chemical found in the brain and other parts of the body, that carries signals between nerve cells.

**Withdrawal symptoms**—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug to which he or she has become dependent.

physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Always take tricyclic antidepressants exactly as directed. Never take larger or more frequent doses, and do not take the drug for longer than directed. Do not stop taking the medicine just because it does not seem to be working. Several weeks may be needed for its effects to be felt. Visit the physician as often as recommended so that the physician can check to see if the drug is working and to note for side effects.

Do not stop taking this medicine suddenly after taking it for several weeks or more. Gradually tapering the dose may be necessary to reduce the chance of withdrawal symptoms.

Taking this medicine with food may prevent upset stomach.

### Precautions

The effects of this medicine may continue for three to seven days after patients stop taking it. All

precautions should be observed during this period, as well as throughout treatment with tricyclic antidepressants.

Some people feel drowsy, dizzy, lightheaded, or sleepy, when taking these drugs. This is a special problem when getting up after sitting or lying down. To lessen the problem, gradually hold onto something for support if possible. The drugs may also cause blurred vision. Anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

Because tricyclic antidepressants work on the central nervous system, they may add to the effects of alcohol and other drugs that cause drowsiness, such as **antihistamines**, cold medicine, allergy medicine, sleep aids, medicine for seizures, tranquilizers, some pain relievers, and **muscle relaxants**. Anyone taking tricyclic antidepressants should check with his or her physician before drinking alcohol or taking any drugs that cause drowsiness.

Tricyclic antidepressants may interact with medicines used during surgery, dental procedures, or emergency treatment. These interactions could increase the chance of side effects. Anyone who is taking tricyclic antidepressants should be sure to tell the health care professional in charge before having any surgical or dental procedures or receiving emergency treatment.

These drugs may also change the results of medical tests. Before having medical tests, anyone taking this medicine should alert the health care professional in charge.

This medicine may increase sensitivity to sunlight. Even brief exposure to sun can cause a severe **sunburn** or a rash. While being treated with this tricyclic antidepressants, avoid being in direct sunlight, especially between 10 in the morning and 3 in the afternoon. Wear a hat and tightly woven clothing that covers the arms and legs, use a sunscreen with a skin protection factor (SPF) of at least 15, protect the lips with a sun block lipstick, and do not use **tanning** beds, tanning booths, or sunlamps while taking these drugs.

Tricyclic antidepressants may cause **dry mouth**. To temporarily relieve the discomfort, chew sugarless gum, suck on sugarless candy or ice chips, or use saliva substitutes, which come in liquid and tablet forms and are available without a prescription.

Children and older people are especially sensitive to the effects of tricyclic antidepressants. This increased sensitivity may increase the chance of side effects.

### *Special conditions*

People with certain medical conditions or who are taking certain other medicines can have problems if they take tricyclic antidepressants. Before taking these drugs, be sure to let the physician know about any of the following these conditions.

**ALLERGIES.** Anyone who has had unusual reactions to tricyclic antidepressants or to carbamazepine (Tegretol), maprotiline (Ludiomil), or trazodone (Desyrel) in the past should let his or her physician know before taking tricyclic antidepressants. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

**PREGNANCY.** Problems have been reported in babies whose mothers took tricyclic antidepressants just before delivery. Women who are pregnant or who may become pregnant should check with their physicians about the safety of using tricyclic antidepressants.

**BREASTFEEDING.** Tricyclic antidepressants pass into breast milk and may cause drowsiness in nursing babies whose mothers take the drugs. Women who are **breastfeeding** should check with their physicians before using tricyclic antidepressants.

**DIABETES.** Tricyclic antidepressants may affect blood sugar levels. Diabetic patients who notice changes in blood or urine test results while taking this medicine should check with their physicians.

**OTHER MEDICAL CONDITIONS.** Before using tricyclic antidepressants, people with any of these medical problems should make sure their physicians are aware of their conditions:

- current or past alcohol or drug abuse
- bipolar disorder (manic-depressive illness)
- schizophrenia
- seizures (convulsions)
- heart disease
- high blood pressure
- kidney disease
- liver disease
- overactive thyroid
- stomach or intestinal problems
- enlarged prostate
- problems urinating
- glaucoma
- asthma

**USE OF CERTAIN MEDICINES.** Taking tricyclic antidepressants with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

### *Side effects*

The most common side effects are **dizziness**, drowsiness, dry mouth, unpleasant taste, **headache**, **nausea**, mild tiredness or weakness, increased appetite or craving for sweets, and weight gain. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side effects, such as **diarrhea**, **vomiting**, sleep problems, sweating, and **heartburn** also may occur and do not need medical attention unless they do not go away or they interfere with normal activities.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine as soon as possible:

- blurred vision
- eye pain

- confusion
- hallucinations
- fainting
- loss of balance
- swallowing problems
- difficulty speaking
- mask-like face
- shakiness or trembling
- nervousness or restlessness
- movement problems, such as shuffling walk, stiff arms and legs, or slow movement
- decreased sexual ability
- fast or irregular heartbeat
- constipation
- problems urinating

Some side effects may continue after treatment with tricyclic antidepressants has ended. Check with a physician if these symptoms occur:

- headache
- nausea, vomiting, or diarrhea
- sleep problems, including vivid dreams
- unusual excitement, restlessness, or irritability

## Interactions

Life-threatening reactions, such as extremely high blood pressure, may occur when tricyclic antidepressants are taken with other antidepressants called monoamine oxidase (MAO) inhibitors (for example, Nardil or Parnate). Do not take tricyclic antidepressants within 2 weeks of taking a MAO inhibitor.

Tricyclic antidepressants may interact with many other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes tricyclic antidepressants should let the physician know all other medicines he or she is taking. Among the drugs that may interact with tricyclic antidepressants are:

- Central nervous system (CNS) depressants such as medicine for allergies, colds, hay fever, and asthma; sedatives; tranquilizers; prescription pain medicine; muscle relaxants; medicine for seizures; sleep aids; barbiturates; and anesthetics.
- diet pills
- amphetamines
- blood thinning drugs
- medicine for overactive thyroid
- cimetidine (Tagamet)

- other antidepressant drugs, including MAO inhibitors (such as Nardil and Parnate) and antidepressants that raise serotonin levels (such as Prozac and Zoloft)
- blood pressure medicines such as clonidine (Catapres) and guanethidine monosulfate (Ismelin)
- disulfiram (Antabuse), used to treat alcohol abuse
- major tranquilizers such as thioridazine (Mellaril) and chlorpromazine (Thorazine)
- antianxiety drugs such as chlordiazepoxide (Librium) and alprazolam (Xanax)
- antiseizure medicines such as carbamazepine (Tegretol) and phenytoin (Dilantin)

The list above does not include every drug that may interact with tricyclic antidepressants. Be sure to check with a physician or pharmacist before combining tricyclic antidepressants with any other prescription or nonprescription (over-the-counter) medicine, or herbal remedy.

## ORGANIZATIONS

- American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Ave. NW, Washington, DC, 20013-3007, (202) 966-7300, (202) 966-2891, communications@aacap.org, <http://www.aacap.org/>.
- American Psychiatric Association (APA), 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (888) 357-7924, apa@psych.org, <http://www.psych.org>.
- National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD, 20892-9663, <http://www.nimh.nih.gov/site-info/contact-nimh.shtml>.

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## Antidiabetic drugs

### Definition

Antidiabetic drugs are medicines that help control blood sugar (glucose) levels in people with **diabetes mellitus**.

### Purpose

Diabetes mellitus is a disease in which the body is unable to properly use sugar (glucose). There are two types of diabetes. In type 1 diabetes (formerly called insulin-dependent, juvenile, or childhood-onset diabetes), the pancreas, a digestive organ, does not produce enough of the hormone insulin to allow the body use glucose. Type 2 diabetes (formerly called noninsulin

## KEY TERMS

**Blood sugar**—The concentration of glucose in the blood.

**Glucose**—A simple sugar that serves as the body's main source of energy.

**Hormone**—A substance that is produced in one part of the body, then travels through the bloodstream to another part of the body where it has its effect.

**Metabolism**—All the physical and chemical changes that occur in cells to allow growth and maintain body functions. These include processes that break down substances to yield energy and processes that build up other substances necessary for life.

**Placebo**—A pill or liquid given during the study of a drug or dietary supplement that contains no medication or active ingredient. Usually study participants do not know if they are receiving a pill containing the drug or an identical-appearing placebo.

**Pregnancy category**—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

**Salicylates**—A group of drugs that includes aspirin and related compounds. Salicylates are used to relieve pain, reduce inflammation, and lower fever.

**Seizure**—A sudden attack, spasm, or convulsion.

dependent or adult-onset diabetes) occurs when the pancreas produces insulin, but cells in the body stop responding to the hormone. In either case, the result is that glucose builds up in the blood because the body cannot use it. **Gestational diabetes** is transient diabetes that occurs during **pregnancy** and resolves after pregnancy is over.

There is no cure for diabetes. Treatment of diabetes focuses on two goals: keeping blood glucose within the normal range and preventing the development of long-term complications. Diet, **exercise**, medication, and careful monitoring of blood glucose levels are the keys to managing diabetes so that patients can live healthier lives.

In addition to monitoring diet and exercise, type 1 diabetes is always treated by giving replacement insulin, usually several times a day. Type 2 diabetes is treatable by a number of therapeutic approaches. Drug therapy may be directed toward increasing insulin secretion, increasing insulin sensitivity, or increasing insulin penetration of the cells.

### Description

Antidiabetic drugs can be subdivided into seven groups: insulin, sulfonylureas, alpha-glucosidase inhibitors, biguanides, meglitinides, thiazolidinediones, and dipeptidyl peptidase IV (DPP-IV) inhibitors. Some of these drugs may be given in combination.

Insulin (Humulin, Novolin, and many others) is the hormone responsible for glucose utilization. It is effective in both types of diabetes, since, even in **insulin resistance**, some sensitivity remains and the condition can be treated with larger doses of insulin. Most insulins are now produced by recombinant DNA techniques, and are chemically identical to natural human insulin. Alternately, insulin from pigs can be chemically treated to convert it into human insulin.

Insulin is always given to people with type 1 diabetes. Some patients with type 2 diabetes may need to use insulin injections if their diabetes cannot be controlled. Injections are given subcutaneously—just under the skin, using a small needle and syringe several times daily. Insulin can also be given more continuously using an insulin pump. Insulin comes in many forms including rapid-acting, short-acting, intermediate-acting, long-acting, and pre-mixed (several types in a specific ratio) insulin. These vary in concentration, speed at which they react, and length of time for which they are effective. These types of insulin are not interchangeable. The individual and his or her physician will determine which type of insulin is best based on lifestyle and disease characteristics.

Sulfonylureas, such as chlorpropamide (Diabinese), tolazamide (Tolinase), glipizide (Glucotrol), glyburide (DiaBeta), and others, act by stimulating the beta cells of the pancreas to release more insulin. Glimepiride (Amaryl), a member of this class, appears

to have a useful secondary action in increasing insulin sensitivity in peripheral cells.

Alpha-glucosidase inhibitors, such as acarbose (Precose) and miglitol (Glyset) do not increase insulin secretion. Instead, they slow the conversion of disaccharides and complex carbohydrates to glucose. This allows glucose to enter the bloodstream more slowly and reduces peak blood glucose levels. Alpha-glucosidase inhibitors are useful for either alone or in combination therapy with other antidiabetic drugs.

Metformin (Glucophage, Glyset, Riomet, Fortamet, and Glumetza) is the only available member of the biguanide class. Metformin decreases glucose production in the liver, decreases intestinal absorption of glucose, and increases peripheral glucose uptake and use. Metformin may be used alone or in combination therapy with other antidiabetic drugs.

There are two members of the meglitinide class: repaglinide (Prandin) and nateglinide (Starlix). The mechanism of action of the meglitinides is to stimulate insulin production. This activity is both dose dependent and dependent on the presence of glucose, so that the drugs have reduced effectiveness in the presence of low blood glucose levels. The meglitinides may be used alone, or in combination with metformin. The manufacturer warns that nateglinide should not be used in combination with other drugs that enhance insulin secretion.

Rosiglitazone (Avandia) and pioglitazone (Actos) are members of the thiazolidinedione class. They act by making muscle cells more responsive to insulin (decreased insulin resistance) and by reducing the amount of glucose released by the liver. Patients may need to take these drugs for several weeks before results are seen. These drugs may be used in combination with metformin or a sulfonylurea.

Dipeptidyl peptidase IV (DPP-IV) inhibitors work to lower glucose levels by increasing insulin production and decreasing the amount of glucose produced by the liver. In 2008, sitagliptin (Januvia) was the only drug in this category approved for use in the United States. It can be used with metformin.

Pramlintide (Symlin) is a new injectable antidiabetic drug that can be used by people with either type 1 or type 2 diabetes. This drug helps control glucose level fluctuations and increases the feeling of fullness, helping diabetic individuals lose weight. Exenatide injection (Byetta) is a new type of drug called incretin mimetics. It slows the release of glucose from the liver and slows stomach emptying thus reducing fluctuations in blood glucose levels. It is used to treat people

with type 2 diabetes, usually in combination with other antidiabetic drugs and is given by injection.

## Recommended dosage

Dosage must be highly individualized for all antidiabetic agents and is based on blood glucose levels, which must be taken regularly, often several times daily. Patients should review specific literature that comes with antidiabetic medications for complete dosage information and receive diabetes education from a healthcare provider.

## Precautions

Insulin. The greatest short-term risk of insulin is **hypoglycemia** (low blood sugar), which may be the result of either a direct overdose or an imbalance between insulin injection and level of exercise and diet. This also may occur in the presence of other conditions that reduce the amount of glucose in the blood, such as illness with **vomiting** and **diarrhea**. Treatment is with glucose in the form of glucose tablets or liquid, although severe cases may require intravenous therapy. Allergic reactions and skin reactions also may occur.

Insulin is classified as category B in pregnancy, and is considered the drug of choice for glucose control during pregnancy. It is recommended that women with insulin-dependent diabetes not breastfeed because either low or high doses of insulin may inhibit milk production.

Sulfonylureas. All sulfonylurea drugs may cause hypoglycemia. Most patients become resistant to these drugs over time, and may require either dose adjustments or a switch to insulin. The list of adverse reactions is extensive, and includes central nervous system problems and skin reactions, among others. Hematologic reactions, although rare, may be severe and include **aplastic anemia** and **hemolytic anemia**. The administration of oral hypoglycemic drugs has been associated with increased cardiovascular mortality as compared with treatment with diet alone or diet plus insulin.

The sulfonylureas are classified as category C during pregnancy, based on animal studies, although glyburide has not shown any harm to the fetus and is classified as category B. Because there may be significant alterations in blood glucose levels during pregnancy, it is recommended that patients be switched to insulin. These drugs have not been fully studied during **breastfeeding**, but it is recommended that because their presence in breast milk might cause

hypoglycemia in the newborn, breast feeding be avoided while taking sulfonylureas.

Alpha-glucosidase inhibitors are generally well tolerated, and do not cause hypoglycemia. The most common adverse effects are gastrointestinal problems, including flatulence (gas), diarrhea, and abdominal pain. These drugs are classified as category B in pregnancy. Although there is no evidence that the drugs are harmful to the fetus, it is important that rigid blood glucose control be maintained during pregnancy, and pregnant women most often should be switched to insulin. Alpha-glucosidase inhibitors may be excreted in small amounts in breast milk, and it is recommended that the drugs not be administered to nursing mothers.

Metformin causes gastrointestinal (stomach and digestive) reactions in about a third of patients. A rare, but very serious, reaction to metformin is lactic acidosis, which is fatal in about 50% of cases. Lactic acidosis occurs in patients with multiple medical problems, including renal (kidney-related) insufficiency. The risk may be reduced with careful renal monitoring, and careful dose adjustments to metformin.

Metformin is category B during pregnancy. There have been no carefully controlled studies of the drug during pregnancy, but there is no evidence of fetal harm from animal studies. It is important that rigid blood glucose control be maintained during pregnancy, and pregnant women should be switched to insulin. Animal studies show that metformin is excreted in milk. It is recommended that metformin not be administered to nursing mothers.

Meglitinides. These drugs are generally well tolerated, with an adverse event profile similar to placebo. The drugs are classified as category C during pregnancy, based on fetal abnormalities in rabbits given about 40 times the normal human dose. It is important that rigid blood glucose control be maintained during pregnancy, and pregnant women should be switched to insulin. It is not known whether the meglitinides are excreted in human milk, but it is recommended that these drugs not be given to nursing mothers.

Thiazolidinediones. These drugs were generally well tolerated in early trials, but they are structurally related to an earlier drug, troglitazone, which was associated with liver function problems. However, in extensive testing, these drugs have not been shown to cause any liver problems. These drugs should not be used in patients with any type of liver disease or heart failure because they tend to increase the amount of fluid the individual retains.

It is recommended that all patients treated with pioglitazone or rosiglitazone have regular liver function monitoring. The drugs are classified as pregnancy category C, based on evidence of inhibition of fetal growth in rats given more than four times the normal human dose. It is important that rigid blood glucose control be maintained during pregnancy, and pregnant women should be switched to insulin. It is not known whether the thiazolidinediones are excreted in human milk, however they have been identified in the milk of lactating rats. It is recommended that these drugs not be administered to nursing mothers.

The DPP-IV drug Januvia can cause severe allergic reaction. Other mild side effects include headache, nausea, and sore throat. Symlin and Byetta can cause hypoglycemia, although the most common side effect is nausea. Nausea can be controlled by slowly increasing the dosage.

## Interactions

The sulfonylureas have a particularly long list of drug interactions, several of which may be severe. Patients should review specific literature for these drugs.

The actions of oral hypoglycemic agents may be strengthened by highly protein bound drugs, including nonsteroidal anti-inflammatory drugs (NSAIDs), salicylates, sulfonamides, chloramphenicol, coumarins, probenecid, monamine oxidase inhibitors (MAOIs), and beta blockers.

The literature that accompanies each medication should list possible drug-drug or food-drug interactions. The patient should review all prescription and non-prescription medicines being taken as well as all herbal remedies and dietary supplements with their physician and pharmacist before starting to take any antidiabetic agent.

## Resources

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## ORGANIZATIONS

- American Diabetes Association, 1701 North Beauregard Street, Alexandria, VA, 22311, (800) 342-2383, Ask ADA@diabetes.org, <http://www.diabetes.org/>.
- Juvenile Diabetes Research Foundation International, 26 Broadway, 14th Floor, New York, NY, 10004, (212) 785-9595, (800) 533-2873, info@jdrf.org, <http://www.jdf.org>.
- National Diabetes Education Program, One Diabetes Way, Bethesda, MD, 20814-9692, (301) 496-3583, (888) 693-6337, <http://www.ndep.nih.gov/>.
- National Diabetes Information Clearinghouse (NDIC), 1 Information Way, Bethesda, MD, 20892-3560, (703) 738-4929, (800) 860-8747, ndic@info.niddk.nih.gov, <http://diabetes.niddk.nih.gov/>.
- National Institute of Diabetes and Digestive and Kidney Diseases, NIDDK, NIH Bldg 31, Rm 9A06 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560, (301) 496-3583, <http://www2.niddk.nih.gov/>.

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## Antidiarrheal drugs

### Definition

Antidiarrheal drugs are medicines that relieve loose bowels or **diarrhea**.

### Purpose

Antidiarrheal drugs help control diarrhea and some of the symptoms that go along with it. An average, healthy person has anywhere from three bowel movements a day to three a week. Normally the stool (the material that is passed in a bowel movement) has a texture something like clay. With diarrhea, bowel movements may be more frequent, and the texture of the stool is thin and sometimes watery.

Diarrhea is not a disease, but a symptom of some other problem. Eating or drinking food or water that is contaminated with bacteria, viruses, or parasites, or eating something that is difficult to digest may cause the symptoms. People who have trouble digesting lactose (milk sugar), for example, may get diarrhea if they

## KEY TERMS

- Colitis**—Inflammation of the colon (large bowel).
- Dehydration**—Excessive loss of water from the body.
- Enzyme**—A type of protein, produced in the body, that brings about or speeds up chemical reactions.
- Nutrient**—A food substance that provides energy or is necessary for growth and repair. Examples of nutrients are vitamins, minerals, carbohydrates, fats, and proteins.

eat dairy products. Diarrhea can also be caused by **stress** or may be a side effect of taking certain medicines.

### Description

Antidiarrheal drugs work in several ways. The drug loperamide, found in Imodium A-D, for example, slows the passage of stools through the intestines. This allows more time for water and salts in the stools to be absorbed back into the body. Adsorbents, such as attapulgite (found in Kapectate) pull diarrhea-causing substances from the digestive tract. However, they may also pull out substances that the body needs, such as enzymes and nutrients. Bismuth subsalicylate, the ingredient in Pepto-Bismol, decreases the secretion of fluid into the intestine and inhibits the activity of bacteria. It not only controls diarrhea, but relieves the cramps that often accompany diarrhea.

Antidiarrheal medicines come in liquid, tablet, caplet, and chewable tablet forms and can be bought without a physician's prescription.

### Recommended dosage

The dose depends on the type of antidiarrheal drug. Individuals should carefully read and follow the directions on the product label. For questions about dosage, individuals should consult a physician or pharmacist. Antidiarrheal drugs should never be taken in larger or more frequent doses than the directions indicate, and they should not be taken for longer than directed.

### Precautions

Diarrhea usually improves within 24–48 hours. If the symptoms last longer or if they keep coming back, this could be a sign of a more serious health problem. Anyone who has any of the symptoms listed below should get medical attention as soon as possible:

- diarrhea that lasts more than two days or gets worse
- fever
- blood in the stool
- vomiting
- cramps or tenderness in the abdomen
- signs of dehydration, such as decreased urination, dizziness or lightheadedness, dry mouth, extreme thirst, or wrinkled skin

Individuals should not use antidiarrheal drugs for more than two days unless told to do so by a physician.

Severe, long-lasting diarrhea can lead to **dehydration**. Dehydration occurs especially rapidly in young children who have fewer fluid reserves. In such cases, lost fluids and salts, such as **calcium**, **sodium**, and potassium, must be replaced.

People over age 60 should not use attapulgite (Kaopectate, Donnagel, Parepectolin), but may use other kinds of antidiarrheal drugs. However, people in this age group may be more likely to have side effects, such as severe **constipation**, from bismuth subsalicylate.

Bismuth subsalicylate may cause the tongue or the stool to temporarily darken. This is harmless. However, this harmless darkening of the stool should not be confused with the black, tarry stools that are a sign of bleeding in the intestinal tract.

Children with **influenza** or **chickenpox** should not be given bismuth subsalicylate. It can lead to **Reye's syndrome**, a life-threatening condition that affects the liver and central nervous system. To be safe, never give bismuth subsalicylate to a child under age 16 without consulting a physician. Children may have unpredictable reactions to other antidiarrheal drugs. Loperamide should not be given to children under 6 years and attapulgite should not be given to children under 3 years unless directed by a physician.

Individuals who have a history of **liver disease** or who have been taking **antibiotics** should check with their physician before taking the antidiarrheal drug loperamide. A physician should also be consulted before anyone with acute ulcerative **colitis** or anyone who has been advised to avoid constipation uses the drug.

People whose diarrhea is caused by certain infections, such as salmonella or shigella bacteria, should not use loperamide. To be safe, check with a physician before using this drug.

Anyone who has a medical condition that causes weakness should check with a physician about the best way to treat diarrhea.

### **Special conditions**

Before taking antidiarrheal drugs, be sure to let the physician know about any of these conditions:

**ALLERGIES.** Anyone who has had unusual reactions to **aspirin** or other drugs containing salicylates should check with a physician before taking bismuth subsalicylate. Anyone who has developed a rash or other unusual reactions after taking loperamide should not take that drug again without checking with a physician. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

**PREGNANCY AND BREASTFEEDING.** Women who are pregnant or **breastfeeding** should check with their physicians before using antidiarrheal drugs. They should also ask advice on how to replace lost fluids and salts.

**OTHER MEDICAL CONDITIONS.** Before using antidiarrheal drugs, people with any of these medical problems should make sure their physicians are aware of their conditions:

- dysentery
- gout
- hemophilia or other bleeding problems
- kidney disease
- stomach ulcer
- severe colitis
- liver disease

**USE OF OTHER DRUGS.** Taking antidiarrheal drugs with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

### **Side effects**

The most common side effects of attapulgite are constipation, bloating, and fullness. Bismuth subsalicylate may cause ringing in the ears, but that side effect is rare. It may also cause harmless darkening of the tongue or stool. Possible side effects from loperamide include skin rash, constipation, drowsiness, **dizziness**, tiredness, **dry mouth**, **nausea**, **vomiting**, and swelling, **pain**, and discomfort in the abdomen. Some of these symptoms are the same as those that occur with diarrhea, so it may be difficult to tell if the antidiarrheal medicine is causing the problems. Children may be more sensitive than adults to certain side effects of loperamide, such as drowsiness and dizziness.

Other rare side effects may occur with any antidiarrheal medicine. Anyone who has unusual symptoms after taking an antidiarrheal drug should call his or her physician.

## Interactions

Attapulgite can decrease the effectiveness of other medicines taken at the same time. Changing the scheduling of these other medicines so that they are not taken at the same time may be necessary. Check with a physician or pharmacist to work out the proper dose schedule.

Bismuth subsalicylate should not be taken with aspirin or any other medicine that contains salicylate. This drug may also interact with other drugs, such as blood thinners such as warfarin (Coumadin), methotrexate (Trexall and others), the antigout medicine probenecid (Benemid), some drugs used to treat arthritis, and some drugs used to treat diabetes. In addition, bismuth subsalicylate may interact with any drug that interacts with aspirin. Anyone taking these drugs should check with a physician or pharmacist before taking bismuth subsalicylate.

## Resources

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American College of Gastroenterology, P. O. Box 342260, Bethesda, MD, 20827-2260, (301) 263-9000, <http://www.acg.gi.org>.

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## Antidiuretic hormone (ADH) test

### Definition

The antidiuretic hormone (ADH) test measures the level of antidiuretic hormone in the blood. ADH, or vasopressin, is produced by the hypothalamus and

stored in the posterior pituitary gland, from where it is released into the bloodstream. ADH signals the kidneys to conserve water by concentrating the urine and reabsorbing water into the blood. ADH can also be given as a medication. The ADH test is also called the vasopressin test, the arginine vasopressin (AVP) test, or simply ADH.

### Purpose

An ADH test is used alone or in combination with other tests to detect and diagnose ADH deficiency or excess. It also can help determine the cause of an ADH abnormality. In particular, the ADH test is used to help diagnosis central **diabetes insipidus**, nephrogenic diabetes insipidus, and the syndrome of inappropriate ADH (SIADH) secretion:

- Central diabetes insipidus is due either to insufficient ADH production by the hypothalamus or failure of the pituitary gland to release ADH into the bloodstream.
- Nephrogenic diabetes insipidus is caused by the failure of the kidneys to respond to ADH, resulting in the production of large volumes of dilute urine.
- SIADH is an abnormal secretion of ADH and is a common hormonal complication of traumatic brain injury (TBI).

An ADH test may be used to investigate the cause of excessive thirst and frequent urination or low blood **sodium** levels (**hyponatremia**). An ADH test is often used in conjunction with a water-loading ADH suppression test or a water-restriction or water-deprivation ADH stimulation test.

### Description

Water is continually taken into the body with food and fluids and is produced from chemical reactions within the cells of the body. Water is continually lost in urine, feces, sweat, and as water vapor in exhaled breath. ADH controls the amount of water that is reabsorbed by the kidneys and excreted in the urine. When the concentration of blood serum increases or blood volume decreases, ADH is released by the pituitary gland in the brain to signal the kidneys to retain water in the body. This message dilutes the blood, increases blood volume and blood pressure, concentrates the urine, and decreases urine volume. ADH is also released in response to **anxiety** or physical **stress**, such as an injury or surgery. Receptors in the hypothalamus respond to the concentration of dissolved particles in the blood and signal the pituitary to release more or less ADH. Receptors in the heart respond to

## KEY TERMS

**Antidiuretic hormone (ADH); vasopressin**—A polypeptide hormone that is secreted by the pituitary gland along with oxytocin, or is chemically synthesized, and which suppresses water loss and increases blood pressure.

**Diabetes insipidus**—A metabolic disorder in which the pituitary gland produces inadequate amounts of antidiuretic hormone (ADH) or the kidneys are unable to respond adequately to ADH. Primary symptoms are excessive urination and constant thirst.

**Hyponatremia**—A deficiency of sodium in the blood.

**Hypothalamus**—A regulatory center in the brain.

**Pituitary gland**—The most important or “master” endocrine gland, which regulates and controls many body processes as well as the release of hormones by other endocrine glands.

**Syndrome of inappropriate antidiuretic hormone (SIADH)**—A potentially fatal condition of excessive secretion of ADH, leading to concentrated urine and blood sodium deficiency.

blood volume and pressure and signal the pituitary to release more or less ADH.

Various factors can affect ADH production and secretion, thereby disturbing the body’s water balance. Medications such as lithium can block the action of ADH. ADH activity can also be partially blocked by high levels of **calcium** or low levels of potassium in the blood.

Factors that can reduce ADH levels include:

- lying down
- alcohol consumption, which reduces ADH production by direct action on the brain, resulting in a temporary increase in urine production
- high blood pressure
- over-hydration
- hypervolemia—increased blood volume

Drugs that decrease ADH levels include:

- alcohol
- beta-adrenergic agents
- morphine antagonists
- phenytoin (Dilantin)

Factors that can increase ADH levels and cause water retention include:

- nighttime
- standing or exercising
- dehydration
- infection
- pneumonia
- hypovolemia—a decrease in blood volume
- major surgery or serious injury
- severe physical stress from pain, trauma, or prolonged mechanical ventilation

- central nervous system tumors
- ectopic ADH secretion by certain lung cancers and some head and neck tumors

Drugs that increase ADH levels include:

- barbiturates
- cholinergic agents
- estrogen
- nicotine
- histamine
- oral hypoglycemia agents such as chlorpropamide
- some diuretics such as thiazides
- cyclophosphamide
- narcotics such as morphine
- tricyclic antidepressants such as desipramine and amitriptyline
- carbamazepine, an anticonvulsant
- clofibrate, a cholesterol-lowering agent

Drugs that promote ADH action include:

- acetaminophen
- aspirin
- non steroidal anti-inflammatory drugs (NSAIDs)
- metformin and tolbutamide—drugs used to treat type 2 diabetes
- theophylline

Other drugs that can affect the results of an ADH test include:

- clonidine
- haloperidol
- insulin
- steroids

## Preparation

No preparation is needed for an ADH test unless it is being performed as part of a water-deprivation ADH stimulation test or a water-loading ADH suppression test. A water-deprivation ADH stimulation test—which is sometimes used to distinguish between the different types of diabetes insipidus—requires fluid restriction prior to the ADH test, followed by the administration of ADH. A water-loading ADH suppression test—which is sometimes performed to diagnose SIADH—requires **fasting** and drinking specific amounts of water prior to the ADH test.

Blood for an ADH test is withdrawn with a needle from a vein—usually from the inside of the elbow or the back of the hand—and collected in a syringe. With infants or young children, the skin may be punctured with a lancet and the blood collected with a pipette or on a slide or test strip.

## Aftercare

The only aftercare for an ADH test is the possible bandaging of the puncture site where the blood was withdrawn.

## Risks

There are only minimal risks from an ADH test, but these can include:

- difficulty obtaining a blood sample
- a prick, sting, or slight pain with the puncture for blood drawing
- throbbing after the blood is drawn
- slight bleeding from the site where blood is drawn
- faintness or lightheadedness after blood drawing
- hematoma—an accumulation of blood under the puncture site
- infection

A water-deprivation ADH stimulation test or a water-loading ADH suppression test must be performed under close medical supervision. The water-deprivation test can potentially cause severe **dehydration**. The water-loading test can potentially cause severe hyponatremia and may be risky for patients with **kidney disease**.

## Results

Normal ADH levels in the blood depend on the laboratory but range from zero to five picograms per milliliter (pg/mL). ADH test results do not indicate any specific conditions, but must be evaluated within the context of other diagnostic tools. High or low

ADH levels can be temporary or chronic and can be due to various underlying conditions, diseases, infections, trauma or surgery, or excessive water intake.

A high ADH level may indicate:

- SIADH
- central nervous system infection
- central nervous system tumor
- lung infection
- lung tumor
- post-surgical fluid imbalance
- very rarely, acute porphyria—an inherited blood disorder

A low ADH level may indicate:

- diabetes insipidus
- primary polydipsia—excessive or abnormal thirst
- damage to the pituitary gland

## Resources

### OTHER

“ADH.” Lab Tests Online. <http://www.labtestsonline.org/understanding/analytes/adh/glance.html> (accessed September 25, 2010).

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### ORGANIZATIONS

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDKD), Building 31, Room 9A06, 31 Center Dr., MSC 2560, Bethesda, MD, 20892–2560 (301) 496–3583, <http://www2.niddk.nih.gov>.

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Antiemetic drugs see **Antinausea drugs**

Antiepileptic drugs see **Anticonvulsant drugs**

## Antifungal drugs, systemic

### Definition

Systemic antifungal drugs are medicines taken by mouth or by injection to treat internal infections caused by fungi.

### Purpose

Systemic antifungal drugs are used to treat infections in various parts of the body that are caused by a

fungus. A fungus is an organism that can be either one-celled or filamentous. Unlike a plant, which makes its own food, or an animal, which eats plants or other animals, a fungus survives by invading and living off other living things. Fungi thrive in moist, dark places, including some parts of the body.

Fungal infections can either be internal, meaning that the infection occurs within the body, or topical (outside the body), meaning that the infection is superficial and occurs on the skin or nails. Additionally, yeast infections can affect the mucous membranes of the body. Fungal infections on the skin are usually treated with creams or ointments (**topical antifungal drugs**). However, internal infections, many yeast infections, or topical infections that do not clear up after treatment with creams or ointments may need to be treated with systemic antifungal drugs. These drugs are used, for example, to treat common fungal infections such as **candidiasis** (a yeast infection, also known as thrush) that can occur in the throat, in the vagina, or in other parts of the body. They are also used to treat deep fungal infections such as **histoplasmosis**, **blastomycosis**, and **aspergillosis** that can affect the lungs and other organs. They are sometimes used to prevent or treat fungal infections in people whose immune systems are weakened, such as bone marrow or organ transplant patients, individuals undergoing **chemotherapy** or radiation treatment, and individuals with HIV/AIDS.

## Description

Antifungal medications work by utilizing several different mechanisms of action at the cellular level. Some of these medications cause fungal cell death by inhibiting DNA synthesis and protein synthesis in the fungal cell leading to the cell's destruction. Other drugs in this class work by inhibiting ergosterol synthesis in the fungal cell. This leads to increased permeability of the cell wall that results in leakage of cellular content, a precursor to fungal cell death.

Antifungal drugs are categorized depending on their route or site of action, their mechanism of action, and their chemical nature. They come in tablet, capsule, liquid, and injectable forms.

### *U.S. brand names*

Brand names of some antifungal drugs available only by prescription that are approved for use in the United States include:

- amphotericin B (Amphocin, Fungizone)
- capsofungin (Cancidas)
- flucytosine (Ancobon)

## KEY TERMS

**Elixir**—Liquid that contains alcohol, water, and a therapeutic agent.

**Fetus**—A developing baby inside the womb.

**Fungus**—A unicellular or filamentous organism that causes parasitic infections.

**Ointment**—A thick substance that contains medicine and is meant to be spread on the skin, or if an ophthalmic ointment, in the eye.

**Systemic**—A term used to describe a medicine that has effects throughout the body as opposed to topical drugs that work on the skin. Most medicines that are taken by mouth or by injection are systemic drugs.

- fluconazole (Diflucan)
- itraconazole (Sporanox)
- ketoconazole (Nizoral)
- miconazole (Monistat I.V.)
- posaconazole (Noxafil)
- voriconazole (Vfend)

### *Canadian brand names*

Flucytosine is available in Canada under the brand name Ancotil.

## Recommended dosage

The recommended dosage depends on the type of antifungal drug and the nature and extent of fungal infection being treated. Doses may also be different for different patients. The prescribing physician or the pharmacist can provide dosage information. Systemic antifungal drugs must be taken exactly as directed. Itraconazole and ketoconazole should be taken with food.

Fungal infections can take a long time to clear up, so it may be necessary to take the medication for several months, or even for a year or longer. Individuals with **AIDS** may need to continue taking the drugs indefinitely to help prevent re-infection. It is important to keep taking the drug for as long as it is prescribed, even if symptoms seem to improve. If the drug is stopped too soon, the symptoms may return.

Systemic antifungal drugs work best when their amount is kept constant in the body, meaning that they have to be taken regularly at the same time every day without missing any doses.

Patients taking the liquid form of ketoconazole should use a specially marked medicine spoon or other medicine-measuring device to make sure they take the correct amount. A regular household teaspoon may not hold the right amount of medicine. The individual should ask a health care provider about ways to accurately measure the dose of these drugs.

## Precautions

If symptoms do not improve within a few weeks, the individual should inform the physician who prescribed the drug.

While taking this medicine, regular medical visits should be scheduled. The physician needs to check for side effects throughout the period of antifungal therapy.

Some people feel drowsy or dizzy while taking systemic antifungal drugs. Anyone who takes these drugs should not drive, use machines, or do anything else that might be dangerous until they determine how the drugs affect them.

Liver problems, stomach problems, and other problems may occur, especially in people who drink alcohol while taking systemic antifungal drugs. Alcohol and prescription or nonprescription (over-the-counter) drugs or herbal remedies that contain alcohol should be avoided while taking antifungal drugs. (Medicines that may contain alcohol include some **cough** syrups, tonics, and elixirs.) Alcohol should be avoided for at least one day after ending antifungal drug therapy.

The antifungal drug ketoconazole may make the eyes unusually sensitive to light. Wearing sunglasses and avoiding exposure to bright light may help.

## Pregnancy and breastfeeding

In laboratory studies of animals, systemic antifungal drugs have caused **birth defects** and other problems in the mother and fetus. Studies have not been done on pregnant women, so it is not known whether these drugs cause similar effects in people. Women who are pregnant or who plan to become pregnant should check with their physicians before taking systemic antifungal drugs. Any woman who becomes pregnant while taking these drugs should let her physician know immediately.

Systemic antifungal drugs pass into breast milk. This means that they can be passed to a **breastfeeding** infant. Women who are breastfeeding should check with their physicians before using systemic antifungal drugs.

**OTHER CONDITIONS AND ALLERGIES.** People who have medical conditions that deplete stomach acid (achlorhydria) or decrease stomach acid (hypochlorhydria) should inform their physicians about the condition before they use a systemic antifungal drug. These drugs are not active in their natural form, but must be converted to the active form by an acid. If there is not enough stomach acid, the drugs will be ineffective. For people with insufficient stomach acid, it may help to take the medicine with an acidic drink, such as a cola. The patient's health care provider can suggest the best way to take the medicine.

Before using systemic antifungal drugs, people with any of these medical problems should make sure their physicians are aware of their conditions:

- current or past alcohol abuse
- liver disease
- kidney disease

Unusual reactions to systemic antifungal drugs in the past should be discussed with a physician before taking the drugs again. The physician should also be told about **allergies** to any other medications, foods, dyes, preservatives, or other substances.

## Side effects

### *Fluconazole*

Although rare, severe allergic reactions to fluconazole have been reported. Seek immediate medical attention if any of these symptoms develop after taking fluconazole (Diflucan):

- hives, itching, or swelling
- breathing or swallowing problems
- sudden drop in blood pressure
- diarrhea
- abdominal pain

### *Ketoconazole*

Ketoconazole has caused **anaphylaxis** (a life-threatening allergic reaction) in some people after their first dose. This is a rare reaction.

### *Systemic antifungal drugs in general*

Systemic antifungal drugs may cause serious and possibly life-threatening liver damage. Patients who take these drugs should have **liver function tests** before they start taking the medicine and as often as their physician recommends while they are taking it. The physician should be notified immediately if any of these symptoms develop:

- loss of appetite
- nausea or vomiting
- yellow skin or eyes
- unusual fatigue
- dark urine
- pale stools

The most common minor side effects of systemic antifungal drugs are **constipation**, **diarrhea**, **nausea**, **vomiting**, **headache**, drowsiness, **dizziness**, and flushing of the face or skin. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side effects, such as menstrual problems in women, breast enlargement in men, and decreased sexual ability in men also may occur and do not need medical attention unless they do not improve in a reasonable amount of time.

More serious side effects are uncommon, but can occur. If any of the following side effects occur, the individual should check with the physician who prescribed the medicine immediately:

- fever and chills
- skin rash or itching
- high blood pressure
- pain, redness, or swelling at site of injection (for injectable miconazole)

Anyone who has unusual symptoms after taking systemic antifungal drugs should contact his or her physician.

## Interactions

Serious and possibly life-threatening side effects can result if the oral forms of itraconazole or ketoconazole or the injectable form of miconazole are taken with certain drugs. Do not use them with any of the following drugs unless the physician approves of the therapy:

- astemizole (Hismanal)
- antacids
- theophylline-containing anti-wheezing medications

Taking an acid blocker such as cimetidine (Tagamet), esomeprazole (Nexium), famotidine (Pepcid), nizatidine (Axid), omeprazole (Prilosec), or ranitidine (Zantac) at the same time as a systemic antifungal drug may prevent the antifungal drug from working properly. For best results, take the acid blocker at least two hours after taking the antifungal drug.

Systemic antifungal drugs may interact with many other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side

effects may be greater. Anyone taking systemic antifungal drugs should inform the prescribing physician about all other prescription and nonprescription medicines he or she is taking. Among the drugs that may interact with systemic antifungal drugs are:

- acetaminophen (Tylenol)
- birth control pills
- male hormones (androgens)
- female hormones (estrogens)
- antibiotics for other types of infections
- antidepressants
- antihistamines
- muscle relaxants
- medicine for diabetes, such as tolbutamide (Orinase), glyburide (DiaBeta), and glipizide (Glucotrol)
- blood-thinning medicine, such as warfarin (Coumadin)

Other drugs, herbal drugs, or dietary supplements may interact with systemic antifungal drugs. The individual should be sure to check with a physician or pharmacist before combining systemic antifungal drugs with any other medicine.

## Resources

### BOOKS

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### ORGANIZATIONS

American Academy of Dermatology (AAD), P.O. Box 4014, Schaumburg, IL, 60168 (866) 503-SKIN (7546) (847) 240-1859, <http://www.aad.org>.

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## Antifungal drugs, topical

### Definition

Topical antifungal drugs are medicines applied to the skin to treat skin infections caused by a fungus.

### Purpose

Dermatologic fungal infections are usually described by their location on the body. *Tinea pedis*, often called athlete's foot is an infection of the skin of the foot, *tinea unguium* is an infection of the nails, *tinea capitis* is an infection of the scalp, and *tinea corporis* is an infection of the skin on the body such as the chest, arms, or legs. Some fungal infections are called "ring-worm" because the way the fungus grows leaves a red, raised circle around normal skin, making it appear as if there is a worm under the skin. Three types of fungi are involved in most skin infections: *Trichophyton*, *Epidermophyton*, and *Microsporum*. Mild infections can usually be treated successfully with topical medicines; however, severe or resistant infections may require systemic treatment such as antifungal drugs taken by mouth. (See **Antifungal drugs, systemic**.)

### Description

Many drugs currently are available in topical form for fungal infections. The imidazole family of drugs includes miconazole (Micatin, Miconazole), clotrimazole (Lotrimin), econazole (Spectazole), ketocanazole (Nizoral), oxiconazole (Oxistat), sulconazole (Exelderm). The allylamine derivatives include butenafine (Mentax), naftifine (Naftin), and terbinafine (Lamisil). The drugs in this therapeutic class are chemically distinct from each other. All drugs when applied topically have a good margin of safety, and most show a high degree of effectiveness. Although some of the topical antifungals are available without a prescription (over-the-counter), they may not be as effective as prescription drugs for treating all fungal infections.

Traditional antifungal drugs such as undecylenic acid (Cruex, Desenex) and gentian violet (also known as crystal violet) remain available, but have a lower success rate in completely eradicating the fungus than the newer agents and are not recommended. Tolnaftate (Tinactin) has a lower cure rate than the newer drugs, but may be used successfully to prevent rather than cure fungal infection.

### KEY TERMS

**Cream**—A spreadable substance, similar to an ointment, but not as thick. Creams may be more appropriate than ointments for application to exposed skin areas such as the face and hands.

**Ointment**—A thick, spreadable substance that contains medicine and is meant to be used on the skin, or if a vaginal preparation, in the vagina.

**Ophthalmic**—Pertaining to the eye.

**Otic**—Pertaining to the ear.

**Topical**—Not ingested; applied to the outside of the body, for example to the skin, eye, or mouth.

### Recommended dosage

All drugs are applied topically. The individual should consult his or her doctor or pharmacist for specific application instructions.

As with all topical products, the selection of the dosage form may be as important as proper drug selection. Factors that the physician may consider include the presence or absence of hair on the affected area and type of skin to which the medication is to be applied. Thin liquids may be recommended for application to hairy areas, creams for the hands and face, and ointments may be recommended for the trunk and legs. Topical antifungal drugs are also available in shampoos and sprays. Ciclopirox and triacetin are available in formulations for topical treatment of nail fungus as well as skin infections (ciclopirox as Penlac Nail Lacquer and triacetin as Ony-Clear Nail).

Most topical antifungal drugs require at least four weeks of treatment. Infections in some areas, particularly the spaces between toes, may take six weeks or longer to treat successfully. In some cases treatment with oral (taken by mouth) antifungal drugs may be required if the topical antifungal treatment is not effective.

### Precautions

Most topical antifungal agents are well tolerated. The most common adverse effects are local irritation. This may include redness, **itching**, blistering, or a burning sensation. Allergic reactions are possible but rare.

Topical antifungal drugs should only be applied in accordance with labeled uses. They are not intended for ophthalmic (eye) or otic (ear) use. Only drugs

specifically intended for application to mucous membranes (such as the interior of the mouth) should be applied to mucous membranes.

Antifungal drugs have not been evaluated for safety in **pregnancy** and while **breastfeeding**. Although absorption of the drugs is probably low, women who are pregnant or breastfeeding should consult their physicians before using any new medication, even an over-the-counter topical treatment. Gentian violet should not be used by pregnant or breastfeeding women.

## Interactions

Topical antifungal drugs are generally believed to have no negative interactions with foods or other medications. However, individuals should check with their doctor or pharmacist before beginning any new drug treatment.

## Resources

### BOOKS

- Ernst, Erika J. *Antifungal Agents: Methods and Protocols*. Totowa, NJ: Humana Press, 2005.  
 Jucker, Ernst, ed. *Antifungal Agents: Advances and Problems*. Boston: Birkhauser, 2004.  
 Richardson, Malcolm D., and Elizabeth M. Johnson. *The Pocket Guide to Fungal Infection*. 2nd ed. Malden, MA: Blackwell, 2006.

### ORGANIZATIONS

- American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, (847) 240-1859, (866) 503-SKIN (7546), <http://www.aad.org>.

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## Antigas agents

### Definition

Antigas agents are medicines that relieve the uncomfortable symptoms of too much gas (flatulence) in the stomach and intestines.

### Purpose

On average adults pass 1–3 pints of gas daily. Foods that cause gas in one person may not cause them in another. Excess gas can build up in the stomach and intestines for a number of reasons. Eating high-fiber foods, such as beans, grains, and fibrous

## KEY TERMS

**Digestive tract**—The stomach, intestines, and other parts of the body through which food passes.

**Diverticulosis**—A condition in which the colon (large intestine) develops a number of outpouchings or sacs.

**Flatulence**—Excess gas in the digestive tract.

**Irritable bowel disease**—An intestinal disorder often accompanied by abdominal pain and diarrhea.

vegetables is one cause. Some people unconsciously swallow air when they eat, drink, chew gum, or smoke cigarettes. This can lead to uncomfortable amounts of gas in the digestive system. Surgery and certain medical conditions, such as irritable bowel disease, peptic ulcer, and **diverticulosis**, can also lead to gas build-up. Some intestinal parasites also can contribute to the production of severe gas. These parasites need to be treated separately with special drugs that go beyond treating the gas and treat the parasitic infestation. Abdominal **pain**, pressure, bloating, and flatulence are signs of too much gas. Antigas agents help relieve the symptoms by preventing the formation of gas pockets and breaking up gas that already is trapped in the stomach and intestines.

### Description

Antigas agents are sold as capsules, liquids, and tablets (regular and chewable) and can be bought without a physician's prescription. Some common American brands are Gas-X, Flatulex, Mylanta Gas Relief, Di-Gel, Bean-O, and Phazyme. The ingredient that helps relieve excess gas is simethicone. Simethicone does not relieve acid **indigestion**, but some products contain a combination of simethicone and **antacids** to relieve both gas and acid indigestion. Check the label of the product or ask the pharmacist for more information.

### Recommended dosage

Check the product container for dosing information. Typically, the doses should be taken after meals and at bedtime. Chewable forms should be chewed thoroughly.

Check with a physician before giving this medicine to children under age 12 years.

## Precautions

Some anti gas medicines may contain sugar, **sodium**, or other ingredients. Anyone who is on a special diet or who is allergic to any foods, dyes, preservatives, or other substances should check with his or her physician or pharmacist before using any of these products.

Anyone who has had unusual reactions to simethicone, the active ingredient in antigas medicines, should check with his or her physician before taking these drugs.

## Side effects

No common or serious side effects have been reported in people who use this medicine. However, anyone who has unusual symptoms after taking an antigas agent should get in touch with his or her physician.

## Interactions

Antigas agents are not known to interact with any other drugs.

## Resources

### OTHER

“Gas in the Digestive Tract.” *National Digestive Diseases Information Clearinghouse*. January 2006 [cited June 12, 2008]. <http://digestive.niddk.nih.gov/ddiseases/pubs/gas/>  
 Maslari, Joseph and Lance W. Kreplick. “Flatulence (Gas).” *eMedicineHealth.com*. October 21, 2005 [cited June 12, 2008]. [http://www.emedicinehealth.com/flatulence\\_gas/article\\_em.htm](http://www.emedicinehealth.com/flatulence_gas/article_em.htm).

### ORGANIZATIONS

National Digestive Diseases Information Clearinghouse (NDDIC), 2 Information Way, Bethesda, MD, 20892-3570, (703) 738-4929, (800) 891-5389, <http://digestive.niddk.nih.gov>.

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## Antigastroesophageal reflux drugs

### Definition

These drugs are used to treat gastroesophageal reflux, the backward flow of stomach contents into the esophagus.

## KEY TERMS

**Esophagus**—The part of the digestive tract between the pharynx and the stomach. (The pharynx is the space just behind the mouth.)

**Inflammation**—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

## Purpose

The drug discussed here, cisapride (Propulsid), is used to treat nighttime **heartburn** resulting from **gastroesophageal reflux disease** (GERD). In this condition, food and stomach juices flow backward from the stomach into the esophagus, the part of the digestive tract through which food passes on its way from the mouth to the stomach. Normally, a muscular ring called the lower esophageal sphincter (LES) opens to allow food into the stomach and then closes to prevent the stomach’s contents from flowing back into the esophagus. In people with GERD, this muscular ring is either weak or it relaxes at the wrong times. The main symptom is heartburn – a burning sensation centered behind the breastbone and spreading upward toward the neck and throat.

Cisapride works by strengthening the lower esophageal sphincter and making the stomach empty more quickly. This shortens the amount of time that the esophagus comes in contact with the stomach contents. Other drugs, such as H2-blockers are sometimes prescribed to reduce the amount of acid in the stomach.

## Description

Cisapride is available only with a physician’s prescription. Cisapride is sold in tablet and liquid forms.

## Recommended dosage

The dose depends on the patient. The average dose for adults and children age 12 and over is 5-20 mg taken two to four times a day. The medicine should be taken 15 minutes before meals and at bedtime. For children under 12, the dose is based on body weight and should be determined by the child’s physician.

## Precautions

This medicine is effective in treating only nighttime heartburn, not daytime heartburn.

Cisapride may increase the effects of alcohol and tranquilizers.

Cisapride has caused dangerous irregular heartbeats in a few people who took it with other medicines. Anyone who takes this drug should let the physician know all other medicines he or she is taking. Patients with heart problems should check with their physicians before taking cisapride.

Anyone who has bleeding, blockage, or leakage in the stomach or intestines should not take cisapride. Cisapride should not be used by anyone who has had an unusual reaction to the drug in the past. In addition, people with any of the following medical problems should make sure their physicians are aware of their conditions:

- Epilepsy or history of seizures
- Kidney disease
- Liver disease.

The effects of taking cisapride during **pregnancy** have not been fully studied. Women who are pregnant or plan to become pregnant should check with their physicians before taking Cisapride. The drug passes into breast milk and may affect nursing babies. Women who are **breastfeeding** and need to take this medicine should check with their physicians. Avoiding breastfeeding while taking the drug may be necessary.

### Side effects

The most common side effects are abdominal **pain**, bloating, gas, **diarrhea**, **constipation**, **nausea**, upper respiratory infections, inflammation of the nasal passages and sinuses, **headache**, and viral infections. Other side effects may occur. Anyone who has unusual or troublesome symptoms after taking this drug should get in touch with his or her physician.

### Interactions

Cisapride may interact with a variety of other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes Cisapride should let the physician know all other medicines he or she is taking. Among the drugs that may interact with cisapride are:

- Antifungal drugs such as ketoconazole (Nizoral), miconazole (Monistat), and fluconazole (Diflucan)
- Antibiotics such as clarithromycin (Biaxin) and erythromycin (E-Mycin, ERYC)
- Blood-thinners such as warfarin (Coumadin)

- H2-blockers such as cimetidine (Tagamet) and ranitidine (Zantac)
- Tranquilizers such as chlordiazepoxide (Librium), diazepam (Valium), and alprazolam (Xanax).

The list above does not include every drug that may interact with cisapride. Be sure to check with a physician or pharmacist before combining cisapride with any other prescription or nonprescription (over-the-counter) medicine.

### ORGANIZATIONS

National Digestive Diseases Information Clearinghouse (NDDIC), 2 Information Way, Bethesda, MD, 20892-3570, (703) 738-4929, (800) 891-5389, <http://digestive.niddk.nih.gov>.

Pediatric/Adolescent Gastroesophageal Reflux Association, PO Box 7728, Silver Spring, MD, 20907, (301) 601-9541, [gergroup@aol.com](mailto:gergroup@aol.com), <http://www.reflux.org>.

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## Antihelminthic drugs

### Definition

Antihelminthic drugs are used to treat parasitic infestations.

### Purpose

Parasitic infestations are caused by protozoa or worms gaining entry into the body. Most of these organisms cause infections by being ingested in the form of eggs or larvae, usually present on contaminated food or clothing. Others gain entry through breaks in the skin. Common parasitic infestations include **amebiasis**, **malaria**, **giardiasis**, hookworm, pinworm, threadworm, whipworm, and tapeworm infestations. Once in the body, parasitic worms may go unnoticed if they cause no severe symptoms. However, if they multiply rapidly and spread to a major organ, they can cause serious and even life-threatening conditions. Antihelminthic drugs are prescribed to treat these infestations. They function either by destroying the worms on contact, by paralyzing them, or by altering the permeability of their plasma membranes. The dead worms then pass out of the body in the feces.

### Description

Antihelminthic drugs are available only with a prescription and are available as liquids, tablets or capsules. Some commonly used antihelminthics include: albendazole (Albenza), diethylcarbamazine

## KEY TERMS

**Amebiasis**—Parasitic infestation caused by amebas, especially by *Entamoeba histolytica*.

**Colitis**—Inflammation of the colon (large intestine).

**Feces**—The solid waste that is left after digestion. Feces form in the intestines and leave the body through the anus.

**Flukes**—Parasite worms that look like leeches. They usually have one or more suckers for attaching to the digestive mucosa of the host. Liver flukes infest the liver, destroying liver tissue and impairing bile production and drainage.

**Giardiasis**—Parasitic infestation caused by a flagellate protozoan of the genus *Giardia*, especially by *Giardia lamblia*.

**Hallucination**—A false or distorted perception of objective reality. Imaginary objects, sounds, and events are perceived as real.

**Hookworm**—Parasitic intestinal infestation caused by any of several parasitic nematode worms of the family Ancylostomatidae. These worms have strong buccal hooks that attach to the host's intestinal lining.

**Larva**—The immature, early form of an organism that at birth or hatching is not like its parent and has to undergo metamorphosis before assuming adult features.

**Malaria**—Disease caused by the presence of sporozoan parasites of the genus *Plasmodium* in the red blood cells, transmitted by the bite of anopheline mosquitoes, and characterized by severe and recurring attacks of chills and fever.

**Microtubules**—Slender, elongated anatomical channels in worms.

**Nematode**—Roundworm.

**Onchocerciasis**—Parasitic infestation caused by filamentous worms of the genus *Onchocerca*, especially *Onchocerca volvulus*, that is found in

tropical America and is transmitted by several types of blackflies.

**Organism**—A single, independent life form, such as a bacterium, a plant or an animal.

**Parasite**—An organism that lives in or with another organism, called the host, in parasitism, a type of association characterized by the parasite obtaining benefits from the host, such as food, and the host being injured as a result.

**Parasitic**—Of, or relating to a parasite.

**Pinworm**—*Enterobius* vermicularis, a nematode worm of the family Oxyuridae that causes parasitic infestation of the intestines and cecum. Pinworm is endemic in both temperate and tropical regions and common especially in school age children.

**Protozoan**—Any unicellular or multicellular organism containing nuclei and organelles (eukaryotic) of the subkingdom Protozoa.

**Roundworm**—Any round-bodied unsegmented worm as distinguished from a flatworm. Also called a nematode, they look similar to the common earthworm.

**Tapeworm**—Flat and very long (up to 30 meters) intestinal parasitic worms, similar to a long piece of tape. Common tapeworms include: *T. saginata* (beef tapeworm), *T. solium* (pork tapeworm), *D. latum* (fish tapeworm), *H. Nana* (dwarf tapeworm), and *E. granulosus* (dog tapeworm). General symptoms are vague abdominal discomfort, nausea, vomiting, diarrhea and weight loss.

**Threadworm**—Any long, thin nematode worm.

**Trematode**—Any parasitic flatworm of the class Trematoda, as the liver fluke.

**Whipworm**—A nematode worm of the family Trichuridae with a body that is thick at one end and very long and slender at the other end.

(Hetrazan), ivermectin (Stromectol), mebendazole (Vermox), metronidazole (Flagyl), niclosamide (Niclocide), nifurtimox (Lampit, Bayer 2502), oxamniquine (Vansil), pentamidine (Pentam), praziquantel (Biltricide), pyrantel (Antiminth), pyrantel pamoate (Antiminth) and thiabendazole (Mintezol). Some types of parasitic infestations are rarely seen in the United States, thus, the corresponding antihelminthic drugs are not widely distributed and need to be

obtained from the United States Centers for Disease Control and Prevention (CDC) when required.

Most antihelminthic drugs are only active against specific parasites, some are also toxic. Before treatment, the parasites must therefore be identified using tests that look for parasites, eggs, or larvae in feces, urine, blood, sputum, or tissues. Thus, niclosamide is used against tapeworms, but will not be effective for the treatment of pinworm or roundworm infestations,

because it acts by inhibiting ATP production in tape-worm cells. Thiabendazole (Mintezole) is the drug usually prescribed for treatment of threadworm, but a similar drug, mebendazole (Vermox) works better on whipworm by disrupting the microtubules of this worm. Praziquantel is another drug that acts by altering the membrane permeability of the worms.

## Preparation

Dosage is established depending on the patient's general health status and age, the type of antihelminthic drug used, and the type of parasitic infestation being treated. The number of doses per day, the time between doses, and the length of treatment will also depend on these factors.

Antihelminthic drugs must be taken exactly as directed to completely rid the body of the parasitic infestation, and for as long as directed. A second round of treatment may be required to ensure that the infection has completely cleared.

## Precautions

Some antihelminthic drugs work best when ingested along with fatty foods, such as milk or ice cream. Oral drugs should be taken with water during or after meals. The prescribing physician should be informed if the patient has a low-fat or other special diet.

Some antihelminthic drugs, such as praziquantel, come in chewable form. These tablets should not be chewed or kept in the mouth, but should swallowed whole because their bitter taste may cause gagging or **vomiting**.

Antihelminthic drugs sometimes need to be taken with other medications. For example, **steroids** such as prednisone are also prescribed together with the antihelminthic drug for tapeworm to reduce the inflammation that the worm may cause.

When required, pre- or post-treatment purges are also performed with magnesium or sodium sulfate.

Regular medical visits are recommended for people affected by parasitic infestations. The physician monitors whether the infection is clearing or not and also keeps track of unwanted side effects. The prescribing physician should be informed if symptoms do not disappear or if they get worse.

Hookworm or whipworm infections are also treated with iron supplements along with the antihelminthic prescription.

Some types of parasitic infestations (e.g. pin-worms) can be passed from one person to another. It is then often recommended that everyone in the household of an infected person be asked to also take the prescribed antihelminthic drug.

## Risks

People with the following medical conditions may have adverse reactions to antihelminthic drugs. The prescribing physician should accordingly be informed if any of these conditions are present:

- **Allergies.** Anyone who has had adverse reactions to antihelminthic drugs should inform the prescribing physician before taking the drugs again. The physician should also be informed about any other pre-existing allergies.
- **Ulcers.** Antihelminthic drugs are also contraindicated for persons diagnosed with ulcers of the digestive tract, especially ulcerative colitis.
- **Pregnancy.** There is research evidence reporting that some antihelminthic drugs cause birth defects or miscarriage in animal studies. Women who are pregnant or expect to become pregnant should generally avoid these drugs. Pregnant women should accordingly inform the prescribing physician.
- **Breastfeeding.** Some antihelminthic drugs can pass into breast milk. Breastfeeding may have to be discontinued until the antihelminthic treatment has ended and breastfeeding mothers must also inform the prescribing physician.
- **Other risk conditions.** Any of the following medical conditions should also be reported to the prescribing physician: Crohn's disease, liver disease, kidney disease and worm cysts in the eyes.

Common side effects of antihelminthic drugs include **dizziness**, drowsiness, **headache**, sweating, dryness of the mouth and eyes, and ringing in the ears. Anyone taking these drugs should accordingly avoid driving, operating machines or other activities that may be dangerous until they know how they are affected by the drugs. Side effects usually wear off as the body adjusts to the drug and do not usually require medical treatment. Thiabendazole may cause the urine to have an unusual odor that can last for a day after the last dose. Other side effects of antihelminthic drugs, such as loss of appetite, **diarrhea**, **nausea**, **vomiting**, or abdominal cramps are less common. If they occur, they are usually mild and do not require medical attention.

More serious side effects, such as **fever**, chills, confusion, extreme weakness, **hallucinations**, severe diarrhea, nausea or vomiting, skin **rashes**, **low back**

**pain**, dark urine, blurred vision, seizures, and **jaundice** have been reported in some cases. The patient's physician should be informed immediately if any should develop. As a rule, anyone who has unusual symptoms after starting treatment with antihelminthic drugs should notify the prescribing physician.

Antihelminthic drugs may interact with each other or with other drugs, whether prescribed or not. For example, it has been reported that use of the antihelminthic drugs pyrantel and piperazine together lowers the efficiency of pyrantel. Similarly, combining a given antihelminthic drug with another medication may increase the risk of side effects from either drug.

#### ORGANIZATIONS

American Society of Parasitologists, P.O. Box 1897, Lawrence, KS, 66044, (785) 843-6153, (800) 627-0326, <http://asp.unl.edu/>.

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, [cdccinfo@cdc.gov](mailto:cdccinfo@cdc.gov), <http://www.cdc.gov>.

World Health Organization (WHO), Avenue Appia 201211, Geneva, Switzerland, 27, 4122 791-2111, [info@who.int](mailto:info@who.int), <http://www.who.int>.

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## KEY TERMS

**Anus**—The opening at the end of the intestine through which solid waste (stool) passes as it leaves the body.

**Rectum**—The end of the intestine closest to the anus.

**Uterus**—A hollow organ in a female in which a fetus develops until birth.

and **itching**, burning, **pain**, and general discomfort in the anal area. Over-the-counter antihemorrhoid products can relieve many of these symptoms. The products contain combinations of four main types of ingredients:

- Local anesthetics, such as benzocaine, lidocaine, and tetracaine to temporarily relieve the pain
- Vasoconstrictors, such as epinephrine base, epinephrine hydrochloride, ephedrine sulfate and phenylephrine hydrochloride that reduce swelling and relieve itching and discomfort by tightening blood vessels
- Astringents (drying agents), such as witch hazel, calamine, and zinc oxide. These help shrink hemorrhoids by pulling water out of the swollen tissue. This, in turn, helps relieve itching, burning, and irritation.
- Protectants, such as cocoa butter, lanolin, glycerin, mineral oil, and shark liver oil which soothe irritated tissues and form a protective barrier to prevent further irritation.

#### Description

Antihemorrhoid drugs are available as creams, ointments and suppositories. Most can be bought without a physician's prescription.

#### Recommended dosage

Follow package instructions for using these products. Do not use more than the recommended amount of this medicine every day. For explanations or further information about how to use antihemorrhoid drugs, check with a physician or pharmacist.

#### Precautions

Do not use antihemorrhoid drugs for more than seven days in a row. If the problem gets worse or does not improve, check with a physician.

If rectal bleeding continues, check with a physician. This could be a sign of a more serious condition that needs medical attention.

## Side effects

Side effects are rare, however, if a rash or any other sign of an allergic reaction occurs, stop using the medicine.

## Interactions

Some antihemorrhoid drugs should not be used by people who are taking or have recently taken **monoamine oxidase inhibitors** (MAO inhibitors), such as phenelzine (Nardil) or tranylcypromine (Parnate), used to treat conditions including depression and Parkinson's disease. Anyone who is not sure if he or she has taken this type of drug should check with a physician or pharmacist before using an antihemorrhoid drug. People who are taking antidepressants or medicine for high blood pressure also should not use certain antihemorrhoid drugs. Check with a pharmacist for a list of drugs that may interact with specific antihemorrhoid drugs.

## Resources

### OTHER

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"Treatment of Hemorrhoids." *U. S. Pharmacist*. undated [cited June 18, 2008]. <http://www.uspharmacist.com/oldformat.asp?url=newlook/files/feat/acf2f25.htm>.

"Hemorrhoids." *MedlinePlus*. May 27, 2008 [cited June 18, 2008]. <http://www.nlm.nih.gov/medlineplus/hemorrhoids.html>.

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## Antihistamines

### Definition

Antihistamines are drugs that block the action of histamine, a compound released in allergic inflammatory reactions. These drugs block the H<sub>1</sub> receptor sites that are responsible for immediate hypersensitivity reactions such as sneezing and **itching**. Members of this class of drugs may also be used for their side effects, including **sedation** and the prevention of **nausea and vomiting** (antiemesis).

## Antihistamines

Brand name (generic name)	Possible side effects
*Atarax (hydroxyzine hydrochloride)	Drowsiness, dry mouth, headache
Benadryl (diphenhydramine hydrochloride)	Dizziness, drowsiness, muscle weakness, nausea, upset stomach
Claritin (loratadine)	Drowsiness, headache, mouth sores, nosebleeds, sore throat
PBZ-SR (tripelennamine hydrochloride)	Chest congestion, decreased coordination, dizziness, drowsiness, dry mouth and throat, upset stomach
Periactin (cyproheptadine hydrochloride)	Chest congestion, dizziness, drowsiness, fluttery heartbeat, hives, loss of appetite, sleepiness, vision problems
Polaramine (dexchlorpheniramine maleate)	Difficulty urinating, drowsiness, dry mouth, headache
Tavist (clemastine fumarate)	Decreased coordination, dizziness, drowsiness, upset stomach
Zyrtec (cetirizine)	Drowsiness, stomach pain, vomiting

\*Also used in the treatment of anxiety

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## Purpose

Antihistamines block the action of histamine H<sub>1</sub> at its receptor sites. These drugs have no effect on rate of histamine release, nor do they inactivate histamine. By inhibiting the activity of histamine, they can reduce capillary fragility, which produces the erythema, or redness, associated with allergic reactions. They also reduce histamine-induced secretions, including excessive tears and salivation. Additional effects vary with the individual drug used. Several of the older drugs, called first-generation antihistamines, bind non-selectively to H<sub>1</sub> receptors in the central nervous system as well as to peripheral receptors, and can produce sedation, inhibition of nausea and vomiting, and reduction of **motion sickness**. The second-generation antihistamines bind only to peripheral H<sub>1</sub> receptors and reduce allergic response with little or no sedation. Below are listed some common antihistamines and their side effects.

The first-generation antihistamines may be divided into several chemical classes. The side effect profile, which also determines the uses of the drugs, will vary by chemical class. The alkylamines include brompheniramine (Dimetapp) and chlorpheniramine (Chlor-Trimeton). These agents cause relatively little

## KEY TERMS

**Allergen**—A substance that causes an allergy.

**Anaphylaxis**—A sudden, life-threatening allergic reaction.

**Hallucination**—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

**Histamine**—A chemical released from cells in the immune system as part of an allergic reaction.

**Pregnancy category**—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

sedation, and are used primarily for treatment of allergic reactions. Promethazine (Phenergan), in contrast, is a phenothiazine, chemically related to the major tranquilizers, and while it is used for treatment of **allergies**, may also be used as a sedative, to relieve **anxiety** prior to surgery, as an anti-nauseant, and for control of motion sickness. Diphenhydramine (Benadryl) is chemically an ethanolamine, and in addition to its role in reducing allergic reactions, may be used as a nighttime sedative, for control of drug-induced Parkinsonism, and, in liquid form, for control of coughs.

The second generation antihistamines have no central action, and are used only for treatment of allergic reactions. These are divided into two chemical classes. Cetirizine (Zyrtec) is a piperazine derivative, and has a slight sedative effect. Loratadine (Claritin) and fexofenadine (Allegra) are members of the piperadine class and are essentially non-sedating.

### Recommended dosage

Dosage varies with drug, patient, and intended use. Consult a physician, or a pharmacist for further information.

When used for control of allergic reactions, antihistamines should be taken on a regular schedule, rather than on an as-needed basis, since they have no effect on histamine itself, nor on histamine already bound to the receptor site.

The effectiveness of different antihistamine drugs varies a great deal from patient to patient. If an antihistamine fails to provide adequate relief, the individual should switch to a drug from a different chemical class. Individual drugs may be effective in no more than 40% of patients, and provide 50% relief of allergic symptoms.

### Side effects

The frequency and severity of adverse effects varies depending on the specific drug. Not all adverse reactions will apply to every member of this class.

Central nervous system reactions include drowsiness, sedation, **dizziness**, faintness, disturbed coordination, lassitude, confusion, restlessness, excitation, tremor, seizures, **headache**, **insomnia**, euphoria, blurred vision, **hallucinations**, disorientation, disturbing dreams/nightmares, schizophrenic-like reactions, weakness, vertigo, **hysteria**, nerve **pain**, and convulsions. Overdoses may cause involuntary movements. Other problems have been reported.

Gastrointestinal problems include increased appetite, decreased appetite, nausea, **vomiting**, **diarrhea**, and **constipation**.

Hematologic reactions are rare, but may be severe. These include anemia, or breakdown of red blood cells, reduced platelets, reduced white cells, and bone marrow failure.

A large number of additional reactions have been reported. Not all apply to every drug, and some reactions may not be drug related. Some of the other adverse effects are chest tightness, **wheezing**, nasal stuffiness, **dry mouth**, nose and throat, **sore throat**, respiratory depression, sneezing, and a burning sensation in the nose.

Antihistamines, including over-the-counter cold and **cough** medicines, should not be given to children under age two. Children are much more susceptible to developing serious side effects including convulsions. Some young children also respond to antihistamines by becoming restless, nervous, and irritable.

The elderly are also more likely to have side effects from antihistamine drugs. The most common are confusion, dizziness, drowsiness, dry mouth, and difficult or painful urination. Like children, they too may become excessively restless or irritable.

## DANIELE BOVET (1907–1992)

A gifted researcher in therapeutic chemistry, Daniele Bovet was born in Neuchatel, Switzerland, one of four children of a professor of experimental education. Bovet studied zoology and comparative anatomy at the University of Geneva, receiving his doctor of science degree in 1929. He then joined the Pasteur Institute in Paris, becoming director of the Laboratory of Therapeutic Chemistry in 1936.

Bovet investigated histamine, thought to cause allergy symptoms. No antagonist of histamine was known, so Bovet—with his research student Anne-Marie Staub—began studying substances that blocked hormones similar to histamine. By 1937 he had produced the first antihistamine, thymoxydiethylamine. Since this substance was too toxic for human use, Bovet and Staub performed thousands more experiments seeking less toxic antihistamines. This work formed the basis for the development of subsequent clinically useful antihistamines.

Hydroxyzine (Atarax) is thought to cause **birth defects** if used early in **pregnancy** and should be avoided. Less is known about other antihistamine drugs. Chlorpheniramine (Chlor-Trimeton), dexchlorpheniramine (Polaramine), diphenhydramine (Benadryl), brompheniramine (Dimetapp), cetirizine (Zyrtec), cyproheptadine (Periactin), clemastine (Tavist), azatadine (Optimine), loratadine (Claritin) are all listed as category B. Azelastine (Astelin), promethazine (Phenergan) are pregnancy category C drugs.

Regardless of chemical class of the drug, it is recommended that mothers not breastfeed while taking antihistamines.

### Contraindications

The following are absolute or relative contraindications to use of antihistamines. The significance of the contraindication will vary with the drug and dose.

- glaucoma
- hyperthyroidism (overactive thyroid)
- high blood pressure
- enlarged prostate
- heart disease
- ulcers or other stomach problems
- stomach or intestinal blockage
- liver disease
- kidney disease

- bladder obstruction
- diabetes

### Interactions

Antihistamines interact with a very long list of other drugs. To avoid **drug interactions**, before taking antihistamines, the individual should review with a physician or pharmacist all prescription and non-prescription drugs, all herbal remedies and dietary supplements that are being taken.

Monoamine oxidase inhibitor antidepressants (phenelzine [Nardil], tranylcypromine [Parnate]) may prolong and increase the effects of some antihistamines. When used with promethazine (Phenergan) this may cause reduced blood pressure and involuntary movements.

### Resources

#### OTHER

- “Allergy Medications.” *WebMD*. March 1, 2007 [cited June 20, 2008]. <http://www.webmd.com/allergies/guide/allergy-medications>.
- “Antihistamine (Oral Route, Parenteral Route, Rectal Route).” *MayoClinic.com*. May 1, 2008 [cited June 20, 2008].

#### ORGANIZATIONS

- Allergy and Asthma Network: Mothers of Asthmatics (AANMA), 8201 Greensboro Drive, Suite 300, McLean, VA, 22102, (703) 288-5271, (800) 878-4403, <http://www.aanma.org>.
- American Academy of Allergy, Asthma & Immunology, 555 East Wells Street, Suite 1100, Milwaukee, WI, 53202-3823, (414) 272-6071, <http://www.aaaai.org>.
- Asthma and Allergy Foundation of America, 8201 Corporate Drive, Suite 1000, Landover, MD, 20785, (800) 727-8462, [info@aafa.org](mailto:info@aafa.org), <http://www.aafa.org/>.

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Antihyperlipidemic drugs see  
**Cholesterol-reducing drugs**

## Antihypertensive drugs

### Definition

Antihypertensive drugs are medicines that help to lower blood pressure (**hypertension**).

### Purpose

High blood pressure is often called the “silent killer” because the individual rarely sees any obvious

signs that something is wrong until damage to the cardiovascular system has been done. Overall, antihypertensive agents lower blood pressure, although the mechanisms of action vary greatly. Within this therapeutic class, there are several subgroups of drugs. In 2003, a Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure report concluded that antihypertensive treatment can reduce incidence of **stroke** by 35–40%, **heart attack** by 20–25%, and onset of new **heart failure** by 50%. Some of the drugs used to control hypertension listed below are representative, but they are not the only antihypertensive drugs available.

There are several classes of antihypertensive drugs, each with a different mechanism of action to lower blood pressure. Calcium channel blocking agents, also called **calcium channel blockers** or calcium antagonists, inhibit the movement of calcium ions across the cell membrane. This reduces the force of contraction of muscles of the heart and arteries. Although the calcium channel blockers are treated as a group, there are four different chemical classes, leading to significant variations in the activity of individual drugs. Nifedipine (Adalat, Procardia) has the greatest effect on the blood vessels, while verapamil (Calan, Isoptin), and diltiazem (Cardizem) have a greater effect on the heart muscle itself.

Peripheral **vasodilators** such as hydralazine (Apresoline), isoxuprine (Vasodilan), and **minoxidil** (Loniten) act by relaxing blood vessels. When the blood vessels are relaxed they open more widely, and the heart has to work less hard to pump blood. This results in lower blood pressure.

Several groups of drugs act by reducing adrenergic nerve stimulation. This type of excitatory nerve stimulation causes contraction of the muscles in the arteries, veins, and heart. These drugs include the beta-adrenergic blockers and alpha/beta adrenergic blockers. There are also non-specific adrenergic blocking agents.

Beta-adrenergic blocking agents, usually just called beta blockers, include propranolol (Inderal), atenolol (Tenormin), acebutolol (Sectral), metoprolol (Lopressor), nadolol (Corgard), and pindolol (Visken). Propranolol acts on the beta-adrenergic receptors anywhere in the body, and has been used as a treatment for emotional **anxiety** and rapid heart beat. Atenolol and acebutolol act specifically on the nerves of the heart and blood vessels.

There are two alpha/beta adrenergic blockers, labetolol (Normodyne, Trandate) and carvedilol (Coreg). These work similarly to the **beta blockers**.

## Antihypertensive drugs

Brand name (generic name)	Possible side effects
Accupril (quinapril hydrochloride)	Cough, dizziness, headache
Aldactazide (spironolactone and hydrochlorothiazide)	Decreased coordination, diarrhea, fever, headache, upset stomach
Altace (ramipril)	Cough, fatigue, headache
Capoten (captopril)	Decreased sense of taste, itching, rash
Cardizem (diltiazem hydrochloride)	Dizziness, fluid retention, headache, nausea, skin rash
Catapres (clonidine)	Constipation, dizziness, drowsiness, dry mouth
Corgard (nadolol)	Behavioral changes, decreased heartbeat, dizziness, tiredness
Diuril (chlorothiazide)	Constipation or diarrhea, cramps, dizziness, fever, increased glucose level in urine
Dyazide, Maxzide (triamterene and hydrochlorothiazide)	Blurred vision, fatigue, muscle and abdominal pain
DynaCirc (isradipine)	Chest pain, fluid retention, headache, fatigue
HydroDIURIL (hydrochlorothiazide; also used in combination with other drugs, such as fosinopril [brand name Monopril] and metoprolol [Lopressor])	Cramps, diarrhea, hair loss, headache, loss of appetite, nausea and vomiting
Inderal, Inderide (propranolol hydrochloride)	Constipation or diarrhea, nausea and vomiting, tingling sensation
Lasix (furosemide)	Back and muscle pain, indigestion, nausea
Prinivil, Zestril (lisinopril)	Dizziness, fatigue, headache, rash
Lotensin (benazepril hydrochloride)	Dizziness, fatigue, headache, nausea
Lozol (indapamide)	Anxiety, headache, loss of energy, muscle cramps
Minipress (prazosin hydrochloride)	Headache, nausea, weakness
Moduretic (amiloride and hydrochlorothiazide)	Diarrhea, fatigue, itching, loss of appetite
Normodyne (labetalol hydrochloride)	Fatigue, nausea, stuffy nose
Procardia, Procardia XL (nifedipine)	Constipation, fatigue, nausea, swelling
Sectral (acebutolol hydrochloride)	Chest and joint pain, constipation, gas
Tenormin, Tenoretic (atenolol, atenolol and chlorthalidone)	Dizziness, fatigue, nausea
Vaseretic (enalapril and hydrochlorothiazide)	Diarrhea, muscle cramps, rash
Zestoretic (lisinopril hydrochlorothiazide)	Dizziness, fatigue, headache

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**Angiotensin-converting enzyme inhibitors**, called ACE inhibitors, are drugs that block the conversion of the chemical angiotensin I into angiotensin II.

## KEY TERMS

**Adrenergic**—Activated by adrenalin (norepinephrine), loosely applied to the sympathetic nervous system responses.

**Angioedema**—An allergic skin disease characterized by patches of confined swelling involving the skin the layers beneath the skin, the mucous membranes, and sometimes the viscera—called also angioneurotic edema, giant urticaria, Quincke's disease, or Quincke's edema.

**Arteries**—Blood vessels that carry blood away from the heart to the cells, tissues, and organs of the body.

**Diuretic**—A substance that removes water from the body by increasing urine production

**Ion**—An atom or molecule that has an electric charge. In the body ions are collectively referred to as electrolytes.

**Laryngospasm**—Spasmodic closure of the larynx.

**Pregnancy category**—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

**Sympathetic nervous system**—The part of the autonomic nervous system that is concerned especially with preparing the body to react to situations of stress or emergency; it contains chiefly adrenergic fibers and tends to depress secretion, decrease the tone and contractility of smooth muscle, and increase heart rate.

Angiotensin II increases blood pressure by causing blood vessels to constrict (narrow) and increases salt and water retention in the body. Thus, ACE inhibitors lower blood pressure by blocking the formation of angiotensin II. ACE inhibitors include captopril (Capoten), enalapril (Vasotec), and lisinopril (Zestril, Prinivil).

Angiotensin-2 (AT-2) receptor agonists directly inhibit the effects of ACE II rather than blocking its production. Their effect is similar to that of the ACE inhibitors, AT-2 receptor agonists have a less intrusive side effects. ACE II inhibitors include candesartan (Atacand), eprosartan (Teveten), irbesartan (Avapro), telmisartan (Micardis), and valsartan (Diovan).

In addition to these drugs, other drugs are used to lower blood pressure, most notably the **diuretics** (water pills). Diuretics include amiloride (Midamor), bumetanide (Bumex), chlorothiazide (Diuril), furosemide (Lasix), hydrochlorothiazide (Hydrodiuril, Esidrex), indapamide (Lozol), and soironolactone (Aldactone). The drugs in this class appear to lower blood pressure through several mechanisms. By promoting **sodium** (salt) loss, they increase urine production and lower blood volume. At the same time, the pressure of the walls of blood vessels (peripheral vascular resistance) is lowered. Diuretics are commonly the first choice for reduction of mild hypertension, and may be used in combination with other antihypertensive drugs.

Many medicines used to treat high blood pressure combine two different drugs from the groups listed above. The correct choice of an antihypertensive drug depends on how high the individual's blood pressure is, other medical problems present (e.g., diabetes, previous heart attack), and willingness to make lifestyle changes (e.g., diet and **exercise** adjustments). Physicians may try several different antihypertensive drugs before finding a good fit the patient.

### Recommended dosage

Recommended dosage varies with patient, drug, severity of hypertension, and whether the drug is being used alone or in combination with other drugs. Individuals who want more information on how to take their antihypertensive drugs should consult the prescribing physician or the pharmacist who fills the prescription.

### Precautions

The side effects of calcium channel blockers vary a great deal from drug to drug. Possible side effects include heart **palpitations**, fluid retention, swollen ankles, **constipation**, **headache**, and **dizziness**.

Beta blockers may cause a large number of adverse reactions including dangerous heart rate abnormalities. **Pregnancy** risk factor is category B (acebutolol, pindolol, sotalol) or category C (atenolol, labetalol, esmolol, metoprolol, nadolol, timolol,

propranolol, penbutolol, carteolol, bisoprolol). **Breastfeeding** is not recommended.

Peripheral vasodilators may cause dizziness and orthostatic hypotension—a rapid lowering of blood pressure when the patient stands up. Patients taking these drugs must be instructed to rise from bed slowly. Pregnancy risk factors for this group are generally category C. Hydralazine has been shown to cause **cleft palate** in animal studies, but insufficient human data is available. Breastfeeding while taking these drugs is not recommended.

ACE inhibitors generally are well tolerated but rarely may cause dangerous reactions including laryngospasm and angioedema. Persistent **cough** is a common side effect. ACE inhibitors should not be used during pregnancy. When used in pregnancy during the second and third trimesters, angiotension-converting inhibitors (ACEIs) can cause injury to and even **death** in the developing fetus. When pregnancy is detected, discontinue the ACE inhibitor as soon as possible. Breastfeeding while taking these drugs should be avoided.

AT-II receptor inhibitors are generally well tolerated and do not cause cough. Pregnancy risk factor is category C during the first trimester and category D during the second and third trimesters. Drugs that act directly on the renin-angiotensin system can cause fetal and neonatal damage and death when administered to pregnant women. When pregnancy is detected, these drugs should be discontinued as soon as possible. Breastfeeding while taking these drugs is not recommended.

Diuretics commonly cause potassium depletion. At the direction of their physician, patients should have potassium supplementation either through diet (bananas are a good source of potassium) or potassium supplements. Pregnancy risk factor is category B or category C, depending on which diuretic is used. Routine use during normal pregnancy is inappropriate. Diuretics are found in breast milk. Breastfeeding is not recommended.

Because of the large number of classes and individual drugs in this group, specialized references offer more complete information. Physicians should review potential side effects and precautions with the patient at the time the drug is prescribed. Additional questions should be addressed to the prescribing physician or a pharmacist.

## Interactions

These drugs may interact with a wide range of other drugs and herbal supplements. Patients should review with the prescribing physician all medications—

prescription, nonprescription, herbal, and dietary supplements—before starting to take an antihypertensive drug. Specific drug references should be consulted, since interactions vary for antihypertensive drugs.

## Resources

### BOOKS

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### OTHER

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“Comparing Two Kinds of Blood Pressure Medicines: ACEIs and ARBs.” *Agency for Healthcare Research and Quality*. October 2007 [cited June 20, 2008]. <http://effectivehealthcare.ahrq.gov/repFiles/ACEI-ARBConsumer.pdf>.

“High Blood Pressure.” *MedlinePlus*. June 18, 2008 [cited June 20, 2008]. <http://www.nlm.nih.gov/medlineplus/highbloodpressure.html>.

## ORGANIZATIONS

American College of Cardiology, Heart House, 2400 N Street NW, Washington, DC, 20037, (202) 375-6000, ext 5603, (202) 375-7000, (800) 223-4636, ext. 5603, [resource@acc.org](mailto:resource@acc.org), <http://www.acc.org>.

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, [Review.personal.info@heart.org](mailto:Review.personal.info@heart.org).

Heart Failure Society of America, Inc., Court International-Suite 240 S, 2550 University Avenue West, St. Paul, MN, 55114, (651) 642-1633, (651) 642-1502, <http://www.hfsa.org>.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, <http://www.nhlbi.nih.gov>.

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## Anti-hyperuricemic drugs

### Definition

Hyperuricemia is a condition in which there is too much uric acid in the blood. Anti-hyperuricemic drugs are used to treat hyperuricemia and lower the amount of uric acid in the blood.

## KEY TERMS

**Gout**—A condition that may develop in people with high uric acid levels. Characterized by attacks of painful, reddened joints.

**Hyperuricemia**—High uric acid levels in the blood.

### Purpose

Anti-hyperuricemic drugs decrease the levels of uric acid in the blood, either by increasing the rate at which uric acid is excreted in the urine or by preventing the formation of excess uric acid.

### Description

#### U.S. brand names

- allopurinol (Aloprim, Zyloprim)
- probenecid (Benemid)
- febuxostat (Uloric)

#### Canadian brand names

- allopurinol (Alloprim, Apo-Allopurinol, Novo-Purol, and Zyloprim)
- probenecid (Benuryl)

Uric acid is a waste product produced by cellular metabolism that is removed from the blood by the kidneys and eliminated from the body in urine. Purines are compounds that are the building blocks of uric acid. Foods high in purines include organ meat (e.g. liver, heart), yeast and yeast extracts (including alcoholic beverages because they are fermented with yeast), asparagus, spinach, beans, peas, lentils, oatmeal, cauliflower, and mushrooms.

Hyperuricemia can be caused by **kidney disease** that prevents the kidneys from removing enough uric acid or by certain **chemotherapy** drugs that cause high levels of cell **death** and the release of excess purines into the blood. Certain drugs can also cause hyperuricemia.

#### Gout and hyperuricemia

People with high levels of uric acid may develop **gout**. Commonly, gout occurs in males in their 40s and 50s. Gout is defined by the attacks of arthritic painful, reddened joints, and is often accompanied by hard lumps in the painful joints. The most common joint affected is the big toe. **Kidney stones**, and/or poor

kidney function may also be associated with hyperuricemia, but are not considered gout if the patient does not have painful joints. In people with gout, uric acid forms crystals, which then cause the aforementioned painful symptoms. Although uric acid levels must be high in order for crystals to form, most people with high uric acid levels do not ever have these symptoms.

#### Acute gout attacks

When patients experience acute attacks of gout, drugs that lower the levels of uric acid can cause an attack to become more severe. Thus, drugs that lower uric acid levels and are used to treat gout in the long term are not used in the short term. Medications used in acute gout attacks include indomethacin (Indochron E-R, Indocin), colchicine, and **corticosteroids**. Colchicine causes side effects, most often **diarrhea**, in many people. The most important factor in the effective treatment of gout may be how quickly treatment is administered after an acute attack has begun. Raspburicase (Elitek) is used to treat severe hyperuricemia caused by chemotherapy. It has potentially serious side effects.

#### Long-term treatment

Long-term treatment of gout or hyperuricemia usually involves one or more of the following drugs: allopurinol (Zyloprim), probenecid (Benemid), acetazolamide (Diamox), prednisone (Deltasone, Orasone, Meticorten), and potassium citrate (Citra K, Polycitra K). Allopurinol decreases the amount of uric acid that the body produces. Other drugs increase the rate at which uric acid is excreted in the urine.

A newer drug to be approved by the FDA for the treatment of gout is febuxostat (Uloric). This drug is more easily tolerated by people with impaired kidney function.

#### Recommended dosage

Patients taking anti-hyperuricemics should have the dose slowly increased (and uric acid levels slowly lowered) to prevent acute attacks of gout. Patients may also be treated with colchicine or non-steroidal anti-inflammatory drugs to prevent acute attacks of gout.

The recommended initial dosage of allopurinol is 100 mg by mouth taken once daily. This dosage can be increased to as much as 800 mg once a day unless the patient has renal insufficiency. The most common daily dose of allopurinol is 300 mg once per day.

The recommended starting dose of probenecid is 250 mg orally two times a day. This dose can be increased if needed to a maximum of 1,000 mg by mouth three times a day.

The recommended starting dose of febuxostat is 40 mg orally one time per day. The dose can be increased to 80 mg once per day if uric acid levels have not decreased to less than 6 mg per dL after two weeks of the 40 mg per day dose.

## Precautions

Before taking any medication, patients should notify their physician of all other prescription, non-prescription medicine, herbal remedies, and dietary supplements that they are taking. Patients should also tell their physician about any health problems they are experiencing, especially any kidney (renal) problems, since this might affect the type of drug administered. **Allergies** to any of the medications used to treat acute or long-term gout should also be made known.

## Pregnant or breastfeeding

Pregnant women should not use colchicine, as it may cause **birth defects**. Other anti-hyperuricemic drugs cross the placenta. The safety of these drugs to the fetus has not been established, and they should not be taken by pregnant women.

## Side effects

Side effects associated with allopurinol include allergic and hypersensitivity reactions. The drug is to be discontinued at the first sign of a rash, bone marrow suppression, or hepatotoxicity.

Probenecid use may cause flushing, **dizziness**, **fever**, **headache**, **dermatitis**, pruritus, and **anaphylaxis** in individuals with sensitivity to the drug.

Patients taking febuxostat may experience an increase in cardiovascular events such as myocardial infarction, **stroke**, and possibly death. Other adverse events noted in clinical trials with this drug included liver function abnormalities, **nausea**, arthralgia, and rash.

## Interactions

The drugs allopurinol and probenecid have the potential for many drug-to-drug interactions. Patients must inform their health care providers of all of the drugs they are taking including non-prescription drugs which may interact with the antihyperuricemic drugs. For example, taking large amounts of vitamin C with

allopurinol may result in increased kidney stone formation. Allopurinol taken in combination with iron supplements can lead to increased iron uptake by the liver.

Like allopurinol, probenecid has multiple drug-to-drug interactions. Non-prescription drugs may also interact with probenecid. Salicylates, such as **aspirin**, may decrease the effectiveness of probenecid when taken with probenecid.

Febuxostat interacts with the drugs azothioprine (Imuran, Azasan), mercaptopurine (Purinethol, 6MP), and theophylline (Theophylline). These drugs should not be taken with febuxostat.

## Resources

### OTHER

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### ORGANIZATIONS

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), Office of Communications & Public Liaison NIDDK, NIH, Building 31, Rm 9A06, 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560 (301) 496-3583, <http://www2.niddk.nih.gov>.

National Kidney Foundation, Inc., 30 East 33rd Street, New York, NY, 10016 (800) 622-9010, <http://www.kidney.org>.

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## Anti-insomnia drugs

### Definition

Anti-insomnia drugs are medicines that help people fall asleep or stay asleep.

### Purpose

Physicians prescribe anti-insomnia drugs for short-term treatment of insomnia—a condition in

Anti-insomnia drugs	
Brand name (generic name)	Possible side effects
Ambien (zolpidem tartrate)	Daytime drowsiness, dizziness, headache, muscle or joint pain, tremors
Dalmane (flurazepam hydrochloride)	Decreased coordination, irritability, lightheadedness, pain
Doral (quazepam)	Daytime drowsiness, dizziness, dry mouth, headache
Halcion (triazolam)	Chest pain, decreased coordination, memory impairment
Lunesta (eszopiclone)	Daytime drowsiness, decreased libido, heartburn, nausea, pain
ProSom (estazolam)	Dizziness, headache, nausea, sleep inertia (grogginess), weakness
Restoril (temazepam)	Dizziness, fatigue, headache, nausea, sleep inertia
Sonata (zaleplon)	Change in vision, decreased coordination, loss of appetite, numbness or tingling

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which people have trouble falling asleep, staying asleep, or waking up too early and failing to go back to sleep. These drugs are generally used only for occasional treatment of temporary sleep problems and should not be taken for more than a week or two at a time. People whose sleep problems do not improve during this time should return to a physician. Their sleep problems could be a sign of another underlying medical problem.

## Description

The anti-insomnia drug drugs fall into two main categories: drugs that primarily help people fall asleep and drugs that primarily help people stay asleep. **Antidepressant drugs** are also sometimes used to treat **insomnia**, as sleep disturbances often accompany depression, but this is an off-label use. See the entries on antidepressants for more information.

Drugs that help people fall asleep include the sedative-hypnotics eszopiclone (Lunesta), zaleplon (Sonata), and zolpidem (Ambien). These are central nervous system (CNS) depressant. CNS depressants are medicines that slow or “damp down” the nervous system. Ramelteon (Rozerem) is another drug that helps people fall asleep more easily. It is not a CNS depressant but is thought to treat insomnia by affecting melatonin, a hormone that helps to regulate the sleep-wake cycle. Ramelteon is not habit-forming. Triazolam (Halcion) is related to **benzodiazepines**

## KEY TERMS

**Off-label use**—Drugs in the United States are approved by the Food and Drug Administration (FDA) for specific uses, periods of time, or dosages based on the results of clinical trials. However, it is legal for physicians to administer these drugs for other “off-label” or non-approved uses. It is not legal for pharmaceutical companies to advertise drugs for off-label uses.

(discussed below) and also primarily helps people fall asleep.

Physicians also prescribe medicines in the benzodiazepine family, such as flurazepam (Dalmane), quazepam (Doral), estazolam (ProSom), and temazepam (Restoril), for insomnia. Benzodiazepine drugs are described more extensively in the essay on **antianxiety drugs**. The effects of these drugs tends to be more long lasting, thus they may help people fall asleep, but also help them stay asleep. A negative consequence of these drugs is that they may leave people feeling sluggish in the morning. Ambien CR (controlled release) is an extended-release formula that can help people both fall and stay asleep. Lunesta also may help people stay asleep. Unlike drugs in the benzodiazepine family, these two drugs generally leave people feeling alert in the morning.

For people with mild insomnia, some **antihistamines**, such as diphenhydramine (Benadryl) or hydroxyzine (Atarax) may be used, since these also cause sleepiness. These drugs are discussed extensively in the entry on antihistamines.

The **barbiturates**, such as pentobarbital (Nembutal) and secobarbital (Seconal) are no longer commonly used to treat insomnia because they are too dangerous if they are taken in overdoses and the increased likelihood that they will cause dependence.

## Recommended dosage

The recommended dose varies depending on the type of drug prescribed. Drugs intended to help people fall asleep tend to work quickly, often within 20 minutes, so they should be taken right before going to bed. Drugs that help people stay asleep tend to work more slowly.

For older people and others who may be more sensitive to the drug’s effects, the recommended starting dosage is usually reduced.

Zolpidem may be taken with food or on an empty stomach, but it may work faster when taken on an empty stomach. Check with a physician or pharmacists for instructions on how to take the medicine.

## Precautions

Zolpidem and zaleplon are meant only for short-term treatment of insomnia. If sleep problems last more than 7–10 days, check with a physician. The controlled release form on zolpidem (Ambien CR) may safely be used longer for longer periods. Nevertheless, sleep problems lasting more than a week or two could be a sign of another medical problem. Also, many of these drugs tend to lose its effectiveness when taken every night for more than a few weeks.

Some people feel drowsy, dizzy, confused, light-headed, or less alert the morning after they have taken any of these anti-insomnia drugs. This effect is more pronounced with drugs in the benzodiazepine family and usually does not occur with ramelteon. These drugs may also cause clumsiness, unsteadiness, double vision, or other vision problems the next day. For these reasons, anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how zolpidem affects them.

These drugs may cause behavior changes in some people. The changes are similar to those seen in people whose behavior changes when they drink alcohol. Examples include giddiness and rage. More extreme changes, such as confusion, agitation, and **hallucinations**, also are possible. Anyone who starts having strange or unusual thoughts or behavior while taking these or any drug or herbal remedy should get in touch with his or her physician immediately.

Some sleep medicines may cause a special type of temporary **memory loss**, in which the person does not remember what happens between the time they take the medicine and the time its effects wear off. This is usually not a problem, because people normally go to sleep right after taking the medicine and stay asleep until its effects wear off. Nevertheless, it could be a problem for anyone who has to wake up before getting a full night's sleep (seven to eight hours). In particular, travelers should not take sleep medicine on airplane flights of less than seven to eight hours.

The drugs that are **central nervous system depressants** may add to the effects of alcohol and other drugs that slow the central nervous system, such as antihistamines, cold medicine, allergy medicine, medicine for seizures, tranquilizers, some **pain** relievers, and **muscle relaxants**. They may also add to the effects

of anesthetics, including those used for dental procedures. The combining these drugs and alcohol or other CNS depressants can be dangerous, leading to unconsciousness or even **death**. People who take anti-insomnia drugs should not drink alcohol and should check with their physicians before taking any other medications. Anyone who shows signs of an overdose or of the effects of combining these drugs with alcohol or other drugs should have immediate emergency help. Warning signs include severe drowsiness, severe **nausea** or **vomiting**, breathing problems, and staggering.

Anyone who takes anti-insomnia drugs for more than 1–2 weeks should not stop taking it without first checking with a physician. Stopping the drug abruptly may cause rebound insomnia; increased difficulty falling asleep for the first one of two nights after the drug has been discontinued. In rare cases, withdrawal symptoms, such as **vomiting**, cramps, and unpleasant feelings may occur. Gradual tapering may be necessary.

Older people may be more sensitive to the effects of these drugs. This may increase the chance of side effects, such as confusion, and may also increase the risk of falling.

In people with breathing problems, these drugs may worsen the symptoms.

## *Special conditions*

People with certain other medical conditions or who are taking certain other medicines can have problems if they take anti-insomnia drugs. Before taking this medicine, be sure to let the physician know about any of these conditions:

**ALLERGIES.** Anyone who has had unusual reactions to any sleep medicine in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

**PREGNANCY.** Most of these drugs are unsafe for women who are or may become pregnant. Women should check with their physicians about the safety of using anti-insomnia drugs or any other drugs or herbal remedies during **pregnancy**.

**BREASTFEEDING.** Women who are **breastfeeding** not take anti-insomnia medicines without first should checking with their physicians. Many of these drugs pass into breast milk and may have damaging effects on the infant.

**OTHER MEDICAL CONDITIONS.** Before using anti-insomnia drugs, people with any of these medical

problems should make sure their physicians are aware of their conditions:

- chronic lung diseases (emphysema, asthma, or chronic bronchitis)
- liver disease
- kidney disease
- current or past alcohol or drug abuse
- depression
- sleep apnea
- history of substance abuse

### Side effects

The most common minor side effects are daytime drowsiness or a sluggish, unfocused feeling, vision problems, memory problems, nightmares or unusual dreams, vomiting, nausea, abdominal or stomach pain, **diarrhea, dry mouth, headache**, and general feeling of discomfort or illness. These problems usually go away as the body adjusts to the drug and do not require medical treatment.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine as soon as possible:

- confusion
- depression
- clumsiness or unsteadiness

Patients who take anti-insomnia drugs may notice additional side effects for a period after they stop taking the drug. They should check with their physicians if these or other troublesome symptoms occur:

- agitation, nervousness, feelings of panic
- uncontrolled crying
- worsening of mental or emotional problems
- seizures
- tremors
- lightheadedness
- sweating
- flushing
- nausea or abdominal or stomach cramps
- muscle cramps
- unusual tiredness or weakness

Other rare side effects may occur. Anyone who has unusual symptoms after taking zolpidem should get in touch with his or her physician.

### Interactions

Anti-insomnia drugs may interact with many other medicines, street drugs, alcohol, and herbal remedies. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes an anti-insomnia drug should review with his or her physician all other medicines, both prescription and nonprescription, herbal remedies, dietary supplements, and street drugs he or she is taking. Among the drugs that may interact with anti-insomnia drugs are:

- other central nervous system (CNS) depressants such as medicine for allergies, colds, hay fever, and asthma, sedatives, tranquilizers, prescription pain medicine, muscle relaxants, medicine for seizures, barbiturates, and anesthetics.
- the major tranquilizer chlorpromazine (Thorazine).
- tricyclic antidepressants such as imipramine (Tofranil) and amitriptyline (Elavil).

This list is not complete. Check with a physician or pharmacist about additional **drug interactions**.

### Resources

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#### ORGANIZATIONS

American Academy of Sleep Medicine (AASM), 2510 N. Frontage Road, Darien, IL, 60561, (630) 737-9700, (630) 737-9790, [inquiries@aasmnet.org](mailto:inquiries@aasmnet.org), <http://www.aasmnet.org>.

National Center on Sleep Disorders Research, National Heart, Lung, and Blood Institute, National Institutes of Health, P.O. Box 30105, Bethesda, MD, 30105, (301) 592-8573, (240) 629-3246, [nhlbiinfo@nhlbi.nih.gov](mailto:nhlbiinfo@nhlbi.nih.gov), <http://www.nhlbi.nih.gov/about/ncsdr>.

National Sleep Foundation, 1522 K St. NW, Suite 500, Washington, DC, 20005, (202) 347-3471, (202) 347-2472, <http://www.sleepfoundation.org>.

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## Anti-itch drugs

### Definition

Anti-itch drugs are medicines taken by mouth or by injection to relieve **itching**.

### Purpose

The medicine described here, hydroxyzine, is a type of antihistamine used to relieve itching caused by allergic reactions. An allergic reaction occurs when the body is unusually sensitive to some substance, such as pollen, dust, mold, or certain foods or medicine. The body reacts by releasing a chemical called histamine that causes itching and other symptoms, such as sneezing and watery eyes. **Antihistamines** reduce the symptoms by blocking the effects of histamine.

Hydroxyzine is also prescribed for **anxiety** and to help people relax before or after having **general anesthesia**.

### Description

Anti-itch drugs, also called antipruritic drugs, are available only with a physician's prescription and come in tablet and injectable forms. Some commonly used brands of the anti-itch drug hydroxyzine are Atarax and Vistaril.

### Recommended dosage

When prescribed for itching, the usual dosage for adults is 25 mg, three to four times a day. For children over six years of age the usual dosage is 50-100 mg per day, divided into several small doses. The usual dosage for children under six years of age is 50 mg per day, divided into several small doses.

The dosage may be different for different people. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage, and take the medicine exactly as directed.

### Precautions

This medicine should not be used for more than four months at a time because its effects can wear off. See a physician regularly while taking the medicine to determine whether it is still needed.

Hydroxyzine may add to the effects of alcohol and other drugs that slow down the central nervous system, such as other antihistamines, cold medicine, allergy medicine, sleep aids, medicine for seizures, tranquilizers, some **pain** relievers, and **muscle relaxants**. Anyone taking

hydroxyzine should not drink alcohol and should check with his or her physician before taking any of the above.

Some people feel drowsy or less alert when using this medicine. Anyone who takes it should not drive, use machines, or do anything else that might be dangerous until they have found out how the drugs affect them.

Anyone who has had unusual reactions to hydroxyzine in the past should let his or her physician know before taking the medicine again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

A woman who is pregnant or who may become pregnant should check with her physician before taking this medicine. In studies of laboratory animals, hydroxyzine has caused **birth defects** when taken during **pregnancy**. Although the drug's effects on pregnant women have not been fully studied, physicians advise against taking it in early pregnancy.

**BREASTFEEDING.** Women who are **breastfeeding** should also check with their physicians before using hydroxyzine. The medicine may pass into breast milk and may cause problems in nursing babies.

### Side effects

The most common side effect, drowsiness, usually goes away as the body adjusts to the drug. If it does not, reducing the dosage may be necessary. Other side effects, such as **dry mouth**, may occur and do not need medical attention unless they continue.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine as soon as possible:

- Twitches or tremors
- Convulsions (seizures)

### Interactions

Hydroxyzine may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes hydroxyzine should let the physician know all other medicines he or she is taking. Among the drugs that may interact with hydroxyzine are:

- Barbiturates such as phenobarbital and secobarbital (Seconal)
- Opioid (narcotic) pain medicines such as meperidine (Demerol) and oxycodone (Percocet)
- Non-narcotic pain medicines such as acetaminophen (Tylenol) and ibuprofen (Motrin, Advil).

The list above may not include every drug that interacts with hydroxyzine. Be sure to check with a physician or pharmacist before combining hydroxyzine with any other prescription or nonprescription (over-the-counter) medicine.

#### ORGANIZATIONS

National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS), 1 AMS Circle, Bethesda, MD, 20892-3675, (301) 495-4484, (301) 718-6366, (877) 226-4267, NIAMSDinfo@mail.nih.gov, http://www.niams.nih.gov.

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## KEY TERMS

**Glucose**—A simple sugar that serves as the body's main source of energy.

**Hypoglycemia**—Abnormally low levels of glucose in the blood.

**Parasite**—An organism that lives and feeds in or on another organism (the host) and does nothing to benefit the host.

**Protozoa**—Animal-like, one-celled organisms, some of which cause diseases in people.

**Psoriasis**—A skin disease in which people have itchy, scaly, red patches on the skin.

**Purpura**—A spotty or patchy purplish rash caused by bleeding under the surface of the skin.

## Antimalarial drugs

### Definition

Antimalarial drugs are medicines that prevent or treat **malaria**.

### Purpose

Antimalarial drugs treat or prevent malaria, a disease that occurs in tropical, subtropical, and some temperate regions of the world. The disease is caused by a parasite, *Plasmodium*, which belongs to a group of one-celled organisms known as protozoa. The only way to get malaria is to be bitten by a certain type of mosquito that has bitten someone who has the disease.

Thanks to mosquito control programs, malaria has been eliminated in the United States, almost all of Europe, and large parts of Central and South America. However, mosquito control has not worked well in other parts of the world, and malaria continues to be a major health problem in parts of Africa, the Middle East, Southeast Asia, Latin America, Haiti, the Dominican Republic, and some Pacific Islands at elevations below about 6,000 feet (2,000 m). In 2005, as many as 30,000 people from North American and Europe who traveled to these areas contracted malaria. People planning to travel to the tropics are often advised to take antimalarial drugs before, during, and after their trips, to help them avoid getting the disease and bringing it home with them. These drugs kill *Plasmodium* or prevent its growth. In recent years, some strains of *Plasmodium* have become resistant to antimalarial drugs, and medical researchers have stepped up efforts to develop new treatments for malaria including new combination drug such as

Artesunate-Amodiaquine Winthrop (ASAQ), which became available in 2007.

### Description

Antimalarial drugs are available only with a physician's prescription. They come in tablet, capsule, and injectable forms. Different drugs are used to prevent malaria or to treat different stages of the disease. Among the commonly used antimalarial drugs are chloroquine (Aralen), quinine sulfate (Formula Q), mefloquine (Lariam, Mephaquine), halofantrine (Halfan), atovaquone (Mepron), proguanil (Paludrine), atovaquone-proguanil (Malarone), sulfadoxine-pyrimethamine (Fansidar), clindamycin (Cleocin HCl, Cleocin T), doxycycline (Vibramycin, Doryx), and primaquine.

### Recommended dosage

Recommended dosage depends on the type of antimalarial drug, its strength, and the form in which it is being administered (i.e., oral or by injection). The dosage may also be different for different people. The physician who prescribes the drug will determine the correct dosage. Antimalarial drugs should be taken exactly as directed and for the full time of treatment. If the drug is being taken to treat malaria, it should not be stopped just because symptoms begin to improve. Symptoms may return if the drug is stopped too soon. Larger or more frequent doses than the physician has ordered should never be taken nor should the drug be taken for longer than directed.

Travelers taking antimalarial drugs to prevent malaria may be told to take it for one to two weeks before their trip and for four weeks afterward, as well as for the whole time they are away. It is important to follow these directions exactly.

Antimalarial drugs work best when they are taken on a regular schedule. When taken once a week to prevent malaria, they should be taken on the same day of the week. When taken daily or several times a day to treat malaria, they should be taken at the same time every day. Doses should not be missed or skipped.

Some antimalarial drugs should be taken with meals or with milk to prevent upset stomach. Others must be taken with a full glass of water. It is important to follow directions along with the prescription.

## Precautions

Antimalarial drugs may cause lightheadedness, **dizziness**, blurred vision, and other vision changes. Anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

The antimalarial drug mefloquine (Lariam) has received attention because of reports that it causes panic attacks, **hallucinations**, **anxiety**, depression, **paranoia**, and other mental and mood changes, sometimes lasting for months after the last dose in a few patients. The U.S. Food and Drug Administration (FDA) began requiring warnings with Lariam beginning in July 2003 because of serious psychiatric effects caused by the drug. Pharmacists are required to include a 2,000-word medication guide detailing the warnings. Psychiatric side effects are uncommon, but anyone who has unexplained anxiety, depression, restlessness, confusion, or other troubling mental or mood changes after taking mefloquine should call a physician immediately.

Anyone taking antimalarial drugs to prevent malaria who develops a **fever** or flu-like symptoms while taking the medicine or within 2–3 months after traveling to an area where malaria is common should call a physician immediately.

If the drug is being taken to treat malaria and symptoms stay the same or get worse, The patient should check with the physician who prescribed the medicine.

Patients who take this medicine over a long period of time need to have a physician check them periodically for unwanted side effects.

Babies and children are especially sensitive to the antimalarial drug chloroquine. Not only are they more likely to have side effects from the medicine, but they are also at greater risk of being harmed by an overdose. A single 300-mg tablet could kill a small child. *This medicine should be kept out of the reach of children and safety vials should be used.*

## Special conditions

People with certain medical conditions or who are taking certain other medicines can have problems if they take antimalarial drugs. Before taking these drugs, the physician should know about any of these conditions:

**ALLERGIES.** Anyone who has had unusual reactions to antimalarial drugs or related medicines in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

**PREGNANCY.** In laboratory animal studies, some antimalarial drugs cause **birth defects**, but it is also risky for a pregnant woman to get malaria. Untreated malaria can cause premature birth, **stillbirth**, and **miscarriage**. Some antimalarial drugs are known to be unsafe during **pregnancy**, while the safety of others has not been established. If possible, pregnant women should avoid traveling to areas where they could get malaria. If travel is necessary, women who are pregnant or who may become pregnant should check with their physicians about the use of antimalarial drugs.

**BREASTFEEDING.** Some antimalarial drugs pass into breast milk. Babies and young children are particularly sensitive to some of these drugs, so **breastfeeding** may not be desirable. Women who want to breastfeed should check with their physicians before using antimalarial drugs.

**OTHER MEDICAL CONDITIONS.** Before using antimalarial drugs, people who have any of these medical problems (or have had them in the past) should make sure their physicians are aware of their conditions:

- blood disease
- liver disease
- nerve or brain disease or disorder, including seizures (convulsions)
- past or current mental disorder
- stomach or intestinal disease
- deficiency of the enzyme glucose-6-phosphate dehydrogenase (G6PD), which is important in the breakdown of sugar in the body

- deficiency of the enzyme nicotinamide adenine dinucleotide (NADH) methemoglobin reductase
- psoriasis
- heart disease
- family or personal history of the genetic condition favism (a hereditary allergic condition)
- family or personal history of hemolytic anemia, a condition in which red blood cells are destroyed
- purpura
- hypoglycemia (low blood sugar)
- blackwater fever (a serious complication of one type of malaria)
- myasthenia gravis (a disease of the nerves and muscles).

**USE OF CERTAIN MEDICINES.** Taking antimalarial drugs with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

### Side effects

The most common side effects of antimalarial drugs are **diarrhea**, **nausea** or **vomiting**, stomach cramps or **pain**, loss of appetite, **headache**, **itching**, difficulty concentrating, dizziness, lightheadedness, and sleep problems. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side effects, such as hair loss or loss of color in the hair; skin rash; or blue-black discoloration of the skin, fingernails, or inside of the mouth also may occur and do not need medical attention unless they are long-lasting.

More serious side effects are not common, but may occur. If any of the following side effects occur, the physician who prescribed the medicine should be contacted immediately:

- blurred vision or any other vision changes
- convulsions (seizures)
- mood or mental changes
- hallucinations
- anxiety
- confusion
- weakness or unusual tiredness
- unusual bruising or bleeding
- hearing loss or ringing or buzzing in the ears
- fever, with or without sore throat
- slow heartbeat
- pain in the back or legs
- dark urine
- pale skin

- taste changes
- soreness, swelling, or burning sensation in the tongue.

High doses of the antimalarial drug pyrimethamine may cause blood problems that can interfere with healing and increase the risk of infection. People taking this drug should be careful not to injure their gums when brushing or flossing their teeth or using toothpicks. If possible, dental work should be postponed until treatment is complete and the blood has returned to normal.

Other rare side effects may occur. Anyone who has unusual symptoms after taking an antimalarial drug should get in touch with his or her physician.

### Interactions

Some antimalarial drugs may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes antimalarial drugs should let the physician know all other medicines he or she is taking. Among the drugs that interact with some antimalarial drugs are:

- beta blockers such as atenolol (Tenormin), propranolol (Inderal), and metoprolol (Lopressor)
- calcium channel blockers such as diltiazem (Cardizem), nifedipine (Cardene), and nifedipine (Procardia)
- other antimalarial drugs
- quinidine, used to treat abnormal heart rhythms
- antiseizure medicines such as valproic acid derivatives (Depakote or Depakene)
- oral typhoid vaccine
- diabetes medicines taken by mouth
- sulfonamides (sulfa drugs)
- vitamin K
- anticancer drugs
- drugs used to treat overactive thyroid
- antiviral drugs such as zidovudine (Retrovir).

The list above does not include every medicine that may interact with every antimalarial drug. It is advised to check with a physician or pharmacist before combining an antimalarial drug with any other prescription or nonprescription (over-the-counter) medicine, herbal remedy, or dietary supplement.

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**ORGANIZATIONS**

- Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, [cdcinfo@cdc.gov](mailto:cdcinfo@cdc.gov), <http://www.cdc.gov>.
- World Health Organization (WHO), Avenue Appia 201211, Geneva, Switzerland, 27, 4122 791-2111, [info@who.int](mailto:info@who.int), <http://www.who.int>.

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Antimicrobial agents see **Antibiotics**

**Antimigraine drugs**

Brand name (generic name)	Possible side effects
Cafergot (ergotamine and caffeine)	Fluid retention, increased blood pressure, increased heart rate, nausea, numbness, tingling sensation
Imitrex (sumatriptan succinate)	Burning, flushing, inflammation at injection site, neck pain, sore throat, tingling sensation
Inderal (propranolol hydrochloride)	Constipation or diarrhea, headache, nausea, rash
Midrin (acetaminophen, isometheptene, and dichloralphenazone)	Dizziness, rash

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people with very severe or frequent migraines. These include antiseizure medicines (e.g., divalproex sodium/valproate [Depakote, Depacon, Depakene], topiramate [Topamax], gabapentin {Neurontin}); **tricyclic antidepressants** (e.g., amitriptyline [Elavil], doxepin [Adapin], nortriptyline [Aventyl], protriptyline [Vivactil]); selective serotonin reuptake inhibitors (e.g., fluoxetine [Prozac], sertraline [Zoloft], paroxetine [Paxil]); **calcium channel blockers** (e.g., verapamil [Calan, Covera]); and **beta blockers** (e.g., propranolol [Inderal], timolol [Blocadren], nadolol [Corgard], atenolol [Tenormin]).

**Description**

Migraine is thought to be caused by electrical and chemical imbalances in certain parts of the brain. These imbalances affect the blood vessels in the brain, first narrowing them and then widening them. As the blood vessels widen, they stimulate the release of chemicals that increase sensitivity to pain and cause inflammation and swelling. Antimigraine drugs are believed to work by correcting the imbalances and possibly by constricting blood vessels.

There are five classes of drugs given to relieve the symptoms of migraine. These drugs are used to treat headaches once they have started. They should not be taken to prevent headaches. Most of these drugs are available only with a doctor's prescription. Each class of drugs works in a different way. The five drug classes are:

- selective serotonin reuptake agonists such as Sumatriptan (Imitrex); naratriptan (Amerge, Naramig); zolmitriptan (Zomig, Zomig-ZMT); rizatriptan

## KEY TERMS

**Analgesic**—Medicine used to relieve pain.

**Anticonvulsant**—A type of drug given to prevent seizures. Some patients with migraines can be treated effectively with an anticonvulsant.

**Antiemetic**—A drug that helps stop nausea and vomiting.

**Aura**—A set of warning symptoms, such as seeing flashing lights, that some people have 10–30 minutes before a migraine attack.

**Inflammation**—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

**Pregnancy category**—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

**Status migrainosus**—The medical term for an acute migraine headache that lasts 72 hours or longer.

(Maxalt, Maxalt-MLT); almotriptan (Axert); frovatriptan (Frova).

- ergot alkaloids such as Ergotamine tartrate (Cafazine, Cafergot, Cafetrate), Dihydroergotamine (DHE-45).
- analgesics such as Acetaminophen (Tylenol), propoxyphene (Darvon), oxycodone (OxyContin), morphine (Duramorph, MS Contin), meperidine (Demerol), hydromorphone (Dilaudid), butorphanol (Stadol).
- nonsteroidal anti-inflammatory drugs such as aspirin (Bayer Aspirin, Anacin), ibuprofen (Motrin, Ibuprofin), naproxen (Naprosyn, Naprelan), ketorolac (Toradol).
- antiemetics such as Droperidol (Inapsine), chlorpromazine (Thorazine), metoclopramide (Reglan).

### Recommended dosage

Recommended dosage depends on the type of drug. Typical recommended adult dosages of some common antimigraine drugs are given below. However, patients should follow exactly the specific dosage instructions given by their physician and pharmacist.

#### *Ergotamine*

Take at the first sign of a migraine attack. Patients who get warning signals (aura) may take the drug as soon as they know a **headache** is coming.

**TABLETS.** No more than 6 tablets for any single attack.

No more than 10 tablets per week.

**SUPPOSITORIES.** No more than 2 suppositories for any single attack.

No more than 5 suppositories per week.

#### *Naratriptan*

Take as soon as pain or other migraine symptoms begin. Also effective if taken any time during an attack. Do not take the drug until the pain actually starts as not all auras result in a migraine.

**TABLETS.** Usual dose is one 1-mg tablet taken with water or other liquid.

Doses of 2.5-mg may be used, but they may cause more side effects.

If the headache returns or if there is only partial response, the dose may be repeated once after 4 hours, for a maximum dose of 5 mg in a 24-hour period. Larger doses do not seem to offer any benefit.

#### *Sumatriptan*

Take as soon as pain or other migraine symptoms begin. Also effective if taken any time during an attack. Do not take the drug until the pain actually starts as not all auras result in a migraine.

**TABLETS.** Usual dose is one 25-mg tablet, taken with water or other liquid.

Doses should be spaced at least 2 hours apart.

Anyone with **liver disease** should consult with a physician for proper dosing.

**INJECTIONS.** No more than 6 mg per dose, injected under the skin.

No more than two 6-mg injections per day. These doses should be taken at least 1 hour apart.

## Zolmitriptan

Take as soon as symptoms begin.

**TABLETS.** Usual dose is 1–5 mg. Additional doses may be taken at 2-hour intervals.

No more than 10 mg per 24 hour period.

### General dosage advice

Always take antimigraine drugs exactly as directed. Never take larger or more frequent doses, and do not take the drug for longer than directed.

If possible, lie down and relax in a dark, quiet room for a few hours after taking the medicine.

### Precautions

These drugs should be used only to treat the type of headache for which they were prescribed. Patients should not use them for other headaches, such as those caused by **stress** or too much alcohol, unless directed to do so by a physician.

Anyone whose headache is unlike any previous headache should check with a physician before taking these drugs. If the headache is far worse than any other, emergency medical treatment should be sought immediately.

Taking too much of the antimigraine drug ergotamine class of drugs (Ergotamine tartrate [Cafatine, Cafergot, Cafetrate], Dihydroergotamine [DHE-45]), can lead to **ergot poisoning**. Symptoms include headache, muscle pain, **numbness**, coldness, and unusually pale fingers and toes. If not treated, the condition can lead to **gangrene** (tissue death).

Sumatriptan (Imitrex), naratriptan (Amerge), rizatriptan (Maxalt) and zolmitriptan (Zomig) may interact with ergotamine. These drugs should not be taken within 24 hours of taking any drug containing ergotamine.

Some antimigraine drugs work by constricting blood vessels in the brain. Because these drugs also affect blood vessels in other parts of the body, people with coronary heart disease, circulatory problems, or high blood pressure should not take these medicines unless directed to do so by their physicians.

Many migraine attacks do not respond to treatment. If the headache lasts longer than 72 hours—a condition known as status migrainosus—the patient may be given narcotic medications to bring on sleep and stop the attack. Patients with status migrainosus are often hospitalized because they are likely to be dehydrated from severe **nausea and vomiting**.

### Special conditions

People with certain other medical conditions or who are taking certain other medicines can have problems if they take antimigraine drugs. Before taking these drugs, be sure to let the physician know about any of these conditions:

**ALLERGIES.** Anyone who has had unusual reactions to ergotamine, **caffeine**, sumatriptan, zolmitriptan, or other antimigraine drugs in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

**PREGNANCY.** Women who are pregnant should not take any antimigraine drugs in the ergotamine class. Risks to the fetus outweigh any benefits to the mother (**Pregnancy** category X). Other classes of drugs have not been well studied in humans and are classified as pregnancy category C.

**BREASTFEEDING.** Some antimigraine drugs can pass into breast milk and may cause serious health problems in nursing babies. Women who are **breastfeeding** should check with their physicians about whether to stop breastfeeding while taking the medicine.

**OTHER MEDICAL CONDITIONS.** Before using antimigraine drugs, people with any of these medical problems should make sure their physicians know about their conditions:

- coronary heart disease
- angina (crushing chest pain)
- circulatory problems or blood vessel disease
- high blood pressure
- liver problems
- kidney (renal) problems
- any infections
- eye problems.

### Side effects

The most common side effects are fluid retention, flushing, high blood pressure, unusually fast or slow heart rate, numbness, tingling, **itching**, nausea, **vomiting**, weakness, neck or jaw pain and stiffness, feelings of tightness, heaviness, warmth, or coldness, **sore throat**, and discomfort of the mouth and tongue.

More serious side effects are not common, but they may occur. If any of the following side effects occur, call a physician immediately:

- tightness in the chest
- bluish tinge to the skin

- cold arms and legs
- signs of gangrene, such as coldness, dryness, and a shriveled or black appearance of a body part
- dizziness
- drowsiness
- shortness of breath or wheezing
- skin rash
- swelling of the eyelids or face.

Other side effects may occur with any antimigraine drug. Anyone who has unusual symptoms after taking this medicine should get in touch with his or her physician.

### Alternative treatments

Two herbal remedies are reported to be effective as alternative treatments for migraine. One is feverfew (*Tanacetum parthenium*), an herb related to the daisy that is traditionally used in England to prevent migraines. Published studies indicate that feverfew can reduce the frequency and intensity of migraines. It does not, however, relieve pain once the headache has begun. The other herbal remedy is butterbur root (*Petasites hybridus*). Petadolex is a natural preparation made from butterbur root that has been sold in Germany since the 1970s as a migraine preventive. Petadolex has been available in the United States since December 1998.

### Interactions

Antimigraine drugs may interact with other medicines. When this happens, the effects of one or both of the drugs may change, or the risk of side effects may be greater. Anyone who takes these drugs should let the physician know all other medicines he or she is taking. Among the drugs that may interact with antimigraine drugs are:

- beta blockers such as atenolol (Tenormin) and propranolol (Inderal)
- drugs that tighten blood vessels such as epinephrine (EpiPen) and pseudoephedrine (Sudafed)
- nicotine such as cigarettes or Nicoderm, Habitrol, and other smoking-cessation drugs
- certain antibiotics, such as erythromycin and clarithromycin (Biaxin)
- monoamine oxidase inhibitors (MAOIs) such as phenelzine (Nardil) and tranylcypromine (Parnate)
- certain antidepressants, such as sertraline (Zoloft), fluoxetine (Prozac), and paroxetine (Paxil)
- fluvoxamine (Luvox), prescribed for obsessive compulsive disorder or chronic pain.

Naratriptan, sumatriptan, rizatriptan and zolmitriptan may interact with ergotamine. These drugs should not be taken within 24 hours of taking any drug containing ergotamine.

## Resources

### BOOKS

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### ORGANIZATIONS

American Headache Society, 19 Mantua Road, Mount Royal, NJ, 08061, (856) 423-0043, (856) 423-0082, [ahshq@talley.com](mailto:ahshq@talley.com), <http://www.AmericanHeadacheSociety.org>.

American Pain Foundation, 201 North Charles Street, Suite 710, Baltimore, MD, (888) 615-7246, [info@painfoundation.org](mailto:info@painfoundation.org), <http://www.painfoundation.org>.

National Institute of Neurological Disorders and Stroke (NINDS), NIH Neurological Institute, P. O. Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, <http://www.ninds.nih.gov/>.

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## Antimyocardial antibody test

### Definition

Testing for antimyocardial antibodies is done when evaluating a person for heart damage or heart disease.

## KEY TERMS

**Antibody**—A special protein built by the body as a defense against foreign material entering the body.

**Antimyocardial antibody**—An autoantibody that attacks a person's own heart muscle, or myocardium.

**Autoantibody**—An antibody that attacks the body's own cells or tissues.

**Myocardial infarction**—A block in the blood supply to the heart, resulting in what is commonly called a heart attack.

**Myocardium**—The muscular middle layer of the heart.

**Titer**—A dilution of a substance with an exact known amount of fluid. For example, one part of serum diluted with four parts of saline is a titer of 1:4.

### Purpose

Antimyocardial antibodies are autoantibodies. Normal antibodies are special proteins built by the body as a defense against foreign material entering the body. Autoantibodies are also proteins built by the body, but instead of attacking foreign material, they inappropriately attack the body's own cells. Antimyocardial antibodies attack a person's heart muscle, or myocardium.

This test may be done on a person who recently had trauma to the heart, such as heart surgery or a myocardial infarction (**heart attack**). It also may be done on someone with heart disease, such as **cardiomyopathy** or **rheumatic fever**.

Although the presence of antimyocardial antibodies does not diagnose heart damage or disease, there is a connection between the presence of these antibodies and damage to the heart. The amount of damage, however, cannot be predicted by the amount of antibodies.

These antibodies usually appear after heart surgery or the beginning of disease, but they may be present before surgery or the onset of disease. In 30% of people with myocardial infarction and 70% of people having heart surgery, antimyocardial antibodies will appear within two to three weeks and stay for three to eight weeks.

### Description

A 5–10 mL sample of venous blood is drawn from the patient's arm in the region of the inner elbow. Antimyocardial antibodies are detected by combining a patient's serum (clear, thin, sticky fluid in blood) with cells from animal heart tissue, usually that of a monkey. Antimyocardial antibodies in the serum bind to the heart tissue cells. A fluorescent dye is then added to the mixture. This dye will attach to any antibodies and heart tissue cells bound together. The final mixture is studied under a microscope that is designed to

show fluorescence. If fluorescent cells are seen under the microscope, the test is positive.

When the test is positive, the next step is to find out how much antibody is present. The patient's serum is diluted, or titered, and the test is done again. The serum is then further diluted and the test repeated until the serum is so dilute that fluorescence is no longer seen. The last dilution that showed fluorescence is the titer reported.

### Preparation

No **fasting** or special preparation is needed. Before the test is done it should be explained to the patient.

### Aftercare

Discomfort or bruising may occur at the puncture site after the blood is drawn or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs on the puncture site relieve discomfort.

### Normal results

Antimyocardial antibodies are not normally seen in healthy individuals.

### Abnormal results

A positive result means that antimyocardial antibodies are present and that heart disease or damage is likely. Further testing may be needed as other autoantibodies could also be present, causing a false abnormal test.

### Resources

#### BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

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## Antinausea drugs

### Definition

Antinausea drugs are medicines that control nausea—a feeling of sickness or queasiness in the stomach with an urge to vomit. These drugs also prevent or stop **vomiting**. Drugs that control vomiting are called antiemetic drugs.

### Purpose

Antinausea drugs such as prochlorperazine (Compazine), usually control both **nausea and vomiting**. Prochlorperazine is also sometimes prescribed for symptoms of mental disorders, such as **schizophrenia**.

Another commonly prescribed antinausea drug is promethazine (Phenergan). Promethazine also may be prescribed to relieve allergy symptoms and apprehension, as well as **motion sickness**.

### Description

Prochlorperazine is available only with a physician's prescription. It is sold in syrup, capsule, tablet, injection, and suppository forms.

### Recommended dosage

To control nausea and vomiting in adults, the usual dose is:

- Tablets—one 5-mg or 10-mg tablet three to four times a day

Antinausea drugs	
Brand name (generic name)	Possible side effects
Compazine, Compro (prochlorperazine)	Dizziness, involuntary muscle spasms, jitteriness, puckering of the mouth
Phenergan (promethazine hydrochloride)	Dizziness, dry mouth, nausea and vomiting, rash
Reglan (metoclopramide hydrochloride)	Drowsiness, fatigue, restlessness
Tigan (trimethobenzamide hydrochloride)	Blurred vision, cramps, diarrhea, headache
Zofan (ondansetron hydrochloride)	Abdominal pain, constipation, fatigue, headache

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### KEY TERMS

**Anesthetic**—Medicine that causes a loss of feeling, especially pain. Some anesthetics also cause a loss of consciousness.

**Antihistamine**—Medicine that prevents or relieves allergy symptoms.

**Central nervous system**—The brain and spinal cord.

**Spasm**—Sudden, involuntary tensing of a muscle or a group of muscles.

**Tranquilizer**—Medicine that has a calming effect and is used to treat anxiety and mental tension.

- Extended-release capsules—one 15-mg capsule first thing in the morning or one 10-mg capsule every 12 hours
- Suppository—25 mg, twice a day
- Syrup—5–10 mg three to four times a day
- Injection—5–10 mg injected into a muscle three to four times a day.

Doses for children must be determined by a physician.

Promethazine may be administered in pill, syrup, chewable tablet, or extended release capsule form by prescription only. For severe nausea, it may be administered by injection or via a suppository. The physician recommends dose depending on the patient's condition.

### Precautions

Prochlorperazine may cause a movement disorder called **tardive dyskinesia**. Signs of this disorder are involuntary twitches and **muscle spasms** in the face and body and jutting or rolling movements of the tongue. The condition may be permanent. Older people, especially women, are particularly at risk of developing this problem when they take prochlorperazine.

Some people feel drowsy, dizzy, lightheaded, or less alert when using this medicine. The drug may also cause blurred vision, and movement problems. For these reasons, anyone who takes this drug should not drive, use machines or do anything else that might be dangerous until they have found out how the drug affects them.

Prochlorperazine makes some people sweat less, which can allow the body to overheat. The drug may also make the skin and eyes more sensitive to the sun.

People who are taking prochlorperazine should try to avoid extreme heat and exposure to the sun. When going outdoors, they should wear protective clothing, a hat, a sunscreen with a skin protection factor (SPF) of at least 15, and sunglasses that block ultraviolet (UV) light. Saunas, sunlamps, **tanning** booths, tanning beds, hot baths, and hot tubs should be avoided while taking this medicine. Anyone who must be exposed to extreme heat while taking the drug should check with his or her physician.

This medicine adds to the effects of alcohol and other drugs that slow down the central nervous system, such as **antihistamines**, cold and flu medicines, tranquilizers, sleep aids, anesthetics, some **pain** medicines, and **muscle relaxants**. Drinking alcohol while taking prochlorperazine is not advised and patients should check with the physician who prescribed the drug before combining it with any other medicines.

Do not stop taking this medicine without checking with the physician who prescribed it. Stopping the drug suddenly can cause **dizziness**, nausea, vomiting, **tremors**, and other side effects. When stopping the medicine, it may be necessary to taper down the dose gradually.

Prochlorperazine may cause false **pregnancy** tests.

Women who are pregnant (or planning to become pregnant) or **breastfeeding** should check with their physicians before using antinausea medicines.

Before using prochlorperazine, people with any of the medical problems should make sure their physicians are aware of their conditions:

- Previous sensitivity or allergic reaction to prochlorperazine
- Heart disease
- Glaucoma
- Brain tumor
- Intestinal blockage
- Abnormal blood conditions, such as leukemia
- Exposure to pesticides.

Some people may experience side effects from promethazine including:

- dry mouth
- drowsiness
- confusion
- fatigue
- difficulty coordinating movements
- stuffy nose.

A physician should be contacted immediately if a patient experiences the following effects while taking promethazine:

- vision problems
- ringing in the ears
- tremors
- insomnia
- excitement
- restlessness
- yellowing of the skin or eyes
- skin rash.

## Side effects

Many side effects are possible with prochlorperazine, including, but not limited to, **constipation**, dizziness, drowsiness, decreased sweating, **dry mouth**, stuffy nose, movement problems, changes in menstrual period, increased sensitivity to sun, and swelling or pain in breasts. Anyone who has unusual or troublesome symptoms after taking prochlorperazine should get in touch with his or her physician.

Side effects associated with promethazine include those listed above and interactions with various medications that may cause complications or lessen the effects of the drug. A physician should be notified of other medications the patient is on when taking promethazine.

## Interactions

Prochlorperazine may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Among the drugs that may interact with prochlorperazine are antiseizure drugs such as phenytoin (Dilantin) and carbamazepine (Tegretol), anticoagulants such as warfarin (Coumadin), and drugs that slow the central nervous system such as alprazolam (Xanax), diazepam (Valium), and secobarbital (Seconal). Not every drug that interacts with prochlorperazine is listed here. A physician or pharmacist can advise patients about prescription or nonprescription (over-the-counter) drugs that might interact with Prochlorperazine.

## Resources

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## Antinuclear antibody test

### Definition

The antinuclear antibody (ANA) test is a test done early in the evaluation of a person for autoimmune or rheumatic disease, particularly **systemic lupus erythematosus** (SLE).

### Purpose

In autoimmune diseases, the body makes antibodies that work against its own cells or tissues. Rheumatic diseases (diseases that affect connective tissue, including the joints, bone, and muscle) are also associated with these antibodies. Autoantibodies are proteins built by the body, but instead of guarding against foreign material (including bacteria, viruses, and fungi) as normal antibodies do, they attack the body's own cells.

Autoimmune and rheumatic diseases can be difficult to diagnose. People with the same disease can have very different symptoms. A helpful strategy in the diagnosis of these diseases is to find and identify an autoantibody in the person's blood.

The antinuclear antibody test looks for a group of autoantibodies that attack substances found in the center (nucleus) of all cells. It is useful as a screen for many autoantibodies associated with diseases that affect the entire body (systemic diseases).

This test is particularly useful when diagnosing a person with symptoms of SLE, an illness that affects many body organs and tissues. If the test is negative, it is unlikely that the person has SLE; if the test is positive, more tests are done to confirm whether the person has SLE or another related disease. Other diseases, such as **scleroderma**, **Sjögren's syndrome**, **Raynaud's disease**, **rheumatoid arthritis**, and **autoimmune hepatitis**, often have a positive test for antinuclear antibodies.

### Description

Five to 10 mL of blood is needed for this test. The antinuclear antibody test is done by adding a person's

## KEY TERMS

**Antibody**—A special protein built by the immune system as a defense against foreign material entering the body.

**Autoantibody**—An antibody that attacks the body's own cells or tissues.

**Antinuclear antibodies**—Autoantibodies that attack substances found in the center, or nucleus, of all cells.

**Autoimmune disease**—Disease in which the body makes antibodies against its own cells or tissues.

**Titer**—A dilution of a substance with an exact known amount of fluid. For example, one part of serum diluted with four parts of saline is a titer of 1:4.

serum to commercial cells mounted on a microscope slide. If antinuclear antibodies are in the serum, they bind to the nuclei of cells on the slide. Next, a second antibody is added to the mixture. This antibody is “tagged” with a fluorescent dye so that it can be seen. The second antibody attaches to any antibodies and cells bound together and, because of the fluorescent “tag,” the areas with antinuclear antibodies seem to glow, or fluoresce, when the slide is viewed under an ultraviolet microscope.

If fluorescent cells are seen, the test is positive. When positive, the serum is diluted, or titered, and the test done again. These steps are repeated until the serum is so dilute it no longer gives a positive result. The last dilution that shows fluorescence is the titer reported.

The pattern of fluorescence within the cells gives the physician clues as to what the disease might be. The test result includes the titer and the pattern.

This test is also called the fluorescent antinuclear antibody test or FANA. Results are available within one to three days.

### Preparation

No special preparations or diet changes are required before a person undergoes an antinuclear antibody test.

### Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs relieve discomfort.

## Normal results

Normal results will be negative, showing no anti-nuclear antibodies.

## Abnormal results

A positive test in a person with symptoms of an autoimmune or rheumatic disease helps the physician make a diagnosis. More than 95% of people with SLE have a positive ANA test. Scleroderma has a 60–71% positive rate; Sjögren's disease, 50–60%, and rheumatoid arthritis, 25–30%.

Several factors must be considered when interpreting a positive test. Diseases other than autoimmune diseases can cause autoantibodies. Some healthy people have a positive test. More testing is done after a positive test to identify individual autoantibodies associated with the various diseases.

## Resources

### BOOKS

Dehn, Richard W., and David P. Asprey. *Essential Clinical Procedures*. 2nd ed. Philadelphia: Saunders, 2006.

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process called oxidation. In the body, antioxidants combine with potentially damaging molecules called free radicals to prevent the free radicals from causing damage to cell membranes, DNA, and proteins in the cell. Common antioxidants important to human health are **vitamins A, C, E**, beta-carotene, and selenium. In the mid-2000s, about 20% of North Americans and Europeans were taking at least one antioxidant dietary supplement.

## Purpose

The role of antioxidants in the body is complex and not completely understood. Antioxidants combine with free radicals so that the free radicals cannot react with, or oxidize, other molecules. In this way, antioxidants help slow or prevent damage to cells. Damage caused by free radicals is thought to cause or contribute to cardiovascular disease, **cancer**, **Alzheimer's disease**, age-related changes in vision, and other signs of **aging**. However, no direct cause and effect relationship between antioxidant intake and disease prevention has been proven. Antioxidants unrelated to those of importance in the body have commercial uses in the preservation of processed food and in many industrial processes.

## Description

Oxygen is essential to many reactions that occur within cells. Free radicals form mainly as a result of normal cellular metabolism involving oxygen. They can also form in abnormally large amounts when the body is exposed to radiation, ultraviolet light, and toxins such as cigarette smoke or certain chemicals.

## Antioxidants

### Definition

Antioxidants are molecules that prevent oxygen molecules from interacting with other molecules in a

### Health benefits of antioxidants and their food sources

Antioxidant	Health benefits	Food sources
Selenium	Helps maintain healthy hair and nails, enhances immunity, works with vitamin E to protect cells from damage. Reduces the risk of cancer, particularly lung, prostate, and colorectal.	Garlic, seeds, Brazil nuts, meat, eggs, poultry, seafood, whole grains. The amount in plant sources varies according to the content of the soil.
Beta-carotene	Keeps skin healthy, helps prevent night blindness and infections, promotes growth and bone development.	Red, yellow-orange, and leafy green vegetables and fruits, including carrots, apricots, cantaloupe, peppers, tomatoes, spinach, broccoli, sweet potatoes, and pumpkin.
Vitamin E	Acts as the protector of essential fats in cell membranes and red blood cells. Reduces risk of cancer, heart disease, and other age-associated diseases.	Peanut butter, nuts, seeds, vegetable oils and margarine, wheat germ, avocado, whole grains, salad dressings.
Vitamin C	Destroys free radicals inside and outside cells. Helps in the formation of connective tissue, the healing of wounds, and iron absorption, and also helps to prevent bruising and keep gums healthy. May reduce risk of cataracts, heart disease, and cancer.	Peppers, tomatoes, citrus fruits and juices, berries, broccoli, spinach, cabbage, potatoes, mango, papaya.

SOURCE: The American Dietetic Association

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The common feature of free radicals is that their molecular structure contains and unpaired electron. Free radical molecules with an unpaired electron are unstable and have a strong tendency to react with other molecules by “stealing” an electron from them to form a more stable electron pair. This reaction is called oxidation (even when it happens with molecules other than oxygen). In the body, free radicals cause damage when they react with deoxyribonucleic acid (DNA—genetic material), proteins, and lipids (fats). Antioxidants are molecules that react with free radicals in ways that neutralize them so they no longer are able to “steal” electrons and cause damage.

Some important human antioxidants must be acquired through diet, while others can be made by the body. Vitamin C (ascorbic acid), vitamin E (alpha-tocopherol), vitamin A (retinol), and beta-carotene are the most important antioxidants the body must obtain from food sources. Flavonoids found in tea, chocolate, grapes, berries, onions, and wine also appear to have antioxidant activity, although their role in health is unclear. Selenium is sometimes classified as an antioxidant, although strictly, it is not. Selenium is a mineral that must be acquired through diet. Plants grown in geographic locations with selenium rich soil provide a rich source of this mineral. Brazil nuts and tuna also have high levels of selenium. It is a necessary part of enzymes involved in antioxidant reactions. Glutathione and coenzyme Q (ubiquinone) are the most important antioxidants the body can make for itself.

### ***Antioxidants and health***

When free radicals build up faster than antioxidants can neutralize them, the body develops a condition called oxidative stress. Oxidative stress reduces the body's ability to deal with damage to cells and is thought to play a role in the development of chronic diseases such as cardiovascular disease, cancer, and Alzheimer's disease. Researchers know that a diet high in fruits and vegetables containing antioxidants promotes health and decreases the risk of developing some chronic diseases such as **atherosclerosis** (hardening of the arteries). In the early 2000s, dietary supplements containing antioxidants were popularized as a way to reduce oxidative stress, prevent health problems such as cancer, **stroke**, **heart attack**, and **dementia**, and live longer. Research has since shown that although there are relationships between antioxidant levels and health, antioxidant dietary supplements are not magic bullets to prevent age-related diseases.

One problem in determining whether there is a cause and effect relationship between oxidative stress and disease is that often it is not possible to tell if oxidative stress causes a disease or if the disease brings about oxidative stress as a result of biochemical changes in diseased cells. Also, everyone develops oxidative stress as they age, but not everyone develops the same diseases. The interactions between an individual's diet, environment, genetic make-up, and health are complex and still not well understood. Antioxidants remain of great interest to researchers seeking ways to prevent and cure chronic disease. Many clinical trials are underway to determine safety and effectiveness of different antioxidants, both alone and in combination with other drugs and supplements.

**CARDIOVASCULAR DISEASE.** The strongest link between antioxidant levels and health is related to the development of cardiovascular disease. Low-density lipoprotein cholesterol (LDL or “bad cholesterol”) appears to react with free radicals. This changes the LDL cholesterol in a way that allows it to accumulate in cells lining the blood vessels. These cholesterol-loaded cells are precursors to the development of plaque, hard deposits that line blood vessels and cause cardiovascular disease, heart attack, and stroke.

Researchers thought increasing the amount of antioxidants in the blood by taking supplements would decrease the number of free radicals available to interact with LDL cholesterol and thus lower the risk of developing cardiovascular disease. This theory has not been proved. In fact, a paper published in the *Journal of the American Medical Association* on February 28, 2007, analyzed 68 trials of antioxidant supplements involving about 232,600 patients. The authors concluded that antioxidant supplements did not prolong life. In fact, when only rigorous, well-controlled studies were analyzed, the risk of dying increased 5%. This analysis is quite controversial, with some experts questioning the analytical methods used. However, the American Heart Association and similar organizations in other countries advocate cardiovascular disease prevention through consumption of fruits, vegetables, whole grains and nuts high in antioxidants and other heart-protecting nutrients instead of antioxidant supplements.

**CANCER.** Free radicals damage DNA, and sometimes this damage leads to development of cancer. In laboratory cell cultures and animal studies, antioxidants appear to slow the development of cancer. The results have been mixed in studies where humans took antioxidant dietary supplements. A large study of 29,000 men showed that when a beta-carotene dietary

## KEY TERMS

**Coenzyme**—Also called a cofactor; a small non-protein molecule that binds to an enzyme and catalyzes (stimulates) enzyme-mediated reactions.

**Dietary supplement**—A product, such as a vitamin, mineral, herb, amino acid, or enzyme, intended to be consumed in addition to an individual's diet with the expectation that it will improve health.

**Enzyme**—A protein that changes the rate of a chemical reaction within the body without themselves being used up in the reaction.

**Free radical**—A molecule with an unpaired electron that has a strong tendency to react with other molecules in deoxyribonucleic acid (DNA), proteins, and lipids (fats), resulting in damage to cells. Free radicals are neutralized by antioxidants.

**Mineral**—An inorganic substance found in the earth that is necessary in small quantities for the body to maintain a health. Examples: zinc, copper, iron.

**Oxidation**—Interaction in which one molecule removes an electron from another molecule to stabilize itself.

**Retina**—The layer of light-sensitive cells on the back of the eyeball that function in converting light into nerve impulses.

**Vitamin**—An essential nutrient the body needs in small amounts to remain healthy but that the body cannot manufacture for itself and must acquire through diet.

supplement was taken by men who smoked, they developed lung cancer at a rate 18% higher and died at a rate 8% higher than men who did not receive the supplement. Another study that gave men dietary supplements of beta-carotene and vitamin A was stopped when researchers found the men receiving the beta-carotene had a 46% greater chance of dying from lung cancer than those who did not receive the supplement. Other large studies have shown either no or only slight protective effects against cancer. The position of the American Cancer Society, the National Cancer Institute, and several international health organizations is that antioxidants should come from a healthy diet high in fruits and vegetables and low in fat and not from dietary supplements.

**AGE-RELATED VISION IMPAIRMENT.** **Cataracts** and age-related **macular degeneration** are two types of vision impairment common in older individuals. Cataracts develop because of changes in the protein in the lens of the eye. These changes cause the lens to become cloudy and limit vision. The changes may be due to damage by free radicals. Age-related macular degeneration is an irreversible disease of the retina that causes blindness. Two carotenoid antioxidants, zeaxanthin and lutein, are found in the retina and are essential to vision. However, study participants who took antioxidant supplements over several years did not have a reduced risk of developing these diseases.

### Precautions

The mixed results obtained in human studies of antioxidant supplements suggests that all antioxidants

should come from foods and not from dietary supplements. There is also little information on the safety of antioxidant supplements in children and women who are pregnant or **breastfeeding**.

### Interactions

The interaction among various antioxidants, enzymes, coenzymes, drugs, herbal and dietary supplements is complex and incompletely understood. Specific antioxidants may have known interactions and should be discussed with a physician.

### Complications

Antioxidants acquired by eating fruits and vegetables promote health. No complications are expected from antioxidants in food. Antioxidant dietary supplements may interact with other supplements, prescription drugs, over-the-counter drugs, and herbal supplements in ways that cause undesirable side effects. Consult a physician prior to taking an antioxidant supplement.

### Parental concerns

Parents should encourage their children to eat a healthy and varied diet high in fruits, vegetables, and whole grains. There is no need to give children antioxidant dietary supplements. The safety of these supplements in children has not been studied.

## Resources

### BOOKS

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- Challem, Jack and Marie Moneysmith. *Basic Health Publications User's Guide to Carotenoids & Flavonoids: Learn How to Harness the Health Benefits of Natural Plant Antioxidants*. North Bergen, NJ: Basic Health Publications, 2005.
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- Wildman, Robert E. C., ed. *Handbook of Nutraceuticals and Functional Foods*, 2nd ed. Boca Raton, FL: CRC/Taylor&Francis, 2007.

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- National Cancer Institute. "Antioxidants and Cancer Prevention: Fact Sheet." National Institutes of Health. July 28, 2004. [cited April 28, 2007] <http://www.cancer.gov/cancertopics/factsheet/antioxidantsprevention>.

### ORGANIZATIONS

- American Cancer Society, 1599 Clifton Road NE, Atlanta, GA, 30329-4251, (800) ACS-2345, <http://www.cancer.org>.

American Dietetic Association, 120 South Riverside Plaza, Suite 2000, Chicago, IL, 60606-6995, (800) 877-1600, <http://www.eatright.org>.

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, <http://www.americanheart.org>.

Linus Pauling Institute, Oregon State University, 571 Weniger Hall, Corvallis, OR, 97331-6512, (541) 717-5075, (541) 737-5077, <http://lpi.oregonstate.edu>.

Office of Dietary Supplements, National Institutes of Health, 6100 Executive Blvd., Room 3B01, MSC 7517, Bethesda, MD, 20892-7517, (301) 435-2920, (301) 480-1845, <http://dietary-supplements.info.nih.gov>.

Tish Davidson A.M.

## Antiparkinson drugs

### Definition

Antiparkinson drugs are medicines that relieve the symptoms of **Parkinson's disease** and other forms of parkinsonism.

### Purpose

Antiparkinson drugs are used to treat symptoms of parkinsonism, a group of disorders that share four main symptoms: tremor or trembling in the hands, arms, legs, jaw, and face; stiffness or rigidity of the arms, legs, and trunk; slowness of movement (bradykinesia); and poor

### Antiparkinson drugs

Brand name (generic name)	Possible side effects
Artane (trihexyphenidyl hydrochloride)	Blurred vision, dry mouth, nausea, nervousness
Benadryl (diphenhydramine hydrochloride)	Dizziness, drowsiness, loss of balance, upset stomach
Cogentin (benztropine mesylate)	Constipation, dry mouth, nausea and vomiting, rash
Eldepryl (selegiline hydrochloride)	Abdominal and back pain, decreased coordination, depression, drowsiness
Parlodel (bromocriptine mesylate)	Abdominal cramps, constipation, decreased blood pressure, heartburn
Sinemet CR (carbidopa and levodopa)	Confusion, hallucinations, involuntary body movements, nausea

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## KEY TERMS

**Anorexia**—Lack or loss of appetite.

**Anticholinergic**—An agent that blocks the parasympathetic nerves and their actions.

**Bradykinesia**—Extremely slow movement.

**Bruxism**—Compulsive grinding or clenching of the teeth, especially at night.

**Carbon monoxide**—A colorless, odorless, highly poisonous gas.

**Central nervous system**—The brain and spinal cord.

**Chronic**—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

**Hallucination**—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

**Heat stroke**—A severe condition caused by prolonged exposure to high heat. Heat stroke interferes with the body's temperature regulating abilities and can lead to collapse and coma.

**Parkinsonism**—A group of conditions that all have these typical symptoms in common: tremor, rigidity, slow movement, and poor balance and coordination.

**Pregnancy category**—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

**Seizure**—A sudden attack, spasm, or convulsion.

**Spasm**—Sudden, involuntary tensing of a muscle or a group of muscles.

**Tremor**—Shakiness or trembling.

balance and coordination. Parkinson's disease is the most common form of parkinsonism and is seen more frequently with advancing age. Other forms of the disorder may result from viral infections, environmental toxins, **carbon monoxide poisoning**, and the effects of treatment with **antipsychotic drugs**.

The immediate cause of Parkinson's disease or Parkinsonian-like syndrome is the lack of the neurotransmitter dopamine in the brain. Drug therapy may take several forms, including replacement of dopamine, inhibition of dopamine metabolism to increase the effects of the dopamine already present, or sensitization of dopamine receptors. Drugs may be used singly or in combination.

### Description

Levodopa (Larodopa) is the mainstay of Parkinson's treatment. The drug crosses the blood-brain barrier, and is converted to dopamine. The drug may be administered alone, or in combination with carbidopa (Lodosyn) which inhibits the enzyme responsible for the destruction of levodopa. The limitation of levodopa or levodopa-carbidopa therapy is that after approximately two years of treatment, the drugs cease to work reliably. This has been termed the "on-off phenomenon." Additional treatment strategies have

been developed to retard the progression of Parkinsonism, or to find alternative approaches to treatment.

Anticholinergic drugs reduce some of the symptoms of Parkinsonism, and reduce the reuptake of dopamine, thereby sustaining the activity of the natural neurohormone. They may be effective in all stages of the disease. All drugs with anticholinergic properties, the naturally occurring belladonna alkaloids (atropine, scopolamine, hyoscyamine), some **antihistamines** with anticholinergic properties, and synthetics such as benztropine (Cogentin), procyclidine (Kemadrin) and biperiden (Akineton) are members of this group. Although the anticholinergic drugs have only limited activity against Parkinson's disease, they are useful in the early stages, and may be adjuncts to levodopa as the disease progresses.

Amantadine (Symmetrel), was developed for prevention of **influenza** virus infection, but has anti-Parkinsonian properties. Its mechanism of action is not known.

Bromocriptine (Parlodel) is a prolactin inhibitor, which is used for a variety of indications including amenorrhea/galactorrhea, female **infertility**, and acromegaly. It appears to work by direct stimulation of the dopamine receptors. Bromocriptine is used as a late adjunct to levodopa therapy, and may permit reduction in levodopa dosage. Pergolide (Permax) is similar

to bromocriptine, but has not been studied as extensively in Parkinson's disease.

Entacapone (Comtan) appears to act by maintaining levels of dopamine through enzyme inhibition. It is used as an adjunct to levodopa when the patient is beginning to experience the on-off effect. Tolcapone (Tasmar) is a similar agent, but has demonstrated the potential for inducing severe liver failure. As such, tolcapone is reserved for cases where all other adjunctive therapies have failed or are contraindicated.

Selegeline (Carbex, Eldepryl) is a selective monoamine oxidase B (MAO-B) inhibitor, however its mechanism of action in Parkinsonism is unclear, since other drugs with MAO-B inhibition have failed to show similar anti-Parkinsonian effects. Selegeline is used primarily as an adjunct to levodopa, although some studies have indicated that the drug may be useful in the early stages of Parkinsonism, and may delay the progression of the disease.

Pramipexole (Mirapex) and ropinirole (Requip) are believed to act by direct stimulation of the dopamine receptors in the brain. They may be used alone in early Parkinson's disease, or as adjuncts to levodopa in advanced stages.

## Recommended dosage

Dosages of anti-Parkinsonian medications must be highly individualized. All doses must be carefully titrated. Specific drug references should be consulted.

## Precautions

There are a large number of drugs and drug classes used to treat Parkinson's disease, and individual references for each drug should be consulted.

The anticholinergics have a large number of adverse effects, all related to their primary mode of activity. Their cardiovascular effects include tachycardia, **palpitations**, **hypotension**, postural hypotension, and mild bradycardia. They may also cause a wide range of central nervous system effects, including disorientation, confusion, **memory loss**, **hallucinations**, psychoses, agitation, nervousness, **delusions**, **delirium**, **paranoia**, euphoria, excitement, lightheadedness, **dizziness**, **headache**, listlessness, depression, drowsiness, weakness, and giddiness. **Dry mouth**, dry eyes and gastrointestinal distress are common problems. **Sedation** has been reported with some drugs in this group, but this may be beneficial in patients who suffer from **insomnia**. **Pregnancy** risk factor is C. Because anticholinergic drugs may inhibit milk production, their use during **breastfeeding** is not recommended.

Patients should be warned that anticholinergic medications will inhibit perspiration, and so **exercise** during periods of high temperature should be avoided.

Levodopa has a large number of adverse effects. Anorexia and/or, loss of appetite occurs in roughly half the patients using this drug. Symptoms of gastrointestinal upset, such as **nausea and vomiting**, have been reported in 80% of cases. Other reported effects include increased hand tremor; headache; dizziness; **numbness**; weakness and faintness; **bruxism**; confusion; insomnia; nightmares; hallucinations and delusions; agitation and **anxiety**; malaise; **fatigue** and euphoria. Levodopa has not been listed under the pregnancy risk factor schedules, but should be used with caution. Breastfeeding is not recommended.

Amantadine is generally well tolerated, but may cause dizziness and **nausea**. It is classified as pregnancy schedule C. Since amantadine is excreted in breast milk, breastfeeding while taking amantidine is not recommended.

Pergolide and bromocriptine have been generally well tolerated. **Orthostatic hypotension** are common problems, and patients must be instructed to rise slowly from bed. This problem can be minimized by low initial doses with small dose increments. Hallucinations may be a problem. Bromocriptine has not been evaluated for pregnancy risk, while pergolide is category B. Since both drugs may inhibit **lactation**, breastfeeding while taking these drugs is not recommended.

Pramipexole and ropinirole cause orthostatic hypotension, hallucinations and dizziness. The two drugs are in pregnancy category C. In animals, ropinirole has been shown to have adverse effects on embryo-fetal development, including teratogenic effects, decreased fetal body weight, increased fetal **death** and digital malformation. Because these drugs inhibit prolactin secretion, they should not be taken while breastfeeding.

## Side effects

The most common side effects are associated with the central nervous system, and include dizziness, lightheadedness, mood changes and hallucinations. Gastrointestinal problems, including nausea and **vomiting**, are also common.

## Interactions

All anti-Parkinsonian regimens should be carefully reviewed for possible **drug interactions**. Note that combination therapy with anti-Parkinsonian

drugs is, in itself, use of additive and potentiating interactions between drugs, and so careful dose adjustment is needed whenever a drug is added or withdrawn.

Samuel D. Uretsky PharmD

Antiplatelet drugs see **Anticoagulant and antiplatelet drugs**

## Antiprotozoal drugs

### Definition

Antiprotozoal drugs are medicines that treat infections caused by protozoa.

### Purpose

Antiprotozoal drugs are used to treat a variety of diseases caused by protozoa. Protozoa are animal-like, one-celled animals, such as amoebas. Some are parasites that cause infections in the body. African **sleeping sickness**, **giardiasis**, **amebiasis**, *Pneumocystis carinii* **pneumonia** (PCP), and **malaria** are examples of diseases caused by protozoa.

### Description

Antiprotozoal drugs come in liquid, tablet, and injectable forms and are available only with a doctor's prescription.

The antiprotozoal drugs work by exerting several mechanisms of action on the protozoal organism. Some of the drugs kill the organisms by damaging DNA synthesis in the organism's cells. Other mechanisms of action that lead to protozoal cell death include disruption of nucleic acid synthesis, altering cellular protein function, and disrupting microtubule function at the cellular level. All of these actions lead to cell death and result in the death of the organism.

### U.S. brand names

Brand names of antiprotozoal drugs approved for use in the United States include:

- metronidazole (Flagyl)
- eflornithine (Ornidyl)
- furazolidone (Furoxone)
- iodoquinol (Diquinol, Yodoquinol, Yodoxin)
- pentamidine (Pentam 300)

### Recommended dosage

The recommended dosage depends on the type of antiprotozoal drug, its strength, and the medical problem for which it is being used. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage. Always take antiprotozoal drugs exactly as directed.

### Precautions

**Dizziness**, confusion, lightheadedness, or poor alertness may occur when using these drugs. They may also cause blurred vision and other vision problems. Anyone taking antiprotozoal drugs should not drive, use machines, or do anything else that might be dangerous until they determine how the drugs affect them.

The antiprotozoal drug furazolidone may cause very dangerous side effects when taken with certain foods or beverages. Likewise, metronidazole (Flagyl) can cause serious liver damage if taken with alcohol. The physician who prescribed the drug or the pharmacist who filled the prescription can provide a list of products to avoid while taking these medicines.

Previous unusual reactions to antiprotozoal drugs or related medicines should be made known to the physician before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Some antiprotozoal drugs may cause problems with the blood. This can increase the risk of infection or excessive bleeding. Patients taking these drugs should be careful not to injure their gums when brushing or flossing their teeth or using a toothpick. Patients should check with their physician before having any dental work done. Care should also be taken to avoid cuts from razors, nail clippers, or kitchen knives, or household tools.

### Other conditions

People with any of the following medical conditions should discuss the use of antiprotozoal drugs with their physician to prevent potentially harmful interactions:

- anemia or other blood problems
- kidney disease
- heart disease
- low blood pressure
- diabetes
- hypoglycemia (low blood sugar)
- liver disease
- stomach or intestinal disease

## KEY TERMS

**Amebiasis**—An infection caused by an ameba, which is a type of protozoan.

**Fetus**—A developing baby inside the womb.

**Giardiasis**—A condition in which the intestines are infected with *Giardia lamblia*, a type of protozoan.

**Inflammation**—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

**Parasite**—An organism that lives and feeds in or on another organism (the host) and does nothing to benefit the host.

***Pneumocystis carinii* pneumonia**—A severe lung infection caused by a parasitic protozoan. The disease mainly affects people with weakened immune systems, such as people with AIDS.

- nerve or brain disease or disorder, including convulsions (seizures)
- psoriasis (a skin condition)
- hearing loss
- deficiency of the enzyme glucose-6-phosphate dehydrogenase (G6PD)
- eye or vision problems
- thyroid disease

### Side effects

The most common side effects are **diarrhea**, **nausea**, **vomiting**, and stomach **pain**. These problems usually go away as the body adjusts to the drug and do not require medical treatment.

Other rare side effects may occur. Anyone who has unusual symptoms after taking an antiprotozoal drug should get in touch with his or her physician.

A physician should be contacted immediately if any of the following symptoms occur while taking antiprotozoal drugs:

- fever or chills
- signs of cold or flu
- signs of infection, such as redness, swelling, or inflammation
- unusual bruising or bleeding
- black, tarry stools
- blood in urine or stools
- pinpoint red spots on the skin
- unusual tiredness or weakness
- blurred vision or other vision changes
- skin rash, hives, or itching
- swelling of the neck
- clumsiness or unsteadiness
- numbness, tingling, pain, or weakness in the hands or feet
- decrease in urination output

### Pediatric

Children are especially sensitive to the effects of some antiprotozoal drugs and should never be given this medicine unless directed to do so by a physician. This medicine should be kept out of the reach of children and stored in safety vials.

### Pregnant or breastfeeding

The effects of antiprotozoal drugs on pregnant women have not been studied. In experiments with pregnant laboratory animals, some antiprotozoal drugs cause **birth defects** or death of the fetus. Women who are pregnant or who plan to become pregnant should check with their physicians before taking antiprotozoal drugs. Mothers who are **breastfeeding** should also check with their physicians about the safety of taking these drugs.

### Interactions

Antiprotozoal drugs may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Before using antiprotozoal drugs, a patient should notify the physician of other medicines currently being used. Among the drugs that may interact with antiprotozoal drugs are:

- alcohol
- anticancer drugs
- medicine for overactive thyroid
- antiviral drugs such as zidovudine (Retrovir)
- antibiotics
- medicine used to relieve pain or inflammation
- amphetamine
- diet pills (appetite suppressants)
- monoamine oxidase inhibitors (MAO inhibitors) such as phenelzine (Nardil) and tranylcypromine

(Parnate), used to treat conditions including depression and Parkinson's disease

- tricyclic antidepressants such as amitriptyline (Elavil) and imipramine (Tofranil)
- decongestants such as phenylephrine (Neo-Synephrine) and pseudoephedrine (Sudafed)
- other antiprotozoal drugs

Be sure to check with a physician or pharmacist before combining antifungal drugs with any other prescription or nonprescription (over-the-counter) medicine.

## Resources

### PERIODICALS

Farthing, M.J. "Treatment Options for the Eradication of Intestinal Protozoa." *Nature Reviews Clinical Practice Gastroenterology & Hepatology* 3 (August 2006): 436–45.

### OTHER

Chacon-Cruz, Enrique, and Douglas K. Mitchell. "Intestinal Protozoal Diseases." *eMedicine*. November 13, 2009. <http://www.emedicine.medscape.com/article/999282-overview> accessed July 25, 2010.

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Antipruritic drugs see **Anti-itch drugs**

<b>Antipsychotic drugs</b>	
<b>Brand name (generic name)</b>	<b>Possible side effects</b>
Clozaril (clozapine)	Dizziness, fainting, myocarditis, seizures
Compro, Compazine (prochlorperazine)	Dizziness, drooling, jitteriness, lactation, puckering of the mouth, tremors
Haldol (haloperidol)	Blurred vision, dehydration, headache, insomnia, involuntary muscle spasms
Mellaril (thioridazine)	Constipation and diarrhea, drowsiness, irregular heartbeat, sensitivity to light, weight fluctuation
Navane (thiothixene)	Dry mouth, excessive thirst, hives, rash, swelling, weakness
Risperdal (risperidone)	Abdominal and chest pain, fever, headache, involuntary muscle spasms, irritability
Stelazine (trifluoperazine hydrochloride)	Agitation, change in pupil size, drowsiness, fatigue, missed menstrual periods in women or decreased sexual function in men
Thorazine (chlorpromazine)	Fever, involuntary muscle spasms, labored breathing, restlessness

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that is largely specific to bipolar mood disorder, is commonly classified among the antipsychotic agents.

## Description

The antipsychotic agents may be divided by chemical class. The phenothiazines are the oldest group, and include chlorpromazine (Thorazine), mesoridazine (Serentil), prochlorperazine (Compazine), and thioridazine (Mellaril). These drugs are essentially similar in action and adverse effects. They may also be used as anti-emetics, although prochlorperazine is the drug most often used for this indication.

The phenylbutylpiperazines are haloperidol (Haldol) and pimozide (Orap). They find primary use in control of Tourette's syndrome. Haloperidol has been extremely useful in controlling aggressive behavior.

The dibenzepin derivatives, clozapine (Clozaril), loxapine (Loxitane), olanzapine (Zyprexa) and quetiapine (Seroquel), have been effective in controlling psychotic symptoms that have not been responsive to other classes of drugs.

The benzisodihydroindole group is composed of risperidone (Risperidol) and ziprasidone (Geodon). Risperidone

## KEY TERMS

**Agranulocytosis**—An acute condition marked by severe depression of the bone marrow, which produces white blood cells, and by prostration, chills, swollen neck, and sore throat sometimes with local ulceration. Also called agranulocytic angina or granulocytopenia.

**Anticholinergic**—Blocking the action of the neurohormone acetylcholine. The most obvious effects include dry mouth and dry eyes.

**Anticonvulsants**—A class of drugs given to control seizures.

**Pregnancy category**—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies, or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies, or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

has been found useful for controlling bipolar mood disorder, while ziprasidone is used primarily as second-line treatment for schizophrenia.

In addition to these drugs, the class of antipsychotic agents includes lithium carbonate (Eskalith, Lithonate), which is used for control of bipolar mood disorder, and thiothixene (Navane), which is used in the treatment of psychosis.

### Newer agents

Some newer antipsychotic drugs have been approved by the Food and Drug Administration (FDA) in the early 2000s. These drugs are sometimes called second-generation antipsychotics or SGAs. Aripiprazole (Abilify), which is classified as a partial dopaminergic agonist, received FDA approval in August 2003. Two drugs that are still under investigation, a neurokinin antagonist and a serotonin 2A/2C antagonist respectively, show promise in the treatment of schizophrenia and **schizoaffective disorder**.

### Recommended dosage

Dose varies with the drug, condition being treated, and patient response. Specific drug references should be consulted.

### Precautions

**Neuroleptic malignant syndrome (NMS).** NMS is a rare, idiosyncratic combination of extra-pyramidal symptoms (EPS), hyperthermia, and autonomic disturbance. Onset may be hours to months after drug initiation, but once started, proceeds rapidly over 24 to 72 hours. It is most commonly associated with haloperidol, long-acting fluphenazine, but has occurred with thiothixene, thioridazine, and

clozapine, and may occur with other agents. NMS is potentially fatal, and requires intensive symptomatic treatment and immediate discontinuation of neuroleptic treatment. There is no established treatment. Most patients who develop NMS will have the same problem if the drug is restarted.

Agranulocytosis has been associated with clozapine. This is a potentially fatal reaction, but can be prevented with careful monitoring of the white blood count. There are no well-established risk factors for developing agranulocytosis, and so all patients treated with this drug must follow the clozapine Patient Management System. For more information, the reader should call 1-800-448-5938.

Anticholinergic effects, particularly **dry mouth**, have been reported with all of the phenothiazines, and can be severe enough to cause patients to discontinue their medication.

Photosensitization is a common reaction to chlorpromazine. Patients must be instructed to use precautions when exposed to sunlight.

Lithium carbonate commonly causes increased frequency of urination.

The so-called atypical antipsychotics are associated with a substantial increase in the risk of developing **diabetes mellitus**. A study done at the University of Rochester (New York) reported in 2004 that 15.2% of patients receiving atypical antipsychotics developed diabetes, compared with 6.3% of patients taking other antipsychotic medications.

Antipsychotic drugs are **pregnancy** category C. (Clozapine is category B.) The drugs in this class appear to be generally safe for occasional use at low doses during pregnancy, but should be avoided near time of delivery. Although the drugs do not appear to be teratogenic, when used near term, they may cross

the placenta and have adverse effects on the newborn infant, including causing involuntary movements. There is no information about safety in **breastfeeding**.

As a class, the antipsychotic drugs have a large number of potential side effects, many of them serious. Because of the potential severity of side effects, these drugs must be used with special caution in children. Specific drug references should be consulted.

## Interactions

Because the phenothiazines have anticholinergic effects, they should not be used in combination with other drugs that may have similar effects.

Because the drugs in this group may cause **hypotension**, or low blood pressure, they should be used with extreme care in combination with blood pressure-lowering drugs.

The antipsychotic drugs have a large number of **drug interactions**. Specific drug references should be consulted.

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## ORGANIZATIONS

- American Society of Health-System Pharmacists (ASHP), 7272 Wisconsin Avenue, Bethesda, MD, 20814, (301) 657-3000, (866) 279-0681, <http://www.ashp.org>.
- United States Food and Drug Administration (FDA), 10903 New Hampshire Ave, Silver Spring, MD, 202993-0002, (888) 463-6332, <http://www.fda.gov>.

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## Antipsychotic drugs, atypical Definition

The atypical antipsychotic agents, sometimes called the “novel” antipsychotic agents are a group of drugs which are different chemically from the older drugs used to treat **psychosis**. The “conventional” **antipsychotic drugs** are classified by their chemical structures as the phenothiazines, thioxanthines (which are chemically very similar to the phenothiazines), butyrophenones, diphenylbutylpiperadines and the indolones. All of the atypical antipsychotic agents are chemically classified as dibenzepines. They are considered *atypical* or *novel* because they have different side effects from the conventional antipsychotic agents. The atypical drugs are far less likely to cause extra-pyramidal side-effects (EPS), drug induced involuntary movements, than are the older drugs. The atypical antipsychotic drugs may also be effective in some cases that are resistant to older drugs.

The drugs in this group are clozapine (Clozaril), loxapine (Loxitane), olanzapine (Zyprexa), and quetiapine (Seroquel).

### Purpose

The antipsychotic drugs are used to treat severe emotional disorders.

### Recommended dosage

The recommended dose depends on the drug, the patient, and the condition being treated. The normal practice is to start each patient at a low dose, and gradually increase the dose until a satisfactory response is achieved. The dose should be held at the lowest level that gives satisfactory results.

Clozapine usually requires doses between 300 and 600 milligrams a day, but some people require as much

## KEY TERMS

**Anxiety**—An abnormal and overwhelming sense of apprehension and fear often marked by physiological signs (as sweating, tension, and increased pulse), by doubt concerning the reality and nature of the threat, and by self-doubt about one's capacity to cope with it.

**Delusions**—A false belief regarding the self or persons or objects outside the self that persists despite the facts.

**Depression**—A state of being depressed marked especially by sadness, inactivity, difficulty with thinking and concentration, a significant increase

or decrease in appetite and time spent sleeping, feelings of dejection and hopelessness, and sometimes suicidal thoughts or an attempt to commit suicide.

**Glucocorticoid**—Any of a group of corticosteroids (as hydrocortisone or dexamethasone) that are anti-inflammatory and immunosuppressive, and that are used widely in medicine (as in the alleviation of the symptoms of rheumatoid arthritis).

**Psychosis**—A serious mental disorder characterized by defective or lost contact with reality often with hallucinations or delusions.

as 900 milligrams/day. Doses higher than 900 milligrams/day are not recommended.

Loxapine is usually effective at doses of 60-100 milligrams/day, but may be used in doses as high as 250 mg/day if needed.

Olanzapine doses vary with the condition being treated. The usual maximum dose is 20 milligrams/day.

Quetiapine may be dosed anywhere from 150-750 milligrams/day, depending on how well the patient responds.

### Precautions

Although the atypical antipsychotics are generally safe, clozapine has been associated with severe agranulocytosis, a shortage of white blood cells. For this reason, people who may be treated with clozapine should have blood counts before starting the drug, blood counts every week for as long as they are using clozapine, and blood counts every week for the first 4 weeks after they stop taking clozapine. If there is any evidence of a drop in the white blood count while using clozapine, the drug should be stopped.

Atypical antipsychotics should not be used in patients with liver damage, brain or circulatory problems, or some types of blood problems.

### Allergies

People who have had an allergic reaction to one of the atypical antipsychotics should not use that medication again. However, sometimes it is possible to use a different drug from the same group safely.

### Pregnancy

The atypical antipsychotics have not been proved safe in **pregnancy**. They should be used only when clearly needed and when potential benefits outweigh potential hazards to the fetus. These drugs have not been reported in human milk.

### Side effects

Although the atypical antipsychotics are less likely to cause involuntary movements than the older antipsychotic drugs, they still have a large number of adverse effects. Review each drug individually for a full list of possible adverse effects.

### Interactions

Taking atypical antipsychotic medications with certain other drugs may affect the way the drugs work or may increase the chance of side effects. While taking antipsychotic drugs, do not take any other prescription or nonprescription (over-the-counter) drugs without first checking with a physician.

Because the atypical antipsychotics may cause lowering of blood pressure, care should be used when these drugs are taken at the same time as other drugs which lower blood pressure.

Quetiapine has many interactions. Doses should be carefully adjusted when quetiapine is used with ketoconazole, itraconazole, fluconazole, erythromycin, carbamazepine, **barbiturates**, rifampin or glucocorticoids including prednisone, dexamethasone and methylprednisolone.

These drugs will also require dose adjustments when used with anti-Parkinson medications.

## Resources

### BOOKS

Carter, Rita. *The Human Brain Book*. New York: DK Adult, 2009.

Samuel D. Uretsky PharmD

## Anti-rejection drugs

### Definition

Anti-rejection drugs are daily medications taken by organ transplant patient's to prevent organ rejection.

### Purpose

Anti-rejection drugs, which are also called immunosuppressants, help to suppress the immune system's response to a new organ. When a new organ is placed inside a patient's body, the patient's immune system recognizes the organ as foreign tissue and tries to reject it.

### Description

When a physician prescribes anti-rejection drugs, the patient's risk of rejection and susceptibility to side effects are considered. The most common drugs prescribed to prevent organ rejection are cyclosporine, prednisone, azathioprine, tacrolimus or FK506, mycophenolate mofetil, sirolimus, and OKT3, as well as ATGAM and Thymoglobulin. As is true with all medications, each of these drugs has benefits and drawbacks. Cyclosporine, which is one of the most frequently used anti-rejection drugs, is usually combined with prednisone. An extremely powerful medicine, cyclosporine is usually taken by a patient over the course of his or her lifetime. Cortisol, which is the naturally produced form of prednisone in a person's body, helps the body manage **stress**, such as infections or organ rejection. Taking prednisone results in less cortisol production in a person's body, thus minimizing the risk of rejection. Azathioprine, which needs to be taken with food to avoid stomach upset, is frequently combined with cyclosporine, prednisone, or tacrolimus. Mycophenolate mofetil is a relatively new immunosuppressant that is similar to azathioprine; therefore, the two drugs should not be taken together. It is preferable to take mycophenolate mofetil on an empty stomach; however, like azathioprine, it can be taken with food because it, too, can cause stomach problems, such as **heartburn** and **nausea**. Like azathioprine, mycophenolate mofetil is not a stand-alone drug;

instead, it must be used in combination with other medications. This is also the case with regard to sirolimus.

Physicians prescribe either mycophenolate mofetil or azathioprine (in combination with other **immunosuppressant drugs**) to help patients cope with acute bouts of organ rejection. The medications work by interfering with the multiplication process of white blood cells, which is part of the body's natural defense system when foreign invaders, such as a new organ, are detected. However, researchers at Duke University and the University of Florida found that mycophenolate mofetil doesn't work any better than azathioprine, but costs significantly more. Aside from cost, another consideration also needs to be the type of organ transplanted, because acute rejection rates differ. For example, six months after surgery, approximately 15% of kidney recipients will have an acute rejection episode as compared to approximately 60% of lung recipients. And because study results vary depending on the organ transplanted, more research is needed with regard to the success of mycophenolate mofetil as compared to azathioprine.

OKT3 prevents is prescribed to prevent organ rejection immediately after surgery and is also used to treat acute rejection episodes; ATGAM and Thymoglobulin, which are similar to OKT3, are used for the same reasons. All three drugs are given intravenously.

Tacrolimus, which is also known as FK506, is a fairly new drug that is considered by many experts to be as effective as cyclosporine. An alternative drug choice for patients that cannot tolerate cyclosporine, tacrolimus has been the subject of much research in recent years. Used to treat rejection episodes that are acute or chronic in nature, tacrolimus is being studied to see if using it will allow patients to reduce their dosage of prednisone without organ rejection.

In a presentation at the 2003 American Transplant Congress, surgeons from the University of Pittsburgh reported that an innovative clinical protocol developed by Dr. Thomas E. Starzl was implemented, which reduced the dosage of tacrolimus needed by lung transplant patients with excellent success. Patients required lower doses of prednisone as well. In fact, in some cases, patients were taking tacrolimus only once a day (rather than twice a day) or only four times a week. Over the long term, physicians hope that there will be less risk of lung recipients developing the kinds of complications normally associated with high levels of immunosuppressants, such as kidney dysfunction, which is a common problem faced by lung transplant patients.

Dr. Thomas E. Starzl, the renowned physician often referred to as the modern-day father of transplantation, developed the protocol based on the knowledge that some of his patients had stopped taking their daily pills with no ill effects. Starzl theorized that giving several drugs to a patient immediately after surgery, which was the normal practice, might inhibit the immune system from developing a tolerance for the new organ. Therefore, his new protocol embraced a different approach. Shortly before the transplantation, patients were given a drug that killed their T-cells and after the operation, patients received only one anti-rejection medicine rather than the multi-pill cocktail normally prescribed. In an article published by *Lancet* in 2003, Starzl and colleagues reported the results of their pilot study involving 82 kidney, liver, pancreas or small bowel transplant patients treated according to the new drug protocol. Out of the 72 patients with successful transplants after one year, over half the patients were taking anti-rejection medication either every other day, three times per week or twice per week. Amazingly, 11 of the patients were taking only one pill a week and they exhibited no signs of organ rejection or complications. Certainly more research needs to be conducted, but these results are very promising.

### Recommended dosage

The dosages vary depending on the drug or drug combination being taken by the patient. In general, cyclosporine is taken every 12 hours in liquid or capsule form. Tacrolimus is generally taken every 12 hours as well. The level of either drug in a patient's blood is monitored carefully and doses are adjusted accordingly in order to not only prevent reject, but also unpleasant side effects. Azathioprine is taken once a day in tablet form, whereas mycophenolate mofetil is generally taken every 12 hours. High doses of prednisone are usually given at first and then tapered down slowly.

### Precautions

Patients should discuss proper storage methods with regard to their medications. Sirolimus, for example, should be stored at room temperature with special care taken to keep it out of excessive heat and humidity.

Although pregnant women taking anti-rejection drugs have delivered healthy babies, women planning on becoming pregnant while taking anti-rejection drugs should talk with their physicians regarding any possible complications. For example, the safety of

taking mycophenolate mofetil during **pregnancy** or while **breastfeeding** is questionable and not advised.

### Side effects

Side effects vary depending on the individual and the drug therapy chosen. Patients should talk with their doctors regarding the various side effects they can expect and under what conditions emergency medical care needs to be sought.

### Interactions

It is essential that patients talk with their pharmacist and transplant team before taking any medications, regardless of whether they are prescription or over-the-counter drugs to ensure that the combinations will not interact. For example, **antacids** can diminish the effectiveness of mycophenolate mofetil and drugs used to treat high cholesterol may increase the potency of sirolimus. In addition, certain food products can also alter the potency of some anti-rejection drugs. For example, grapefruit and grapefruit juice can cause cyclosporine blood levels to increase.

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Lee Ann Paradise

## Antiretroviral drugs

### Definition

Antiretroviral drugs inhibit the reproduction of retroviruses, which are viruses whose genetic code is made up of ribonucleic acid (RNA) instead of deoxyribonucleic acid (DNA). Although the genetic material of these viruses is RNA, the viruses contain enzymes that

## KEY TERMS

**CD4**—A type of protein molecule in human blood, sometimes called the T4 antigen, that is present on the surface of 65% of immune cells. The HIV virus infects cells with CD4 surface proteins (CD4+ cells), and as a result, depletes the number of immune system cells in the individual's blood. Most of the damage to the immune system of an HIV-infected individual is done by viral destruction of CD4+ T cells.

**Hypoxemia**—Lower than normal oxygenation of arterial blood.

**Immune system**—Mechanism that protects the body from foreign substances, foreign cells, and pathogens. The thymus, spleen, lymph nodes, white blood cells, including the B cells and T cells, and antibodies are involved in the immune response, which aims to destroy these foreign bodies.

**Mutate**—Undergo a spontaneous change in the make-up of genes or chromosomes.

**Opportunistic infection**—An infection by organisms that usually do not cause infection in people whose immune systems are working normally.

**Pregnancy category**—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies; or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate human or animal studies; or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

**Retrovirus**—A virus composed of ribonucleic acid (RNA) instead of deoxyribonucleic acid (DNA).

**Virus**—A tiny, disease-causing particle that can reproduce only inside living cells.

transcribe this RNA into DNA, which then can be used to infect host cells. The best known of this type of virus is HIV, human **immunodeficiency** virus, the causative agent of **AIDS**.

### Purpose

Antiretroviral drugs do not kill viruses outright. Instead, they block specific steps in the replication of the virus. As a result, the drugs do not cure viral infections; however continued use of antiretroviral drugs, particularly in multi-drug regimens, significantly slows and controls disease progression. The development of new antiretroviral drugs in the 2000s has allowed many patients with HIV infection to live longer and with a better quality of life. Zidovudine (AZT) was the first antiretroviral drug approved by the United States Food and Drug Administration (FDA) for the treatment of HIV.

### Description

Antiretroviral drugs are classified based on the steps in virus replication that they disrupt. Medications may combine two or more drugs from different classes to boost effectiveness. Classes are as follows:

- Nucleoside and nucleotide reverse transcriptase inhibitors (NRTIs) insert material into newly synthesized viral DNA that prevents it from being completely

assembled. This was the first class of antiretroviral drugs to be developed. Drugs in this class include zidovudine (AZT, Retrovir, ZDV), didanosine (ddI, Videx), stavudine (d4T, Zerit), lamivudine (Epivir, 3TC), abacavir (ABC, Ziagen), emtricitabine (Emtriva, FTC), and tenofovir (Viread, TDF).

- Non-nucleoside reverse transcriptase inhibitors (NNRTIs) interfere directly with the enzyme reverse transcriptase needed to transcribe RNA of the virus into DNA. Drugs in this class include efavirenz (Sustiva, EFV), etravirine (Intelence, ETR), and nevirapine (Viramune, NVP).
- Protease inhibitors prevent the assembly of new virus particles (virions). Drugs in this class include atazanavir (Reyataz, ATV), darunavir (Prezista, DRV), fosamprenavir (Lexiva, f-APV), indinavir (Crixivan, IDV), lopinavir/ritonavir (Kaletra, LPV/r), nelfinavir (Viracept, NVF), ritonavir (Norvir, RTV), saquinavir (Fortovase, Invirase), and tipranavir (Aptivus, TPV).
- Integrase inhibitors prevent viral DNA from being incorporated into host cells the virus infects. As of early 2010, the only FDA-approved drug in this class is raltegravir (Isentress, RAL). Other drugs of this type are under active development or in clinical trials.
- Entry inhibitors, also called fusion inhibitors, prevent the entry of the virus into a host cell. Drugs in

this class include maraviroc (Selzentry, MVC) and enfuvirtide (Fuzeon, T-20).

- Maturation inhibitors prevent the maturing of new viroids in a way that makes them non-infectious. As of January 2010, the United States Food and Drug Administration (FDA) had approved no drugs in this category. However, clinical trials of two drugs, bevirimat and vivecon were underway and second-generation maturation inhibitors were in development.

Because HIV exists in several different genetic variations (called clades) and mutates readily, the virus can develop resistance to single drug therapy. However, treatment with drug combinations appears to produce a durable response. Using antiretroviral drugs in combination helps lower risk of developing viral resistance. About half of patients who fail antiretroviral therapy are resistant to one class of drug. Research into optimal multiple drug combinations is ongoing.

Proper antiretroviral treatment can slow the progression of HIV infections and reduce the frequency of opportunistic infections. One of the most notable advances in recent years has been the success of highly active antiretroviral therapy (HAART). In most infected individuals, this multi-drug approach reduces the risk of opportunistic infections in persons with HIV/AIDS and slows the progression of the disease and **death**. Good adherence to HAART also reduces health-care costs over the life of the HIV-infected individual.

The scientific community continues to make advancements in developing and evaluating antiretroviral drug therapy. Information on current clinical trials of antiretroviral drugs and other treatments or vaccines in development for the treatment of HIV infection is available at <http://www.clinicaltrials.gov>. There is no fee charged to participate in a clinical trial and participants may be compensated for their time and travel expenses.

### Recommended dosage

Dosage must be individualized based on the patient and use of interacting drugs. The optimum combinations of antiretroviral drugs have not been determined, and likely vary from patient to patient. The decision to start antiretroviral therapy is based on many factors including the patient's clinical picture, ability to comply with the drug regimen, and other treatment options. Early treatment with antiretroviral drugs has been shown to offer little or no benefit to the patient and has led to unwanted side effects in some patients. Starting treatment with antiretroviral drugs is based on the level of CD4+ lymphocytes, which falls as HIV disease progresses, and the general health status of the individual.

### Precautions

Although the antiretroviral drugs fall into several classes, each drug has a unique pattern of adverse effects and **drug interactions**. Since the drugs are used in various combinations, the frequency and severity of adverse effects will vary with the combination. Although most drug combinations show a higher rate of adverse events than single drug therapy, some patterns are not predictable.

The most severe adverse effects associated with the **protease inhibitors** are kidney and liver toxicity. Patients also have reported a syndrome of abdominal distention (swelling and expansion) and increased body odor, which may be socially limiting. Hemophilic patients have reported increased bleeding tendencies while taking protease inhibitors.

The nucleoside reverse transcriptase inhibitors have significant levels of toxicity. Lactic acidosis (build up of lactic acid in the blood) in the absence of hypoxemia and severe liver enlargement with fatty degeneration have been reported with zidovudine and zalcitabine, and are potentially fatal. Rare cases of liver failure, considered possibly related to underlying **hepatitis B** and zalcitabine monotherapy, have been reported.

Abacavir has been associated with fatal hypersensitivity reactions. Didanosine has been associated with severe **pancreatitis**. Nucleoside reverse transcriptase inhibitors are **pregnancy** category C. There is limited information regarding safety during pregnancy, however, zidovudine has been used during pregnancy to reduce the risk of HIV infection to the infant.

Efavirenz has been associated with a high frequency of skin rash. Nevirapine has been associated with severe liver damage and skin reactions. All of the **non-nucleoside reverse transcriptase inhibitors** are pregnancy category C, based on animal studies.

The safety of antiretroviral drugs during pregnancy has not been established. HIV-infected women who are pregnant should discuss the benefits and risks with their physician. HIV-infected mothers are advised not to breastfeed in order to prevent transmission of the virus to the newborn.

### Interactions

Because of the high frequency of drug interactions associated with AIDS therapy, specialized references should be consulted. Use of recreational drugs while on antiretroviral therapy can trigger potentially lethal side effects or negate the positive effects of the therapy. Patients should discuss both potential side effects and

drug interactions with a specialist in HIV/AIDS treatment.

## Resources

### BOOKS

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- AIDS Medicines. Medline Plus. January 5, 2010. <http://www.nlm.nih.gov/medlineplus/aidsmedicines.html>.
- Drugs and Treatments: HIV/AIDS. AIDS.gov. Undated [accessed January 21, 2010]. <http://www.aids.gov/treatment/drugs/index.html>.
- HIV InSite: Comprehensive Up-to-date Information on HIV/AIDS Prevention, Treatment, and Policy From the University of California San Francisco. Continuously updated [accessed January 10, 2010]. <http://hivinsite.ucsf.edu/InSite>

### ORGANIZATIONS

- AIDS Education and Training Centers (AETC) National Resource Center, 65 Bergen Street, 8th floor, Newark, NJ, 07101, [info@aidsetc.org](mailto:info@aidsetc.org), <http://www.aidsetc.org>.
- AIDS.gov, U.S. Department of Health and Human Services, 200 Independence Avenue, S.W., Washington, DC, 20201, <http://www.aids.gov>.
- United States Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333 (404) 639-3534 800-CDC-INFO (800-232-4636). TTY: (888) 232-6348, [inquiry@cdc.gov](mailto:inquiry@cdc.gov), <http://www.cdc.gov>.
- World Health Organization (WHO), Avenue Appia 20, 1211 Geneva 27, Switzerland +22 41 791 21 11 +22 41 791 31 11, [info@who.int](mailto:info@who.int), <http://www.who.int>.

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health. It is classified as an auto immune disease, because the disease is caused by the body's own immune system acting against the body itself. Symptoms include painful, stiff, swollen joints, **fever**, **fatigue**, and loss of appetite.

In recent years, there has been a change in attitude concerning the treatment of rheumatoid arthritis. Physicians now use Disease Modifying Anti-Rheumatic Drugs (DMARDs) early in the history of the disease and are less inclined to wait for crippling stages before resorting to the more potent drugs. Fuller understanding of the side-effects of non steroidal anti-inflammatory drugs (NSAIDs) has also stimulated reliance on other types of antirheumatic drugs.

## Description

The major classes of antirheumatic drugs include:

- Nonsteroidal Anti-Inflammatory Drugs (NSAIDs). Drugs belonging to this class bring symptomatic relief of both inflammation and pain, but have a limited effect on the progressive bone and cartilage loss associated with rheumatoid arthritis. They act by slowing the body's production of prostaglandins. Common NSAIDs include: ibuprofen (Motrin, Nuprin or Advil), naproxen (Naprosyn, Aleve) and indomethacin (Indocin).
- Corticosteroids. These drugs are very powerful anti-inflammatory agents. They are the synthetic analogs of cortisone, produced by the body. Corticosteroids are used to reduce inflammation and suppress activity of the immune system. The most commonly prescribed are prednisone and dexamethasone.
- Disease Modifying Anti-Rheumatic Drugs (DMARDs). DMARDs influence the disease process itself and do not only treat symptoms, hence their name. DMARDs also have anti-inflammatory effects, and most were borrowed from the treatment of other diseases, such as cancer and malaria. Antimalarials DMARDs include chloroquine (Aralen) and hydroxychloroquine (Plaquenil). Powerful DMARDs include: methotrexate (Rheumatrex), sulfasalazine, cyclosporine, azathioprine (Imuran) and cyclophosphamide (Cytoxan), azathioprine, sulfasalazine, penicillamine, and organic gold compounds such as aurothioglucose (Solganol), gold sodium thiomalate (Aurolate) and auranofin (Ridaura).
- Slow-Acting Antirheumatic Drugs (SAARDs). SAARDs are a special class of DMARDs and the effect of these drugs is slow acting and not so quickly apparent as that of the NSAIDs. Examples are hydroxychloroquine and aurothioglucose.
- Immunosuppressive cytotoxic drugs. This class of drugs is used if treatment with NSAIDs and

## Antirheumatic drugs

### Definition

Antirheumatic drugs are drugs used to treat **rheumatoid arthritis**.

### Purpose

Rheumatoid arthritis is a progressive form of arthritis that has devastating effects on joints and general

## KEY TERMS

**Anti-inflammatory drugs**—A class of drugs that lower inflammation and that includes NSAIDs and corticosteroids.

**Arthritis**—A painful condition that involves inflammation of one or more joints.

**Conception**—The union of egg and sperm to form a fetus.

**Corticosteroids**—A class of drugs that are synthetic versions of the cortisone produced by the body. They rank among the most powerful anti-inflammatory agents.

**Cortisone**—Glucocorticoid produced by the adrenal cortex in response to stress. Cortisone is a steroid and has anti-inflammatory and immunosuppressive properties.

**Cytotoxic drugs**—Drugs that function by destroying cells.

**Disease Modifying Anti-Rheumatic Drugs (DMARDs)**—A class of antirheumatic drugs, including chloroquine, methotrexate, cyclosporine, and gold compounds, that influence the disease process itself and do not only treat its symptoms.

**Inflammation**—A process occurring in body tissues, characterized by increased circulation and the accumulation of white blood cells. Inflammation also occurs in disorders such as arthritis and causes harmful effects.

**Inflammatory**—Pertaining to inflammation.

**Immune response**—Physiological response of the body controlled by the immune system that

involves the production of antibodies to fight off specific foreign substances or agents (antigens).

**Immune system**—The sum of the defense mechanisms of the body that protects it against foreign substances and organisms causing infection.

**Immunosuppressive**—Any agent that suppresses the immune response of an individual.

**Immunosuppressive cytotoxic drugs**—A class of drugs that function by destroying cells and suppressing the immune response.

**Methotrexate**—A drug that interferes with cell growth and is used to treat rheumatoid arthritis as well as various types of cancer. Side-effects may include mouth sores, digestive upsets, skin rashes, and hair loss.

**Non steroidal**—Not containing steroids or cortisone. Usually refers to a class of drugs called Nonsteroidal Anti-Inflammatory Drugs (NSAIDs).

**Nonsteroidal Anti-Inflammatory Drugs (NSAIDs)**—A class of drugs that is used to relieve pain, and symptoms of inflammation, such as ibuprofen and ketoprofen.

**Osteoarthritis**—A form of arthritis that occurs mainly in older people and involves the gradual degeneration of the cartilage of the joints.

**Prostaglandins**—Prostaglandins are produced by the body and are responsible for inflammation features, such as swelling, pain, stiffness, redness and warmth.

SAARDs have no effect. Immunosuppressive drugs have a stabilizing effect on the immune system. Since the inflammation associated with chronic arthritis is due to malfunctions of the immune system, use of this class of drugs has been shown to be beneficial for the treatment of rheumatoid arthritis as well. Examples are: methotrexate, mechlorethamine, cyclophosphamide, chlorambucil, and azathioprine.

### Recommended dosage

Recommended dosage depends on the type of drug. The prescribing physician or the pharmacist provides information for the correct dosage. The drugs must be taken exactly as directed.

When taking methotrexate for rheumatoid arthritis, it should be taken only *once or twice a week as*

*prescribed*, not every day. Taking it every day can lead to a fatal overdose.

### Precautions

Many antirheumatic drugs such as azathioprine (Imuran) and methotrexate (Rheumatrex) are very powerful drugs. They are usually prescribed in severe cases, when all other treatments have failed. Thus, they may have serious side effects, so it is important to be monitored closely by a physician while taking any of these drugs.

### Side effects

Hydroxychloroquine (Plaquenil) may cause vision problems. Anyone taking it should see an

ophthalmologist (a physician who specializes in treating eyes) for a thorough **eye examination** every six months.

Methotrexate and penicillamine may cause **birth defects**. Women taking these drugs must stop taking them during **pregnancy** and for several months before a planned pregnancy. Methotrexate may also cause lung damage or fertility problems and should not be taken by anyone with serious kidney or **liver disease** or by anyone who drinks alcohol.

Azathioprine may cause birth defects if either the man or woman is using it at the time of conception. Anyone who uses this drug and is sexually active should consult with a physician about an effective birth control method.

Other common side effects of antirheumatic drugs include abdominal cramps, **diarrhea**, **dizziness**, loss of appetite, **headache**, **nausea**, **vomiting**, fever and chills, and mouth sores. A variety of other side effects may occur. Anyone who has unusual symptoms while taking antirheumatic drugs should notify the treating physician.

The gold compounds may cause serious blood problems by reducing the ability of the blood forming organs to produce blood cells. These drugs may decrease the number of white blood cells, red blood cells, or both. Patients taking these drugs should have regular blood counts.

Entanercept (Enbrel) may also cause blood problems, and some patients who received this drug have developed eye problems and **multiple sclerosis**. It is not certain whether these reactions were caused by entanercept, but multiple sclerosis has been seen in patients taking other drugs which act against tumor necrosis factor.

## Interactions

Antirheumatic drugs may interact with a variety of other medicines or other antirheumatic drugs. When this happens, the effects of one or both of the drugs may change, or the risk of side effects may be greater. Anyone who takes this type of drug should inform the prescribing physician about any other medication he or she is taking. Among the drugs that may interact with antirheumatic drugs are phenytoin (Dilantin), **aspirin**, sulfa drugs such as Bactrim and Gantrisin, tetracycline and some other **antibiotics** and cimetidine (Tagamet). NSAIDs such as ibuprofen (Motrin, Advil) are also known to interact with other classes of antirheumatic drugs.

Nancy Ross-Flanigan

## Antiseptics

### Definition

An antiseptic is a substance which inhibits the growth and development of microorganisms. For practical purposes, antiseptics are routinely thought of as topical agents, for application to skin, mucous membranes, and inanimate objects, although a formal definition includes agents which are used internally, such as the urinary tract antiseptics.

### Purpose

Antiseptics are a diverse class of drugs which are applied to skin surfaces or mucous membranes for their anti-infective effects. This may be either bacteriocidal or bacteriostatic. Their uses include cleansing of skin and wound surfaces after injury, preparation of skin surfaces prior to injections or surgical procedures, and routine disinfection of the oral cavity as part of a program of **oral hygiene**. Antiseptics are also used for disinfection of inanimate objects, including instruments and furniture surfaces.

Commonly used antiseptics for skin cleaning include benzalkonium chloride, chlorhexidine, hexachlorophine, iodine compounds, mercury compounds, alcohol and hydrogen peroxide. Other agents which have been used for this purpose, but have largely been supplanted by more effective or safer agents, include boric acid and volatile oils such as methyl salicylate (oil of wintergreen.)

Chlorhexidine shows a high margin of safety when applied to mucous membranes, and has been used in oral rinses and preoperative total body washes.

Benzalkonium chloride and hexachlorophine are used primarily as hand scrubs or face washes. Benzalkonium may also find application as a disinfecting agent for instruments, and in low concentration as a preservative for drugs including ophthalmic solutions. Benzalkonium chloride is inactivated by organic compounds, including soap, and must not be applied to areas which have not been fully rinsed.

Iodine compounds include tincture of iodine and povidone iodine compounds. Iodine compounds have the broadest spectrum of all topical anti-infectives, with action against bacteria, fungi, viruses, spores, protozoa, and yeasts. Iodine tincture is highly effective, but its alcoholic component is drying and extremely irritating when applied to abraded (scraped or rubbed) skin. Povidone iodine, an organic compound, is less irritating and less toxic, but not as effective. Povidone iodine has been used for hand

## KEY TERMS

**Antibiotic**—A medicine used to treat infections.

**Bacteria**—Tiny, one-celled forms of life that cause many diseases and infections.

**Mucous membrane**—The moist lining of a body cavity or structure, such as the mouth or nose.

**Residue**—Traces that remain after most of the rest of the material is gone.

scrubs and disinfection of surgical sites. Aqueous solutions of iodine have also been used as antiseptic agents, but are less effective than alcoholic solutions and less convenient to use than the povidone iodine compounds.

Hydrogen peroxide acts through the liberation of oxygen gas. Although the antibacterial activity of hydrogen peroxide is relatively weak, the liberation of oxygen bubbles produces an effervescent action, which may be useful for wound cleansing through removal of tissue debris. The activity of hydrogen peroxide may be reduced by the presence of blood and pus. The appropriate concentration of hydrogen peroxide for antiseptic use is 3%, although higher concentrations are available.

Thimerosal (Mersol) is a mercury compound with activity against bacteria and yeasts. Prolonged use may result in mercury toxicity.

### Recommended dosage

Dosage varies with product and intended use.

### Precautions

Precautions vary with individual product and use.

Hypersensitivity reactions should be considered with organic compounds such as chlorhexidine, benzalkonium and hexachlorophine.

Skin dryness and irritation should be considered with all products, but particularly with those containing alcohol.

Systemic toxicity may result from ingestion of iodine containing compounds or mercury compounds.

Chlorhexidine should not be instilled into the ear. There is one anecdotal report of deafness following use of chlorhexidine in a patient with a **perforated eardrum**. Safety in **pregnancy** and **breastfeeding** have not been reported, however there is one anecdotal

report of an infant developing slowed heartbeat apparently related to maternal use of chlorhexidine.

Iodine compounds should be used sparingly during pregnancy and **lactation** due to risk of infant absorption of iodine with alterations in thyroid function.

### Interactions

Antiseptics are not known to interact with any other medicines. However, they should not be used together with any other topical cream, solution, or ointment.

### Resources

#### PERIODICALS

Farley, Dixie. "Help for Cuts, Scrapes and Burns." *FDA Consumer* May 1996: 12.

Samuel D. Uretsky PharmD

## Antispasmodic drugs

### Definition

Antispasmodic drugs relieve cramps or spasms of the stomach, intestines, and bladder.

### Purpose

Antispasmodic drugs have been used to treat stomach cramps. Traditionally, they were used to treat stomach ulcers, but for this purpose they have largely been replaced by the acid inhibiting compounds, the H-2 receptor blockers such as cimetidine and ranitidine and the proton pump inhibitors such as omeprazole, lansoprazole and rabeprazole.

Most of the drugs are used as "anti-cholinergics." Since they counteract the effects of the neurohormone acetylcholine. Some of these drugs are derived from the plant belladonna, also known as Deadly Nightshade. There is also a group of drugs with similar activity, but not taken from plant sources. The anticholinergics decrease both the movements of the stomach and intestine, and also the secretions of stomach acid and digestive enzymes. They may be used for other purposes including treatment of Parkinson's **disease**, and bladder urgency. These drugs inhibit secretions and cause **dry mouth** and dry eyes because of reduced salivation and tearing. Dicyclomine is an antispasmodic with very little

## KEY TERMS

**Heat stroke**—A serious condition that results from exposure to extreme heat. The body loses its ability to cool itself. Severe headache, high fever, and hot, dry skin may result. In severe cases, a person with heat stroke may collapse or go into a coma.

**Hiatal hernia**—A condition in which part of the stomach protrudes through the diaphragm.

**Hyperthyroidism**—Secretion of excess thyroid hormones by the thyroid gland.

**Inflammation**—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

**Myasthenia gravis**—A condition in which certain muscles weaken and may become paralyzed.

**Reflux esophagitis**—Inflammation of the lower esophagus caused by the backflow of stomach contents.

**Spasm**—Sudden, involuntary tensing of a muscle or a group of muscles

**Ulcerative colitis**—Long-lasting and repeated inflammation of the colon with the development of sores.

effect on secretions. It is used to treat **irritable bowel syndrome**.

### Description

Dicyclomine is available only with a prescription and is sold as capsules, tablets (regular and extended-release forms), and syrup.

### Recommended dosage

The usual dosage for adults is 20 mg, four times a day. However, the physician may recommend starting at a lower dosage and gradually increasing the dose to reduce the chance of unwanted side effects.

The dosage for children depends on the child's age. Check with the child's physician for the correct dosage.

### Precautions

Dicyclomine makes some people sweat less, which allows the body to overheat and may lead to heat prostration (**fever** and heat stroke). Anyone taking this drug should try to avoid extreme heat. If that is

not possible, check with the physician who prescribed the drug. If heat prostration occurs, stop taking the medicine and call a physician immediately.

This medicine can cause drowsiness and blurred or double vision. People who take this drug should not drive, use machines, or do anything else that might be dangerous until they have found out how the medicine affects them.

Dicyclomine should not be given to infants or children unless the physician decides the use of this drug is necessary. Dicyclomine should not be used by women who are **breastfeeding**. Women who are pregnant or plan to become pregnant should check with their physicians before using this drug.

Anyone with the following medical conditions should not take dicyclomine unless directed to do so by a physician:

- Previous sensitivity or allergic reaction to dicyclomine
- Glaucoma
- Myasthenia gravis
- Blockage of the urinary tract, stomach, or intestines
- Severe ulcerative colitis
- Reflux esophagitis.

In addition, patients with these conditions should check with their physicians before using dicyclomine:

- Liver disease
- Kidney disease
- High blood pressure
- Heart problems
- Enlarged prostate gland
- Hiatal hernia
- Autonomic neuropathy (a nerve disorder)
- Hyperthyroidism.

### Side effects

The most common side effects are **dizziness**, drowsiness, lightheadedness, **nausea**, nervousness, blurred vision, dry mouth, and weakness. Other side effects may occur. Anyone who has unusual symptoms after taking dicyclomine should get in touch with his or her physician.

### Interactions

Dicyclomine may interact with other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Among the drugs that may interact with Dicyclomine are:

- Antacids such as Maalox
- Antihistamines such as clemastine fumarate (Tavist)
- Bronchodilators (airway opening drugs) such as albuterol (Proventil, Ventolin)
- Corticosteroids such as prednisone (Deltasone)
- Monoamine oxidase inhibitors (MAO inhibitors) such as phenelzine (Nardil) and tranylcypromine (Parnate)
- Tranquilizers such as diazepam (Valium) and alprazolam (Xanax).

The list above does not include every drug that may interact with dicyclomine. Be sure to check with a physician or pharmacist before combining dicyclomine with any other prescription or nonprescription (over-the-counter) medicine.

Nancy Ross-Flanigan

Antistreptolysin O titer (ASO) see  
**Streptococcal antibody tests**  
 Antithrombin III deficiency see  
**Hypercoagulation disorders**

## Antituberculosis drugs

### Definition

Antituberculosis drugs are medicines used to treat **tuberculosis**, an **infectious disease** that can affect the lungs and other organs.

### Purpose

Tuberculosis is a disease caused by *Mycobacterium tuberculosis*, a bacteria that is passed between people through the air. The disease can be cured with proper drug therapy, but because the bacteria may become resistant to any single drug, combinations of antituberculosis drugs are used to treat tuberculosis (TB) and are normally required for effective treatment. At the start of the 20th Century, tuberculosis was the most common cause of **death** in the United States, but was largely eliminated with better living conditions. It is most common in areas of crowding and poor ventilation, such as crowded urban areas and prisons. In some areas, the **AIDS** epidemic has been accompanied by an increase in the prevalence of tuberculosis.

Some antituberculosis drugs also are used to treat or prevent other infections such as *Mycobacterium avium* complex (MAC), which causes disease throughout the bodies of people with AIDS or other diseases of the immune system.

### Description

Antituberculosis drugs are available only with a physician's prescription and come in tablet, capsule, liquid and injectable forms. Some commonly used antituberculosis drugs are cycloserine (Seromycin), ethambutol (Myambutol), ethionamide (Trecator-SC), isoniazid (Nydrazid, Laniazid), pyrazinamide, rifabutin (Mycobutin), and rifampin (Rifadin, Rimactane).

### Recommended dosage

The recommended dosage depends on the type of antituberculosis drug and may be different for different patients. Check with the physician who prescribed the medicine or the pharmacist who filled the prescription for the proper dosage. The physician may gradually increase the dosage during treatment. Be sure to follow the physician's orders. Patients who are infected with HIV must usually take larger combinations of drugs for a longer period of time than is needed for patients with an unimpaired immune system.

Some antituberculosis drugs must be taken with other drugs. If they are taken alone, they may encourage the bacteria that cause tuberculosis to become resistant to drugs used to treat the disease. When the bacteria become resistant, treating the disease becomes more difficult.

To clear up tuberculosis completely, antituberculosis drugs must be taken for as long as directed. This may mean taking the medicine every day for a year or two or even longer. Symptoms may improve very quickly after treatment with this medicine begins. However, they may come back if the medicine is stopped too quickly. Do not stop taking the medicine just because symptoms improve.

Because people may neglect to take their medication for tuberculosis, it is common to have tuberculosis centers develop a program of Directly Observed Therapy (DOT). In these programs, patients come to the hospital or clinic, and take their medication in front of an observer. These programs may be annoying to the patients, but are justified by the risks to public health if tuberculosis germs that have become resistant to drugs were to be spread.

## KEY TERMS

**Bacteria**—Tiny, one-celled forms of life that cause many diseases and infections.

**Feces**—(Also called stool.) The solid waste that is left after food is digested. Feces form in the intestines and pass out of the body through the anus.

**Fetus**—A developing baby inside the womb.

**Gout**—A disease in which uric acid, a waste product that normally passes out of the body in urine, collects

in the joints and the kidneys. This causes arthritis and kidney stones.

**Immune system**—The body's natural defenses against disease and infection.

**Microorganism**—An organism (life form) that is too small to be seen with the naked eye.

**Platelets**—Disk-shaped bodies in the blood that are important in clotting.

**Seizure**—A sudden attack, spasm, or convulsion.

Cycloserine works best when it is at constant levels in the blood. To help keep levels constant, take the medicine in doses spaced evenly through the day and night. Do not miss any doses. If taking medicine at night interferes with sleep, or if it is difficult to remember to take the medicine during the day, check with a health care professional for suggestions.

Do not take **antacids** that contain aluminum, such as Maalox, within 1 hour of taking isoniazid, as this may keep the medicine from working.

### Precautions

Seeing a physician regularly while taking antituberculosis drugs is important. The physician will check to make sure the medicine is working as it should and will watch for unwanted side effects. These visits also will help the physician know if the dosage needs to be changed.

Symptoms should begin to improve within a few weeks after treatment begins with antituberculosis drugs. If they do not, or if they become worse, check with a physician.

Some people feel drowsy, dizzy, confused, or less alert when using these drugs. Some may also cause vision changes, clumsiness, or unsteadiness. Because of these possible problems, anyone who takes antituberculosis drugs should not drive, use machines, or do anything else that might be dangerous until they have found out how the medicine affects them.

Daily doses of pyridoxine (vitamin B<sub>6</sub>) may lessen or prevent some side effects of ethionamide or isoniazid. If the physician who prescribed the medicine recommends this, be sure to take the pyridoxine every day.

Certain kinds of cheese (such as Swiss and Cheshire) and fish (such as tuna and skipjack) may cause an

unusual reaction in people taking isoniazid. Symptoms of this reaction include fast or pounding heartbeat, sweating or a hot feeling, chills or a clammy feeling, **headache**, lightheadedness, and red or itchy skin. This reaction is very rare. However, if any of these symptoms occur, check with a physician as soon as possible.

Rifabutin and rifampin will make saliva, sweat, tears, urine, feces, and skin turn reddish orange to reddish brown. This is nothing to worry about. However, the discolored tears may permanently stain soft **contact lenses** (but not hard contact lenses). To avoid ruining contact lenses, do not wear soft contacts while taking these medicines.

Rifampin may temporarily lower the number of white blood cells. Because the white blood cells are important in fighting infection, this effect increases the chance of getting an infection. This drug also may lower the number of platelets that play an important role in clotting. To reduce the risk of bleeding and infection in the mouth while taking this medicine, be especially careful when brushing and flossing the teeth. Check with a physician or dentist for suggestions on how to keep the teeth and mouth clean without causing injuries. Put off any dental work until blood counts return to normal.

Rifampin may affect the results of some medical tests. Before having medical tests, anyone taking this medicine should alert the health care professional in charge.

People who have certain medical conditions may have problems if they take antituberculosis drugs. For example:

- cycloserine or isoniazid may increase the risk of seizures (convulsions) in people with a history of seizures.

- the dosage of cycloserine may need to be adjusted for people with kidney disease.
- ethambutol or pyrazinamide may cause or worsen attacks of gout in people who are prone to having them.
- ethambutol may cause or worsen eye damage.
- diabetes may be harder to control in patients who take ethionamide.
- isoniazid may cause false results on some urine sugar tests, and pyrazinamide may cause false results on urine ketone tests. Diabetic patients who use either of these medicines should discuss the possibility of false test results with their physicians.
- people with liver disease or a history of alcohol abuse may be more likely to develop hepatitis when taking isoniazid and are more likely to have side effects that affect the liver when taking rifampin.
- in people with kidney disease, ethambutol, ethionamide, or isoniazid may be more likely to cause side effects.
- side effects are also more likely in people with liver disease who take pyrazinamide.

Before taking antituberculosis drugs, be sure to let the physician know about these or any other medical problems.

In laboratory tests of pregnant animals, high doses of some antituberculosis drugs have caused **birth defects** and other problems in the fetus or newborn. However, pregnant women with tuberculosis need to take antituberculosis drugs to clear up their disease. Knowing that many women have had healthy babies after taking these drugs during **pregnancy** may be reassuring. Pregnant women who need to take this medicine and are worried about birth defects or other problems should talk to their physicians.

Anyone who has had unusual reactions to antituberculosis drugs or to niacin should let his or her physician know before taking any antituberculosis drug. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Patients who are on special **diets**, such as low-sodium or low-sugar diets, should make sure their physicians know. Some antituberculosis medicines may contain **sodium**, sugar, or alcohol.

## Side effects

### *Cycloserine*

In some people, this medicine causes depression and thoughts of **suicide**. If this happens, check with a

physician immediately. Switching to another medicine will usually stop these troubling thoughts and feelings. Also let the physician know immediately about any other mood or mental changes; such as nervousness, nightmares, **anxiety**, confusion, or irritability; and about symptoms such as muscle twitches, convulsions, or speech problems.

Headache is a common side effect that usually goes away as the body adjusts to this medicine. This problem does not need medical attention unless it continues or it interferes with everyday life.

### *Ethambutol*

This medicine may cause eye **pain** or vision changes, including loss of vision or changes in color vision. Check with a physician immediately if any of these problems develop.

In addition, anyone who has any of these symptoms while taking ethambutol should check with a physician immediately:

- painful or swollen joints, especially in the knee, ankle, or big toe
- a tight, hot sensation in the skin over painful or swollen joints
- chills.

Other side effects may occur but do not need medical attention unless they are bothersome or they do not go away as the body adjusts to the medicine. These include: headache, confusion, **nausea and vomiting**, stomach pain, and loss of appetite.

### *Ethionamide*

Check with a physician immediately if eye pain, blurred vision, or other vision changes occur while taking this medicine.

Symptoms such as unsteadiness, clumsiness and pain, **numbness**, **tingling**, or burning in the hands or feet could be the first signs of nerve problems that may become more serious. If any of these symptoms occur, check with a physician immediately. Other side effects that should be brought to a physician's attention immediately include yellow eyes or skin and mood or mental changes such as depression or confusion.

Less serious side effects such as **dizziness**, nausea or vomiting, appetite loss, sore mouth, or metallic taste may also occur. These problems usually go away as the body adjusts to the medicine. They do not need medical attention unless they continue or they interfere with normal activities.

### Isoniazid

This medicine may cause serious liver damage, especially in people over 40 years of age. However, taking medicine for tuberculosis is very important for people with the disease. Anyone who has tuberculosis and has been advised to take this drug should thoroughly discuss treatment options with his or her physician.

Recognizing the early signs of liver and nerve damage can help prevent the problems from getting worse. If any of these symptoms occur, check with a physician immediately:

- unusual tiredness or weakness
- clumsiness or unsteadiness
- pain, numbness, tingling, or burning in the hands and feet
- loss of appetite
- vomiting

This medicine may also cause less serious side effects such as **diarrhea** and stomach pain. These usually go away as the body adjusts to the medicine and do not need medical attention unless they continue.

If eye pain, blurred vision, or other vision changes occur while taking this medicine, check with a physician immediately.

### Pyrazinamide

Check with a physician immediately if pain in the joints occurs.

### Rifabutin

Check with a physician immediately if a skin rash occurs.

### Rifampin

Stop taking rifampin and check with a physician immediately if any of the following symptoms occur. These symptoms could be early signs of problems that may become more serious. Getting prompt medical attention could prevent them from getting worse.

- unusual tiredness or weakness
- nausea or vomiting
- loss of appetite

In addition, anyone who has any of these symptoms while taking rifampin should check with a physician immediately:

- breathing problems
- fever

- chills
- shivering
- headache
- dizziness
- itching
- skin rash or redness
- muscle and bone pain

Other side effects, such as diarrhea and stomach pain, may occur with this medicine, but should go away as the body adjusts to the drug. Medical treatment is not necessary unless these problems continue.

Other side effects may occur with any antituberculosis drug. Anyone who has unusual symptoms while taking an antituberculosis drug should get in touch with his or her physician.

### Interactions

Taking cycloserine and ethionamide together may increase the risk of seizures and other nervous system problems. These and other side effects also are more likely in people who drink alcohol while taking cycloserine. To avoid these problems, *do not drink alcohol while taking cycloserine* and check with a physician before combining cycloserine and ethionamide.

Drinking alcohol regularly may prevent isoniazid from working properly and may increase the chance of liver damage. Anyone taking this medicine should strictly limit the use of alcohol. Check with a health care professional for advice on the amount of alcohol that may safely be used.

Many drugs may interact with isoniazid or rifampin, increasing the chance of liver damage or other side effects. Among these drugs are **acetaminophen** (Tylenol), birth control pills and other drugs that contain female hormones, and the antiseizure drugs divalproex (Depakote) and valproic acid (Depakene). For a complete list of drugs that may have this effect, check with a pharmacist.

Isoniazid may also decrease the effects of the anti-fungal drug ketoconazole (Nizoral) and the antituberculosis drug rifampin (Rifadin).

Rifampin may make many drugs less effective. Among the drugs that may be affected are diabetes medicines taken by mouth (oral hypoglycemics), digitalis heart drugs, many antifungal drugs, and birth control pills. Because it makes birth control pills less effective, taking rifampin may increase the chance of becoming pregnant. Women who take this medicine along with birth control pills should use an

additional form of birth control. For a complete list of drugs that may be affected by rifampin, check with a pharmacist.

Using rifabutin with the antiretroviral drug zidovudine (AZT, Retrovir) may make the zidovudine less effective. Consult with a physician if both drugs are prescribed.

Not every drug that may interact with an antituberculosis drug is listed here. Be sure to check with a physician or pharmacist before combining an antituberculosis drug with any other prescription or nonprescription (over-the-counter) medicine.

## Resources

### PERIODICALS

Arbex MA, Varella MD, Siqueira HR, et al. "Antituberculosis drugs: drug interactions, adverse effects, and use in special situations - part 1: first-line drugs." *J Bras Pneumol* 36, no. 5 (October 2010): 626–640.

Arbex MA, Varella MD, Siqueira HR, et al. "Antituberculosis drugs: drug interactions, adverse effects, and use in special situations - part 2: second-line drugs." *J Bras Pneumol* 36, no. 5 (October 2010): 641–656.

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Brand name (generic name)	Possible side effects
Axid (nizatidine)	Diarrhea, headache, nausea and vomiting, sore throat
Carafate (sucralfate)	Constipation, hives, insomnia, upset stomach, vomiting
Cytotec (misoprostol)	Cramps, diarrhea, gas, headache, menstrual disorders (including heavy bleeding), nausea
Pepcid (famotidine)	Constipation or diarrhea, dizziness, fatigue, fever
Prilosec (omeprazole)	Abdominal pain, diarrhea, headache, nausea and vomiting
Tagamet (cimetidine)	Breast development in men, depression and disorientation, headache
Zantac (ranitidine hydrochloride)	Constipation or diarrhea, headache, joint pain

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indicated, or those whose gastric ulcers are caused by **nonsteroidal anti-inflammatory drugs** (NSAIDs) rather than *H. pylori* infections.

## Description

The proton pump inhibitors block the secretion of gastric acid by the gastric parietal cells. The extent of inhibition of acid secretion is dose related. In some cases, gastric acid secretion is completely blocked for over 24 hours on a single dose. In addition to their role in treatment of gastric ulcers, the proton pump inhibitors are used to treat syndromes of excessive acid secretion (Zollinger-Ellison Syndrome) and **gastroesophageal reflux disease** (GERD).

Histamine H-2 receptor blockers stop the action of histamine on the gastric parietal cells, inhibiting the secretion of gastric acid. These drugs are less effective than the proton pump inhibitors, but may achieve a 75–79% reduction in acid secretion. Higher rates of acid inhibition may be achieved when the drug is administered by the intravenous route. The H-2 receptor blockers may also be used to treat **heartburn** and hypersecretory syndromes. When given before surgery, the H-2 receptor blockers are useful in prevention of aspiration **pneumonia**.

Sucralfate (Carafate), a substituted sugar molecule with no nutritional value, does not inhibit gastric acid, but rather, reacts with existing stomach acid to form a thick coating that covers the surface of an ulcer,

## Antiulcer drugs

### Definition

Antiulcer drugs are a class of drugs, exclusive of antibacterial agents, used to treat ulcers in the stomach and the upper part of the small intestine.

### Purpose

Recurrent gastric and duodenal ulcers are caused by *Helicobacter pylori* infections, and are treated with combination treatments that incorporate antibiotic therapy with gastric acid suppression. Additionally, bismuth compounds have been used. The primary class of drugs used for gastric acid suppression are the **proton pump inhibitors**, omeprazole, lansoprazole, pantoprazole and rabeprazole. The H-2 receptor blocking agents, cimetidine, famotidine, nizatidine, and ranitidine have been used for this purpose, but are now more widely used for maintenance therapy after treatment with the proton pump inhibitors. Sucralfate, which acts by forming a protective coating over the ulcerate lesion, is also used in ulcer treatment and may be appropriate for patients in whom other classes of drugs are not

## KEY TERMS

**Antibiotic**—Medicine used to treat infections.

**Enzyme**—A type of protein, produced in the body, that brings about or speeds up chemical reactions.

**Gastrointestinal tract**—The stomach, small intestine and large intestine.

**Hypersecretory**—Excessive production of a bodily secretion. The most common hypersecretory syndrome of the stomach is Zollinger-Ellison Syndrome, a syndrome consisting of fulminating intractable peptic ulcers, gastric hypersecretion and hyperacidity,

and the occurrence of gastrinomas of the pancreatic cells of the islets of Langerhans.

**Inflammation**—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

**Mucous**—Thick fluid produced by the moist membranes that line many body cavities and structures.

**Nonsteroidal anti-inflammatory drug (NSAID)**—A type of medicine used to relieve pain, swelling, and other symptoms of inflammation, such as ibuprofen or ketoprofen.

protecting the open area from further damage. A secondary effect is to act as an inhibitor of the digestive enzyme pepsin. Sucralfate does not bind to the normal stomach lining. The drug has been used for prevention of stress ulcers, the type seen in patients exposed to physical stress such as **burns** and surgery. It has no systemic effects.

### Recommended dosage

The doses of the proton pump inhibitors and H-2 receptor blockers vary depending on the drug and condition being treated. Consult individual references.

The dose of sucralfate for acute ulcer therapy is 1 gram four times a day. After the ulcer has healed, maintenance treatment may continue at 1 gram two times daily.

### Precautions

The proton pump inhibitors are generally well tolerated, and the most common adverse effects are **diarrhea**, **itching**, skin rash, **dizziness** and **headache**. Muscle aches and a higher than normal rate of respiratory infections are among the other adverse reactions reported. Omeprazole has an increased rate of fetal deaths in animal studies. It is not known if these drugs are excreted in human milk, but because of reported adverse effects to infants in animal studies, it is recommended that proton pump inhibitors not be used by nursing mothers.

The H-2 receptor blockers vary widely in their adverse effects. Although they are generally well tolerated, cimetidine may cause confusion in elderly patients, and has an antiandrogenic effect that may cause **sexual dysfunction** in males. Famotidine has been reported to cause headache in 4.7% of patients.

It is advisable that mothers not take H-2 receptor blockers while nursing.

Sucralfate is well tolerated. It is poorly absorbed, and its most common side effect is **constipation** in 2% of patients. Diarrhea, **nausea**, **vomiting**, gastric discomfort, **indigestion**, flatulence, **dry mouth**, rash, pruritus (itching), back **pain**, headache, dizziness, sleepiness, and vertigo have been reported, as well as rare allergic responses. Because sucralfate releases small amounts of aluminum into the system, it should be used with caution in patients with renal insufficiency. There is no information available about sucralfate's safety in **breastfeeding**.

### Interactions

Proton pump inhibitors may increase the pH of the stomach. This will inactivate some antifungal drugs that require an acid medium for effectiveness, notable itraconazole and ketoconazole.

H-2 receptor blocking agents have a large number of **drug interactions**.

Sucralfate should not be used with aluminum containing **antacids**, because of the risk of increased aluminum absorption. Sucralfate may inhibit absorption and reduce blood levels of anticoagulants, **digoxin**, quinidine, ketoconazole, quinolones and phenytoin.

### Resources

#### OTHER

National Institute of Diabetes and Digestive and Kidney Diseases. <http://www.niddk.nih.gov>.

*Stomach Ulcer (Gastric Ulcer).* Fact sheet. Johns Hopkins Health Information Adult Health Advisor. <http://csi.intelihealth.com>.

**ORGANIZATIONS**

Digestive Disease National Coalition, 507 Capitol Court NE, Suite 200, Washington, DC, 20002, (202) 544-7497, (202) 546-7105, ddnc@hmcw.org, <http://www.ddnc.org>.

National Digestive Diseases Information Clearinghouse (NDDIC), 2 Information Way, Bethesda, MD, 20892-3570, (703) 738-4929, (800) 891-5389, <http://digestive.niddk.nih.gov>.

Samuel D. Uretsky PharmD

## Antiviral drugs

### Definition

Antiviral drugs are medicines that cure or control virus infections.

### Purpose

Antivirals are used to treat infections caused by viruses. Unlike antibacterial drugs, which may cover a wide range of pathogens, antiviral agents tend to be narrow in spectrum, and have limited efficacy.

### Description

Exclusive of the antiretroviral agents used in HIV (**AIDS**) therapy, there are currently only 11 antiviral drugs available, covering four types of virus. Acyclovir (Zovirax), famciclovir (Famvir), and valacyclovir (Valtrex) are effective against herpes virus, including herpes zoster and herpes genitalis. They may also be of value in either conditions caused by herpes, such as **chickenpox** and **shingles**. These drugs are not curative, but may reduce the **pain** of a herpes outbreak and shorten the period of viral shedding.

Amantadine (Symmetrel), oseltamivir (Tamiflu), rimantidine (Flumadine), and zanamivir (Relenza) are useful in treatment of **influenza** virus. Amantadine, rimantadine, and oseltamivir may be administered throughout the flu season as preventatives for patients who cannot take influenza virus vaccine.

Cidofovir (Vistide), foscarnet (Foscavir), and ganciclovir (Cytovene) have been beneficial in treatment of cytomegalovirus in immunosuppressed patients, primarily HIV-positive patients and transplant recipients. Ribavirin (Virazole) is used to treat respiratory syncytial virus. In combination with interferons, ribavirin has shown some efficacy against

**hepatitis C**, and there have been anecdotal reports of utility against other types of viral infections.

As a class, the antivirals are not curative, and must be used either prophylactically or early in the development of an infection. Their mechanism of action is typically to inactivate the enzymes needed for viral replication. This will reduce the rate of viral growth, but will not inactive the virus already present. Antiviral therapy must normally be initiated within 48 hours of the onset of an infection to provide any benefit. Drugs used for influenza may be used throughout the influenza season in high risk patients, or within 48 hours of exposure to a known carrier. Antiherpetic agents should be used at the first signs of an outbreak. Anti-cytomegaloviral drugs must routinely be used as part of a program of secondary **prophylaxis** (maintenance therapy following an initial response) in order to prevent reinfection in immunocompromised patients.

### Recommended dosage

Dosage varies with the drug, patient age and condition, route of administration, and other factors. Specific drug references should be consulted.

### Precautions

Ganciclovir is available in intravenous injection, oral capsules, and intraocular inserts. The capsules should be reserved for prophylactic use in organ transplant patients, or for HIV infected patients who cannot be treated with the intravenous drug. The toxicity profile of this drug when administered systemically includes granulocytopenia, anemia and **thrombocytopenia**. The drug is in **pregnancy** category C, but has caused significant fetal abnormalities in animal studies including **cleft palate** and organ defects. **Breastfeeding** is not recommended.

Cidofovir causes renal toxicity in 53% of patients. Patients should be well hydrated, and renal function should be checked regularly. Other common adverse effects are **nausea and vomiting** in 65% of patients, asthenia in 46% and **headache** and **diarrhea**, both reported in 27% of cases. The drug is category C in pregnancy, due to fetal abnormalities in animal studies. Breast feeding is not recommended.

Foscarnet is used in treatment of immunocompromised patients with cytomegalovirus infections and in acyclovir-resistant herpes simples virus. The primary hazard is renal toxicity. Alterations in electrolyte levels may cause seizures. Foscarnet is category C during pregnancy. The drug has caused skeletal abnormalities in developing fetuses. It is not known

## KEY TERMS

**Asthenia**—Muscle weakness.

**Cytomegalovirus (CMV)**—A type of virus that attacks and enlarges certain cells in the body. The virus also causes a disease in infants.

**Herpes simplex**—A virus that causes sores on the lips (cold sores) or on the genitals (genital herpes).

**HIV**—Acronym for human immunodeficiency virus, the virus that causes AIDS.

**Parkinsonism**—A group of conditions that all have these typical symptoms in common: tremor, rigidity, slow movement, and poor balance and coordination.

**Pregnancy category**—A system of classifying drugs according to their established risks for use during pregnancy. Category A: Controlled human studies have demonstrated no fetal risk. Category B: Animal studies indicate no fetal risk, but no human studies, or adverse effects in animals, but not in well-controlled human studies. Category C: No adequate

human or animal studies, or adverse fetal effects in animal studies, but no available human data. Category D: Evidence of fetal risk, but benefits outweigh risks. Category X: Evidence of fetal risk. Risks outweigh any benefits.

**Prophylactic**—Guarding from or preventing the spread or occurrence of disease or infection.

**Retrovirus**—A group of viruses that contain RNA and the enzyme reverse transcriptase. Many viruses in this family cause tumors. The virus that causes AIDS is a retrovirus.

**Shingles**—An disease caused by an infection with the Herpes zoster virus, the same virus that causes chickenpox. Symptoms of shingles include pain and blisters along one nerve, usually on the face, chest, stomach, or back.

**Virus**—A tiny, disease-causing structure that can reproduce only in living cells and causes a variety of infectious diseases.

whether foscarnet is excreted in breast milk, however the drug does appear in breast milk in animal studies.

Valaciclovir is metabolized to acyclovir, so that the hazards of the two drugs are very similar. They are generally well tolerated, but nausea and headache are common adverse effects. They are both pregnancy category B. Although there have been no reports of fetal abnormalities attributable to either drug, the small number of reported cases makes it impossible to draw conclusions regarding safety in pregnancy. Acyclovir is found in breast milk, but no adverse effects have been reported in the newborn. Famciclovir is similar in actions and adverse effects.

Ribavirin is used by aerosol for treatment of hospitalized infants and young children with severe lower respiratory tract infections due to respiratory syncytial virus (RSV). When administered orally, the drug has been used in adults to treat other viral diseases including acute and chronic hepatitis, herpes genitalis, **measles**, and Lassa **fever**, however there is relatively little information about these uses. In rare cases, initiation of ribavirin therapy has led to deterioration of respiratory function in infants. Careful monitoring is essential for safe use.

The anti-influenza drugs are generally well tolerated. Amantadine, which is also used for treatment of

Parkinsonism, may show more frequent CNS effects, including **sedation** and **dizziness**. Rapid discontinuation of amantadine may cause an increase in Parkinsonian symptoms in patients using the drug for that purpose. All are schedule C for pregnancy. In animal studies, they have caused fetal malformations in doses several times higher than the normal human dose. Use caution in breast feeding.

## Interactions

Consult your physician or pharmacist for information on **drug interactions**.

Use particular caution in HIV-positive patients, since these patients are commonly on multi-drug regimens with a high frequency of interactions. Ganciclovir should not be used with other drugs which cause hematologic toxicity, and cidofovir should not be used with other drugs that may cause kidney damage.

## Resources

### PERIODICALS

Antiviral Drugs. Merck Manual Online. [http://www.merckmanuals.com/home/index/ind\\_an.html](http://www.merckmanuals.com/home/index/ind_an.html) [accessed November 23, 2010].

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# Anxiety

## Definition

Anxiety is a multisystem response to a perceived threat or danger. It reflects a combination of biochemical changes in the body, the patient's personal history and memory, and the social situation. It is important to distinguish between anxiety as a feeling or experience, and an anxiety disorder as a psychiatric diagnosis. A person may feel anxious without having an anxiety disorder. In addition, a person facing a clear and present danger or a realistic fear is not usually considered to be in a state of anxiety. Anxiety frequently occurs as a symptom in other categories of psychiatric disturbance.

## Description

Although anxiety is a commonplace experience that everyone has from time to time, it is difficult to describe concretely because it has so many different potential causes and degrees of intensity. Doctors sometimes categorize anxiety as an emotion or an affect depending on whether it is being described by the person having it (emotion) or by an outside observer (affect). The word *emotion* is generally used for the biochemical changes and feeling state that underlie a person's internal sense of anxiety. *Affect* is used to describe the person's emotional state from an observer's perspective. If a doctor says that a patient has an anxious affect, he or she means that the patient appears nervous or anxious, or responds to others in an anxious way (for example, the individual is shaky, tremulous, etc.).

Although anxiety is related to fear, it is not the same thing. Fear is a direct, focused response to a specific event or object, and the person is consciously aware of it. Most people will feel fear if someone points a loaded gun at them or if they see a tornado forming on the horizon. They also will recognize that they are afraid. Anxiety, on the other hand, is often unfocused, vague, and hard to pin down to a specific cause. In this form it is called free-floating anxiety. Sometimes anxiety being experienced in the present may stem from an event or person that produced **pain** and fear in the past, but the anxious individual is not consciously aware of the original source of the feeling. It is anxiety's aspect of remoteness that makes it hard for people to compare their experiences of it. Whereas most people will be fearful in physically dangerous situations, and can agree that fear is an appropriate response in the presence of danger, anxiety is

often triggered by objects or events that are unique and specific to an individual. An individual might be anxious because of a unique meaning or memory being stimulated by present circumstances, not because of some immediate danger. Another individual looking at the anxious person from the outside may not be aware of the reason for the person's anxiety.

## Causes and symptoms

Anxiety can have a number of different causes. It can be a response to stimuli in the person's environment, such as a bridge, or a response to a stimulus within the individual, such as a hypochondriac's reaction to a stomach rumbling.

### Physical

In some cases, anxiety is produced by physical responses to **stress**, or by certain disease processes or medications.

**THE AUTONOMIC NERVOUS SYSTEM (ANS).** The nervous system of human beings is "hard-wired" to respond to dangers or threats. These responses are not subject to conscious control, and are the same in humans as in many lower animals. They represent an evolutionary adaptation to the predators and other dangers with which all animals, including primitive humans, had to cope. The most familiar reaction of this type is often referred to as the "fight-or-flight" response. This response is the human's automatic response in a life-threatening situation. It is a state of physiological and emotional hyperarousal marked by high muscle tension and strong feelings of fear or anger. When a person has a fight-or-flight reaction, the level of stress hormones in the blood rises. He or she becomes more alert and attentive, the eyes dilate, the heartbeat increases, the breathing rate increases, and the digestion slows down, allowing more energy to be available to the muscles.

This emergency reaction is regulated by a part of the nervous system called the autonomic nervous system (ANS). The ANS is controlled by the hypothalamus, a specialized part of the brainstem that is among a group of structures called the limbic system. The limbic system controls human emotions through its connections to glands and muscles; it also connects to the ANS and "higher" brain centers, such as parts of the cerebral cortex. The limbic system cannot tell the difference between a realistic physical threat and an anxiety-producing thought or idea. The hypothalamus may trigger the release of stress hormones by the

## KEY TERMS

**Affect**—An observed emotional expression or response.

**Anxiolytic**—A type of medication that helps to relieve anxiety.

**Autonomic nervous system (ANS)**—The part of the nervous system that supplies nerve endings in the blood vessels, heart, intestines, glands, and smooth muscles, and governs their involuntary functioning. The autonomic nervous system is responsible for the biochemical changes involved in experiences of anxiety.

**Endocrine gland**—A ductless gland, such as the pituitary, thyroid, or adrenal gland, that secretes its products directly into the blood or lymph.

**Free-floating anxiety**—Anxiety that lacks a definite focus or content.

**Hyperarousal**—A state or condition of muscular and emotional tension produced by hormones released during the fight-or-flight response to a stimuli.

**Hypothalamus**—A portion of the brain that regulates the autonomic nervous system, the release of hormones from the pituitary gland, sleep cycles, and body temperature.

**Limbic system**—A group of structures in the brain that includes the hypothalamus, amygdala, and hippocampus. The limbic system plays an important part in regulation of human moods and emotions. Many psychiatric disorders are related to malfunctioning of the limbic system.

**Phobia**—A fear of a specific situation, object, or type of object. Phobias are often considered illogical or irrational, as the situation or object does not pose any significant danger for the individual experiencing the phobia.

pituitary gland, even when there is no objective danger.

A problem may be caused by the biochemical side effects of too many “false alarms” in the ANS. When a person responds to a real danger, his or her body is aided by the stress hormones released. The hormones allow the individual to run faster, or fight harder, than normal. However if the individual does not make use of the stress hormones released, the body has to absorb all the biochemical changes of hyperarousal, rather than release them. These biochemical changes can produce anxious feelings, as well as muscle tension and other physical symptoms associated with anxiety. They may even produce permanent changes in the brain, if the process occurs repeatedly. Some chronic physical disorders, such as **coronary artery disease**, may be worsened by anxiety, as chronic hyperarousal can put stress on the heart, stomach, and other organs.

**DISEASES AND DISORDERS.** Anxiety can be a symptom of certain medical conditions. Some of these diseases are disorders of the endocrine system, such as **Cushing's syndrome** (overproduction of cortisol by the adrenal cortex), and include over- or underactivity of the thyroid gland. Other medical conditions that can produce anxiety include **respiratory distress syndrome**, **mitral valve prolapse**, porphyria, and chest pain caused by inadequate blood supply to the heart (**angina pectoris**).

**MEDICATIONS AND SUBSTANCE USE.** Numerous medications may cause anxiety-like symptoms as a side effect. They include birth control pills; some thyroid or **asthma** drugs; some psychotropic agents; occasionally, local anesthetics; **corticosteroids**; **antihypertensive drugs**; and **nonsteroidal anti-inflammatory drugs** (like flurbiprofen and ibuprofen).

**Caffeine** can cause anxiety-like symptoms when consumed in sufficient quantities. Individuals who consume caffeine rich foods and beverages, such as chocolate, cocoa, coffee, tea, or carbonated soft drinks (especially cola beverages), can sometimes lower their anxiety symptoms simply by reducing their intake of these substances.

Withdrawal from certain prescription drugs, primarily **beta blockers** and corticosteroids, can cause anxiety. Withdrawal from drugs of abuse, including **LSD**, **cocaine**, alcohol, and opiates, can also cause anxiety.

**CHILDHOOD DEVELOPMENT AND ANXIETY.** Some researchers in early childhood believe that there may be a link between anxiety and childhood memories of dependency. Humans survival during the first years of life depends on the care of others. It is thought that this early experience of helplessness underlies the most common anxieties of adult life, including fear of powerlessness and fear of being unloved. Thus, adults may be made anxious by symbolic threats to their

sense of competence and/or significant relationships, even though they are no longer helpless children.

**SYMBOLIZATION.** The psychoanalytic model gives considerable weight to the symbolic aspect of human anxiety; examples include phobic disorders, obsessions, compulsions, and other forms of anxiety that are highly individualized. The length of the human maturation process allows many opportunities for children and adolescents to connect their experiences with certain objects or events that can bring back feelings in later life. For example, a person who was frightened as a child by a tall man wearing glasses may feel panicky years later by something that reminds him of that person or experience without consciously knowing why.

Freud thought that anxiety results from a person's internal conflicts. According to his theory, people feel anxious when they feel torn between desires or urges toward certain actions, on the one hand, and moral restrictions, on the other. In some cases, the person's anxiety may attach itself to an object that represents the inner conflict. For example, someone who feels anxious around money may be pulled between a desire to steal and the belief that stealing is wrong. Money becomes a symbol for the inner conflict between doing what is considered right and doing what one wants.

**PHOBIAS.** **Phobias** are a type of anxiety reaction in which the person's anxiety is concentrated on a specific object, type of object, or situation. The object or situation causes fear out of proportion to any possible threat that it poses. Prior to the *Diagnostic and Statistical Manual of Mental Disorders*, 4th edition (*DSM-IV*), these specific phobias were called simple phobias. It is estimated that specific phobias affect about 9% of the population. Men and women are believed to be equally likely to develop specific phobias. Some phobias are more common than others. Common phobias include **agoraphobia** (fear of open spaces), claustrophobia (fear of small or confined spaces), and social phobia. Others phobias are less common or may be unique to the individual.

### Social and environmental stressors

Anxiety often has a social dimension. People frequently report feelings of high anxiety when they anticipate and, therefore, fear the loss of social approval or love. Social phobia is a specific anxiety disorder that is marked by high levels of anxiety or fear of embarrassment in social situations.

Another social stressor is prejudice. People who belong to groups that are targets of bias are at higher risk for developing **anxiety disorders**. Some experts think, for example, that the higher rates **panic**

**disorder** among women reflects their greater social and economic vulnerability.

Some controversial studies indicate that the increase in violent or upsetting pictures and stories in news reports and entertainment may raise the anxiety level of many people. Stress and anxiety management programs often suggest that patients cut down their exposure to upsetting stimuli.

Anxiety may also be caused by environmental or occupational factors. People who must live or work around sudden or loud noises, bright or flashing lights, chemical vapors, or similar nuisances, which they cannot avoid or control, may develop heightened anxiety levels.

Another factor that shapes human experiences of anxiety is knowledge of personal mortality. Humans are the only animals that appear to be aware of their limited life span. Some researchers think that awareness of **death** influences experiences of anxiety from the time that a person is old enough to understand death.

### Symptoms of anxiety

**SOMATIC.** The somatic or physical symptoms of anxiety include headaches, **dizziness** or lightheadedness, **nausea** and/or **vomiting**, **diarrhea**, **tingling**, pale complexion, sweating, **numbness**, difficulty in breathing, and sensations of tightness in the chest, neck, shoulders, or hands. These symptoms are produced by the hormonal, muscular, and cardiovascular reactions involved in the fight-or-flight reaction. Children and adolescents with **generalized anxiety disorder** show a high percentage of physical complaints.

**BEHAVIORAL.** Behavioral symptoms of anxiety include pacing, trembling, general restlessness, hyper-ventilation, pressured speech, hand wringing, and finger tapping.

**COGNITIVE.** Cognitive symptoms of anxiety include recurrent or obsessive thoughts, feelings of doom, morbid or fear-inducing thoughts or ideas, and confusion, or inability to concentrate.

**EMOTIONAL.** Feeling states associated with anxiety include tension or nervousness, feeling "hyper" or "keyed up," and feelings of unreality, panic, or terror.

**DEFENSE MECHANISMS.** When anxiety is untreated, the individual may use, consciously or unconsciously, a number of coping strategies. These psychological defenses include:

- **Repression.** The person pushes anxious thoughts or ideas out of conscious awareness.
- **Displacement.** Anxiety from one source is attached to a different object or event. Phobias are an example of the mechanism of displacement in psychoanalytic theory.

- Rationalization. The person justifies the anxious feelings by saying that any normal person would feel anxious in their situation.
- Somatization. The anxiety emerges in the form of physical complaints and illnesses, such as recurrent headaches, stomach upsets, or muscle and joint pain.
- Delusion formation. The person converts anxious feelings into conspiracy theories or similar ideas without reality testing. Delusion formation can involve groups as well as individuals.

Some instances of alcohol or drug use, abuse, or **addiction** may stem from attempts to self-medicate for anxiety. In these cases treating underlying anxiety along with issues of dependence may help the treatment be successful in the long run.

## Diagnosis

The diagnosis of anxiety is difficult and complex because of the variety of its causes and the highly personalized and individualized nature of its symptoms. There are no medical tests that can be used to diagnose anxiety by itself. When a doctor examines an anxious patient, he or she will first rule out physical conditions and diseases that have anxiety as a symptom. Apart from these exclusions, the **physical examination** is usually inconclusive. Some anxious patients may have their blood pressure or pulse rate affected by anxiety, or may look pale or perspire heavily, but others may appear physically completely normal. The doctor will then take the patient's medication, dietary, and occupational history to see if they are taking prescription drugs that might cause anxiety, if they are abusing alcohol or mood-altering drugs, if they are consuming large amounts of caffeine, or if their workplace is noisy or dangerous. In most cases, the most important source of diagnostic information is the patient's psychological and social history. The doctor may administer a brief psychological test to help evaluate the intensity of the patient's anxiety and some of its features. Tests that may be used for this purpose are the Hamilton Anxiety Scale and the Anxiety Disorders Interview Schedule (ADIS). Many doctors will check a number of chemical factors in the blood, such as the level of thyroid hormone and blood sugar.

## Treatment

Because anxiety often has more than one cause and is experienced in highly individual ways, individuals may benefit from more than one type of therapy. In addition, there is no way to tell in advance how patients will respond to a specific drug or therapy. Sometimes the doctor will need to try different medications or methods of treatment before finding the best combination for a

particular patient. Many treatments for anxiety take time to be fully effective, which may require waiting six or more weeks before determining if another treatment option may be more effective.

### Medications

Medications are often prescribed to relieve the physical and psychological symptoms of anxiety. Most agents work by counteracting the biochemical and muscular changes involved in the fight-or-flight reaction. Some work directly on the chemicals in the brain that are thought to underlie the anxiety.

**ANXIOLYTICS.** Anxiolytics are sometimes called tranquilizers. Most anxiolytic drugs are either **benzodiazepines** or **barbiturates**. Barbiturates, once commonly used, are now rarely used in clinical practice. Barbiturates work by slowing down the transmission of nerve impulses from the brain to other parts of the body. They include such drugs as phenobarbital (Luminal) and pentobarbital (Nembutal). Benzodiazepines work by relaxing the skeletal muscles and calming the limbic system. They include such drugs as chlordiazepoxide (Librium) and diazepam (Valium). Both barbiturates and benzodiazepines are potentially habit-forming and may cause withdrawal symptoms when stopped, but benzodiazepines are less likely than barbiturates to cause physical dependency. Both drugs also increase the effects of alcohol.

Two other types of anxiolytic medications include meprobamate (Equanil), which is now rarely used, and buspirone (BuSpar), a type of anxiolytic that works by increasing the efficiency of the body's own emotion-regulating brain chemicals. Buspirone has several advantages over other anxiolytics. It does not cause dependence problems, does not interact with alcohol, and does not affect the patient's ability to drive or operate machinery. However, buspirone is not effective against certain types of anxiety, such as panic disorder.

**ANTIDEPRESSANTS AND BETA BLOCKERS.** For some anxiety disorders, such as **obsessive-compulsive disorder** and panic type anxiety, a type of drugs used to treat depression, **selective serotonin reuptake inhibitors** (SSRIs; such as Prozac and Paxil), are the treatment of choice. A newer drug that has been shown as effective as Paxil is called escitalopram oxalate (Lexapro). Because anxiety often coexists with symptoms of depression, many doctors prescribe antidepressant medications for patients with anxiety to help treat both problems. While SSRIs are more common, antidepressants are sometimes prescribed, including **tricyclic antidepressants** such as imipramine (Tofranil) or

**monoamine oxidase inhibitors** (MAO inhibitors) such as phenelzine (Nardil).

Beta blockers are medications that work by blocking the body's reaction to the stress hormones that are released during the fight-or-flight reaction. They include drugs like propranolol (Inderal) or atenolol (Tenormin). Beta blockers are sometimes given to patients with post-traumatic anxiety symptoms. More commonly, the beta blockers are given to patients with a mild form of social phobic anxiety, such as fear of public speaking.

### **Psychotherapy**

Most patients with anxiety are treated using some form of **psychotherapy** along with medications. Two approaches that may work well for anxious patients are **cognitive-behavioral therapy** (CBT), and relaxation training. In CBT, the patient is taught to identify the thoughts and situations that stimulate his or her anxiety, and works with the therapist to develop strategies for overcoming his or her anxiety. In the behavioral part of the program, the patient is exposed to the anxiety-provoking object, situation, or internal stimulus (like a rapid heart beat) in gradual stages until he or she is desensitized to it. Relaxation training, which is sometimes called anxiety management training, includes breathing exercises and similar techniques intended to help the patient prevent hyperventilation and relieve the muscle tension associated with the fight-or-flight reaction. Both CBT and relaxation training can be used in **group therapy** as well as individual treatment. In addition to CBT, support groups are often helpful to anxious patients, because they provide a social network and can help lessen the embarrassment that often accompanies anxiety symptoms.

### **Psychosurgery**

Surgery on the brain is very rarely recommended for patients with anxiety; however, some patients with severe cases of obsessive-compulsive disorder (OCD) have been helped by an operation on a part of the brain that is involved in OCD. Normally, this operation is attempted after all other treatments have failed, and the OCD is severe enough to prevent normal functioning.

### **Alternative treatment**

Alternative treatments for anxiety cover a variety of approaches. **Meditation** and mindfulness training are thought beneficial to patients with phobias and panic disorder. **Hydrotherapy** is useful to some anxious patients because it promotes general relaxation of the nervous system. **Yoga**, aikido, t'ai chi, and dance therapy help patients work with the physical, as well as

the emotional, tensions that either promote anxiety or are created by the anxiety.

Homeopathy and **traditional Chinese medicine** approach anxiety as a symptom of a systemic disorder. Homeopathic practitioners select a remedy based on other associated symptoms and the patient's general constitution. Chinese medicine regards anxiety as a blockage of *qi*, or vital force, inside the patient's body that is most likely to affect the lung and large intestine meridian flow. The practitioner of Chinese medicine chooses **acupuncture** point locations and/or herbal therapy to move the *qi* and rebalance the entire system in relation to the lung and large intestine.

### **Prognosis**

The prognosis for resolution of anxiety depends on the specific disorder and a wide variety of factors, including the patient's age, sex, general health, living situation, belief system, social support network, and responses to different medications and forms of therapy.

### **Prevention**

Because it is possible for individuals to exercise significant control over their thoughts, it may be possible for an individual to learn ways of preventing anxiety by changing thought patterns. Individuals may also be able to exercise some control over anxiety arising from social and environmental conditions. Feelings of anxiousness arising occasionally from situations generally expected to cause anxiety generally cannot, and do not need to be, prevented.

### **Resources**

#### **BOOKS**

- Beck, Aaron T., Gary Emery and Ruth L. Greenberg. *Anxiety Disorders and Phobias: A Cognitive Perspective*. Cambridge, MA: Basic Books, 2005.  
 Kase, Larina and Deborah Roth Ledley. *Anxiety Disorders*. Hoboken, NJ: John Wiley and Sons, 2007.  
 Velotis, Calvin M., ed. *Anxiety Disorder Research*. New York: Nova Science, 2005.

#### **OTHER**

- Medline Plus. "Anxiety." July 27, 2007. <http://www.nlm.nih.gov/medlineplus/anxiety.html>

#### **ORGANIZATIONS**

- Anxiety Disorders Association of America, 8730 Georgia Ave., Suite 600, Silver Spring, MD, 20910, (240) 485-1001.  
 American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (703) 907-7300.

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## Anxiety disorders

### Definition

**Anxiety** disorders are a group of mental disturbances characterized by anxiety as a central or core symptom. Although anxiety is a commonplace experience, not everyone who experiences it has an anxiety disorder. Anxiety is associated with a wide range of physical illnesses, medication side effects, and other psychiatric disorders.

The revisions of the *Diagnostic and Statistical Manual of Mental Disorders (DSM)* that took place after 1980 brought major changes in the classification of the anxiety disorders. Prior to 1980, psychiatrists classified patients on the basis of a theory that defined anxiety as the outcome of unconscious conflicts in the patient's mind. *DSM-III* (1980), *DSM-III-R* (1987), and *DSM-IV* (1994) introduced and refined a new classification that considered recent discoveries about the biochemical and post-traumatic origins of some types of anxiety. The present definitions are based on the external and reported symptom patterns of the disorders rather than on theories about their origins.

### Demographics

The anxiety disorders vary widely in their frequency of occurrence in the general population, age of onset, family patterns, and gender distribution. The **stress** disorders and anxiety disorders caused by medical conditions or **substance abuse** are less age- and gender-specific. Whereas **obsessive-compulsive disorder (OCD)** affects males and females equally, **generalized anxiety disorder (GAD)**, **panic disorder**, and specific **phobias** all affect women more frequently than men. GAD and panic disorders are more likely to develop in young adults, while phobias and OCD often begin in childhood.

### Anxiety disorders in children and adolescents

*DSM-IV* defines one anxiety disorder as specific to children, namely, separation anxiety disorder. This disorder is defined as anxiety regarding separation from home or family that is excessive or inappropriate for the child's age. In some children, separation anxiety takes the form of school avoidance.

Children and adolescents can also be diagnosed with panic disorder, phobias, generalized anxiety disorder, and the post-traumatic stress syndromes.

### Description

Anxiety disorders are the most common form of mental disturbance in the United States population. According to the Anxiety Disorders Association of America, as many as 40 million American adults are affected by anxiety disorders. These disorders are a serious problem for society because they can interfere with work, schooling, and family life. They also contribute to the high rates of alcohol and substance abuse in the United States. Anxiety disorders are an additional problem for health professionals because the physical symptoms of anxiety frequently bring people to primary care doctors or emergency rooms.

*DSM-IV* defines 12 types of anxiety disorders in the adult population. They can be grouped under seven headings:

- Panic disorders with or without agoraphobia. The chief characteristic of panic disorder is the occurrence of panic attacks coupled with fear of their recurrence. In clinical settings, agoraphobia is usually not a disorder by itself, but is typically associated with some form of panic disorder. Patients with agoraphobia are afraid of places or situations in which they might have a panic attack and be unable to leave or to find help. Panic disorder affects approximately 2.7% of adults.
- Phobias. These include specific phobias and social phobia. A phobia is an intense irrational fear of a specific object or situation that compels the individual to avoid it. Some phobias concern activities or objects that involve some risk (for example, flying or driving) but many are focused on harmless animals or other objects. Social phobia involves a fear of being humiliated, judged, or scrutinized. It manifests itself as a fear of performing certain functions in the presence of others, such as public speaking or using public lavatories.
- Obsessive-compulsive disorder (OCD). This disorder is marked by unwanted, intrusive, persistent thoughts or repetitive behaviors that reflect the patient's anxiety or attempts to control it. It affects about 1% of the population. About 6% of individuals who have OCD also have panic disorders.
- Stress disorders. These include post-traumatic stress disorder (PTSD) and acute stress disorder. Stress disorders are symptomatic reactions to traumatic events in the patient's life.
- Generalized anxiety disorder (GAD). GAD is the most commonly diagnosed anxiety disorder and occurs most frequently in young adults.
- Anxiety disorders due to known physical causes. These include general medical conditions or substance abuse.

## KEY TERMS

**Agoraphobia**—Abnormal anxiety regarding public places or situations from which the patient may wish to flee or in which he or she would be helpless in the event of a panic attack.

**Compulsion**—A repetitive or ritualistic behavior that a person performs to reduce anxiety. Compulsions often develop as a way of controlling or undoing obsessive thoughts.

**Obsession**—A repetitive or persistent thought, idea, or impulse that is perceived as inappropriate and distressing.

**Panic attack**—A time-limited period of intense fear accompanied by physical and cognitive symptoms. Panic attacks may be unexpected or triggered by specific internal or external cues.

- Anxiety disorder not otherwise specified. This last category is not a separate type of disorder, but is included to cover symptoms that do not meet the specific *DSM-IV* criteria for other anxiety disorders.

All *DSM-IV* anxiety disorder diagnoses include a criterion of severity. The anxiety must be severe enough to interfere significantly with the patient's occupational or educational functioning, social activities or close relationships, and other customary activities.

### Causes and symptoms

The causes of anxiety include a variety of individual and general social factors, and may produce physical, cognitive, emotional, or behavioral symptoms. The patient's ethnic or cultural background may also influence his or her vulnerability to certain forms of anxiety. Genetic factors that lead to biochemical abnormalities may also play a role.

Anxiety in children may be caused by suffering from abuse, as well as by the factors that cause anxiety in adults.

### Diagnosis

The diagnosis of anxiety disorders is complicated by the variety of causes of anxiety and the range of disorders that may include anxiety as a symptom. Many patients who have anxiety disorders have features or symptoms of more than one disorder. Patients whose anxiety is accounted for by another psychic disorder, such as **schizophrenia** or major depression, are not diagnosed with an anxiety disorder.

### Examination

A doctor examining an anxious patient will usually begin by ruling out diseases that are known to cause anxiety and then proceed to take the patient's medication history, in order to exclude side effects of prescription drugs. Most doctors ask about **caffeine** consumption to see if the patient's dietary habits are a factor. The patient's work and family situation will also be discussed. Often, primary care physicians exhaust resources looking for medical causes for general patient complaints, which may indicate a physical illness. The Anxiety Disorders Association of America has published guidelines to aid physicians in diagnosing and managing generalized anxiety disorder.

### Tests

There are no laboratory tests that can diagnose anxiety, although the doctor may order some specific tests to rule out diseases and conditions, such as laboratory tests for blood sugar and thyroid function. Although there is no psychiatric test that can provide definite diagnoses of anxiety disorders, there are several short-answer interviews or symptom inventories that doctors can use to evaluate the intensity of a patient's anxiety and some of its associated features. These measures include the Hamilton Anxiety Scale and the Anxiety Disorders Interview Schedule (ADIS).

### Treatment

#### Traditional

For relatively mild anxiety disorders, **psychotherapy** alone may be sufficient. In general, doctors prefer to use a combination of medications and psychotherapy with more severely anxious patients. Most patients respond better to a combination of treatment methods than to either medications or psychotherapy in isolation.

#### Drugs

Because of the variety of medications and treatment approaches that are used to treat anxiety disorders, the doctor cannot predict in advance which combination will be most helpful to a specific patient. In many cases the doctor will need to try a new medication or treatment over a six- to eight-week period in order to assess its effectiveness. Trying a few different treatment options does not necessarily mean that the patient cannot be helped or that the doctor is incompetent.

Although anxiety disorders are not always easy to diagnose, there are several reasons why it is important for patients with severe anxiety symptoms to get help. Anxiety does not always go away by itself; it often

progresses to panic attacks, phobias, and episodes of depression. Untreated anxiety disorders may eventually lead to a diagnosis of major depression, or interfere with the patient's education or ability to keep a job. In addition, many anxious patients develop addictions to drugs or alcohol when they try to "medicate" their symptoms. Moreover, since children learn ways of coping with anxiety from their parents, adults who get help for anxiety disorders are in a better position to help their families cope with factors that lead to anxiety than those who remain untreated.

### **Alternative**

Alternative treatments for anxiety cover a variety of approaches. **Meditation** and mindfulness training are thought beneficial to patients with phobias and panic disorder. **Hydrotherapy** is useful to some anxious patients because it promotes general relaxation of the nervous system. **Yoga**, aikido, t'ai chi, and dance therapy help patients work with the physical, as well as the emotional, tensions that either promote anxiety or are created by the anxiety.

Homeopathy and **traditional Chinese medicine** approach anxiety as a symptom of a systemic disorder. Homeopathic practitioners select a remedy based on other associated symptoms and the patient's general constitution. Chinese medicine regards anxiety as a blockage of *qi*, or vital force, inside the patient's body that is most likely to affect the lung and large intestine meridian flow. The practitioner of Chinese medicine chooses **acupuncture** point locations and/or herbal therapy to move the *qi* and rebalance the entire system in relation to the lung and large intestine.

### **Prognosis**

The prognosis for recovery depends on the specific disorder, the severity of the patient's symptoms, the specific causes of the anxiety, and the patient's degree of control over these causes.

### **Prevention**

Anxiety is an unavoidable feature of human existence. However, humans have some power over their reactions to anxiety-provoking events and situations. Cognitive therapy and meditation or mindfulness training appear to be beneficial in helping people lower their long-term anxiety levels.

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### **ORGANIZATIONS**

American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209 (703) 907-7300, [apa@psych.org](mailto:apa@psych.org), <http://www.psych.org>.

Anxiety Disorders Association of America, 8730 Georgia Ave., Suite 600, Silver Spring, MD, 20910 (240) 485-1001, <http://www.adaa.org>.

National Alliance on Mental Illness (NAMI), Colonial Place Three, 2107 Wilson Blvd., Suite 300, Arlington, VA, 22201 (703) 524-7600 (800) 950-NAMI (6264) (703) 524-9094, <http://www.nami.org>.

National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD, 20892 (301) 443-4513 (866) 615-6464 (301) 443-4279, [nimhinfo@nih.gov](mailto:nimhinfo@nih.gov), <http://www.nimh.nih.gov>.

National Mental Health Association (NMHA), 2000 N. Beauregard Street, 6th Floor, Alexandria, VA, 22311 (703) 684-7722 (800) 969-NMHA (703) 684-5968, <http://www1.nmha.org>.

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Anxiolytics see **Antianxiety drugs**

## Aortic aneurysm

### Definition

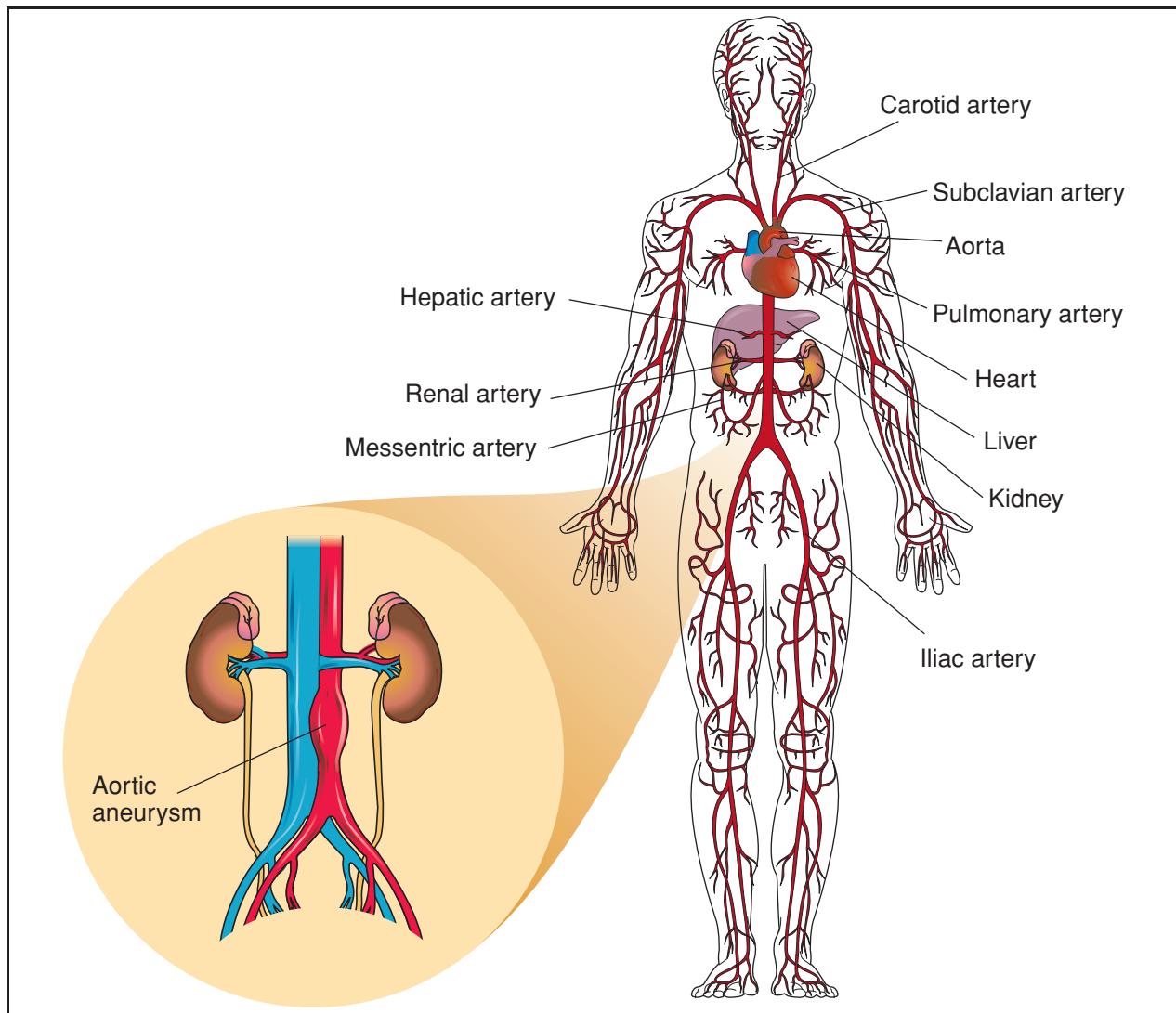
An aneurysm is an abnormal bulging or swelling of a portion of a blood vessel. The aorta, which can develop these abnormal bulges, is the large blood vessel that carries oxygen-rich blood away from the heart to the rest of the body.

### Description

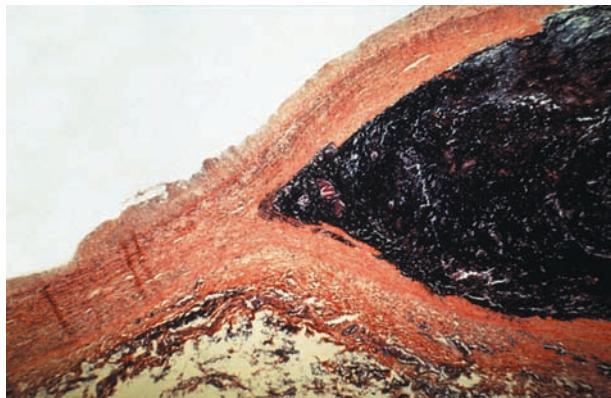
The aorta carries oxygen-rich blood to the body, and is therefore called an artery. Because the aorta is an

artery, its walls are made up of three layers; a thin inner layer, a muscular middle layer (that gives the vessel its flexibility under pressure from the filling blood), and a fiber-like outer layer that gives the vessel strength to not burst when the heart pumps blood to the body.

Aortic aneurysms occur when a weakness develops in part of the wall of the aorta; three basic types are usually found. If all three layers of the vessel are affected and weakness develops along an extended area of the vessel, the weakened area will appear as a large, bulging region of blood vessel; this is called a fusiform aneurysm. If weakness develops between the inner and outer layers of the aortic wall, a bulge results



**Aortic aneurysms occur when a weakness develops in a part of the wall of the aorta. The aorta is the large blood vessel that carries oxygen-rich blood away from the heart to the rest of the body.** (*Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.*)



**An aneurysm in progress.** An aneurysm is an abnormal bulging or swelling of a portion of a blood vessel. (Custom Medical Stock Photo, Inc. Reproduced by permission.)



**Surgery being performed to correct aortic aneurysm.** (Custom Medical Stock Photo, Inc. Reproduced by permission.)

as blood from the interior of the vessel is pushed around the damaged region in the wall and collects between these layers. This is called a dissecting aneurysm because one layer is “dissected” or separated from another. If damage occurs to only the middle (muscular) layer of the vessel, a sack-like bulge can form; therefore, this is a saccular aneurysm.

### Causes and symptoms

Aortic aneurysms occur in different portions of the aorta, which begins in the chest (at the heart) and travels downward through the abdomen. Aneurysms found in the region of the aorta within the chest are called thoracic aortic aneurysms. Aneurysms that occur in the part of the aorta within the abdomen are called abdominal aortic aneurysms.

Thoracic aortic aneurysms do not usually produce any noticeable symptoms. However, as the

### KEY TERMS

**Atherosclerosis**—The accumulation of fat on the inner wall of an artery. This fat is largely made up of cholesterol being carried in the blood.

**Dacron**—A synthetic polyester fiber used to surgically repair damaged sections of blood vessel walls.

aneurysm becomes larger, chest, shoulder, neck, lower back, or abdominal **pain** can result. Abdominal aortic aneurysms occur more often in men, and these aneurysms can cause pain in the lower back, hips, and abdomen. A painful abdominal aortic aneurysm usually means that the aneurysm could burst very soon.

Most abdominal aortic aneurysms are caused by **atherosclerosis**, a condition caused when fat (mostly cholesterol) carried in the blood builds up in the inner wall of the aorta. As more and more fat attaches to the aortic wall, the wall itself becomes abnormally weak and often results in an aneurysm or bulge.

Aortic aneurysms are also caused by a breakdown of the muscular middle layer of the artery wall, by high blood pressure, by direct injury to the chest, and although rare, by bacteria that can infect the aorta.

### Diagnosis

Silent, stable aneurysms are often detected when a person has an x ray as part of a routine examination or for other medical reasons. Otherwise, when chest, abdominal, or back pain is severe, aortic aneurysm is suspected and x-ray (radiographic) studies can confirm or rule out that condition.

### Treatment

Aortic aneurysms are potentially life-threatening conditions. Small aneurysms should be monitored for their rate of growth and large aneurysms require consideration for a surgical repair. The most common method of surgical repair is to cut out the bulging section of artery wall and sew a Dacron fiber material into its place in the vessel wall.

### Prognosis

Only 1-2% of people die from having surgical repair of an aortic aneurysm. However, if the

aneurysm is untreated and eventually ruptures, less than half of the people with ruptured aneurysms will survive. The challenge for the physician is to decide when or if to do the preventive surgery.

### Prevention

Aneurysms can develop in people with atherosclerosis. High blood pressure can also lead to this condition. Although no definite prevention exists, lifestyle and dietary changes that help lower blood pressure and the amount of fat in the blood stream may slow the development of aneurysms.

### ORGANIZATIONS

- American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.  
 National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, <http://www.nhlbi.nih.gov>.

Dominic De Bellis PhD

## Aortic dissection

### Definition

Aortic dissection is a rare, but potentially fatal, condition in which blood passes through the inner lining and between the layers of the aorta. The dissecting aorta usually does not burst, but has an abnormal second channel within it.

### Description

A defect in the inner lining of the aorta allows an opening or tear to develop. The aorta is the main artery of the body and is an area of high blood pressure. When a defect develops, blood pressure can force the tear to open and allow blood to pass through. Since the blood is under pressure, it eventually splits (dissecting) the middle layer of the blood vessel, creating a new channel for blood. The length of the channel grows over time and can result in the closing off of connection points to other arteries. This can lead to **heart attack**, strokes, abdominal **pain**, and nerve damage. Blood may leak from the dissection and collect in the chest and around the heart.

A second mechanism leading to aortic dissection is medial hemorrhage. A medial hemorrhage occurs in the middle layer of the blood vessel and spills through the inner lining of the aorta wall. This opening then

## KEY TERMS

**Dissection**—A cut or divide.

**Hemorrhage**—A large discharge of blood, profuse bleeding.

allows blood from the aorta to enter the vessel wall and begin a dissection. Approximately 2,000 cases of aortic dissection occur yearly in the United States.

### Causes and symptoms

Aortic dissection is caused by a deterioration of the inner lining of the aorta. There are a number of conditions that predispose a person to develop defects of the inner lining, including high blood pressure, Marfan's disease, **Ehlers-Danlos syndrome**, connective tissue diseases, and defects of heart development which begin during fetal development. A dissection can also occur accidentally following insertion of a catheter, trauma, or surgery. The main symptom is sudden, intense pain. The pain can be so intense as to immobilize the patient and cause him to fall to the ground. The pain is frequently felt in both the chest and in the back, between the shoulder blades. The extent of the pain is proportional to the length of the dissection.

### Diagnosis

The pain experienced by the patient is the first symptom of aortic dissection and is unique. The pain is usually described by the patient as "tearing, ripping, or stabbing." This is in contrast to the pain associated with heart attacks. The patient frequently has a reduced or absent pulse in the extremities. A murmur may be heard if the dissection is close to the heart. An enlarged aorta will usually appear in the chest x rays and ultrasound exams of most patients. The use of a blood dye in angiograms and/or CT scans (**computed tomography scans**) will aid in diagnosing and visualizing the dissection.

### Treatment

Because of the potentially fatal nature of aortic dissection, patients are treated immediately. Drugs are administered to reduce the blood pressure and heart rate. If the dissection is small, drug therapy alone may be used. In other cases, surgery is performed. In surgery, damaged sections of the aorta are removed and a synthetic graft is often used to reconstruct the damaged vessel.

## Prognosis

Depending on the nature and extent of the dissection, **death** can occur within a few hours of the start of a dissection. Approximately 75% of untreated people die within two weeks of the start of a dissection. Of those who are treated, 40% survive more than 10 years. Patients are usually given long-term treatment with drugs to reduce their blood pressure, even if they have had surgery.

## Resources

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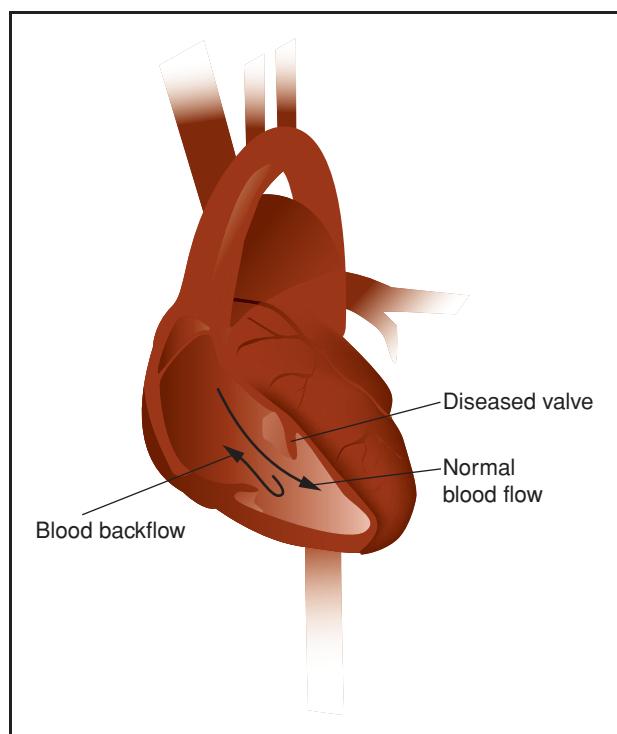
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John T. Lohr PhD

Aortic incompetence see **Aortic valve insufficiency**

Aortic regurgitation see **Aortic valve insufficiency**

Aortic stenosis see **Aortic valve stenosis**



**A human heart with a diseased valve that doesn't open and close properly, allowing blood to backflow to the heart.**  
*(Illustration by Argosy, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)*

## Aortic valve insufficiency

### Definition

The aortic valve separates the left ventricle of the heart (the heart's largest pumping chamber) from the aorta, the large artery that carries oxygen-rich blood out of the left ventricle to the rest of the body. In aortic valve insufficiency, the aortic valve becomes leaky, causing blood to flow backwards into the left ventricle.

### Description

Aortic valve insufficiency occurs when this valve cannot properly close after blood that is leaving the heart's left ventricle enters the aorta. With each contraction of the heart more and more blood flows back into the left ventricle, causing the ventricle to become overfilled. This larger-than-normal amount of blood that collects in the left ventricle puts pressure on the walls of the heart, causing the heart muscle to increase in thickness (hypertrophy). If this thickening continues, the heart can be permanently damaged.

Aortic valve insufficiency is also known as aortic valve regurgitation because of the abnormal reversed flow of blood leaking through the poorly functioning valve.

### Causes and symptoms

The faulty working of the aortic valve can be caused by a birth defect; by abnormal widening of the aorta (which can be caused by very high blood pressure and a variety of other less common conditions); by various diseases that cause large amounts of swelling (inflammation) in different areas of the body, like **rheumatic fever**; and, although rarely, by the sexually transmitted disease, **syphilis**.

About 75% of people with aortic valve insufficiency are men. Rheumatic (inflammatory) diseases have been the main cause of this condition in both men and women.

Aortic valve insufficiency can remain unnoticed for 10 to 15 years. In cases of severe insufficiency a person may notice a variety of symptoms, including an uncomfortable pounding of the heart when lying down, a very rapid or hard heart beat (**palpitations**), **shortness of breath**, **chest pain**, and if untreated for very long times, swelling of the liver, ankles, and belly.

### Diagnosis

A poorly functioning or insufficient aortic valve can be identified when a doctor listens to the heart during a

## KEY TERMS

**Rheumatic fever**—A disease believed to be caused by a bacterium named group A streptococcus. This bacterium causes a sore “strep throat” and can also result in fever. Infection by this bacterium can also damage the heart and its valves, but how this takes place is not clearly understood.

**physical examination.** A **chest x ray**, an electrocardiogram (ECG, an electrical printout of the heart beats), as well as an echocardiogram (a test that uses sound waves to create an image of the heart and its valves), can further evaluate or confirm the condition.

### Treatment

Aortic insufficiency is usually corrected by having the defective valve surgically replaced. However, such an operation is done in severe cases. Before the condition worsens, certain drugs can be used to help manage this condition.

Drugs that remove water from the body, drugs that lower blood pressure, and drugs that help the heart beat more effectively can each be used for this condition. Reducing the amount of salt in the diet also helps lower the amount of fluid the body holds and can help the heart to work more efficiently as well.

In cases of a severely malfunctioning valve that has been untreated for a long time, surgery is the treatment of choice, especially if the heart is not functioning normally. Human heart valves can be replaced with man-made valves or with valves taken from pig hearts.

### Prognosis

Although drug treatment can help put off the need for surgical valve replacement, it is important to replace the faulty valve before the heart muscle itself is damaged beyond recovery.

### ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.  
National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, <http://www.nhlbi.nih.gov>.

Dominic De Bellis PhD

## Aortic valve replacement

### Definition

Aortic valve replacement is the insertion of a mechanical or tissue valve in place of the diseased biological aortic valve.

### Purpose

Aortic valve replacement is necessary when the aortic valve has become diseased. The aortic valve can suffer from insufficiency (inability to perform adequately) or stenosis (narrowing). An insufficient valve is leaky and allows blood to flow backward from the aorta to the left ventricle during diastole, which occurs when the ventricles fill with blood. A stenotic valve prevents the forward-moving flow of blood from the left ventricle to the aorta, during systole, which is the time period when the heart is contracting.

Either situation can result in **heart failure** and an enlarged left ventricle. With aortic stenosis, the symptoms of **angina pectoris**, **fainting**, and congestive heart failure will develop with the severity of the narrowing. There is an increased rate of sudden **death** of patients with aortic stenosis. Dyspnea (labored breathing), **fatigue**, and **palpitations** are late symptoms of aortic insufficiency. Angina pectoris is associated with the latest stages of aortic insufficiency.

### Demographics

Congenital **birth defects** involving a bicuspid aortic valve can develop stenosis. These patients may become symptomatic in mid-teen years through age 65. Patients with a history of **rheumatic fever** have a disposition for aortic stenosis, but may live symptom free for more than four decades. Calcification of the aortic valve tends to effect an older population with 30% of patients over age 85 having stenosis at **autopsy**.

Patients with aortic stenosis who have angina, dyspnea, or fainting are candidates for aortic valve replacement. Asymptomatic patients undergoing coronary artery bypass grafting should be treated with aortic valve replacement, but otherwise are not candidates for preventive aortic valve replacement.

Patients with a history of rheumatic fever or syphilitic aortitis (inflammation of the aorta) face the possibility of developing aortic insufficiency. Successful treatment has decreased this causative relationship. Primary causes of aortic valve disease include bacterial

## KEY TERMS

**Antithrombic**—Preventing clot formation.

**Biological tissue valve**—A replacement heart valve that is harvested from the patient (autograft), a human cadaver (homograft or allograft), or other animal, such as a pig (heterograft).

**Diastole**—Period between contractions of the heart.

**Hemolysis**—Separation of hemoglobin from the red blood cells.

**Mechanical valve**—An artificial device used to replace the patient's heart valve. They include three types: ball valve, disk valve, and bileaflet valve.

**Systole**—Period while the heart is contracting.

**endocarditis**, trauma, **aortic dissection**, and congenital diseases.

Patients showing acute symptoms, including **pulmonary edema**, heart rhythm problems, or circulatory collapse, are candidates for aortic valve replacement. Chronic pathologies are recommended for surgery when patients appear symptomatic, demonstrating angina and dyspnea. Asymptomatic patients also must be monitored for heart dysfunction. Left ventricular dimensions greater than 2 in (50 mm) at diastole or 3 in (70 mm) at systole are indications for replacement when aortic insufficiency is diagnosed.

### Description

While receiving **general anesthesia** in preparation for the surgery, the patient's cardiac function will be monitored. A sternotomy (incision into the sternum) or thoracotomy may be used to expose the heart, with the thoracotomy providing a smaller incision through the ribs. Minimally invasive techniques may also be used, utilizing a partial sternotomy or a lateral minithoracotomy. These approaches seem to decrease patient recovery time, as well as decreasing potential complications. Anticoagulant is administered in preparation for cardiopulmonary bypass. Cardiopulmonary bypass is instituted by exposing and cannulating (putting tubes into) the great blood vessels of the heart, or by cannulating the femoral artery and vein. A combination of cannulation sites may also be used. The heart is stopped after the aorta is clamped. The base of the aorta root is opened, and the diseased valve is removed. Sutures are placed in the aortic rim and into the replacement valve.

The replacement valve can be either mechanical or biological tissue. The replacement valve will be sized prior to implant to ensure that it fits the patient based on the size of the aortic valve annulus. Once seated, the valve is secured by tying the individual sutures. The heart is then deaired. The cross clamp is removed and the heart is allowed to beat as deairing continues by manipulation of the left ventricle. Cardiopulmonary bypass is terminated, the tubes are removed, and drugs to reverse anticoagulation are administered.

A heart valve prevents the flow of blood backward during heartbeats. Replacement heart valves can be mechanical or biological tissue valves. For patients younger than 65 years of age, the mechanical valve offers superior longevity. Anticoagulant medication is required for the life of the patient implanted with a mechanical valve. The biological tissue valve does not require anticoagulation but suffers from deterioration, leading to reoperation, particularly in those under age 50. Women considering bearing children should be treated with biological tissue valves because the anticoagulant of choice with mechanical valves, warfarin, is associated with developmental effects in the fetus. **Aspirin** can be substituted in certain circumstances.

### Diagnosis/Preparation

Initial diagnosis by auscultation (listening) is done with a stethoscope. Additional procedures associated with diagnosis to judge severity of the lesion include **chest x ray**, **echocardiography**, and **angiography** with **cardiac catheterization**. In the absence of angiography, **magnetic resonance imaging** (MRI) or computed tomographic (CT) imaging may be used.

### Aftercare

The patient will have continuous cardiac monitoring performed in the intensive care unit (ICU) post-operatively. Medications or mechanical circulatory assist may be instituted during the surgery or post-operatively to help the heart provide the necessary cardiac output to sustain the pulmonary and systemic circulations. These will be discontinued as cardiac function improves. As the patient is able to breathe without assistance, ventilatory support will be discontinued. Drainage tubes allow blood to be collected from the chest cavity during healing and are removed as blood flow decreases. Prophylactic **antibiotics** are given. Anticoagulation (warfarin, aspirin, or a combination) therapy is instituted and continued for patients who have received a mechanical valve. The ICU stay is approximately three days with a final

hospital discharge occurring within a week after the procedure.

The patient receive wound care instructions prior to leaving the hospital. The instructions include how to recognize such adverse conditions as infection or valve malfunction, contact information for the surgeon, and guidelines on when to return to the emergency room.

## Risks

There are unassociated risks with general anesthetic and cardiopulmonary bypass. Risks associated with aortic valve replacement include **embolism**, bleeding, and operative valvular endocarditis. Hemolysis is associated with certain types of mechanical valves, but is not a contraindication for implantation.

## Normal results

Myocardial function typically improves rapidly, with decrease in left ventricle enlargement and size of the inner chamber over several months, allowing the heart to return to normal dimensions. Anticoagulation therapy will be continued, depending on the type of mechanical valve implanted. Implantation of biological tissue valves are associated with the formation of **blood clots**. If non-cardiac surgery or dental care is needed, the anticoagulant medication will be adjusted to prevent bleeding complications.

## Morbidity and mortality rates

There is a 3–5% hospital mortality associated with aortic valve replacement. The average survival rate after five years is 85% for patients suffering from aortic stenosis who undergo aortic valve replacement. Structural valve deterioration can occur and is higher in mechanical valves during the first five years; however, biological tissue and mechanical valves have the same failure incidence at 10 years, with a 60% probability of death at 11 years as a result of valve-related complications. Patients with a mechanical valve are more likely to experience bleeding complications. Reoperation is more likely for patients treated with a biological tissue valve, but not significantly different when compared to their mechanical valve counterparts. This combines to an average rate of significant complications of 2–3% per year, with death rate of approximately 1% per year associated directly with the prosthesis.

## Alternatives

Balloon valvotomy may provide short-term relief of aortic stenosis, but is considered a temporary

treatment until valve replacement can be accomplished. Aortic valve repair by direct commissurotomy may also be successful for some cases of aortic stenosis. Medical treatment for inoperable patients with severe aortic stenosis is used to relieve pulmonary congestion and prevent **atrial fibrillation**.

Severe aortic insufficiency can be treated with medical therapy. Pharmaceuticals to decrease blood pressure, along with **diuretics** and **vasodilators**, are helpful in patients with aortic insufficiency.

## Resources

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Rosalyne Carson-DeWitt MD

## Aortic valve stenosis

### Definition

When aortic valve stenosis occurs, the aortic valve, located between the aorta and left ventricle of the heart, is narrower than normal size.

### Description

A normal aortic valve, when open, allows the free flow of blood from the left ventricle to the aorta. When the valve narrows, as it does with stenosis, blood flow is impeded. Because it is more difficult for blood to flow through the valve, there is increased strain on the heart. This can cause the left ventricle to enlarge and malfunction, resulting in reduced blood supply to the heart muscle and body, as well as fluid build up in the lungs.

### Cause and symptoms

Aortic valve stenosis can occur because of a birth defect in the formation of the valve. Calcium deposits may form on the valve with **aging**, causing the valve to become stiff and narrow. Stenosis can also occur as a



**A close-up view of a calcified stenosis of the aortic valve.**  
(Custom Medical Stock Photo, Inc. Reproduced by permission.)

result of **rheumatic fever**. Mild aortic stenosis may produce no symptoms at all. The most common symptoms, depending on the severity of the disease, are chest **pain**, blackouts, and difficulty breathing.

## Diagnosis

Using a stethoscope, a physician may hear a murmur and other abnormal heart sounds. An ECG, also called an electrocardiogram, records the electrical activity of the heart. This technique and **chest x ray** can show evidence that the left ventricle is enlarged. An x ray can also reveal calcium deposits on the valve, as well as congestion in the lungs. **Echocardiography** can pick up thickening of the valve, heart size, and whether or not the valve is working properly. This is a procedure in which high frequency sound waves harmlessly bounce off organs in the body. **Cardiac catheterization**, in which a contrast dye is injected in an artery using a catheter, is the key tool to confirm stenosis and gauge its severity.

## Treatment

Treatment depends on the symptoms and how the heart's function is affected. The valve can be opened without surgery by using a balloon catheter, but this is often a temporary solution. The procedure involves inserting a deflated balloon at the end of a catheter through the arteries to the valve. Inflating the balloon should widen the valve. In severe stenosis, **heart valve replacement** is recommended, most often involving open-heart surgery. The valve can be replaced with a mechanical valve, a valve from a pig, or by moving the patient's other heart valve (pulmonary) into the position of the aortic valve and then replacing the pulmonary valve with an mechanical one. Anyone with

## KEY TERMS

**Aorta**—The largest artery in the body, which moves blood from the left ventricle to the rest of the body.

**ECG**—Also called an electrocardiogram, it records the electrical activity of the heart.

**Echocardiogram**—A procedure in which high frequency sound waves harmlessly bounce off organs in the body providing an image so one can determine their structure and function.

**Cardiac catheterization**—A procedure in which dye is injected through a tube or catheter into an artery to more easily observe valves or blood vessels seen on an x ray.

**Left ventricle**—One of the lower chambers of the heart, which pumps blood to the aorta.

**Murmur**—An abnormal heart sound that can reflect a valve dysfunction.

**Rheumatic fever**—A bacterial infection that often causes heart inflammation.

**Pulmonary valve**—The valve located between the pulmonary artery and the right ventricle, which brings blood to the lungs.

aortic stenosis needs to take **antibiotics** (amoxicillin, erythromycin, or clindamycin) before dental and some other surgical procedures, to prevent a heart valve infection.

## Prognosis

The prognosis for aortic valve stenosis depends on the severity of the disease. With surgical repair, the disease is curable. Patients suffering mild stenosis can usually lead a normal life; a minority of the patients progress to severe disease. Anyone with moderate stenosis should avoid vigorous physical activity. Most of these patients end up suffering some kind of coronary heart disease over a 10 year period. Because it is a progressive disease, moderate and severe stenosis will be treated ultimately with surgery. Severe disease, if left untreated, leads to **death** within 2 to 4 years once the symptoms start.

## Prevention

There is no way to prevent aortic stenosis.

## Resources

### BOOKS

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Jeanine Barone Physiologist

slight cry or grimace in response to the stimulus; 0 for no response.

- Muscle tone (activity): 2 for vigorous movements of arms and legs; 1 for some movement; 0 for no movement, limpness.
- Respirations: 2 for visible breathing and crying; 1 for slow, weak, irregular breathing; 0 for apnea, or no breathing. A crying newborn can adequately oxygenate its lungs. Respirations are best assessed by watching the rise and fall of the neonate’s abdomen, as infants are diaphragmatic breathers.

The combined first letters of appearance, pulse, grimace, activity, and respirations spell Apgar.

## Purpose

Apgar scoring was originally developed in the 1950s by the anesthesiologist Virginia Apgar to assist practitioners attending a birth in deciding whether a newborn was in need of resuscitation. Using a scoring method fosters consistency and standardization among different practitioners. A February 2001 study published in the *New England Journal of Medicine* investigated whether Apgar scoring continues to be relevant. Researchers concluded that “The Apgar scoring system remains as relevant for the prediction of neonatal survival today as it was almost 50 years ago.” However, a 2006 study published in the *Journal of Pediatrics* found that there was a wide variability of Apgar scores among observers.

## Apgar testing

### Definition

Apgar testing is an assessment of the newborn by rating color, heart rate, stimulus response, muscle tone, and respirations on a scale of zero to two in each category, for a maximum possible score of 10. It is performed twice, first at one minute and then again at five minutes after birth.

### Description

The five areas (color, heart rate, stimulus response, muscle tone, and respirations) are scored as follows:

- Color or appearance: 2 if the skin is pink all over; 1 for acrocyanosis, where the trunk and head are pink, but the arms and legs are blue; and 0 if the whole body is blue. Newborns with naturally darker skin color will not be pink. However, pallor is still noticeable, especially in the soles and palms. Color is related to the neonate’s ability to oxygenate its body and extremities and is dependent on heart rate and respirations. A perfectly healthy newborn will often receive a score of 9 because of some blueness in the hands and feet.
- heart rate (pulse): 2 for a pulse of 100+ beats per minute (bpm); 1 for a pulse below 100 bpm; 0 for no pulse. Heart rate is assessed by listening with a stethoscope to the newborn’s heart and counting the number of beats.
- Stimulus response (grimace, or reflex irritability): 2 if the neonate coughs, sneezes, or vigorously cries in response to a stimulus (such as the use of nasal suctioning, stroking the back to assess for spinal abnormalities, or having the foot tapped); 1 for a

### Benefits

The Apgar test is a quick determination of a newborn’s health and alerts medical caregivers to whether the baby needs immediate medical intervention.

### Preparation

No preparation is needed to perform the test. However, while being born the neonate may receive nasal and oral suctioning to remove mucus and amniotic fluid. This may be done when the head of the newborn is safely out, while the mother rests before she continues to push.

### Aftercare

Since the test is primarily observational in nature, no aftercare is needed. However, the test may flag the need for immediate intervention or prolonged observation.

## DR. VIRGINIA APGAR (1909–1974)



(AP Images.)

As one of very few female medical students at Columbia University College of Physicians and Surgeons in New

York during the early 1930s and one of the first women to graduate from its medical school, Apgar knew that her goal of becoming a surgeon would not be achieved easily in a male-dominated profession. Reluctantly, she switched her medical specialty to anesthesiology, she embraced her new field with typical intelligence and energy. At this time, anesthesiology was a relatively new field, having been left by the doctors mostly to the attention of nurses. Apgar realized immediately how much in need of scientifically trained personnel was this significant part of surgery, and she set out to make anesthesiology a separate medical discipline. By 1937, she had become the fiftieth physician to be certified as an anesthesiologist in the United States. The following year she was appointed director of anesthesiology at the Columbia-Presbyterian Medical Center, becoming the first woman to head a department at that institution.

As the attending anesthesiologist who assisted in the delivery of thousands of babies during these years, Apgar realized that infants had died from respiratory or circulatory complications that early treatment could have prevented. Apgar decided to bring her considerable research skills to this childbirth dilemma, and her careful study resulted in her publication of the Apgar Score System in 1952.

### Normal results

The maximum possible score is 10, the minimum is zero. It is rare to receive a true 10, as some **acrocyanosis** in the newborn is considered normal, and therefore not a cause for concern. Most infants score between 7 and 10. These infants are expected to have an excellent outcome. A score of 4, 5, or 6 requires immediate intervention, usually in the form of oxygen and respiratory assistance, or perhaps just suctioning if breathing has been obstructed by mucus. While suctioning is being done, a source of oxygen may be placed near, but not over the newborn's nose and mouth. This form of oxygen is referred to as *blow-by*. A score in the 4–6 range indicates that the neonate is having some difficulty adapting to extrauterine life. This may be due to medications given to the mother during a difficult labor, or at the very end of labor, when these medications have an exaggerated effect on the neonate.

### Abnormal results

With a score of 0–3, the newborn is unresponsive, apneic, pale, limp, and may not have a pulse. Interventions to resuscitate will begin immediately. The test is repeated at five minutes after birth and both scores are documented. Should the resuscitation effort continue into the five-minute time period, interventions would not stop in order to perform the test. The one-minute score indicates the need for intervention at birth. It addresses survival and prevention of birth-related complications resulting from inadequate oxygen supply. Poor oxygenation may be due to inadequate neurological and/or chemical control of respiration. The five-minute score appears to have a more predictive value for morbidity and normal development, although research studies on this are inconsistent in their conclusions.

## KEY TERMS

**Acrocyanosis**—A slight cyanosis, or blueness of the hands and feet of the neonate is considered normal. This impaired ability to fully oxygenate the extremities is due to an immature circulatory system which is still in flux.

**Amniotic fluid**—The protective bag of fluid that surrounds the fetus while growing in the uterus.

**Neonate**—A term referring to the newborn infant, from birth until one month of age.

**Neonatologist**—A physician who specializes in problems of newborn infants.

**Pallor**—Extreme paleness in the color of the skin.

## Resources

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What is the Apgar Score? Kidshealth.org February 2008. [http://kidshealth.org/parent/newborn/first\\_days/apgar.html#](http://kidshealth.org/parent/newborn/first_days/apgar.html#)

### ORGANIZATIONS

American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098 (847) 434-4000 (847) 434-8000, <http://www.aap.org>.

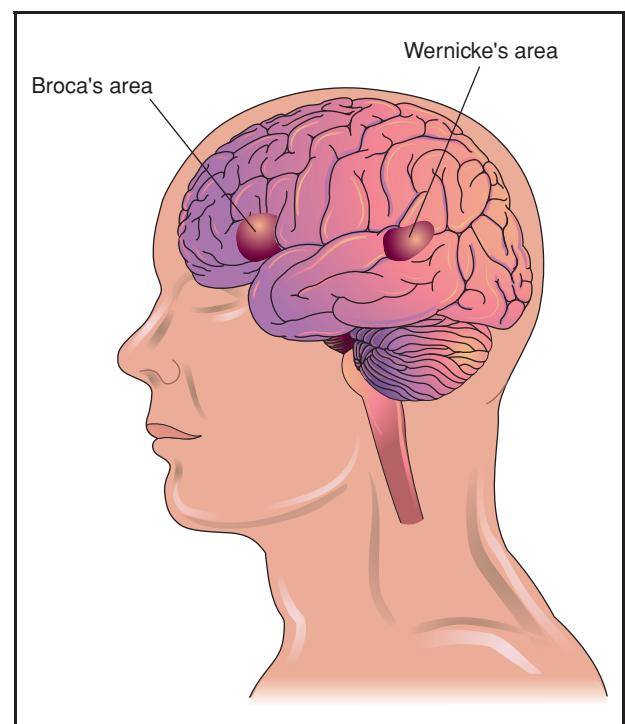
American Pregnancy Association, 431 Greenway Drive, Suite 800, Irving, TX, 75038 (972) 550-0140 (972) 550-0800, [Questions@AmericanPregnancy.org](mailto:Questions@AmericanPregnancy.org), <http://www.americanpregnancy.org>.

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## Aphasia

### Definition

Aphasia is condition characterized by either partial or total loss of the ability to communicate verbally or using written words. A person with aphasia may have difficulty speaking, reading, writing, recognizing the



Broca's aphasia results from damage to the frontal lobe of the language-dominant area of the brain. Individuals with Broca's aphasia may become mute or may be able to use single-word statements or full sentences, although it may require great effort. Wernicke's aphasia is caused by damage to the temporal lobe of the language-dominant area of the brain. People with this condition speak in long, uninterrupted sentences, but the words used are often unnecessary and unintelligible. (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

names of objects, or understanding what other people have said. Aphasia is caused by a brain injury, as may occur during a traumatic accident or when the brain is deprived of oxygen during a **stroke**. It may also be caused by a **brain tumor**, a disease such as Alzheimer's, or an infection, like **encephalitis**. Aphasia may be temporary or permanent. Aphasia does not include speech impediments caused by loss of muscle control.

### Description

To understand and use language effectively, an individual draws upon word memory—stored information on what certain words mean, how to put them together, and how and when to use them properly. For a majority of people, these and other language functions are located in the left side (hemisphere) of the brain. Damage to this side of the brain is most commonly linked to the development of aphasia. Interestingly, however, left-handed people appear to have

## KEY TERMS

**Anomic aphasia**—A condition characterized by either partial or total loss of the ability to recall the names of persons or things as a result of a stroke, head injury, brain tumor, or infection.

**Broca's aphasia**—A condition characterized by either partial or total loss of the ability to express oneself, either through speech or writing. Hearing comprehension is not affected. This condition may result from a stroke, head injury, brain tumor, or infection.

**Computed tomography (CT)**—An imaging technique that uses cross-sectional x rays of the body to create a three-dimensional image of the body's internal structures.

**Conduction aphasia**—A condition characterized by the inability to repeat words, sentences, or phrases as a result of a stroke, head injury, brain tumor, or infection.

**Frontal lobe**—The largest, most forward-facing part of each side or hemisphere of the brain.

**Global aphasia**—A condition characterized by either partial or total loss of the ability to communicate verbally or using written words as a result of widespread injury to the language areas of the brain. This condition may be caused by a stroke, head injury, brain tumor, or infection. The exact language abilities affected vary depending on the location and extent of injury.

**Hemisphere**—One of the two halves or sides—the left and the right—of the brain.

**Magnetic resonance imaging (MRI)**—An imaging technique that uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

**Subcortical aphasia**—A condition characterized by either partial or total loss of the ability to communicate verbally or using written words as a result of damage to non-language-dominated areas of the brain. This condition may be caused by a stroke, head injury, brain tumor, or infection.

**Temporal lobe**—The part of each side or hemisphere of the brain that is on the side of the head, nearest the ears.

**Transcortical aphasia**—A condition characterized by either partial or total loss of the ability to communicate verbally or using written words that does not affect an individual's ability to repeat words, phrases, and sentences.

**Wernicke's aphasia**—A condition characterized by either partial or total loss of the ability to understand what is being said or read. The individual maintains the ability to speak, but speech may contain unnecessary or made-up words.

language areas in both the left and right hemispheres of the brain and, as a result, may develop aphasia from damage to either side of the brain.

Stroke is the most common cause of aphasia in the United States. Approximately 500,000 individuals suffer strokes each year, and 20% of these individuals develop some type of aphasia. Other causes of brain damage include head injuries, brain tumors, and infection. About half of the people who show signs of aphasia have what is called temporary or transient aphasia and recover completely within a few days. An estimated one million Americans suffer from some form of permanent aphasia. As yet, no connection between aphasia and age, gender, or race has been found.

Aphasia is sometimes confused with other conditions that affect speech, such as dysarthria and **apraxia**. These conditions affect the muscles used in speaking rather than language function itself. Dysarthria is a speech disturbance caused by lack of

control over the muscles used in speaking, perhaps due to nerve damage. Speech apraxia is a speech disturbance in which language comprehension and muscle control are retained, but the memory of how to use the muscles to form words is not.

### Causes and symptoms

Aphasia can develop after an individual sustains a brain injury from a stroke, head trauma, tumor, or infection, such as herpes encephalitis. As a result of this injury, the pathways for language comprehension or production are disrupted or destroyed. For most people, this means damage to the left hemisphere of the brain. (In 95 to 99% of right-handed people, language centers are in the left hemisphere, and up to 70% of left-handed people also have left-hemisphere language dominance.) According to the traditional classification scheme, each form of aphasia is caused by damage to a different part of the left hemisphere of the brain. This damage affects one or more of the basic

language functions: speech, naming (the ability to identify an object, color, or other item with an appropriate word or term), repetition (the ability to repeat words, phrases, and sentences), hearing comprehension (the ability to understand spoken language), reading (the ability to understand written words and their meaning), and writing (the ability to communicate and record events with text).

The traditional classification scheme includes eight types of aphasia:

- Broca's aphasia, also called motor aphasia, results from damage to the front portion or frontal lobe of the language-dominant area of the brain. Individuals with Broca's aphasia may be completely unable to use speech (mutism) or may be able to use single-word statements or even full sentences, though these sentences may require a great deal of effort to construct. Small words, such as conjunctions (and, or, but) and articles (the, an, a), may be omitted, leading to a "telegraph" quality in their speech. Hearing comprehension is usually not affected, so they are able to understand other people's speech and conversation and can follow commands. Often, they may experience weakness on the right side of their bodies, which can make it difficult to write. Reading ability is impaired, and they may have difficulty finding the right word when speaking. Individuals with Broca's aphasia may become frustrated and depressed because they are aware of their language difficulties.
- Wernicke's aphasia is caused by damage to the side portion or temporal lobe of the language-dominant area of the brain. Individuals with Wernicke's aphasia speak in long, uninterrupted sentences; however, the words used are frequently unnecessary or even made-up. They have a great deal of difficulty understanding other people's speech, sometimes to the point of being unable to understand spoken language at all. Reading ability is diminished, and although writing ability is retained, what is written may be abnormal. No physical symptoms, such as the right-sided weakness seen with Broca's aphasia, are typically observed. Also, in contrast to Broca's aphasia, individuals with Wernicke's aphasia are not aware of their language errors.
- Global aphasia is caused by widespread damage to the language areas of the left hemisphere. As a result, all basic language functions are affected, but some areas may be more affected than others. For example, an individual may have difficulty speaking but may be able to write well. The individual may experience weakness and loss of feeling on the right side of their body.
- Conduction aphasia, also called associative aphasia, is rather uncommon. Individuals with conduction aphasia are unable to repeat words, sentences, and phrases. Speech is fairly unbroken, although individuals may frequently correct themselves and words may be skipped or repeated. Although able to understand spoken language, it may also be difficult for the individual with conduction aphasia to find the right word to describe a person or object. The impact of this condition on reading and writing ability varies. As with other types of aphasia, right-sided weakness or sensory loss may be present.
- Anomic or nominal aphasia primarily influences an individual's ability to find the right name for a person or object. As a result, an object may be described rather than named. Hearing comprehension, repetition, reading, and writing are not affected, other than by this inability to find the right name. Speech is fluent, except for pauses as the individual tries to recall the right name. Physical symptoms are variable, and some individuals have no symptoms of one-sided weakness or sensory loss.
- Transcortical aphasia is caused by damage to the language areas of the left hemisphere outside the primary language areas. There are three types of aphasia: transcortical motor aphasia, transcortical sensory aphasia, and mixed transcortical aphasia. All of the transcortical aphasias are distinguished from other types by the individual's ability to repeat words, phrases, or sentences. Other language functions may also be impaired to varying degrees, depending on the extent and particular location of brain damage.

As researchers continue to learn more about the brain's structure and function, new types of aphasia are being recognized. One newly recognized type of aphasia, subcortical aphasia, mimics the symptoms of other traditional types of aphasia but involves language disorders that are not typical. This type of aphasia is associated with injuries to areas of the brain typically not identified with language and language processing.

## Diagnosis

Following brain injury, an initial bedside assessment is made to determine whether language function has been affected. If the individual experiences difficulty communicating, attempts are made to determine whether this difficulty arises from impaired language comprehension or an impaired ability to speak. A typical examination involves listening to spontaneous speech and evaluating the individual's ability to recognize and name objects, comprehend what is heard,

and repeat sample words and phrases. The individual may also be asked to read text aloud and explain what the passage means. In addition, writing ability is evaluated by having the individual copy text, transcribe dictated text, and write something without prompting.

A speech pathologist or neuropsychologist may be asked to conduct more extensive examinations using in-depth, standardized tests. Commonly used tests include the Boston Diagnostic Aphasia Examination, the Western Aphasia Battery, and possibly, the Porch Index of Speech Ability.

The results of these tests indicate the severity of the aphasia and may also provide information regarding the exact location of the brain damage. This more extensive testing is also designed to provide the information necessary to design an individualized **speech therapy** program. Further information about the location of the damage is gained through the use of imaging technology, such as **magnetic resonance imaging** (MRI) and **computed tomography scans** (CT).

## Treatment

Initially, the underlying cause of aphasia must be treated or stabilized. To regain language function, therapy must begin as soon as possible following the injury. Although there are no medical or surgical procedures currently available to treat this condition, aphasia resulting from stroke or **head injury** may improve through the use of speech therapy. For most individuals, however, the primary emphasis is placed on making the most of retained language abilities and learning to use other means of communication to compensate for lost language abilities.

Speech therapy is tailored to meet individual needs, but activities and tools that are frequently used include the following:

- Exercise and practice. Weakened muscles are exercised by repetitively speaking certain words or making facial expressions, such as smiling.
- Picture cards. Pictures of everyday objects are used to improve word recall and increase vocabulary. The names of the objects may also be repetitively spoken aloud as part of an exercise and practice routine.
- Picture boards. Pictures of everyday objects and activities are placed together, and the individual points to certain pictures to convey ideas and communicate with others.
- Workbooks. Reading and writing exercises are used to sharpen word recall and regain reading and writing abilities. Hearing comprehension is also redeveloped using these exercises.

- Computers. Computer software can be used to improve speech, reading, recall, and hearing comprehension by, for example, displaying pictures and having the individual find the right word.

## Prognosis

The degree to which an individual can recover language abilities is highly dependent on how much brain damage occurred and the location and cause of the original brain injury. Other factors include the individual's age, general health, motivation and willingness to participate in speech therapy, and whether the individual is left or right handed. Language areas may be located in both the left and right hemispheres in left-handed individuals. Left-handed individuals are, therefore, more likely to develop aphasia following brain injury, but because they have two language centers, may recover more fully because language abilities can be recovered from either side of the brain. The intensity of therapy and the time between diagnosis and the start of therapy may also affect the eventual outcome.

## Prevention

Because there is no way of knowing when a stroke, traumatic head injury, or disease will occur, very little can be done to prevent aphasia. The extent of recovery, however, in some cases, can be affected by an individual's willingness to cooperate and participate in speech therapy directly following the injury.

## Resources

### BOOKS

Pitts, Bill, and Sue Sheridan. *Coping with Aphasia*. 2009.

### ORGANIZATIONS

National Aphasia Association, 350 Seventh Avenue, Suite 902, New York, NY, 10001, (800) 922-4622, [responsecenter@aphasia.org](mailto:responsecenter@aphasia.org), <http://www.aphasia.org>.

Julia Barrett

Apheres see **Transfusion**

## Aplastic anemia

### Definition

Aplastic anemia is a disorder in which the bone marrow significantly decreases or stops production of blood cells.

## KEY TERMS

**Autoimmune disease**—A disease that occurs when the body's tissues and cells are attacked by the person's own immune system.

**Bone marrow**—A substance found in the cavities of bones, especially the long bones and the sternum (breast bone). The bone marrow contains those cells that are responsible for the production of the blood cells (red blood cells, white blood cells, and platelets).

**Bone marrow transplant**—A procedure in which a quantity of bone marrow is extracted through a

needle from a donor, and then passed into a patient to replace the patient's diseased or absent bone marrow.

**Hematopoietic cells**—Those cells that are lodged within the bone marrow and are responsible for producing the cells that circulate in the blood (red blood cells, white blood cells, and platelets).

**Immunosuppressive therapy**—Treatment that suppresses the immune system's functioning.

### Demographics

Yearly, aplastic anemia is diagnosed in about six out of every million people in the United States. Incidence of this disorder in Europe is similar to the U.S. incidence rate. More cases of aplastic anemia are observed in Asian countries, particularly in Japan, where the disorder is diagnosed in 14 people out of every million. This increased incidence rate is thought to be from environmental causes such as increased exposure to toxic chemicals rather than to genetics or heredity because Americans of Asian heritage do not have higher incidence rates than the general U.S. population.

Aplastic anemia affects both males and females of all ages. There are two age groups that have an increased risk. Both young adults (between 20–25 years of age) and the elderly (over the age of 60) have higher rates of aplastic anemia than the general population.

### Description

The bone marrow (soft tissue located within the hard outer shell of the bones) is responsible for the production of all types of blood cells. The mature forms of these cells include red blood cells, which carry oxygen throughout the body; white blood cells, which fight infection; and platelets, which are involved in clotting. In aplastic anemia, the basic structure of the marrow becomes abnormal, and those cells responsible for generating blood cells (hematopoietic cells) are greatly decreased in number or absent. These hematopoietic cells are replaced by large quantities of fat.

### Risk factors

Eighty percent of cases of aplastic anemia are termed "acquired" cases because the cause can often be traced to a non-genetic or non-inherited cause such as:

- previous infection with viruses and bacteria such as a hepatitis virus, the Epstein-Barr virus, HIV, parovirus and mycobacteria
- exposure to toxic chemicals such as benzene
- radiation exposure
- exposure to the drugs chloramphenicol and phenylbutazone
- exposure to the element gold
- history of transfusional graft-versus-host disease (GVHD)
- history of liver transplant for fulminant hepatitis
- pregnancy in rare instances

Hereditary aplastic anemia is relatively rare (20% of cases), but occurs in Fanconi's anemia, Shwachman-Diamond syndrome, congenital dyskeratosis, and other rare congenital or inherited diseases.

### Causes and symptoms

Aplastic anemia falls into three basic categories based on the origin of its cause: idiopathic, acquired, and hereditary.

Acquired aplastic anemia refers to cases where certain environmental factors and physical conditions seem to be associated with development of the disease. However, it is sometimes difficult to pinpoint the exact cause. About 80% of cases of aplastic anemia are considered to be acquired. Many clinicians believe aplastic anemia is an autoimmune disorder.

Symptoms of aplastic anemia tend to be the same as those of other **anemias**, including **fatigue**, weakness, tiny reddish-purple marks (petechiae) on the skin (evidence of pinpoint hemorrhages into the skin), evidence of abnormal bruising, and bleeding from the gums, nose, intestine, or vagina. The patient is likely to appear pale. If the anemia progresses,

decreased oxygen circulating in the blood may lead to an increase in heart rate and the sudden appearance of a new heart murmur.

## Diagnosis

### *Examination*

During an office visit, a physician may suspect a form of anemia based on the patient's physical appearance and symptoms. A patient history is taken and exposure to any environmental toxins is noted. In order to confirm aplastic anemia, a blood draw is normally performed and additional testing is recommended as needed.

### *Tests*

A complete blood cell count (CBC) is performed on patients suspected of having anemia. This involves a simple blood draw, usually from the patient's arm. The blood is then analyzed at a lab. The blood count in aplastic anemia reveals low numbers of all formed blood cells. Red blood cells appear normal in size and coloration, but are greatly decreased in number. Cells called reticulocytes—very young red blood cells, which are usually produced in great numbers by the bone marrow in order to compensate for a severe anemia—are very low in number. Platelets and white blood cells are also decreased in number, though normal in structure.

Blood tests to determine histocompatibility with potential related donors for bone marrow transplant should be conducted early in the diagnostic process.

Radiographic imaging studies of the skeleton may be performed if there is suspicion of an inherited form of aplastic anemia since these conditions often cause skeletal abnormalities.

### *Procedures*

A sample of the patient's bone marrow may need to be removed by needle (usually from the hip bone) and examined under a microscope. If aplastic anemia is present, this examination reveals very few or no hematopoietic cells, and replacement with fat.

## Treatment

### *Traditional*

The first step in the treatment of aplastic anemia involves discontinuing exposure to any substance that may be causing the disorder. Although it would seem that blood transfusions would be helpful in this disease, in fact, they only serve as a temporary help and

may complicate future attempts at **bone marrow transplantation**.

The most successful treatment for aplastic anemia is bone marrow transplantation. To do this, a marrow donor, preferably a human leukocyte antigen (HLA)-matched sibling, must be identified. There are a number of tissue markers that must be examined to determine whether a bone marrow donation is likely to be compatible with the patient's immune system. Compatibility is necessary to avoid complications, including the destruction of the donor marrow by the patient's own immune system.

### *Drugs*

Infections are a great cause of concern in patients with aplastic anemia. The patient should be started on a course of broad spectrum **antibiotics** as soon as an infection is suspected. Patients with persistent **fever** may also be treated with antifungal medications.

Patients who cannot undergo bone marrow transplant can be treated with a number of agents, including antithymocyte globulin (ATG), cyclophosphamide, **steroids**, and cyclosporine. These agents all have the potential to cause a number of troublesome side-effects and may have a success rate of only 60–80%. Still, even among those patients who have a good response, many later have a relapse (return) of aplastic anemia. Researchers are trying to identify the molecules in certain stem cells that the immune system targets in aplastic anemia.

## Prognosis

Aplastic anemia is a life-threatening illness. Without treatment, the condition is likely to be fatal. Survival depends on how severe the disease is at diagnosis, the type of treatment a patient is eligible for, and what kind of response their body has to that treatment.

Patients with a very low number of a particular type of white blood cell have a poor prognosis. They have an increased chance of dying from overwhelming bacterial infections. However, the estimated five-year survival rate for patients with aplastic anemia who have been treated with immunosuppressive therapy is 75%. Patients who undergo bone marrow transplantation using an HLA-matched sibling donor have a five-year survival rate greater than 90%.

### *Prevention*

Since most cases of aplastic anemia can be linked to an identifiable cause, minimizing or eliminating

exposure to the known causes of aplastic anemia should be strongly considered.

## Resources

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### ORGANIZATIONS

- Aplastic Anemia and MDS International Foundation, 100 Park Avenue, Suite 108, Rockville, MD, 20850 (800) 747-2820, <http://www.aamds.org>.

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**Aplastic crisis** see **Fifth disease**

## Appendectomy

### Definition

Appendectomy is the surgical removal of the appendix. The appendix is a worm-shaped hollow pouch attached to the cecum, the beginning of the large intestine.

### Purpose

Appendectomies are performed to treat **appendicitis**, an inflamed and infected appendix.

### Precautions

Since appendicitis occurs most commonly in males between the ages of 10-14 and in females between the ages of 15-19, appendectomy is most often performed during this time. The diagnosis of appendicitis is most difficult in the very young (less than two years of age) and in the elderly.

### Description

Appendectomy is considered a major surgical operation. Therefore, a general surgeon must perform this operation in the operating room of a hospital. An anesthesiologist is also present during the operation to administer an anesthetic. Most often the anesthesiologist uses a general anesthetic technique whereby patients are put to sleep and made **pain** free by administering drugs in the vein or by agents inhaled through a tube placed in the windpipe. Occasionally a spinal anesthetic may be used.

After the patient is anesthetized, the general surgeon can remove the appendix either by using the traditional open procedure (in which a 2-3 in. [5-7.6 cm] incision is made in the abdomen) or via **laparoscopy** (in which four 1 in. [2.5cm] incisions are made in the abdomen).

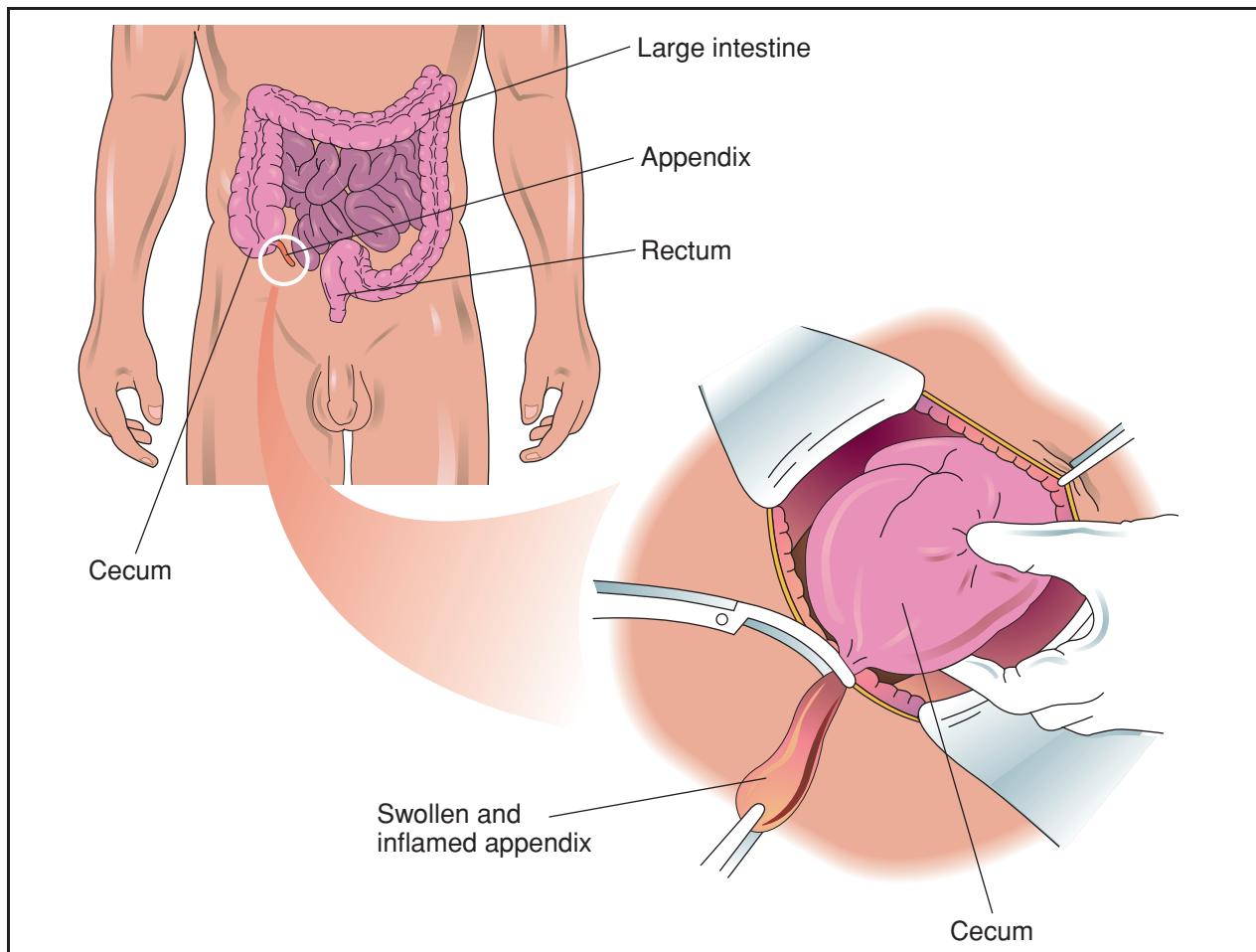
#### *Traditional open appendectomy*

When the surgeon uses the open approach, he or she makes an incision in the lower right section of the abdomen. Most incisions are less than 3 in. (7.6 cm) in length. The surgeon then identifies all of the organs in the abdomen and examines them for other disease or abnormalities. The appendix is located and brought up into the **wounds**. The surgeon separates the appendix from all the surrounding tissue and its attachment to the cecum and then removes it. The site where the appendix was previously attached, the cecum, is closed and returned to the abdomen. The muscle layers and then the skin are sewn together.

#### *Laposcopic appendectomy*

When the surgeon conducts a laposcopic appendectomy, four incisions, each about 1 in. (2.5 cm) in length, are made. One incision is near the umbilicus, or navel, and one is between the umbilicus and the pubis. Two other incisions are smaller and are in the right side of the lower abdomen. The surgeon then passes a camera and special instruments through these incisions. With the aid of this equipment, the surgeon visually examines the abdominal organs and identifies the appendix. Similarly, the appendix is freed from all of its attachments and removed. The place where the appendix was formerly attached, the cecum, is stitched. The appendix is removed through one of the incisions. The instruments are removed and then all of the incisions are closed.

Studies and opinions about the relative advantages and disadvantages of each method are divided. A skilled surgeon can perform either one of these procedures in less than one hour. However, laproscopic



**A traditional open appendectomy.** After the surgeon makes an incision in the lower right section of the abdomen, he/she pulls the appendix up, separates it from the surrounding tissue and its attachment to the cecum, and then removes it. (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

appendectomy (LA) always takes longer than traditional appendectomy (TA). The increased time required to do a LA increases the patient's exposure to anesthetics, which increases the risk of complications. The increased time requirement also escalates fees charged by the hospital for operating room time and by the anesthesiologist. Since LA also requires specialized equipment, the fees for its use also increases the hospital charges. Patients with either operation have similar pain medication needs, begin eating **diets** at comparable times, and stay in the hospital equivalent amounts of time. LA is of special benefit in women in whom the diagnosis is difficult and gynecological disease (such as **endometriosis**, **pelvic inflammatory disease**, ruptured ovarian follicles, ruptured **ovarian cysts**, and tubal pregnancies) may be the source of pain and not appendicitis. If LA is done in these patients, the pelvic organs can be more thoroughly examined and a definitive

diagnosis made prior to removal of the appendix. Most surgeons select either TA or LA based on the individual needs and circumstances of the patient.

Insurance plans do cover the costs of appendectomy. Fees are charged independently by the hospital and the physicians. Hospital charges include fees for operating and recovery room use, diagnostic and laboratory testing, as well as the normal hospital room charges. Surgical fees vary from region to region and range between \$250-\$750. The anesthesiologist's fee depends upon the health of the patient and the length of the operation.

### Preparation

Once the diagnosis of appendicitis is made and the decision has been made to perform an appendectomy, the patient undergoes the standard preparation for an

## KEY TERMS

**Abscess**—A collection of pus buried deep in the tissues or in a body cavity.

**Anesthesiologist**—A physician who has special training and expertise in the delivery of anesthetics.

**Anesthetics**—Drugs or methodologies used to make a body area free of sensation or pain.

**Cecum**—The beginning of the large intestine and the place where the appendix attaches to the intestinal tract.

**General surgeon**—A physician who has special training and expertise in performing a variety of operations.

**Pelvic organs**—The organs inside of the body that are located within the confines of the pelvis. This includes the bladder and rectum in both sexes and the uterus, ovaries, and fallopian tubes in females.

**Pubis**—The anterior portion of the pelvis located in the anterior abdomen.

**Thrombophlebitis**—Inflammation of the veins, usually in the legs, which causes swelling and tenderness in the affected area.

**Umbilicus**—The navel.

operation. This usually takes only one to two hours and includes signing the operative consents, patient identification procedures, evaluation by the anesthesiologist, and moving the patient to the operating suites of the hospital. Occasionally, if the patient has been ill for a prolonged period of time or has had protracted **vomiting**, a delay of few to several hours may be necessary to give the patient fluids and **antibiotics**.

### Aftercare

Recovery from an appendectomy is similar to other operations. Patients are allowed to eat when the stomach and intestines begin to function again. Usually the first meal is a clear liquid diet—broth, juice, soda pop, and gelatin. If patients tolerate this meal, the next meal usually is a regular diet. Patients are asked to walk and resume their normal physical activities as soon as possible. If TA was done, work and physical education classes may be restricted for a full three weeks after the operation. If a LA was done, most patients are able to return to work and strenuous activity within one to three weeks after the operation.

### Risks

Certain risks are present when any operation requires a general anesthetic and the abdominal cavity is opened. **Pneumonia** and collapse of the small airways (**atelectasis**) often occurs. Patients who smoke are at a greater risk for developing these complications. **Thrombophlebitis**, or inflammation of the veins, is rare but can occur if the patient requires prolonged bed rest. Bleeding can occur but rarely is a blood **transfusion** required. **Adhesions** (abnormal connections to abdominal organs by thin fibrous

tissue) is a known complication of any abdominal procedure such as appendectomy. These adhesions can lead to intestinal obstruction which prevents the normal flow of intestinal contents. **Hernia** is a complication of any incision. However, they are rarely seen after appendectomy because the abdominal wall is very strong in the area of the standard appendectomy incision.

The overall complication rate of appendectomy depends upon the status of the appendix at the time it is removed. If the appendix has not ruptured the complication rate is only about 3%. However, if the appendix has ruptured the complication rate rises to almost 59%. Wound infections do occur and are more common if the appendicitis was severe, far advanced, or ruptured. An **abscess** may form in the abdomen as a complication of appendicitis.

Occasionally, an appendix will rupture prior to its removal, spilling its contents into the abdominal cavity. **Peritonitis** or a generalized infection in the abdomen will occur. Treatment of peritonitis as a result of a ruptured appendix includes removal of what remains of the appendix, insertion of drains (rubber tubes that promote the flow of infection inside the abdomen to outside of the body), and antibiotics. **Fistula** formation (an abnormal connection between the cecum and the skin) rarely occurs. It is only seen if the appendix has a broad attachment to the cecum and the appendicitis is far advanced causing destruction of the cecum itself.

### Normal results

Most patients feel better immediately after an operation for appendicitis. Many patients are discharged from the hospital within 24 hours after the appendectomy. Others may require a longer stay—

three to five days. Almost all patients are back to their normal activities within three weeks.

The mortality rate of appendicitis has dramatically decreased over time. Currently, the mortality rate is estimated at one to two per 1,000,000 cases of appendicitis. **Death** is usually due to peritonitis, intra abdominal abscess or severe infection following rupture.

The complications associated with undiagnosed, misdiagnosed, or delayed diagnosis of appendectomy are very significant. The diagnosis is of appendicitis is difficult and never certain. This has led surgeons to perform an appendectomy any time that they feel appendicitis is the diagnosis. Most surgeons feel that in approximately 20% of their patients, a normal appendix will be removed. Rates much lower than this would seem to indicate that the diagnosis of appendicitis was being frequently missed.

## Resources

### OTHER

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**An extracted appendix.** (© Lester V. Bergman/Corbis.)

and among females aged 15–19. It is rare in the elderly and in children under the age of two. In a few cases, appendicitis has been diagnosed in newborn babies.

Appendicitis is equally common in persons of all races and ethnic groups. It is more common in men than in women, however; the male/female ratio is about 1.7:1. Although appendicitis is not hereditary, it does appear to be more common in some families; in 2009, a team of Australian researchers reported a possible link to chromosome 1p37.3.

About 1 person in every 100,000 is born without an appendix; there are a few rare cases of persons born with two.

## Description

The average human appendix ranges in size from about 3 inches in length to 4 or 5 inches, but appendices as long as 11 inches have been recorded. The appendix is longer in children than in adults, and shrinks still further in older adults. Appendicitis develops when the lumen (inner cavity) of the appendix is blocked. This blockage can be caused by a number of different objects ranging from intestinal parasites to thick mucus or fecal matter,

## Appendicitis

### Definition

Appendicitis is an inflammation of the appendix, which is the worm- or finger-shaped pouch attached to the cecum, the beginning of the large intestine. The appendix has no known function in the human body, but it can become diseased. Appendicitis is a medical emergency, and if it is left untreated the appendix may rupture and cause a potentially fatal infection.

### Demographics

Appendicitis is the most common abdominal emergency in children and young adults in Canada and the United States as of 2010. The National Institutes of Health (NIH) estimates that about 7 percent of the general population will develop appendicitis at some point in life. There are on average about 1.1 cases per 1000 people each year in North America. The disorder is most common in people between the ages of 10 and 30, but it can develop at any age. The incidence is highest among males aged 10–14,

## KEY TERMS

**Alvarado score**—A ten-point scoring system used by doctors to evaluate the likelihood that a patient has acute appendicitis.

**Antiemetic**—A type of medication given to prevent or reduce nausea and vomiting.

**Appendectomy**—Surgical removal of the appendix.

**Appendix (plural: appendices)**—The finger-shaped pouch attached to the cecum, the beginning of the large intestine.

**Laparotomy**—A surgical incision into the abdomen, made between the ribs and the pelvis, that

offers surgeons a view inside the abdominal cavity.

**Lumen**—The hollow interior of a tube-shaped organ such as the appendix.

**Peritonitis**—Inflammation of the peritoneum, membranes lining the abdominal pelvic wall.

**Pus**—A whitish-yellow material produced by the body in response to a bacterial infection. It consists of tissue fluid and dead white blood cells.

**Ulceration**—An abnormal change in tissue accompanied by the death of cells.

or an infection. As the blockage progresses, the tissues of the appendix begin to die from lack of blood flow. They are then invaded by bacteria and form pus. If the condition is not treated, the appendix swells and eventually bursts, spreading the infection throughout the abdomen. This spread of infection and inflammation to the tissues lining the abdomen is called **peritonitis** and is a very dangerous condition.

The **pain** of appendicitis usually starts two to three days before the appendix gets to the point of bursting. The person typically notices a vague discomfort in the area underneath the navel (belly button). Over the next day the pain gets worse and moves downward toward the lower right portion of the abdomen near the right hip. The “classic” symptoms of appendicitis at this point are **nausea**, **vomiting**, low-grade **fever** (below 100.3°F), **constipation** or **diarrhea**, swelling of the abdomen, pain that is worsened by coughing or walking, and loss of appetite. Fewer than 50 percent of patients with appendicitis, however, have the full set of classic symptoms. Children and the elderly are often misdiagnosed because they have fewer of these symptoms; in particular, very young children may be misdiagnosed because they cannot explain or describe their symptoms. As a result, their treatment is often delayed. The appendix ruptures before surgery in about 270 out of every 1,000 cases; the risk of rupture is higher in children, pregnant women, and older adults.

### Risk factors

There are no significant risk factors for appendicitis; it can develop in persons of either sex, in all age groups, and in all racial or ethnic groups. Some

doctors, however, think that people with a history of intestinal parasites, those whose **diets** are very low in fiber, and those with Coxsackievirus B infection may have a slightly increased risk of developing appendicitis over their lifetimes.

### Causes and symptoms

#### Causes

The basic cause of appendicitis is inflammation of the appendix resulting from an obstruction of some kind or an infection. The appendix can be blocked by an overgrowth of lymphoid tissue, food wastes, small pieces of hardened stool, worms or other parasites, **foreign objects**, or a cancerous tumor. It may also become inflamed as a result of trauma or infection, or as a complication of Crohn’s disease.

The blocked appendix swells up with pus and mucus, shutting down the blood vessels that supply it with blood. As the tissues of the appendix die, bacteria from the intestine grow rapidly within it. If the infection is not stopped by surgical removal of the organ, the appendix will eventually burst and the bacteria inside it will spread to other parts of the abdomen. Signs of rupture include the presence of symptoms for more than 24 hours, a fever, a high **white blood cell count**, and a fast heart rate. Very rarely, the inflammation and symptoms of appendicitis may disappear but recur again later.

#### Symptoms

There is no single symptom that is unique to appendicitis, nor is there a “typical” group of symptoms that all patients experience. The following are the most common symptoms and the percentages of patients who report having them:

- Pain in the abdomen moving from the navel to the right lower part of the abdomen: 80%
- Nausea: 85%
- Fever: 60%
- Loss of appetite: 74%
- Diarrhea or constipation: 18%
- Symptoms lasting less than 48 hours: 80% (About 2 percent of patients, however, report pain in the abdomen lasting as long as 2 weeks.)
- A previous history of pain in the abdomen: 23%

The location of the pain may vary depending on the location of the appendix. In about half the population, the appendix is located behind the cecum rather than at its beginning, and in some people, it is located on the left side of the body.

## Diagnosis

A careful history-taking and **physical examination** is the best way to diagnose appendicitis. It is often difficult even for experienced physicians to distinguish the symptoms of appendicitis from those of other abdominal disorders. A physician should ask such questions as where the pain is centered, whether the pain has shifted, and where the pain began. The physician should press on the abdomen to judge the location of the pain and the degree of tenderness.

The diagnosis of appendicitis can be tricky and complicated. The typical sequence of symptoms is present in only 50% of cases. In the other half of cases, less typical patterns may be seen, especially in pregnant women, older people, and infants. In pregnant women, appendicitis is easily masked by the frequent occurrence of mild abdominal pain and nausea from other causes. Elderly people may feel less pain and tenderness than most individuals, thereby delaying diagnosis and treatment, and leading to rupture in 30% of cases. Infants and young children often have diarrhea, vomiting, and fever in addition to pain. Another factor that complicates diagnosis is the variation in size and location of the appendix in different people. In some patients the appendix is located on the left side of the body rather than the right, and in others the appendix is unusually long and extends from the right side toward the left side of the body.

Some doctors use a scoring system called the Alvarado score to assess the patient's likelihood of having appendicitis. The score is based on six clinical signs (fever, rebound tenderness, abdominal pain migrating to the lower right quadrant, nausea or vomiting, loss of appetite, and pain on pressure in the lower right quadrant) and two laboratory

measurements of white blood cells (number and type of WBCs) in the patient's blood serum. Two factors are assigned two points each and the remaining six one point each, for a maximum total score of ten points. A score below 5 generally indicates that the patient does not have appendicitis, while a score of 7 or higher is considered strongly predictive of acute appendicitis.

## Examination

In addition to taking the patient's temperature and asking about recent nausea or loss of appetite, the doctor may perform certain maneuvers during the physical examination when appendicitis is suspected. Patients with appendicitis typically feel what is called rebound tenderness (soreness) when the doctor first presses on the abdomen and then releases the pressure. The patient may also stiffen the muscles of the abdomen in response to pressure; this reaction is called guarding. In addition, the doctor may be able to feel that the abdomen itself is rigid. The doctor may move or rotate the patient's right leg or hip in order to test for unusual pain during this maneuver. This is called the psoas sign, named for two muscles involved in bending or rotating the hip. Rectal exams for both men and women may be performed in order to rule out other possible diagnoses.

## Tests

Several different types of laboratory and imaging tests may be performed as part of the diagnostic workup:

- Blood test. A high white blood cell count indicates the presence of infection, and the presence of a large number of white blood cells called neutrophils is one of the signs evaluated in the Alvarado score.
- Imaging tests. These may include x rays, ultrasound, or computed tomography (CT) scans. The CT scan is the most commonly used imaging test to diagnose appendicitis, but x-ray studies can be useful for detecting foreign bodies or hardened stools that may be blocking the appendix. The use of imaging studies to diagnose appendicitis is increasingly controversial as of 2010, however, as many surgeons maintain that they increase the risk of perforation by delaying surgery, add to the total cost of the procedure, and have a low rate of accuracy in distinguishing between healthy and infected appendices.
- Urine test. This test may be done to rule out kidney stones or a urinary tract infection.
- Pregnancy test. Women of childbearing age are tested for pregnancy to rule out the possibility of an ectopic pregnancy (one in which the fetus is growing

in the Fallopian tubes, cervix, or abdomen rather than the uterus). The pain caused by an ectopic pregnancy resembles that of acute appendicitis, and the consequences of a missed diagnosis are potentially life-threatening.

In early 2010 a group of researchers in Colorado reported on a new possible diagnostic test for appendicitis that measures the levels of a protein called S100A8/A9 in the patient's blood serum. The biomarker appears to be more sensitive than WBC measurements in diagnosing acute appendicitis.

### **Procedures**

Persons with a diagnosis of appendicitis are usually taken immediately to surgery, where a laparotomy (surgical exploration of the abdomen) is done to confirm the diagnosis. Often, the diagnosis is not certain until an operation is completed. To avoid a ruptured appendix, surgery may be recommended without delay if the symptoms point clearly to appendicitis. If the symptoms are not clear, surgery may be postponed until they progress enough to confirm a diagnosis.

When appendicitis is strongly suspected in a woman of child-bearing age, a diagnostic **laparoscopy** is sometimes recommended even after a **pregnancy** test to be sure that a gynecological problem such as a ruptured ovarian cyst is not causing the pain. In this procedure, a lighted viewing tube is inserted into the abdomen through a small incision around the navel.

A normal appendix is discovered in about 10–20% of patients who undergo laparotomy for suspected appendicitis. Sometimes the surgeon will remove a normal appendix as a safeguard against appendicitis in the future. During the surgery, another specific cause for the pain and symptoms of appendicitis is found for about 30% of these patients.

### **Treatment**

The standard treatment for acute (sudden, severe) appendicitis is an **appendectomy**, surgery to remove the appendix. Because of the potential for a life-threatening ruptured appendix, persons suspected of having appendicitis are often taken to surgery before the diagnosis is certain.

#### **Traditional**

The surgeon can perform an appendectomy (surgical removal of the appendix) in several different ways. The oldest procedure is called an open appendectomy. The surgeon makes an incision (cut) between 2 and 4 inches in length on the lower right side of the abdomen. The appendix is removed from its location

and the area is rinsed with sterile fluid to prevent further infection.

A newer and more commonly used technique is called a laparoscopic appendectomy. It requires much smaller incisions, only an inch or so long. The surgeon inserts a laparoscope, which is an instrument that allows the surgeon to see inside the abdomen, through one incision, and surgical instruments to remove the appendix through another small incision. If the surgeon finds that the infection has spread or that there are other complications, the operation may have to be completed as an open appendectomy; according to the American College of Surgeons, about 110 in every 1,000 laparoscopic procedures have to be completed as open appendectomies.

In March 2008, surgeons at a medical center in California successfully removed a woman's appendix through her vagina. The procedure is still considered experimental but allows female patients to recover more rapidly.

### **Drugs**

In a few cases, if the doctor is not certain of the diagnosis, he or she may prescribe a course of **antibiotics** to see whether the patient's symptoms are caused by something other than an inflamed appendix and may not require surgery. Antibiotics are also given intravenously during and after surgery to reduce the risk of infection. Treatment with antibiotics is essential if the appendix has ruptured before surgery.

Patients who have not yet been evaluated by a surgeon should not be given pain relievers, as they may mask the underlying symptoms. After surgery, however, patients are given pain relievers and antiemetics (drugs to prevent **nausea and vomiting**) as needed. Patients may be given **narcotics** (opioids, most often morphine or oxycodone) for severe pain but are encouraged to use NSAIDs (naproxen or ibuprofen) as soon as possible, as narcotic pain relievers often cause constipation. Patients should not drive or drink alcohol for at least two days after returning home because drowsiness is another common side effect of opioids.

### **Prognosis**

Most people do very well after an appendectomy if their appendix was removed before it ruptured; about 10 percent will have complications after surgery. The average hospital stay is between 1 and 3 days after the operation but full recovery at home may take 2–6 weeks before the patient can return to vigorous **exercise** or lifting heavy objects. Patients are usually

advised to eat a light diet and drink plenty of fluids (8–10 glasses per day) during recovery at home.

The mortality rate for appendicitis in the United States is very low, between 0.2 and 0.8 percent of patients; most of these deaths are caused by complications of peritonitis rather than by the appendectomy itself. The rate of complications in appendicitis increases tenfold if the appendix bursts before surgery. There are higher rates of perforation and mortality among children and elderly persons.

## Prevention

There is some evidence that people from cultures whose diets have a high level of fiber (the part of plants that is not digested) are less likely to develop appendicitis than those whose diets are low in fiber. It is thought that higher levels of fiber in the diet help the intestines push food along more efficiently, thus lowering the likelihood that the appendix will become blocked by fecal matter. Apart from increasing the amount of fiber in one's diet through eating more vegetables, however, there is no definitive way to predict or prevent appendicitis.

## Health care team roles

A physician, physician assistant, or nurse practitioner usually makes an initial diagnosis of appendicitis based on history, physical findings, and laboratory results. A laboratory technician may provide a test that confirms a diagnosis. A surgeon removes an appendix. Nurses assist by collecting data from the patient and family, monitoring vital signs and status of pain, and providing patient education about the diagnosis, surgery, and recovery.

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## ORGANIZATIONS

American College of Gastroenterology (ACG), P.O. Box 342260, Bethesda, MD, 20827-2260 301-263-9000, <http://www.acg.gi.org/>.

American College of Surgeons (ACS), 633 North Saint Clair Street, Chicago, IL, 60611-3211 312-202-5000 800-621-4111 312-202-5001, [postmaster@facs.org](mailto:postmaster@facs.org), <http://www.facs.org/>.

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), Building 31, Rm 9A06, 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560 301-496-3583, <http://www2.niddk.nih.gov>.

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Appendix removal see **Appendectomy**

## Appetite-stimulant drugs

### Definition

Appetite stimulant drugs are medicines used to increase the desire to eat.

### Purpose

These drugs are sometimes used to treat people who are very elderly or have chronic, debilitating diseases like **cancer** or HIV/AIDS to stimulate them eat enough food to preserve their strength and keep from losing weight.

### Description

Two drugs, megestrol (Megace) and dronabinol (Marinol) are FDA approved as appetite stimulants for people with **AIDS**. None are approved, but are sometimes used, to increase appetites in the elderly or those suffering from cancer or other chronic, debilitating conditions.

Megace is available in capsule and liquid form. Marinol is available as capsules.

### Recommended dosage

Doses depend on the conditions being treated and the condition of patients at the time of treatment.

### Precautions

#### *Megestrol (Megace)*

Megace is a hazardous agent with precautions for appropriate handling and disposal.

With prolonged use, this drug may lower the ability of the body to respond to **stress**. It may produce or worsen existing diabetes.

This drug should be used with caution by people who have had **blood clots** or emboli.

#### *Dronabinol (Marinol)*

This drug should be used with caution in patients with seizure disorders or liver diseases.

Marinol may increase the effects of sedative or tranquilizing drugs.

### Side effects

#### *Megestrol (Megace)*

Adverse effects include high blood pressure, chest **pain**, swelling of the feet and legs, **headache**, mood

changes, lethargy, skin rash, **nausea**, **diarrhea**, abdominal pain, **constipation**, weakness, and **shortness of breath**.

#### *Dronabinol (Marinol)*

This drug may cause flushing and **palpitations**, **dizziness**, giddiness, distorted thinking, confusion, lack of muscle coordination, nausea, **vomiting**, abdominal pain, and weakness.

### Interactions

#### *Megestrol (Megace)*

This drug should not be used with dofetilide (Tikosyn), as fatal heart **arrhythmias** may occur.

#### *Dronabinol (Marinol)*

Alcohol will increase the effects of this drug on the mind and muscle coordination.

James Waun MD, RPh

Applied kinesiology see **Kinesiology, applied**

## Apraxia

### Definition

Apraxia is neurological condition characterized by loss of the ability to perform activities that a person is physically able and willing to do.

### Description

Apraxia is caused by brain damage related to conditions such as **head injury**, **stroke**, **brain tumor**, and **Alzheimer's disease**. The damage affects the brain's ability to correctly signal instructions to the body. Forms of apraxia include the inability to say some words or make gestures.

Various conditions cause apraxia, and it can affect people of all ages. A baby might be born with the condition. A car accident or fall that resulted in head trauma could lead to apraxia.

From 500,000 to 750,000 people need to be hospitalized each year for head injuries according to the American Medical Association (AMA). Men between the ages of 18 and 24 form the largest group of people with head injuries. While not all severe injuries result in apraxia, men in that age group are at risk.

## KEY TERMS

**CT scanning**—Computer tomography scanning is a diagnostic imaging tool that uses x rays sent through the body at different angles.

**MRI**—Magnetic resonance imaging is a diagnostic imaging tool that utilizes an electromagnetic field and radio waves.

Risk factors for strokes include high blood pressure, diabetes, and heart disease. Cigarette **smoking** also puts a person at risk for a stroke. Brain tumors are abnormal tissue growths in the skull. They may be secondary tumors caused by the spread of **cancer** through the body.

There is more than one type of apraxia, and a person may have one or more form of this condition. A milder form of apraxia is called dyspraxia.

### Causes and symptoms

Apraxia is caused by conditions that affect parts of the brain that control movements. Apraxia is a result of damage to the brain's cerebral hemispheres. These are the two halves of the cerebrum and are the location of brain activities such as voluntary movements.

Apraxia causes a lapse in carrying out movements that a person knows how to do, is physically able to perform, and wants to do. A person may be willing and able to do something like bathe. However, the brain does not send the signals that allow the person to perform the necessary sequence of activities to do this correctly.

#### Types of apraxia

There are several types of apraxia, and a patient could be diagnosed with one or more forms of this condition. The types of apraxia include:

- Buccofacial or orofacial apraxia is the inability of a person to follow through on commands involving face and lip motions. These activities include coughing, licking the lips, whistling, and winking. Also known as facial-oral apraxia, it is the most common form of apraxia, according to the National Institute of Neurological Disorders and Stroke (NINDS).
- Limb-kinetic apraxia is the inability to make precise movements with an arm or leg.

- Ideomotor apraxia is the inability to make the proper movement in response to a command to pantomime an activity like waving.
- Constructional apraxia is the inability to copy, draw, or build simple figures.
- Ideational apraxia is the inability to do an activity that involves performing a series of movements in a sequence. A person with this condition could have trouble dressing, eating, or bathing. It is also known as conceptual apraxia.
- Oculomotor apraxia is characterized by difficulty moving the eyes.
- Verbal apraxia is a condition involving difficulty coordinating mouth and speech movements. It is referred to as apraxia of speech by organizations including the American Speech Language Hearing Association (ASHA).

A baby who does not coo or babble may display a symptom of apraxia of speech, according to ASHA. A young child may only say a few consonant sounds, and an older child may have difficulty imitating speech. An adult also has this difficulty. Other symptoms include saying the wrong words. A person wants to say "kitchen," but says "bipem" instead, according to an ASHA report.

A person diagnosed with apraxia may also have **aphasia**, a condition caused by damage to the brain's speech centers. This results in difficulty reading, writing, speaking, and understanding when others speak.

#### Post-apraxia changes

A person with apraxia could experience frustration about difficulty communicating or trouble performing tasks. In some cases, the condition could affect the person's ability to live independently.

### Diagnosis

Diagnosis of apraxia could begin with testing of its underlying cause. Testing for conditions like a stroke or cancer includes the MRI (**magnetic resonance imaging**) and CT scanning (computer tomography scanning). A **brain biopsy** is used to measure changes caused by Alzheimer's disease. In all cases, the physician takes a family history. Head trauma that could cause apraxia is first treated in the emergency room.

Other diagnostic treatment is related to identifying the type of apraxia. For example, the physician may ask the patient to demonstrate how to blow out a candle, wave, use a fork, or use a toothbrush.

Assessment for speech apraxia in children includes a hearing evaluation to determine if difficulty in speaking is related to a **hearing loss**. If the condition appears related to apraxia, a speech-language pathologist examines muscle development in the jaw, lips, and tongue. The examination of adults and children includes an evaluation of how words are pronounced individually and in conversation. The pathologist observes how the patient breathes when speaking and the ability to perform actions like smiling.

The costs of diagnosis vary because the process could include examinations and diagnostic screening related to the underlying cost of the apraxia. Insurance generally covers part of these costs.

## Treatment

The treatment for apraxia usually involves **rehabilitation** through speech-language therapy, **physical therapy**, or **occupational therapy**. In addition, treatment such as **chemotherapy** is administered for the condition that caused the apraxia.

Family education is an important component of apraxia treatment. The rehabilitation process takes time, and relatives can offer encouragement and support to the patient. They may be asked to help the patient with in-home exercises. Furthermore, family members sometimes need to take on the role of caregivers.

### *Speech-language therapy*

Speech-language therapy focuses on helping the patients learn or regain communication skills. Therapists teach exercises to strengthen facial muscles used in speech. Other exercises concentrate on patients learning to correctly pronounce sounds and then turn those sounds into words.

In cases where apraxia limits the ability to speak, therapists help patients develop alternate means of communication. These alternatives range from gesturing to using a portable computer that writes and produces speech, according to ASHA.

### *Occupational and physical therapies*

Occupational and physical therapies focus on helping patients regain the skills impaired by apraxia. Physical therapy exercises concentrate on areas such as mobility and balance. Occupational therapy helps patients relearn daily living skills.

## *Treatment costs*

The costs of therapy vary by the type of treatment, regional location, and where the therapy is offered. Fees can range for \$40 per hour for in-office **speech therapy** for a child to \$85 per hour for in-home physical or occupational therapy for a senior citizen. Part of therapy costs may be covered by insurance.

## Alternative treatment

Most alternative treatments target Alzheimer's disease and other conditions that cause apraxia. Herbal remedies thought to help people with Alzheimer's include **ginkgo biloba**, a plant extract. However, organizations including the Alzheimer's Association caution that the effectiveness and safety of this herbal remedy has not been evaluated by the U.S. Food and Drug Administration. The government does not require a review of supplements like ginkgo. Furthermore, there is a risk of internal bleeding if ginkgo is taken in combination with **aspirin** and blood-thinning medications.

## Prognosis

The prognosis for apraxia depends on factors such as what caused the condition. While Alzheimer's is a degenerative condition, a child with verbal apraxia or a stroke patient could make progress.

In some cases, treatment helps a person to relearn or acquire skills needed to function. A caregiver may be required, and some people with **dementia** require supervised, long-term care.

## Prevention

The methods of preventing apraxia focus on preventing the underlying causes of this condition. This may not be entirely possible when there is a family history of conditions such as stroke, dementia, and cancer. However, a person at risk by not smoking, exercising, and eating a diet based on the American Heart Association guidelines.

Head injury can be prevented by wearing a helmet when participating in activities like sports and bicycling. Wearing a seatbelt when in a vehicle also helps reduce the risk of head injury.

## Resources

### OTHER

"Apraxia in Adults." American Speech Language Hearing Association. 2005. [cited March 29, 2005].  
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- “NINDS Apraxia Information Page.” National Institute of Neurological Disorders and Stroke. February 09, 2005 [cited March 29, 2005]. <http://www.ninds.nih.gov/disorders/apraxia/apraxia.htm>.

#### ORGANIZATIONS

- Alzheimer’s Association, 225 N. Michigan Ave., Fl. 17, Chicago, IL, 60601-7633, (312) 335-8700, (866) 699-1246, (800) 272-3900, [info@alz.org](mailto:info@alz.org), <http://www.alz.org>. This website is an excellent resource for anyone with a loved one suffering from Alzheimer’s or another dementing illness.
- American Speech Language Hearing Association, 2200 Research Boulevard , Rockville, MD, 20850-3289, (301) 296-5700, (301) 296-8580, (800) 638-8255, [action-center@asha.org](mailto:action-center@asha.org), <http://asha.org/>.
- National Institute of Neurological Disorders and Stroke (NINDS), NIH Neurological Institute, P. O. Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, <http://www.ninds.nih.gov/>.
- National Rehabilitation Information Center, 8201 Corporate Drive, Suite 600, Landover, MD, 20785, (800) 346-2742, [naricinfo@heitechservices.com](mailto:naricinfo@heitechservices.com), <http://www.naric.com>.
- National Stroke Association, 9707 E Easter Lane Building B, Centennial, CO, 80112, (303) 649-1328, (800) 787-6537, [Info@stroke.org](mailto:Info@stroke.org), <http://www.stroke.org>.

Liz Swain

**APSGN** see **Acute poststreptococcal glomerulonephritis**

**APTT** see **Partial thromboplastin time**

**Arachnodactyly** see **Marfan syndrome**

## KEY TERMS

**Arthropods**—A phylum name referring to certain insects (including mosquitoes and ticks) and spiders.

**Encephalitis**—A condition in which the brain swells.

## Description

Of the huge number of arboviruses known to exist, about 80 types are responsible for human disease. In addition to the virus, there are usually two other types of living creatures involved in the cycle leading to human disease. When large quantities of virus are present in an arthropod (often a tick or mosquito), the viruses are passed to a bird or small mammal when the arthropod attempts to feed on the blood of that creature. The virus thrives within the new host, sometimes causing illness, sometimes not. More ticks or mosquitoes are infected with the virus when they feed on the host’s blood. Eventually, a tick or mosquito **bites** a human, and the virus is passed along. Just a few types of arboviruses cycle only between arthropods and humans, with no intermediate stop in a bird or small mammal.

Because the arboviruses require an arthropod to pass them along to humans, the most common times of year for these illnesses include summer and fall, when mosquitoes and ticks are most prevalent. Damp environments favor large populations of mosquitoes, and thus also increase the risk of arbovirus infections.

The major causes of arbovirus encephalitis include the members of the viral families alphavirus (causing Eastern equine encephalitis, Western equine encephalitis, and Venezuelan equine encephalitis), flavivirus (responsible for St. Louis encephalitis, Japanese encephalitis, Tick-borne encephalitis, Murray Valley encephalitis, Russian spring-summer encephalitis, and Powassan), and bunyavirus (causing California encephalitis).

In the United States, the most important types of arbovirus encephalitis include Western equine encephalitis (WEE), Eastern equine encephalitis (EEE), St. Louis encephalitis, and California encephalitis. WEE strikes young infants in particular, with a 5% chance of **death** from the illness. Of those who survive, about 60% suffer permanent brain damage. EEE strikes infants and children, with a 20% chance of death, and a high rate of permanent brain damage among survivors. St. Louis encephalitis tends to strike

## Arbovirus encephalitis

### Definition

**Encephalitis** is a serious inflammation of the brain. Arbovirus encephalitis is caused by a virus from the Arbovirus group. The term *arbovirus* stands for *Arthro-pod-borne virus* because these viruses are passed to humans by members of the phylum Arthropoda (which includes insects and spiders).

adults older than 40 years of age, and older patients tend to have higher rates of death and long-term disability from the infection. California virus primarily strikes 5-18 year olds, with a lower degree of permanent brain damage.

### Causes and symptoms

Encephalitis occurs because specific arboviruses have biochemical characteristics which cause them to be particularly attracted to the cells of the brain and the nerves. The virus causes cell death and inflammation, with **fever** and swelling within the brain and nerves. The membranous coverings of the brain and spinal cord (the meninges) may also become inflamed, a condition called **meningitis**. The brain is swollen, and patches of bleeding occur throughout the brain and spinal cord.

Patients with encephalitis suffer from headaches, fever, **nausea and vomiting**, stiff neck, and sleepiness. As the disease progresses, more severe symptoms develop, including **tremors**, confusion, seizures, **coma**, and **paralysis**. Loss of function occurs when specific nerve areas are damaged and/or killed.

### Diagnosis

Early in the disease, laboratory testing of blood may reveal the presence of the arbovirus. The usual technique used to verify the presence of arbovirus involves injecting the patient's blood into the brain of a newborn mouse, then waiting to see if the mouse develops encephalitis. Diagnosis is usually based on the patient's symptoms, history of tick or mosquito bites, and knowledge that the patient has been in an area known to harbor the arbovirus.

### Treatment

Treatment is mostly supportive, meaning it is directed at improving the symptoms, but does not shorten the course of the illness. The main concerns of treatment involve lowering fever, treating **pain**, avoiding **dehydration** or other chemical imbalances, and decreasing swelling in the brain with **steroids**.

### Prognosis

Prognosis depends on the particular type of arbovirus causing disease, and on the age and prior health status of the patient. Death rates range all the way up to 20% for arbovirus encephalitis, and the rates of lifelong effects due to brain damage reach 60% for some types of arboviruses.

### Prevention

Prevention involves avoiding contact with arthropods which carry these viruses. This means wearing appropriate insect repellents, and dressing properly in areas known to be infested. Insecticides and the avoidance of collections of standing water (which are good breeding ground for arthropods) is also effective at decreasing arthropod populations.

There are immunizations available against EEE and WEE. These have primarily been used to safeguard laboratory workers who have regular exposure to these viruses.

### Resources

#### BOOKS

Stoffman, Phyllis, and Susan Champion. *Is It Catching? Visiting Nurse Service of New York Family Guide to Preventing & Treating 100 Infectious Diseases*. 2nd ed. New York: New York Visiting Nurse Service, 2006.

Rosalyne Carson-DeWitt MD

ARDS see **Adult respiratory distress syndrome**

## Aromatherapy

### Definition

Aromatherapy is the therapeutic use of plant-derived, aromatic essential oils to promote physical and psychological well-being. It is sometimes used in combination with massage and other therapeutic techniques as part of a holistic treatment approach.

### Purpose

Aromatherapy offers diverse physical and psychological benefits, depending on the essential oil or oil combination and method of application used. Some common medicinal properties of essential oils used in aromatherapy include: analgesic, antimicrobial, antiseptic, anti-inflammatory, astringent, anti-spasmodic, expectorant, diuretic, and sedative. Essential oils are used to treat a wide range of symptoms and conditions, including, but not limited to, gastrointestinal discomfort, skin conditions, menstrual **pain** and irregularities, stress-related conditions, **mood disorders**, circulatory problems, respiratory infections, and **wounds**.

## Examples of aromatherapy oils

Name	Description	Conditions treated
Bay laurel	Antiseptic, diuretic, sedative, etc.	Bronchitis, common cold, digestive problems, influenza, and scabies and lice (CAUTION: Don't use if pregnant.)
Chamomile	Anti-inflammatory, antiseptic, pain reliever, and sedative	Acne, arthritis, burns, digestive problems, hay fever, menstrual and menopausal symptoms, and sunburn.
Clary sage	Anticonvulsive, anti-inflammatory, antiseptic, and relaxant	Anxiety, burns, eczema, and menstrual and menopausal symptoms (CAUTION: Don't use if pregnant.)
Eucalyptus	Analgesic, antibacterial, antiseptic, astringent, and expectorant	Boils, breakouts, common cold, cough, influenza, and sinusitis (CAUTION: Not to be taken orally.)
Lavender	Analgesic, antiseptic, calming/soothing	Depression, headache, insomnia, nausea, sprains, and stress
Peppermint	Pain reliever	Headache, indigestion, motion sickness, muscle pain, and nausea
Rosemary	Antiseptic, diuretic, and stimulant	Bronchitis, fluid retention, gas, indigestion, and influenza (CAUTION: Don't use if pregnant or have epilepsy or hypertension.)
Tarragon	Antispasmodic, diuretic, laxative, and stimulant	Gas, indigestion, and menstrual and menopausal symptoms (CAUTION: Don't use if pregnant.)
Tea tree	Antiseptic and soothing	Abscesses, acne, bronchitis, burns, common cold, and vaginitis
Thyme	Antibacterial, antiseptic, antispasmodic, and stimulant	Cough, diarrhea, gas, intestinal worms, laryngitis (CAUTION: Don't use if pregnant or have hypertension.)

(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

### Description

#### Origins

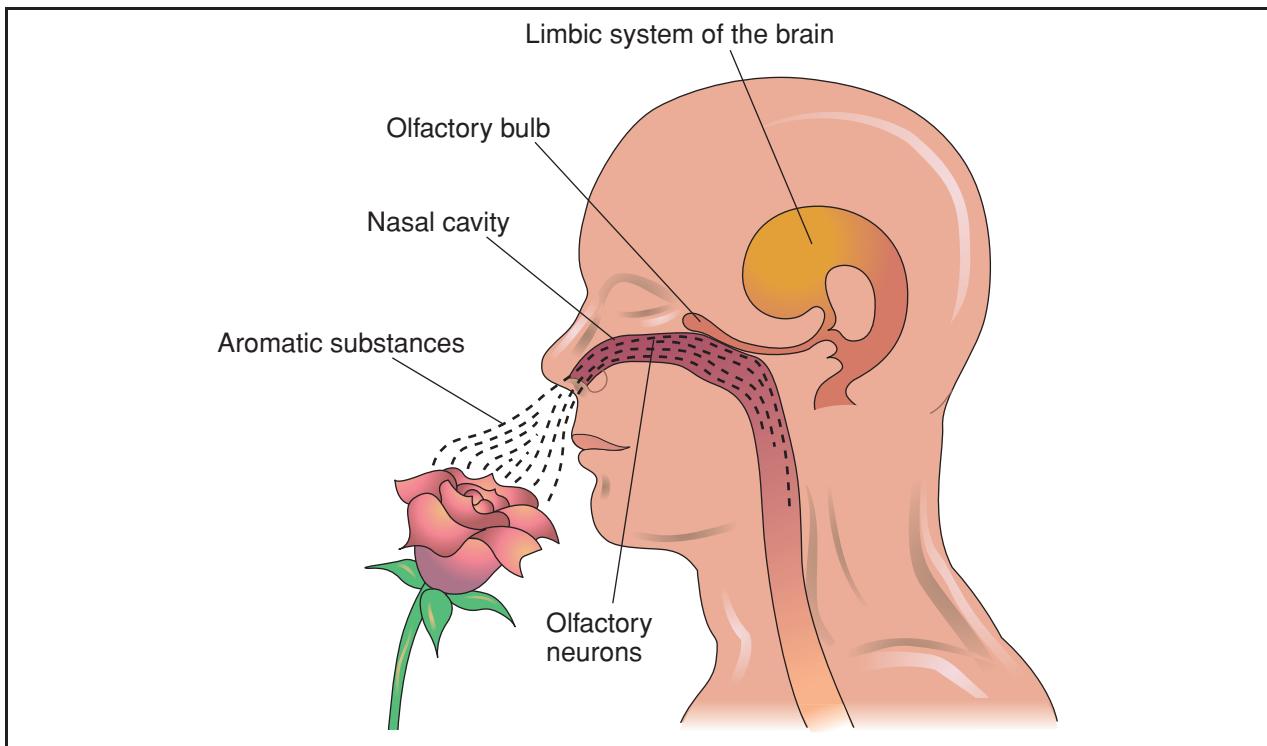
Aromatic plants have been employed for their healing, preservative, and pleasurable qualities throughout recorded history in both the East and West. As early as 1500 B.C. the ancient Egyptians used waters, oils, incense, resins, and ointments scented with botanicals for their religious ceremonies.

There is evidence that the Chinese may have recognized the benefits of herbal and aromatic remedies much earlier than this. The oldest known herbal text, Shen Nung's *Pen Ts'ao* (c. 2700-3000 B.C.) catalogs over 200 botanicals. Ayurveda, a practice of traditional Indian medicine that dates back over 2,500 years, also used aromatic herbs for treatment.

The Romans were well-known for their use of fragrances. They bathed with botanicals and integrated them into their state and religious rituals. So did the Greeks, with a growing awareness of the medicinal properties of herbs, as well. Greek physician and surgeon Pedanios Dioscorides, whose renowned herbal text *De Materia Medica* (60 A.D.) was the standard textbook for Western medicine for 1,500 years, wrote extensively on the medicinal value of botanical aromatics. The *Medica* contained detailed information on over 500 plants and 4,740 separate medicinal uses for them, including an entire section on aromatics.

Written records of herbal distillation are found as early as the first century A.D., and around 1000 A.D., the noted Arab physician and naturalist Avicenna described the distillation of rose oil from rose petals, and the medicinal properties of essential oils in his writings. However, it wasn't until 1937, when French chemist René-Maurice Gattefossé published *Aromatherapie: Les Huiles essentielles, hormones végétales*, that aromatherapie, or aromatherapy, was introduced in Europe as a medical discipline. Gattefossé, who was employed by a French perfumer, discovered the healing properties of lavender oil quite by accident when he suffered a severe burn while working and used the closest available liquid, lavender oil, to soak it in.

In the late 20th century, French physician Jean Valnet used botanical aromatics as a front line treatment for wounded soldiers in World War II. He wrote about his use of essential oils and their healing and antiseptic properties, in his 1964 book *Aromatherapie, traitement des maladies par les essences des plantes*, which popularized the use of essential oils for medical and psychiatric treatment throughout France. Later, French biochemist Mauguierite Maury popularized the cosmetic benefits of essential oils, and in 1977 Robert Tisserand wrote the first English language book on the subject, *The Art of Aromatherapy*, which introduced massage as an adjunct treatment to aromatherapy and sparked its popularity in the United Kingdom.



**As a holistic therapy, aromatherapy is believed to benefit both the mind and body. Here, the aromatic substances from a flower stimulates the olfactory bulb and neurons. The desired emotional response (such as relaxation) is activated from the limbic system of the brain.** (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

In aromatherapy, essential oils are carefully selected for their medicinal properties. As essential oils are absorbed into the bloodstream through application to the skin or inhalation, their active components trigger certain pharmacological effects (e.g., pain relief).

In addition to physical benefits, aromatherapy has strong psychological benefits. The volatility of an oil, or the speed at which it evaporates in open air, is thought to be linked to the specific psychological effect of an oil. As a rule of thumb, oils that evaporate quickly are considered emotionally uplifting, while slowly-evaporating oils are thought to have a calming effect.

Essential oils commonly used in aromatherapy treatment include:

- Roman chamomile (*Chamaemelum nobilis*). An anti-inflammatory and analgesic. Useful in treating otitis media (earache), skin conditions, menstrual pains, and depression.
- Clary sage (*Salvia sclarea*). This natural astringent is not only used to treat oily hair and skin, but is also

said to be useful in regulating the menstrual cycle, improving mood, and controlling high blood pressure. Clary sage should not be used by pregnant women.

- Lavender (*Lavandula officinalis*). A popular aromatherapy oil which mixes well with most essential oils, lavender has a wide range of medicinal and cosmetic applications, including treatment of insect bites, burns, respiratory infections, intestinal discomfort, nausea, migraine, insomnia, depression, and stress.
- Myrtle (*Myrtus communis*). Myrtle is a fungicide, disinfectant, and antibacterial. It is often used in steam aromatherapy treatments to alleviate the symptoms of whooping cough, bronchitis, and other respiratory infections.
- Neroli (bitter orange), (*Citrus aurantium*). Citrus oil extracted from bitter orange flower and peel and used to treat sore throat, insomnia, and stress and anxiety-related conditions.
- Sweet orange (*Citrus sinensis*). An essential oil used to treat stomach complaints and known for its reported ability to lift the mood while relieving stress.

## KEY TERMS

**Antiseptic**—Inhibits the growth of microorganisms.

**Bactericidal**—An agent that destroys bacteria (e.g., *Staphylococci aureus*, *Streptococci pneumoniae*, *Escherichia coli*, *Salmonella enteritidis*).

**Carrier oil**—An oil used to dilute essential oils for use in massage and other skin care applications.

**Contact dermatitis**—Skin irritation as a result of contact with a foreign substance.

**Essential oil**—A volatile oil extracted from the leaves, fruit, flowers, roots, or other components of a plant and used in aromatherapy, perfumes, and foods and beverages.

**Holistic**—A practice of medicine that focuses on the whole patient, and addresses the social, emotional,

and spiritual needs of a patient as well as their physical treatment.

**Phototoxic**—Causes a harmful skin reaction when exposed to sunlight.

**Remedy antidote**—Certain foods, beverages, prescription medications, aromatic compounds, and other environmental elements that counteract the efficacy of homeopathic remedies.

**Steam distillation**—A process of extracting essential oils from plant products through a heating and evaporation process.

**Volatile**—Something that vaporizes or evaporates quickly when exposed to air.

- Peppermint (*Mentha piperita*). Relaxes and soothes the stomach muscles and gastrointestinal tract. Peppermint's actions as an anti-inflammatory, anti-septic, and antimicrobial also make it an effective skin treatment, and useful in fighting cold and flu symptoms.
- Rosemary (*Rosmarinus officinalis*). Stimulating essential oil used to treat muscular and rheumatic complaints, as well as low blood pressure, gastrointestinal problems, and headaches.
- Tea tree (*Melaleuca alternifolia*). Has bactericidal, virucidal, fungicidal, and anti-inflammatory properties that make it a good choice for fighting infection. Recommended for treating sore throat and respiratory infections, vaginal and bladder infections, wounds, and a variety of skin conditions.
- Ylang ylang (*Cananga odorata*). A sedative essential oil sometimes used to treat hypertension and tachycardia.

Essential oils contain active agents that can have potent physical effects. While some basic aromatherapy home treatments can be self-administered, medical aromatherapy should always be performed under the guidance of an aromatherapist, herbalist, massage therapist, nurse, or physician.

### Inhalation

The most basic method of administering aromatherapy is direct or indirect inhalation of essential oils. Several drops of an essential oil can be applied to a tissue or handkerchief and gently inhaled. A small amount of essential oil can also be added to a bowl

of hot water and used as a steam treatment. This technique is recommended when aromatherapy is used to treat respiratory and/or skin conditions. Aromatherapy steam devices are also available commercially. A warm bath containing essential oils can have the same effect as steam aromatherapy, with the added benefit of promoting relaxation. When used in a bath, water should be lukewarm rather than hot to slow the evaporation of the oil.

Essential oil diffusers, vaporizers, and light bulb rings can be used to disperse essential oils over a large area. These devices can be particularly effective in aromatherapy that uses essential oils to promote a healthier home environment. For example, eucalyptus and tea tree oil are known for their antiseptic qualities and are frequently used to disinfect sickrooms, and citronella and geranium can be useful in repelling insects.

### Direct application

Because of their potency, essential oils are diluted in a carrier oil or lotion before being applied to the skin to prevent an allergic skin reaction. The carrier oil can be a vegetable or olive based one, such as wheat germ or avocado. Light oils, such as safflower, sweet almond, grapeseed, hazelnut, apricot seed, or peach kernel, may be absorbed more easily by the skin. Standard dilutions of essential oils in carrier oils range from 2–10%. However, some oils can be used at higher concentrations, and others should be diluted further for safe and effective use. The type of carrier oil used and the therapeutic use of the application may also influence how the essential oil is mixed.

Individuals should seek guidance from a healthcare professional and/or aromatherapist when diluting essential oils.

Massage is a common therapeutic technique used in conjunction with aromatherapy to both relax the body and thoroughly administer the essential oil treatment. Essential oils can also be used in hot or cold compresses and soaks to treat muscle aches and pains (e.g., lavender and ginger). As a **sore throat** remedy, antiseptic and soothing essential oils (e.g., tea tree and sage) can be thoroughly mixed with water and used as a gargle or mouthwash.

#### *Internal use*

Some essential oils can be administered internally in tincture, infusion, or suppository form to treat certain symptoms or conditions; however, this treatment should never be self-administered. Essential oils should only be taken internally under the supervision of a qualified healthcare professional.

As non-prescription botanical preparations, the essential oils used in aromatherapy are typically not paid for by health insurance. The self-administered nature of the therapy controls costs to some degree. Aromatherapy treatment sessions from a professional aromatherapist are not covered by health insurance in most cases, although aromatherapy performed in conjunction with **physical therapy**, nursing, therapeutic massage, or other covered medical services may be. Individuals should check with their insurance provider to find out about their specific coverage.

The adage “You get what you pay for” usually applies when purchasing essential oils, as bargain oils are often adulterated, diluted, or synthetic. Pure essential oils can be expensive; and the cost of an oil will vary depending on its quality and availability.

#### **Preparations**

The method of extracting an essential oil varies by plant type. Common methods include water or steam distillation and cold pressing. Quality essential oils should be unadulterated and extracted from pure botanicals. Many aromatherapy oils on the market are synthetic and/or diluted, contain solvents, or are extracted from botanicals grown with pesticides or herbicides. To ensure best results, essential oils should be made from pure organic botanicals and labeled by their full botanical name. Oils should always be stored dark bottles out of direct light.

Before using essential oils on the skin, individuals should perform a skin patch test by applying a small amount of the diluted oil behind the wrist and

covering it with a bandage or cloth for up to 12 hours. If redness or irritation occurs, the oil should be diluted further and a second skin test performed, or it should be avoided altogether. Individuals should never apply undiluted essential oils to the skin unless advised to do so by a trained healthcare professional.

#### **Precautions**

Individuals should only take essential oils internally under the guidance and close supervision of a health-care professional. Some oils, such as eucalyptus, wormwood, and sage, should never be taken internally. Many essential oils are highly toxic and should never be used at all in aromatherapy. These include (but are not limited to) bitter almond, pennyroyal, mustard, sassafras, rue, and mugwort.

Citrus-based essential oils, including bitter and sweet orange, lime, lemon, grapefruit, and tangerine, are phototoxic, and exposure to direct sunlight should be avoided for at least four hours after their application.

Other essential oils, such as cinnamon leaf, black pepper, juniper, lemon, white camphor, eucalyptus blue gum, ginger, peppermint, pine needle, and thyme can be extremely irritating to the skin if applied in high enough concentration or without a carrier oil or lotion. Caution should always be exercised when applying essential oils topically. Individuals should never apply undiluted essential oils to the skin unless directed to do so by a trained healthcare professional and/or aromatherapist.

Individuals taking homeopathic remedies should avoid black pepper, camphor, eucalyptus, and peppermint essential oils. These oils may act as a remedy antidote to the homeopathic treatment.

Children should only receive aromatherapy treatment under the guidance of a trained aromatherapist or healthcare professional. Some essential oils may not be appropriate for treating children, or may require additional dilution before use on children.

Certain essential oils should not be used by pregnant or nursing women or by people with specific illnesses or physical conditions. Individuals suffering from any chronic or acute health condition should inform their healthcare provider before starting treatment with any essential oil.

Asthmatic individuals should not use steam inhalation for aromatherapy, as it can aggravate their condition.

Essential oils are flammable, and should be kept away from heat sources.

## Side effects

Side effects vary by the type of essential oil used. Citrus-based essential oils can cause heightened sensitivity to sunlight. Essential oils may also cause **contact dermatitis**, an allergic reaction characterized by redness and irritation. Anyone experiencing an allergic reaction to an essential oil should discontinue its use and contact their healthcare professional for further guidance. Individuals should do a small skin patch test with new essential oils before using them extensively (see “Preparations” above).

## Research and general acceptance

The antiseptic and bactericidal qualities of some essential oils (such as tea tree and peppermint) and their value in fighting infection has been detailed extensively in both ancient and modern medical literature.

Recent research in mainstream medical literature has also shown that aromatherapy has a positive psychological impact on patients, as well. Several clinical studies involving both post-operative and chronically ill subjects showed that massage with essential oils can be helpful in improving emotional well-being, and consequently, promoting the healing process.

Today, the use of holistic aromatherapy is widely accepted in Europe, particularly in Great Britain, where it is commonly used in conjunction with massage as both a psychological and physiological healing tool. In the United States, where aromatherapy is often misunderstood as solely a cosmetic treatment, the mainstream medical community has been slower to accept it.

## Resources

### BOOKS

Price, Shirley, and Len Price. *Aromatherapy for Health Professionals*. 3rd ed. New York: Churchill Livingstone, 2006.

### ORGANIZATIONS

National Association of Holistic Aromatherapy, PO Box 1868, Banner Elk, NC, 28604, (828) 898-6161, (828) 898-1965, info@naha.org, <http://www.naha.org>.

Paula Anne Ford-Martin

## Arrhythmias

### Definition

An arrhythmia is an abnormality in the heart's rhythm, or heartbeat pattern. The heartbeat can be

too slow, too fast, have extra beats, skip a beat, or otherwise beat irregularly.

## Description

Arrhythmias are deviations from the normal cadence of the heartbeat, which cause the heart to pump improperly. The normal heartbeat starts in the right atrium, where the heart's natural pacemaker (the sinus node) sends an electrical signal to the center of the heart to the atrioventricular node. The atrioventricular node then sends signals into the main pumping chamber to make the ventricle contract. Arrhythmias occur when the heartbeat starts in a part of the heart other than the sinus node, an abnormal rate or rhythm develops in the sinus node, or a heart conduction “block” prevents the electrical signal from traveling down the normal pathway.

More than four million Americans have arrhythmias, most of which are harmless. Middle-aged adults commonly experience arrhythmias. As people age, the probability of experiencing an arrhythmia increases. Arrhythmias often occur in people who do not have heart disease. In people with heart disease, it is usually the heart disease which is dangerous, not the arrhythmia. Arrhythmias often occur during and after heart attacks. Some types of arrhythmias, such as **ventricular tachycardia**, are serious and even life threatening. In the United States, arrhythmias are the primary cause of **sudden cardiac death**, accounting for more than 350,000 deaths each year.

Slow heart rates (less than 60 beats per minute) are called bradycardias, while fast heart rates (more than 100 beats per minute) are called tachycardias. Bradycardia can result in poor circulation of blood, and, hence, a lack of oxygen throughout the body, especially the brain. Tachycardias also can compromise the heart's ability to pump effectively because the ventricles do not have enough time to completely fill.

Arrhythmias are characterized by their site of origin: the atria or the ventricles. Supraventricular arrhythmias occur in the upper areas of the heart and are less serious than ventricular arrhythmias. **Ventricular fibrillation** is the most serious arrhythmia and is fatal unless medical help is immediate.

## Causes and symptoms

In many cases, the cause of an arrhythmia is unknown. Known causes of arrhythmias include heart disease, **stress**, **caffeine**, tobacco, alcohol, diet pills, and **decongestants** in **cough** and cold medicines.

## KEY TERMS

**Bradycardia**—A slow heart rate. Bradycardia is one of the two types of arrhythmia.

**Electrocardiogram**—A test which uses electric sensors placed on the body to monitor the heartbeat.

**Electrophysiology study**—A test using cardiac catheterization to stimulate an electrical current to provoke an arrhythmia. The test identifies the origin of arrhythmias and is used to test the effectiveness of antiarrhythmic drugs.

**Tachycardia**—A fast heart rate. Tachycardia is one of the two types of arrhythmia.

Symptoms of an arrhythmia include a fast heartbeat, pounding or fluttering chest sensations, skipping a heartbeat, “flip-flops,” **dizziness**, faintness, **shortness of breath**, and chest pains.

## Diagnosis

Examination with a stethoscope, electrocardiograms, and electrophysiologic studies is used to diagnose arrhythmias. Sometimes arrhythmias can be identified by listening to the patient’s heart through a stethoscope, but, since arrhythmias are not always present, they may not occur during the physical exam.

An electrocardiogram (ECG) shows the heart’s activity and may reveal a lack of oxygen from poor circulation (**ischemia**). Electrodes covered with conducting jelly are placed on the patient’s chest, arms, and legs. They send impulses of the heart’s activity through an electrical activity monitor (oscilloscope) to a recorder that traces them on paper. The test takes about 10 minutes and is performed in a physician’s office. Another type of ECG, commonly known as the exercise **stress test**, measures how the heart and blood vessels respond to exertion while the patient is exercising on a treadmill or a stationary bike. This test is performed in a physician’s office or an exercise laboratory and takes 15–30 minutes. Other types of ECGs include 24-hour ECG monitoring and transtelephonic monitoring. In 24-hour ECG (Holter) monitoring, the patient wears a small, portable tape recorder connected to disks on his/her chest that record the heart’s rhythm during daily activities. Transtelephonic monitoring can identify arrhythmias that occur infrequently. Similar to **Holter monitoring**, transtelephonic monitoring can continue for days or weeks, and it enables patients to send the ECG via telephone to a monitoring station

when an arrhythmia is felt, or the patient can store the information in the recorder and transmit it later.

Electrophysiologic studies are invasive procedures performed in a hospital to identify the origin of serious arrhythmias and responses to various treatments. They involve **cardiac catheterization**, in which catheters tipped with electrodes are passed from a vein in the arm or leg through the blood vessels into the heart. The electrodes record impulses in the heart, highlighting where the arrhythmia starts. During the procedure, physicians can test the effects of various drugs by provoking an arrhythmia through the electrodes and trying different drugs. The procedure takes one to three hours, during which the patient is awake but mildly sedated. Local anesthetic is injected at the catheter insertion sites.

## Treatment

Many arrhythmias do not require any treatment. For serious arrhythmias, treating the underlying heart disease sometimes controls the arrhythmia. In some cases, the arrhythmia itself is treated with drugs, electrical shock (**cardioversion**), automatic implantable defibrillators, artificial **pacemakers**, **catheter ablation**, or surgery. Supraventricular arrhythmias often can be treated with drug therapy. Ventricular arrhythmias are more complex to treat.

Drug therapy can manage many arrhythmias, but finding the right drug and dose requires care and can take some time. Common drugs for suppressing arrhythmias include beta blockers, **calcium channel blockers**, quinidine, digitalis preparations, and procainamide. Because of their potential serious side effects, stronger, desensitizing drugs are used only to treat life-threatening arrhythmias. All of the drugs used to treat arrhythmias have possible side effects, ranging from mild complications with beta blockers and calcium channel blockers to more serious effects of desensitizing drugs that can, paradoxically, cause arrhythmias or make them worse. Response to drugs is usually measured by ECG, Holter monitor, or electrophysiologic study.

In emergency situations, cardioversion or **defibrillation** (the application of an electrical shock to the chest wall) is used. Cardioversion restores the heart to its normal rhythm. It is followed by drug therapy to prevent recurrence of the arrhythmia.

Artificial pacemakers that send electrical signals to make the heart beat properly can be implanted under the skin during a simple operation. Leads from the pacemaker are anchored to the right side of the heart. Pacemakers are used to correct bradycardia and are sometimes used after surgical or catheter ablation.

Automatic implantable defibrillators correct life-threatening ventricular arrhythmias by recognizing them and then restoring a normal heart rhythm by pacing the heart or giving it an electric shock. They are implanted within the chest wall without major surgery and store information for future evaluation by physicians. Automatic implantable defibrillators have proven to be more effective in saving lives than drugs alone. They often are used in conjunction with drug therapy.

Ablation, a procedure to alter or remove the heart tissue causing the arrhythmia in order to prevent a recurrence, can be performed through a catheter or surgery. Supraventricular tachycardia can be treated successfully with ablation. Catheter ablation is performed in a catheterization laboratory with the patient under **sedation**. A catheter equipped with a device that maps the heart's electrical pathways is inserted into a vein and is threaded into the heart. High-frequency radio waves are then used to remove the pathway(s) causing the arrhythmia. Surgical ablation is similar in principle but it is performed in a hospital, using a cold probe instead of radio waves to destroy tissue. Ablation treatments are used when medications fail.

Maze surgery treats **atrial fibrillation** by making multiple incisions through the atrium to allow electrical impulses to move effectively. This is often recommended for patients who have not responded to drugs or cardioversion.

## Alternative treatment

Since some arrhythmias can be life threatening, a conventional medical doctor should always be consulted first. **Acupuncture** can correct an insignificant number (1.5%) of atrial fibrillation cases. For new, minor arrhythmias, acupuncture may be effective in up to 70% of cases, but this figure may not differ much from placebo therapy. Both western and Chinese herbal remedies are also used in the treatment of arrhythmias. Since hawthorn (*Crataegus laevigata*) dilates the blood vessels and stimulates the heart muscle, it may help to stabilize arrhythmias. It is gentle and appropriate for home use, unlike foxglove (*Digitalis purpurea*), an herb whose action on the heart is too potent for use without supervision by a qualified practitioner. Homeopathic practitioners may prescribe remedies such as *Lachesis* and aconite or monkshood (*Aconitum napellus*) to treat mild arrhythmias.

## Prognosis

Advances in diagnostic techniques, new drugs, and medical technology have extended the lives of many patients with serious arrhythmias. Diagnostic

techniques enable physicians to accurately identify arrhythmias, while new drugs, advances in pacemaker technology, the development of implantable defibrillators, and progress in ablative techniques offer effective treatments for many types of arrhythmia.

## Prevention

Some arrhythmias can be prevented by managing stress, controlling **anxiety**, and avoiding caffeine, alcohol, decongestants, **cocaine**, and cigarettes.

## ORGANIZATIONS

American Heart Association National Center, 7272

Greenville Avenue, Dallas, TX, 75231, (800) 242-8721,  
Review. personal.info@heart.org.

National Heart Lung and Blood Institute Health

Information Center, P.O. Box 30105, Bethesda, MD,  
20824-0105, (301) 592-8573, (240) 629-3246, http://  
www.nhlbi.nih.gov.

Texas Heart Institute. Heart Information Service, MC

3-116, PO Box 20345, Houston, TX, 77225, (832)  
355-4011, (800) 292-2221, http://www.texasheart.org.

Lori De Milto

## Art therapy

### Definition

Art therapy, sometimes called creative arts therapy or expressive arts therapy, encourages people to express and understand emotions through artistic expression and through the creative process.

### Purpose

Art therapy provides the client-artist with critical insight into emotions, thoughts, and feelings. Key benefits of the art therapy process include:

- Self-discovery. At its most successful, art therapy triggers an emotional catharsis.
- Personal fulfillment. The creation of a tangible reward can build confidence and nurture feelings of self-worth. Personal fulfillment comes from both the creative and the analytical components of the artistic process.
- Empowerment. Art therapy can help people visually express emotions and fears that they cannot express through conventional means, and can give them some sense of control over these feelings.
- Relaxation and stress relief. Chronic stress can be harmful to both mind and body. Stress can weaken and damage the immune system, can cause insomnia



**A cancer patient applies papier-mâché to an intravenous drip stand during an art therapy session.** (Ronen Zvulun/Reuters/Landov.)

and depression, and can trigger circulatory problems (like high blood pressure and irregular heartbeats). When used alone or in combination with other relaxation techniques such as guided imagery, art therapy can effectively relieve stress.

- Symptom relief and physical rehabilitation. Art therapy can also help patients cope with pain. This therapy can promote physiological healing when patients identify and work through anger, resentment, and other emotional stressors. It is often prescribed to accompany pain control therapy for chronically and terminally ill patients.

## Description

### Origins

Humans have expressed themselves with symbols throughout history. Masks, ritual pottery, costumes, other objects used in rituals, cave drawings, Egyptian hieroglyphics, and Celtic art and symbols are all visual records of self-expression and communication through art. Art has also been associated with spiritual power, and artistic forms such as the Hindu and Buddhist mandala and Native American sand painting are considered powerful healing tools.

In the late nineteenth century, French psychiatrists Ambrose Tardieu and Paul-Max Simon both published studies on the similar characteristics of and symbolism in the artwork of the mentally ill. Tardieu and Simon viewed art therapy as an effective diagnostic tool to identify specific types of mental illness or traumatic events. Later, psychologists would use this diagnostic aspect to develop psychological drawing tests (the Draw-A-Man test, the Draw-A-Person Questionnaire [DAP.Q]) and projective personality

## KEY TERMS

**Catharsis**—Therapeutic discharge of emotional tension by recalling past events.

**Mandala**—A design, usually circular, that appears in religion and art. In Buddhism and Hinduism, the mandala has religious ritual purposes and serves as a yantra (a geometric emblem or instrument of contemplation).

**Organic illness**—A physically, biologically based illness.

tests involving visual symbol recognition (e.g., the Rorschach Inkblot Test, the **Thematic Apperception Test** [TAT], and the Holtzman Inkblot Test [HIT]).

The growing popularity of milieu therapies at psychiatric institutions in the twentieth century was an important factor in the development of art therapy in the United States. Milieu therapies (or environmental therapy) focus on putting the patient in a controlled therapeutic social setting that provides the patient with opportunities to gain self-confidence and interact with peers in a positive way. Activities that encourage self-discovery and empowerment such as art, music, dance, and writing are important components of this approach.

Educator and therapist Margaret Naumburg was a follower of both Freud and Jung, and incorporated art into **psychotherapy** as a means for her patients to visualize and recognize the unconscious. She founded the Walden School in 1915, where she used students' artworks in psychological counseling. She published extensively on the subject and taught seminars on the technique at New York University in the 1950s. Today, she is considered the founder of art therapy in the United States.

In the 1930s, Karl, William, and Charles Menninger introduced an art therapy program at their Kansas-based psychiatric hospital, the Menninger Clinic. The Menninger Clinic employed a number of artists in residence in the following years, and the facility was also considered a leader in the art therapy movement through the 1950s and 60s. Other noted art therapy pioneers who emerged in the 50s and 60s include Edith Kramer, Hanna Yaxa Kwiatkowska (National Institute of Mental Health), and Janie Rhyne.

Art therapy, sometimes called expressive art or art psychology, encourages self-discovery and emotional growth. It is a two part process, involving both the

creation of art and the discovery of its meaning. Rooted in Freud and Jung's theories of the subconscious and unconscious, art therapy is based on the assumption that visual symbols and images are the most accessible and natural form of communication to the human experience. Patients are encouraged to visualize, and then create, the thoughts and emotions that they cannot talk about. The resulting artwork is then reviewed and its meaning interpreted by the patient.

The "analysis" of the artwork produced in art therapy typically allows patients to gain some level of insight into their feelings and lets them to work through these issues in a constructive manner. Art therapy is typically practiced with individual, group, or family psychotherapy (talk therapy). While a therapist may provide critical guidance for these activities, a key feature of effective art therapy is that the patient/artist, not the therapist, directs the interpretation of the artwork.

Art therapy can be a particularly useful treatment tool for children, who frequently have limited language skills. By drawing or using other visual means to express troublesome feelings, younger patients can begin to address these issues, even if they cannot identify or label these emotions with words. Art therapy is also valuable for adolescents and adults who are unable or unwilling to talk about thoughts and feelings.

Beyond its use in mental health treatment, art therapy is also used with traditional medicine to treat organic diseases and conditions. The connection between mental and physical health is well documented, and art therapy can promote healing by relieving **stress** and allowing the patient to develop coping skills.

Art therapy has traditionally centered on visual mediums, like paintings, sculptures, and drawings. Some mental healthcare providers have now broadened the definition to include music, film, dance, writing, and other types of artistic expression.

Art therapy is often one part of a psychiatric inpatient or outpatient treatment program, and can take place in individual or **group therapy** sessions. Group art therapy sessions often take place in hospital, clinic, shelter, and community program settings. These group therapy sessions can have the added benefits of positive social interaction, empathy, and support from peers. The client-artist can learn that others have similar concerns and issues.

## Preparations

Before starting art therapy, the therapist may have an introductory session with the client-artist to discuss art therapy techniques and give the client the

opportunity to ask questions about the process. The client-artist's comfort with the artistic process is critical to successful art therapy.

The therapist ensures that appropriate materials and space are available for the client-artist, as well as an adequate amount of time for the session. If the individual artist is exploring art as therapy without the guidance of a trained therapist, adequate materials, space, and time are still important factors in a successful creative experience.

The supplies used in art therapy are limited only by the artist's (and/or therapist's) imagination. Some of the materials often used include paper, canvas, poster board, assorted paints, inks, markers, pencils, charcoal, chalks, fabrics, string, adhesives, clay, wood, glazes, wire, bendable metals, and natural items (like shells, leaves, etc.). Providing artists with a variety of materials in assorted colors and textures can enhance their interest in the process and may result in a richer, more diverse exploration of their emotions in the resulting artwork. Appropriate tools such as scissors, brushes, erasers, easels, supply trays, glue guns, smocks or aprons, and cleaning materials are also essential.

An appropriate workspace should be available for the creation of art. Ideally, this should be a bright, quiet, comfortable place, with large tables, counters, or other suitable surfaces. The space can be as simple as a kitchen or office table, or as fancy as a specialized artist's studio.

The artist should have adequate time to become comfortable with and explore the creative process. This is especially true for people who do not consider themselves "artists" and may be uncomfortable with the concept. If performed in a therapy group or one-on-one session, the art therapist should be available to answer general questions about materials and/or the creative process. However, the therapist should be careful not to influence the creation or interpretation of the work.

## Precautions

Art materials and techniques should match the age and ability of the client. People with impairments, such as traumatic brain injury or an organic neurological condition, may have difficulties with the self-discovery portion of the art therapy process depending on their level of functioning. However, they may still benefit from art therapy through the sensory stimulation it provides and the pleasure they get from artistic creation.

While art is accessible to all (with or without a therapist to guide the process), it may be difficult to tap the full potential of the interpretive part of art

therapy without a therapist to guide the process. When art therapy is chosen as a therapeutic tool to cope with a physical condition, it should be treated as a supplemental therapy and not as a substitute for conventional medical treatments.

### Research and general acceptance

A wide body of literature supports the use of art therapy in a mental health capacity. And as the mind-body connection between psychological well-being and physical health is further documented by studies in the field, art therapy gains greater acceptance by mainstream medicine as a therapeutic technique for organic illness.

### Resources

#### BOOKS

Soneff, Sharon. *Art Journals and Creative Healing: Restoring the Spirit Through Self-Expression*. Minneapolis, MN: Quarry Books, 2008.

#### ORGANIZATIONS

American Art Therapy Association, 225 N. Fairfax St., Alexandria, VA, 22314, (703) 548-5860, (703) 783-8468, (888) 290-0878, info@arttherapy.org, <http://www.arttherapy.org>.

Paula Anne Ford-Martin

Arterial blood gas analysis see **Blood gas analysis**

## Arterial embolism

### Definition

An embolus is a blood clot, bit of tissue or tumor, gas bubble, or other foreign body that circulates in the blood stream until it becomes stuck in a blood vessel.

### Description

When a blood clot develops in an artery and remains in place, it is called a thrombosis. If all or part of the blockage breaks away and lodges in another part of the artery, it is called an **embolism**. Blockage of an artery in this manner can be the result of a blood clot, fat cells, or an air bubble.

When an embolus blocks the flow of blood in an artery, the tissues beyond the plug are deprived of normal blood flow and oxygen. This can cause severe damage and even death of the tissues involved.

## KEY TERMS

**Atrial fibrillation**—An arrhythmia; chaotic quivering of the arteries.

**Thrombosis**—A blockage in a blood vessel that builds and remains in one place.

Embololi can affect any part of the body. The most common sites are the legs and feet. When the brain is affected, it is called a **stroke**. When the heart is involved, it is called a **heart attack** or myocardial infarction (MI).

### Causes and symptoms

A common cause of embolus is when an artery whose lining has become thickened or damaged, usually with age, allows cholesterol to build up more easily than normal on the artery wall. If some of the cholesterol breaks off, it forms an embolus. Emboli also commonly form from **blood clots** in a heart that has been damaged from heart attack or when the heart contracts abnormally from **atrial fibrillation**.

Other known causes are fat cells that enter the blood after a major bone fracture, infected blood cells, **cancer** cells that enter the blood stream, and small gas bubbles.

Symptoms of an embolus can begin suddenly or build slowly over time, depending on the amount of blocked blood flow.

If the embolus is in an arm or leg, there will be muscle **pain**, **numbness** or **tingling**, pale skin color, lower temperature in the limb, and weakness or loss of muscle function. If it occurs in an internal organ, there is usually pain and/or loss of the organ's function.

### Diagnosis

The following tests can be used to confirm the presence of an arterial embolism:

- **Electrocardiogram**, also known as an EKG or ECG. For this test, patches that detect electrical impulses from the heart are attached to the chest and extremities. The information is displayed on a monitor screen or a paper tape in the form of waves. Reduced blood and oxygen supply to the heart shows as a change in the shape of the waves.
- **Noninvasive vascular tests**. These involve measuring blood pressure in various parts of the body and comparing the results from each location. When there is a decrease in blood pressure beyond what is

normal between two points, a blockage is presumed to be present.

- **Angiography.** In this procedure, a colored liquid material (a dye, or contrast material) that can be seen with x rays is injected into the blood stream through a small tube called a catheter. As the dye fills the arteries, they are easily seen on x-ray motion pictures. If there is a blockage in the artery, it shows up as a sudden cut off in the movement of contrast material. Angiography is an expensive procedure and does carry some risk. The catheter may cause a blood clot to form, blocking blood flow. There is also the risk of poking the catheter through the artery or heart muscle. Some people may be allergic to the dye. The risk of any of these injuries occurring is small.

### Treatment

Arterial embolism can be treated with medication or surgery, depending on the extent and location of the blockage.

Medication to dissolve the clot is usually given through a catheter directly into the affected artery. If the embolus was caused by a blood clot, medications that thin the blood will help reduce the risk of another embolism.

A surgeon can remove an embolus by making an incision in the artery above the blockage and, using a catheter inserted past the embolus, drag it out through the incision.

If the condition is severe, a surgeon may elect to bypass the blocked vessel by grafting a new vessel in its place.

### Prognosis

An arterial embolism is serious and should be treated promptly to avoid permanent damage to the affected area. The outcome of any treatment depends on the location and seriousness of the embolism. New arterial emboli can form even after successful treatment of the first event.

### Prevention

Prevention may include diet changes to reduce cholesterol levels, medications to thin the blood, and practicing an active, healthy lifestyle.

### ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Dorothy Elinor Stonely

Arteriogram see **Angiography**

Arteriography see **Angiography**

Arteriosclerosis see **Atherosclerosis**

## Arteriovenous fistula

### Definition

An arteriovenous **fistula** (AV fistula) is an abnormal connection between a vein and an artery. The connection can be congenital (present at birth). Occasionally the connection can develop because of trauma such as a knife or bullet wound. Most often, the AV fistula is created surgically to allow access to the vascular system for hemodialysis. When created surgically, the connection of a vein and an artery is usually done in the forearm. The fistula develops over a period of months after the surgery.

### Purpose

Hemodialysis is the process of mechanically cleansing the blood when the kidneys have failed. The surgical creation of an AV fistula provides a long-lasting site through which blood can be removed and returned during hemodialysis. The fistula, which allows the person to be connected to a dialysis machine, must be prepared by a surgeon weeks or months before dialysis is started. When the vein and artery are joined, blood flow increases and the vein gradually becomes larger and stronger, creating a site that provides vascular access years longer than other types of access and with fewer complications. AV fistulas are for people who will need dialysis for long periods—either until a kidney becomes available for transplantation or for the rest of their life. Short-term access to the vascular system for dialysis can be had by the insertion of a venous catheter.

### Demographics

According to the National Kidney Foundation, at the end of 2008, 485,000 people were being treated for kidney failure or end-stage renal (kidney) disease. They are of varying ages and backgrounds and typically suffer from another condition or disease that has led to kidney shutdown, and most (about 341,000 annually) will require dialysis. Among dialysis patients, over half will have an AV fistula as vascular access. In the United States, kidney failure is disproportionately high among minority populations with

## KEY TERMS

**Access**—The point where a needle or catheter is inserted for dialysis.

**Acute renal (kidney) failure**—Abrupt loss of kidney function, possibly temporary.

**Artery**—Blood vessel that carries blood away from the heart to the body.

**Chronic renal (kidney) failure**—Progressive loss of kidney function over several years that can result in permanent kidney failure requiring dialysis.

**Electrolyte**—Ions in the body that participate in metabolic reactions. The major human electrolytes are sodium ( $\text{Na}^+$ ), potassium ( $\text{K}^+$ ), calcium ( $\text{Ca}^{2+}$ ), magnesium ( $\text{Mg}^{2+}$ ), chloride ( $\text{Cl}^-$ ), phosphate ( $\text{HPO}_4^{2-}$ ), bicarbonate ( $\text{HCO}_3^-$ ), and sulfate ( $\text{SO}_4^{2-}$ ).

**Hypertension**—High blood pressure.

the highest rate being found among African Americans, Hispanic Americans, and Native Americans.

### Description

The kidneys are paired organs in the mid-abdomen, one on each side of the lower back. Their function is to clean the blood of wastes and to regulate fluid and electrolyte balance in the body. Dialysis performs these functions in place of the failing kidneys. Dialysis cannot restore kidney function, but it can prolong life, often for years, by preventing the build-up of waste products in the body.

**Acute kidney failure** usually happens in circumstances where an extra burden is placed on the renal system. For example, acute kidney failure can occur in advanced **liver disease**, rapidly progressing terminal illnesses such as **cancer** and certain severe **anemias**, after severe allergic reactions, as a reaction to drugs or poisons, in heart and lung diseases, during the formation of **blood clots (embolism)**, and following heart bypass surgery. Diabetes and vascular diseases, especially those with **hypertension**, are the two most common underlying diseases contributing to **chronic kidney failure**.

Many advances in the treatment of kidney failure have been made since the first attempts at dialysis treatments in the 1920s. At one time, dialysis was thought of only as a way to keep people alive until kidney function could be restored. Often the treatment for kidney failure had to be discontinued within

several days because patients' veins could not endure the trauma that occurred with frequent withdrawing and replacing of blood. The first breakthrough came in 1960 with the introduction of an implantable Teflon tube, called a shunt, that became the first effective vascular access device. Since then, the development of the AV fistula has marked another important advance, allowing effective treatment for longer periods.

### Hemodialysis

Dialysis is performed as critical **life support** when a person experiences acute or chronic kidney failure. It is a mechanical way to cleanse the blood and balance body fluids when the kidneys are not able to perform these essential functions. Kidney failure can, in some cases, be reversible, and dialysis can provide temporary support until renal function is restored. Dialysis may also be used in irreversible or chronic kidney shutdown when transplantation is the medical goal and the patient is waiting for a donated kidney. Some critically ill patients with life-threatening illnesses such as cancer or severe heart disease are not candidates for transplantation and dialysis for them is the only option for treating permanent kidney failure, also called end-stage renal disease (ESRD).

There are two types of dialysis, hemodialysis and peritoneal dialysis. In hemodialysis, the blood circulates through a machine outside the body and is filtered as it circulates. In peritoneal dialysis, the blood is filtered through a membrane that has been placed in the abdomen. Blood remains in the body and waste material is filtered into an exchange fluid through an opening in the abdomen called a port. Only hemodialysis requires an AV fistula or other vascular access.

Hemodialysis circulates blood through a dialysis machine that contains a filter membrane. The blood is slowly pumped out of the body and into the machine for cleansing. After being filtered, the blood is returned to the body through the same vascular access. About one cup (235 mL) of blood is outside the body at any given moment during the continuous circulation process.

Hemodialysis is usually done three times a week, taking between three and five hours each time. Health-care professionals perform the procedure either at independent dialysis centers or in hospitals or medical centers. Dialysis patients must go to the hemodialysis center where they will sit to receive the treatment. Although they cannot walk around, they can watch television, read, or talk to other patients. Dialysis centers offer patient education, including videos and

brochures that describe treatment options and self-care. Patients can also receive advice and information about paying for this ongoing treatment through nationally sponsored programs that are available especially for those who need long-term dialysis. Often the dialysis center offers emotional support as well, letting people meet and talk with others who have kidney problems. Some people prefer to perform their own dialysis by having a home dialysis machine. This requires that the dialysis patient and another person, usually a family member, take a three- to six-week training program to learn how to do the treatment.

### Vascular access

An access or entry to the vascular system is needed to perform the blood-cleansing role of the kidneys through hemodialysis. There are three types of vascular access: AV fistula, grafts, and catheters.

**ARTERIOVENOUS FISTULA.** An AV fistula has proven to be the best kind of vascular access for people whose veins are large enough, not only because it lasts longer, but also because it is less likely than other types of access to form clots or become infected. If the veins are not large enough or there is no time to wait for a fistula to develop, a graft or a catheter must be used.

**GRAFT.** Grafts are often the access of choice when a hemodialysis patient has small veins that will not likely develop properly into a fistula. This type of access uses a synthetic tube implanted under the skin of the arm that can be used repeatedly for needle placement. Unlike a fistula, which requires time to develop, a graft can be used as soon as two to three weeks after placement. Grafts are known to have more problems than fistulas, such as clots and infection, and will likely need replacement sooner.

**CATHETER** A catheter is used to provide temporary vascular access. When **kidney disease** has progressed quickly, there may not be time to prepare a permanent vascular access site before dialysis treatments are started. The catheter is a tube that is inserted into a vein in the neck, chest, or in the leg near the groin. Two chambers in the tube allow blood to flow in and out. Once the catheter is in place, needle insertion is not necessary. Catheters are effective for dialysis for several weeks or months while surgery is performed and an AV fistula develops. They are not selected for permanent access because they can clog, become infected, or cause the veins to narrow. Long-term catheter access must be used in patients for whom AV fistula or graft surgery has not been successful. If more than three weeks' use is expected, catheters can

be made to tunnel under the skin, which increases comfort and reduces complications

### Diagnosis/Preparation

#### Diagnosis

The diagnosis of kidney disease and its progression to kidney failure is typically made by a nephrologist, a specialist in kidney structure and function. The nephrologist will determine whether the patient has acute or chronic kidney failure and if dialysis is appropriate for the patient. If dialysis is recommended, the nephrologist will determine if an AV fistula is the ideal vascular access for the patient. To make these determinations, the nephrologist will need to evaluate the patient's general health, especially the presence of any underlying disease. Kidney function must be evaluated and determined to be seriously impaired before dialysis is recommended. It is typically started when kidney function is down to about 10% of its normal level. Among other tests that will be performed, such as **urinalysis** with microscopic examination of the urine, several blood and urine tests can be used to measure a person's kidney function when chronic or acute kidney failure is suspected. Some of the tests measure electrolytes and other metabolites produced by the body that are normally excreted by the kidneys and passed through urine. The tests can measure effectively if the kidney is filtering out these materials, and how much remains in the blood. These tests include, but are not limited to:

- serum creatinine—found in higher levels in the blood if kidneys fail;
- urinary creatinine—readings are lower in kidney failure;
- urinary output—measuring both fluid intake and all urine produced;
- urinary osmolality—measures the concentration of the urine, an indicator of kidney filtering ability;
- blood urea nitrogen (BUN)—harmful nitrogen waste increases in the blood as kidney function decreases; and
- electrolytes in blood and urine—ions in the blood such as sodium, potassium, magnesium, and chloride are often out of balance when kidneys fail. Potassium, for example, increases in the blood during kidney failure and can cause heart irregularities.

### Description

Surgery to create an AV fistula is usually done using a local anesthetic that is injected into the forearm at the site of the proposed fistula. The procedure

is performed in a hospital or at an outpatient surgery if the patient is not already hospitalized and has no serious underlying disease.

After cleaning and sterilizing the site, the surgeon makes a small incision in the forearm sufficient to allow the permanent uniting of a vein and an artery. The blood vessels will be appropriately blocked to stop blood flow while incisions are made to join them. Silk sutures, just as those used in other types of surgical incisions, are used to close incised areas as needed after the vein and artery have been joined. Once joined, blood flow increases. The vein will become thicker, and over a period of months the connection will become strong and develop into the fistula that will allow permanent vascular access.

### Aftercare

The hemodialysis patient should expect needle insertion in the AV fistula at every dialysis session. Patients who prefer to insert their own needles or who perform dialysis at home will need training, and all patients have to learn how to avoid infection and to protect the vascular access. Because vascular access problems can lead to treatment failure, the AV fistula requires regular care to make dialysis easier and to help avoid clots, infection, and other complications.

Patients can help protect the access by:

- making sure the access is checked before each treatment;
- not allowing blood pressure to be taken on the access arm;
- checking the pulse in the access every day;
- keeping the access clean at all times;
- using the access site only for dialysis;
- taking care not to bump or cut the access;
- avoiding wearing tight jewelry or clothing near or over the access site;
- avoiding lifting heavy objects or putting pressure on the access arm; and
- sleeping with the access arm free, not under the head or body.

### Risks

The most frequent complications in hemodialysis relate to the vascular access site where needles are inserted. Complications include infection around the access area and formation of clots in the fistula. Usually, because they are in the fistula itself, these clots are not life threatening. The greatest danger is that clots may block the fistula and have to be removed

surgically. Frequent clotting may require creating a back-up fistula at another site, to allow dialysis when one access is blocked.

Other complications from dialysis are not directly related to the vascular access. For example, when the kidneys have shut down, they produce very little urine. Because dialysis is the only way people with kidney failure can balance fluid levels in their bodies, hemodialysis can cause bloating and fluid overload, indicating that too much fluid remains in the body. If fluid overload occurs, patients develop swollen ankles, puffy eyes, weight gain, and **shortness of breath**. Fluid overload can cause heart and circulatory problems and fluctuations in blood pressure. Medications may be prescribed and changes in fluid intake or diet may be made to help balance fluids safely in conjunction with dialysis.

Other problems that can occur during or after hemodialysis include:

- low blood pressure when fluid and wastes are removed from the blood too quickly;
- nausea due to changes in blood pressure;
- muscle cramps from the removal of too much fluid from the blood;
- headaches near the end of a dialysis session resulting from changes in the concentration of fluid and waste in the blood; or
- fatigue after treatment, lasting sometimes into the next day.

### Normal results

An AV fistula can usually be created and can function well with no adverse affects in a person whose veins are large enough. The amount of time it takes to develop the fistula after surgery (usually months) depends upon the size and strength of the patient's blood vessels and on the person's health and nutritional status. When the fistula develops, the thickened vein that has been joined to an artery can be seen in the arm and a pulse can be felt in it. The early development of an AV fistula as access for long-term dialysis has been shown to improve the survival of patients with chronic renal failure and to reduce the chances of being hospitalized with complications. It also gives patients a better opportunity to choose self-dialysis as their treatment.

With good **nutrition** and a fully functioning AV fistula, dialysis patients can be relatively comfortable and free of complications. People may become tired and uncomfortable when it is close to the time for their next dialysis session. This is to be expected because

wastes are building up in the blood, and the body senses that it is time to remove them.

## Morbidity and mortality rates

Earlier use of dialysis, especially with AV fistula access, has been shown to increase survival in patients with renal failure. The AV fistula is designed to improve the effectiveness of dialysis and is reported to present fewer risks and complications, reduced incidence of clotting and infection, and longer use than other types of vascular access.

Kidney failure is reported to account for 1% of hospital admissions in the United States. It occurs in 2–5% of patients hospitalized for other conditions, surgeries, or diseases. In patients undergoing cardiac bypass surgery, 15% are reported to require dialysis for kidney failure. Overall, deaths in people undergoing dialysis are reported to be about 50% because of the multi-organ dysfunction that has influenced kidney failure.

## Resources

### BOOKS

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*Dialysis without Fear: A Guide to Living Well on Dialysis for Patients and Their Families.* New York: Oxford University Press, 2007.

### OTHER

“Treatment Methods for Kidney Failure: Hemodialysis.”

*National Kidney and Urologic Diseases Information Clearinghouse.* December 2006 (accessed June 20, 2010).

“Vascular Access for Hemodialysis.” *National Kidney and Urologic Diseases Information Clearinghouse.* February 2008. <http://kidney.niddk.nih.gov/kudiseases/pubs/vascular> (accessed June 20, 2010).

“Vascular Access for Hemodialysis.” *Texas Heart Institute.* July 2007. [http://www.texasheartinstitute.org/HIC/Topics/Proced/vascular\\_access\\_surgery.cfm](http://www.texasheartinstitute.org/HIC/Topics/Proced/vascular_access_surgery.cfm) (accessed June 20, 2010).

### ORGANIZATIONS

National Kidney and Urologic Diseases, 3 Information Way, Bethesda, MD, 20892-3580 (800) 891-5390, <http://kidney.niddk.nih.gov>.

National Kidney Foundation, 30 East 33rd Street, New York, NY, 10016 (800) 622-9010, <http://www.kidney.org>.

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## Arteriovenous malformations

### Definition

Arteriovenous malformations are blood vessel defects that occur before birth when the fetus is growing in the uterus (prenatal development). The blood vessels appear as a tangled mass of arteries and veins. They do not possess the capillary (very fine blood vessels) bed which normally exists in the common area where the arteries and veins lie in close proximity (artery-vein interface). An arteriovenous malformation (AVM) may hemorrhage, or bleed, leading to serious complications that can be life-threatening.

### Description

AVMs represent an abnormal interface between arteries and veins. Normally, arteries carry oxygenated blood to the body's tissues through progressively smaller blood vessels. The smallest are capillaries, which form a web of blood vessels (the capillary bed) through the body's tissues. The arterial blood moves through tissues by these tiny pathways, exchanging its load of oxygen and nutrients for carbon dioxide and other waste products produced by the body cells (cellular wastes). The blood is carried away by progressively larger blood vessels, the veins. AVMs lack a capillary bed and arterial blood is moved (shunted) directly from the arteries into the veins.

AVMs can occur anywhere in the body and have been found in the arms, hands, legs, feet, lungs, heart, liver, and kidneys. However, 50% of these malformations are located in the brain, brainstem, and spinal cord. Owing to the possibility of hemorrhaging, such



**Arteriovenous malformations.** (Custom Medical Stock Photo, Inc. Reproduced by permission.)

## KEY TERMS

**Aneurysm**—A weak point in a blood vessel where the pressure of the blood causes the vessel wall to bulge outwards.

**Angiography**—A mapping of the brain's blood vessels, using x-ray imaging.

**Capillary bed**—A dense network of tiny blood vessels that enables blood to fill a tissue or organ.

**Hydrocephalus**—Swelling of the brain caused by an accumulation of fluid.

**Lumbar puncture**—A diagnostic procedure in which a needle is inserted into the lower spine to withdraw a small amount of cerebrospinal fluid. This fluid is examined to assess trauma to the brain.

**Saccular aneurysm**—A type of aneurysm that resembles a small sack of blood attached to the outer surface of a blood vessel by a thin neck.

AVMs carry the risk of **stroke**, **paralysis**, and the loss of speech, memory, or vision. An AVM that hemorrhages can be fatal.

Approximately three of every 100,000 people have a cerebral AVM and roughly 40-80% of them will experience some bleeding from the abnormal blood vessels at some point. The annual risk of an AVM bleeding is estimated at about 1-4%. After age 55, the risk of bleeding decreases. Pre-existing high blood pressure or intense physical activity do not seem to be associated with AVM hemorrhage, but **pregnancy** and labor could cause a rupture or breaking open of a blood vessel. An AVM hemorrhage is not as dangerous as an aneurysmal rupture. (An aneurysm is a swollen, blood filled vessel where the pressure of the blood causes the wall to bulge outward.) There is an approximate 10% fatality rate associated with AVM hemorrhage, compared to a 50% fatality rate for ruptured aneurysms.

Although AVMs are congenital defects, meaning a person is born with them, they are rarely discovered before age 20. A genetic link has been proposed for some AVMs, but studies are only suggestive, not positive. The majority of AVMs are discovered in people age 20-40. Medical researchers estimate that the malformations are created during days 45-60 of fetal development. A second theory suggests that AVMs are primitive structures that are left over from the

period when fetal blood circulating systems began to develop.

However they form, AVMs have blood vessels that are abnormally fragile. The arteries that feed into the malformation are unusually swollen and thin walled. They lack the usual amount of smooth muscle tissue and elastin, a fibrous connective tissue. These blood vessels commonly accumulate deposits of calcium salts and hyalin. The venous part of the malformation receives blood directly from the artery. Without the intervening capillary bed, the veins receive blood at a higher pressure than they were designed to handle. This part of the malformation is also swollen (dilated) and thin walled. There is a measurable risk of an aneurysm forming near an AVM, increasing the threat of hemorrhage, brain damage, and **death**. Approximately 10-15% of AVMs are accompanied by saccular aneurysms, a type of aneurysm that looks like a small sac attached to the outer wall of the blood vessel.

Although the malformation itself lacks capillaries, there is often an abnormal proliferation of capillaries next to the defect. These blood vessels feed into the malformation, causing it to grow larger in some cases. As the AVM receives more blood through this "steal," adjacent brain tissue does not receive enough. These areas show abnormal nerve cell growth, cell death, and deposits of calcium in that area (calcification). Nerve cells within the malformation may demonstrate abnormal growth and are believed to be nonfunctional.

### Causes and symptoms

Most people do not realize that they have an AVM unless it hemorrhages enough to produce symptoms. Small AVMs are more likely to hemorrhage. If a hemorrhage occurs, it produces a sudden, severe **headache**. The headache may be focused in one specific area or it may be more general. It can be mistaken for a migraine in some cases. The headache is accompanied by other symptoms, such as **vomiting**, a stiff neck, sleepiness, lethargy, confusion, irritability, or weakness anywhere in the body. Seizures occur in about a quarter of AVM cases. A person may experience decreased, double, or blurred vision. Hemorrhaging from an AVM is generally less dangerous than hemorrhaging from an aneurysm, with a survival rate of 80-90%.

Other symptoms occur less frequently, but sometimes appear alongside major symptoms such as the sudden severe headache. Additional warning signs of a bleeding AVM are impaired speech or smell, **fainting**,

facial paralysis, a drooping eyelid, **dizziness**, and ringing or buzzing in the ears.

Although large AVMs are less likely to hemorrhage, they can induce symptoms based on their mass alone. Large AVMs exert pressure against brain tissue, cause abnormal development in the surrounding brain tissue, and slow down or block blood flow. **Hydrocephalus**, a swelling of brain tissue caused by accumulated fluids, may develop. The warning signs associated with a large non-bleeding AVM are similar to the symptoms of a small malformation that is bleeding. Unexplained headaches, seizures, dizziness, and neurological symptoms, such as sensory changes, are signals that demand medical attention.

## Diagnosis

Based on the clinical symptoms such as severe headache and neurological problems, and after a complete neurologic exam, a computed tomography scan (CT) of the head will be done. In some cases, a whooshing sound from arteries in the neck or over the eye or jaw (called a bruit), can be heard with a stethoscope. The CT scan will reveal whether there has been bleeding in the brain and can identify AVMs larger than 1 inch (2.5 cm). **Magnetic resonance imaging** (MRI) is also used to identify an AVM. A **lumbar puncture**, or spinal tap, may follow the MRI or CT scan. A lumbar puncture involves removing a small amount of cerebrospinal fluid from the lower part of the spine. Blood cells or blood breakdown products in the cerebrospinal fluid indicate bleeding.

To pinpoint where the blood is coming from, a cerebral **angiography** is done. This procedure uses x rays to map out the blood vessels in the brain, including the vessels that feed into the malformation. The information gained from angiography complements the MRI and helps distinguish the precise location of the AVM.

## Treatment

Neurosurgeons consider several factors before deciding on a treatment option. There is some debate over whether or not to treat AVMs that have not ruptured and are not causing any symptoms. The risks and benefits of proceeding with treatment need to be measured on an individual basis, taking into account factors such as the person's age and general health, as well as the AVM's size and location. Several treatment options are available, both for symptomatic or asymptomatic AVMs. These treatment options may be used alone or in combination.

## Surgery

Removing the AVM is the surest way of preventing it from causing future problems. Both small and large AVMs can be handled in surgery. Surgery is recommended for superficial AVMs, but may be too dangerous for deep or very large AVMs. Unless it is an emergency situation, an AVM that has hemorrhaged is treated conservatively for several weeks. Conservative treatment consists of managing the immediate symptoms and allowing the patient's condition to stabilize. Surgery requires **general anesthesia** and a longer period of recuperation than any other treatment option.

## Radiation

Radiation is particularly useful to treat small (under 1 in.) malformations that are deep within the brain. Ionizing radiation is directed at the malformation, destroying the AVM without damaging the surrounding tissue. Radiation treatment is accomplished in a single session and it is not necessary to open the skull. However, success can only be measured over the course of the following two years. A year after the procedure, 50-75% of treated AVMs are completely blocked; two years after radiation treatment, the percentage increases to 85-95%.

## Embolization

Embolization involves plugging up access to the malformation. This technique does not require opening the skull to expose the brain and can be used to treat deep AVMs. Using x-ray images as a guide, a catheter is threaded through the artery in the thigh (femoral artery) to the affected area. The patient remains awake during the procedure and medications can be administered to prevent discomfort. The blood vessel leading into the AVM is assessed for its importance to the rest of the brain before a balloon or other blocking agent is inserted via the catheter. The block chokes off the blood supply to the malformation. There may be a mild headache or **nausea** associated with the procedure, but patients may resume normal activities after leaving the hospital. At least two to three embolization procedures are usually necessary at intervals of two to six weeks. At least a three-day hospital stay is associated with each embolization.

## Prognosis

Approximately 10% of AVM cases are fatal. Seizures and neurological changes may be permanent in another 10-30% cases of AVM rupture. If an AVM bleeds once, it is about 20% likely to bleed again in the

next year. As time passes from the initial hemorrhage, the risk for further bleeding drops to about 3-4%. If the AVM has not bled, it is possible, but not guaranteed, that it never will. Untreated AVMs can grow larger over time and rarely go away by themselves. Once an AVM is removed and a person has recovered from the procedure, there should be no further symptoms associated with that malformation.

#### ORGANIZATIONS

American Chronic Pain Association, PO Box 850, Rocklin, CA, 95677, (916) 632-3208, (800) 533-3231, APA  
[@pacbell.net](http://pacbell.net), <http://www.theacpa.org>.

Americna Pain Society, 4700 W. Lake Ave., Glenview, IL, 60025, (847) 375-4715, (866) 574-2654, [info@ampainsoc.org](mailto:info@ampainsoc.org).  
<http://www.ampainsoc.org>.

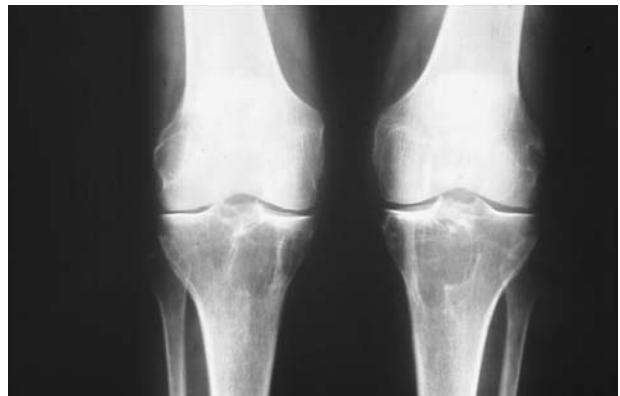
AVM Survivors Network, <http://www.avmsurvivors.org/>.

Julia Barrett

Arthritis see **Juvenile arthritis;**  
**Osteoarthritis; Psoriatic arthritis;**  
**Rheumatoid arthritis**

Arthrocentesis see **Joint fluid analysis**

Arthrogram see **Arthrography**



An x-ray image of the knees of a patient with cysts caused by rheumatoid arthritis. The cysts appear as dark areas just below the knee joints. (Custom Medical Stock Photo, Inc. Reproduced by permission.)

#### Precautions

Patients who are pregnant or may be pregnant should not have this procedure unless the benefits of the findings outweigh the risk of radiation exposure. Patients who are known to be allergic to iodine need to discuss this complication with their physician. Patients who have a known allergy to shellfish are more likely to be allergic to iodine contrast.

#### Description

Arthrography may be referred to as “joint radiography” or “x rays of the joint.” The term arthrogram may be used interchangeably with arthrography. The joint area will be cleaned and a local anesthetic will be injected into the tissues around the joint to reduce pain. Next, if fluids are present in the joint, the physician may suction them out (aspirate) with a needle. These fluids may be sent to a laboratory for further study. Contrast agents are then injected into the joint through the same location by attaching the aspirating needle to a syringe containing the contrast medium. The purpose of contrast agents in x-ray procedures is to help highlight details of areas under study by making them opaque. Agents for arthrography are generally air and water-soluble dyes, the most common containing iodine. Air and iodine may be used together or independently. After the contrast agent is administered, the site of injection will be sealed and the patient may be asked to move the joint around to distribute the contrast.

Before the contrast medium can be absorbed by the joint itself, several films will be quickly taken under the guidance of the fluoroscope. The patient will be asked to move the joint into a series of positions,

## Arthrography

### Definition

Arthrography is a procedure involving multiple x rays of a joint using a fluoroscope, or a special piece of x-ray equipment, which shows an immediate x-ray image. A contrast medium (in this case, a an iodine solution) injected into the joint area helps highlight structures of the joint.

### Purpose

Frequently, arthrography is ordered to determine the cause of unexplained joint **pain**. This fluoroscopic procedure can show the internal workings of specific joints and outline soft tissue structures. The procedure may also be conducted to identify problems with the ligaments, cartilage, tendons, or the joint capsule of the hip, shoulder, knee, ankle or wrist. An arthrography procedure may locate cysts in the joint area, evaluate problems with the joint's arrangement and function, or indicate the need for **joint replacement** (prostheses). The most commonly studied joints are the knee and shoulder.

## KEY TERMS

**Aspirate**—Remove fluids by suction, often through a needle.

**Contrast (agent, medium)**—A substance injected into the body that illuminates certain structures that would otherwise be hard to see on the radiograph (film).

**Fluoroscope**—A device used in some radiology procedures that provides immediate images and motion on a screen much like those seen at airport baggage security stations.

**Radiologist**—A medical doctor specially trained in radiology (x ray) interpretation and its use in the diagnosis of diseases and injuries.

**X ray**—A form of electromagnetic radiation with shorter wavelengths than normal light. X rays can penetrate most structures.

keeping still between positioning. Sometimes, the patient will experience some **tingling** or discomfort during the procedure, which is normal and due to the contrast. Following fluoroscopic tracking of the contrast, standard x rays of the area may also be taken. The entire procedure will last about one hour.

### Preparation

It is important to discuss any known sensitivity to local anesthetics or iodine prior to this procedure. A physician should explain the procedure and the risks associated with contrast agents and ask the patient to sign an informed consent. If iodine contrast will be administered, the patient may be instructed not to eat before the exam. The timeframe of **fasting** may extend from only 90 minutes prior to the exam up to the night before. There is no other preparation necessary.

### Aftercare

The affected joint should be rested for approximately 12 hours following the procedure. The joint may be wrapped in an elastic bandage and the patient should receive instructions on the care and changing of the bandage. Noises in the joint such as cracking or clicking are normal for a few days following arthrography. These noises are the result of liquid in the joints. Swelling may also occur and can be treated with application of ice or cold packs. A mild pain reliever can be used to lessen pain in the first few days. However, if any of these symptoms persist for

more than a few days, patients are advised to contact their physician.

### Risks

In some patients iodine can cause allergic reactions, ranging from mild **nausea** to severe cardiovascular or nervous system complications. Since the contrast dye is put into a joint, rather than into a vein, allergic reactions are rare. Facilities licensed to perform contrast exams should meet requirements for equipment, supplies and staff training to handle a possible severe reaction. Infection or joint damage are possible, although not frequent, complications of arthrography.

### Normal results

A normal arthrography exam will show proper placement of the dye or contrast medium throughout the joint structures, joint space, cartilage and ligaments.

### Abnormal results

The abnormal placement of dye may indicate **rheumatoid arthritis**, cysts, joint dislocation, rupture of the rotator cuff, tears in the ligament and other conditions. The entire lining of the joint becomes opaque from the technique, which allows the radiologist to see abnormalities in the intricate workings of the joint. In the case of recurrent shoulder **dislocations**, arthrography results can be used to evaluate damage. Patients with hip prostheses may receive arthrography to evaluate proper placement or function of their prostheses.

### ORGANIZATIONS

American College of Radiology, 1891 Preston White Drive, Reston, VA, 20191, (703) 648-8900, (800) 227-5463, [info@acr.org](mailto:info@acr.org), <http://www.acr.org>.

Arthritis Foundation, P.O. Box 7669, Atlanta, GA, 30357-0669, (404) 872-7100, <http://www.arthritis.org>.

Teresa G. Odle

## Arthroplasty

### Definition

Arthroplasty is surgery to relieve **pain** and restore range of motion by realigning or reconstructing a joint.

## KEY TERMS

**Fascia**—Thin connective tissue covering or separating the muscles and internal organs of the body.

**Rheumatoid arthritis**—A joint disease of unknown origins that may begin at an early age, causing deformity and loss of function in the joints.

### Purpose

The goal of arthroplasty is to restore the function of a stiffened joint and relieve pain. Two types of arthroplastic surgery exist. Joint resection involves removing a portion of the bone from a stiffened joint, creating a gap between the bone and the socket, to improve the range of motion. Scar tissue eventually fills the gap. Pain is relieved and motion is restored, but the joint is less stable.

Interpositional reconstruction is surgery to reshape the joint and add a prosthetic disk between the two bones forming the joint. The prosthesis can be made of plastic and metal or from body tissue such as fascia and skin. When interpositional reconstruction fails, total **joint replacement** may be necessary. Joint replacement is also called total joint arthroplasty.

In recent years, joint replacement has become the operation of choice for most knee and hip problems. Elbow, shoulder, ankle, and finger joints are more likely to be treated with joint resection or interpositional reconstruction.

Arthroplasty is performed on people suffering from severe pain and disabling joint stiffness that result from **osteoarthritis** or **rheumatoid arthritis**. Joint resection, rather than joint replacement, is more likely to be performed on people with rheumatoid arthritis, especially when the elbow joint is involved. Total joint replacement is usually reserved for people over the age of 60.

### Precautions

If both the bone and socket of a joint are damaged, joint replacement is usually the preferred treatment.

### Description

Arthroplasty is performed under general or regional anesthesia in a hospital, by an orthopedic surgeon. Certain medical centers specialize in joint

surgery and tend to have higher success rates than less specialized centers.

In joint resection, the surgeon makes an incision at the joint, then carefully removes minimum amount of bone necessary to allow free motion. The more bone that remains, the more stable the joint. Ligament attachments are preserved as much as possible. In interpositional reconstruction, both bones of the joint are reshaped, and a disk of material is placed between the bones to prevent their rubbing together. Length of hospital stay depends on which joint is treated, but is normally only a few days.

### Preparation

Prior to arthroplasty, all the standard preoperative blood and urine tests are performed. The patient meets with the anesthesiologist to discuss any special conditions that affect the administration of anesthesia.

### Aftercare

Patients who have undergone arthroplasty must be careful not to over stress or destabilize the joint. **Physical therapy** is begun immediately. **Antibiotics** are given to prevent infection.

### Risks

Joint resection and interpositional reconstruction do not always produce successful results, especially in patients with rheumatoid arthritis. Repeat surgery or total joint replacement may be necessary. As with any major surgery, there is always a risk of an allergic reaction to anesthesia or that **blood clots** will break loose and obstruct the arteries.

### Normal results

Most patients recover with improved range of motion in the joint and relief from pain.

### Resources

#### BOOKS

Morrey, Bernard J., ed. *Joint Replacement Arthroplasty: Basic Science, Elbow, and Shoulder*. 4th ed. Philadelphia: Lippincott Williams & Wilkins, 2010.

#### OTHER

“Darrach’s Procedure.” *Wheeler’s Textbook of Orthopaedics*  
Page. <http://www.medmedia.com/ooa1/119.htm>.

Tish Davidson A.M.

## Arthroscopic surgery

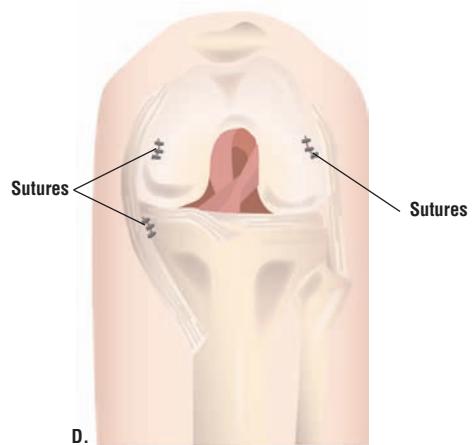
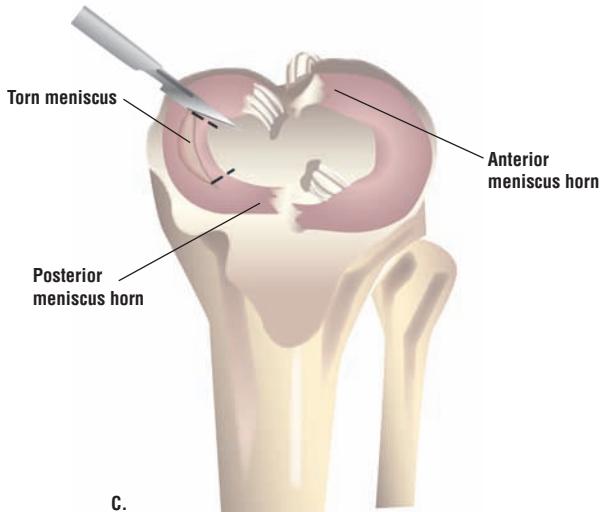
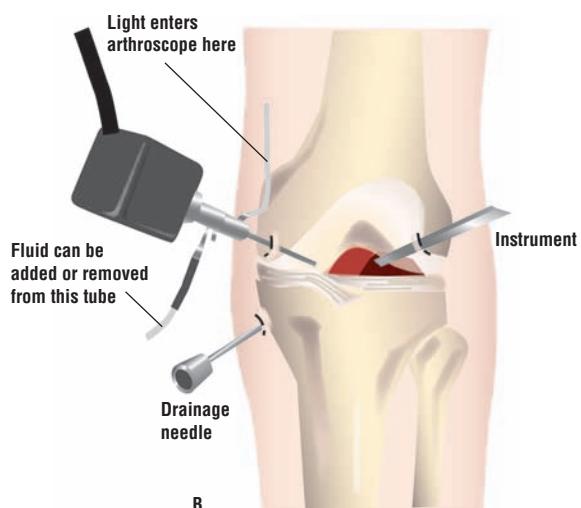
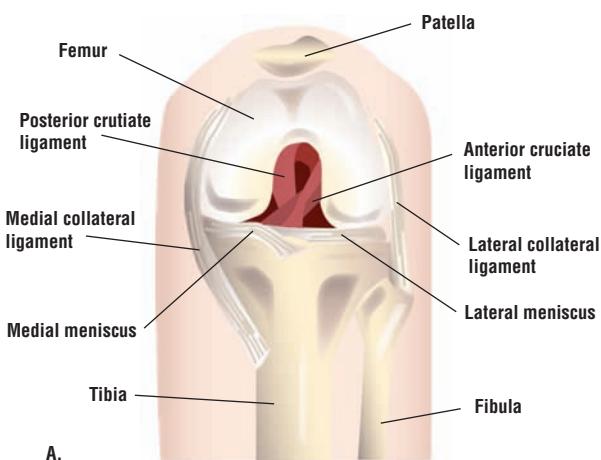
### Definition

Arthroscopic surgery is a procedure to visualize, diagnose, and treat joint problems. The name is derived from the Greek words *arthron*, which means *joint*, and *skopein*, which means *to look at*.

### Purpose

Arthroscopic surgery is used to identify, monitor, and diagnose joint injuries and disease; or to remove bone or cartilage or repair tendons or ligaments. Diagnostic arthroscopic surgery is performed when medical history, physical exam, x rays, and other tests such as **magnetic resonance imaging (MRI)** or **computed tomographic scans (CT)** don't provide a definitive diagnosis.

### Knee arthroscopic surgery



Step A shows the anatomy of the knee from the front with the leg bent. To repair a torn meniscus, three small incisions are made into the knee to admit laparoscopic instruments (B). Fluid is injected into the joint to aid in the operation. The injury is visualized via the instruments, and the torn area is removed (C). (Illustration by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

## KEY TERMS

**Joint**—The point where bones meet. Arthroscopic surgery is used on joint problems.

**Laser**—A device that concentrates electromagnetic radiation into a narrow beam and treats tissue quickly without heating surrounding areas.

**Orthopedics**—The medical specialty that deals with preserving, restoring, and developing form and function in the extremities, spine, and other structures using medical, surgical, and physical methods. Arthroscopic surgery is performed by orthopedic surgeons.

### Precautions

Diagnostic arthroscopic surgery should not be performed unless conservative treatment does not fix the problem.

### Description

In arthroscopic surgery, an orthopedic surgeon uses an arthroscope, a fiber-optic instrument, to see the inside of a joint. After making an incision about the size of a buttonhole in the patient's skin, a sterile sodium chloride solution is injected to distend the joint. The arthroscope, an instrument the size of a pencil, is then inserted into the joint. The arthroscope has a lens and a lighting system through which the structures inside the joint are transmitted to a miniature television camera attached to the end of the arthroscope. The surgeon uses irrigation and suction to remove blood and debris from the joint before examining it. Other incisions may be made in order to see other parts of the joint or to insert additional instruments. Looking at the interior of the joint on the television screen, the surgeon can then determine the amount or type of injury and, if necessary, take a biopsy specimen or repair or correct the problem. Arthroscopic surgery can be used to remove floating bits of cartilage and treat minor tears and other disorders. When the procedure is finished, the arthroscope is removed and the joint is irrigated. The site of the incision is bandaged.

Arthroscopic surgery is used to diagnose and treat joint problems, most commonly in the knee, but also in the shoulder, elbow, ankle, wrist, and hip. Some of the most common joint problems seen with an arthroscope are:

- inflammation in the knee, shoulder, elbow, wrist, or ankle
- injuries to the shoulder (rotator cuff tendon tears, impingement syndrome, and recurrent dislocations), knee (cartilage tears, wearing down of or injury to the cartilage cushion, and anterior cruciate ligament tears with instability), and wrist (carpal tunnel syndrome)
- loose bodies of bone and/or cartilage in the knee, shoulder, elbow, ankle, or wrist

Corrective arthroscopic surgery is performed with instruments that are inserted through additional incisions. Arthritis can sometimes be treated with arthroscopic surgery. Some problems are treated with a combination of arthroscopic and standard surgery.

Also called **arthroscopy**, the procedure is performed in a hospital or outpatient surgical facility. The type of anesthesia (local, spinal, or general) and the length of the procedure depends on the joint operated on and the complexity of the suspected problem. Arthroscopic surgery rarely takes more than an hour. Most patients who have arthroscopic surgery are released that same day; some patients stay in the hospital overnight.

Considered the most important orthopedic development in the 20th century, arthroscopic surgery is widely used. The use of arthroscopic surgery on famous athletes has been well publicized. It is estimated that 80% of orthopedic surgeons practice arthroscopic surgery. Arthroscopic surgery was initially a diagnostic tool used prior to open surgery, but as better instruments and techniques were developed, it began to be used to actually treat a variety of joint problems. New techniques currently under development are likely to lead to other joints being treated with arthroscopic surgery in the future. Recently, lasers were introduced in arthroscopic surgery and other new energy sources are being explored. Lasers and electromagnetic radiation can repair rather than resect injuries and may be more cost effective than instruments.

### Preparation

Before the procedure, blood and urine studies and x rays of the joint will be conducted.

### Aftercare

Immediately after the procedure, the patient will spend several hours in the recovery room. An ice pack will be put on the joint that was operated on for up to 48 hours after the procedure. **Pain** medicine,

prescription or non-prescription, will be given. The morning after the surgery, the dressing can be removed and replaced by adhesive strips. The patient should call his/her doctor upon experiencing an increase in pain, swelling, redness, drainage or bleeding at the site of the surgery, signs of infection (**headache**, muscle aches, **dizziness**, **fever**), or **nausea** or **vomiting**.

It takes several days for the puncture **wounds** to heal, and several weeks for the joint to fully recover. Many patients can resume their daily activities, including going back to work, within a few days of the procedure. A **rehabilitation** program, including **physical therapy**, may be suggested to speed recovery and improve the future functioning of the joint.

## Risks

Complications are rare in arthroscopic surgery, occurring in less than 1% of patients. These include infection and inflammation, blood vessel clots, damage to blood vessels or nerves, and instrument breakage.

## Resources

### OTHER

Arthroscopy. American Academy of Orthopaedic Surgeons.  
<http://orthoinfo.aaos.org/topic.cfm?topic=a00109>  
 (accessed November 23, 2010).

Lori De Milto

# Arthroscopy

## Definition

Arthroscopy is the examination of a joint, specifically, the inside structures. The procedure is performed by inserting a specifically designed illuminated device into the joint through a small incision. This instrument is called an arthroscope. The procedure of arthroscopy is primarily associated with the process of diagnosis. However, when actual repair is performed, the procedure is called **arthroscopic surgery**.

## Purpose

Arthroscopy is used primarily by doctors who specialize in treating disorders of the bones and related structures (orthopedics) to help diagnose joint problems. Once described as essential for those who primarily care for athletic injuries, arthroscopy is now a technique commonly used by orthopedic surgeons for

the treatment of patients of all ages. This procedure is most commonly used to diagnose knee and shoulder problems, although the elbow, hip, wrist, and ankle may also be examined with an arthroscope.

A joint is a complex system. Within a joint, ligaments attach bones to other bones, tendons attach muscles to bones, cartilage lines and helps protect the ends of bones, and a special fluid (synovial fluid) cushions and lubricates the structures. Looking inside the joint allows the doctors to see exactly which structures are damaged. Arthroscopy also permits earlier diagnosis of many types of joint problems, which had been difficult to detect in previous years.

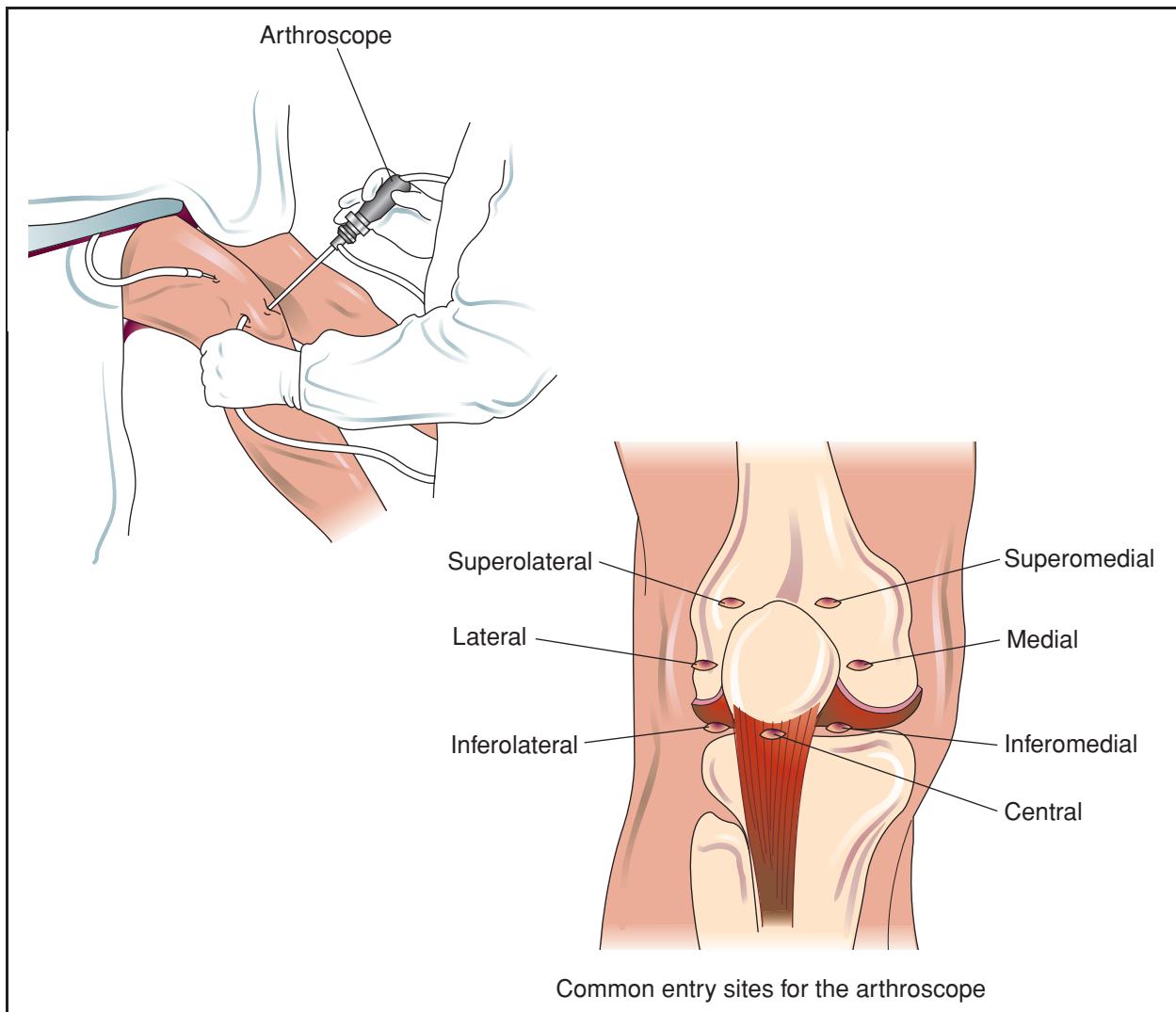
## Precautions

Most arthroscopic procedures today are performed in same-day surgery centers where the patient is admitted just before surgery. A few hours following the procedure, the patient is allowed to return home, although usually someone else must drive. Depending on the type of anesthesia used, the patient may be told not to eat for several hours before arriving. Before the procedure, the anesthesiologist will ask if the patient has any known **allergies** to local or general anesthetics. Airway obstruction is always possible in any patient who receives a **general anesthesia**. Because of this, oxygen, suction, and monitoring equipment must be available. The patient's cardiac status should always be monitored in the event that any cardiac abnormalities arise during the arthroscopy.

## Description

The arthroscope is an instrument used to look directly into the joint. It contains magnifying lenses and glass-coated fibers that send concentrated light into the joint. A camera attached to the arthroscope allows the surgeon to see a clear image of the joint. This image is then transferred to a monitor located in the operating room at the time of the arthroscopy. This video technology is also important for documentation of the arthroscopic procedure. For example, if the surgeon decides after the arthroscopic examination that a conventional approach to surgically expose or "open" the joint (arthrotomy) must be used, a good photographic record will be useful when the surgeon returns to execute the final surgical plan.

The procedure requires the surgeon to make several small incisions (portals) through the skin's surface into the joint. Through one or two of the portals, a large-bore needle, called a cannula, is attached to tubing and inserted into the joint. The joint is inflated with a sterile saline solution to expand the joint and ensure



**Arthroscopy** is primarily used to help diagnose joint problems. This procedure, most commonly associated with knee and shoulder problems, allows accurate examination and diagnosis of damaged joint ligaments, surfaces, and other related joint structures. The illustration above indicates the most common entry sites, or portals, in knee arthroscopy. (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

clear arthroscopic viewing. Often, following a recent traumatic injury to a joint, the joint's natural fluid may be cloudy, making interior viewing of the joint difficult. In this condition, a constant flow of the saline solution is necessary. This inflow of saline solution may be through the cannula with the outflow through the arthroscope, or the positions may be reversed. The arthroscope is placed through one of the portals to view and evaluate the condition of the joint.

### Preparation

Before an arthroscopy can take place, the surgeon completes a thorough medical history and evaluation.

Important for the accuracy of this diagnostic procedure, a medical history and evaluation may discover other disorders of the joint or body parts, proving the procedure unnecessary. This is always an important preliminary step, because **pain** can often be referred to a joint from another area of the body. Anatomical models and pictures are useful aids to explain to the patient the proposed arthroscopy and what the surgeon may be looking at specifically.

Proper draping of the body part is important to prevent contamination from instruments used in arthroscopy, such as the camera, light cords, and inflow and outflow drains placed in the portals. Draping packs used

## KEY TERMS

- Hemarthrosis**—A condition of blood within a joint.
- Pulmonary embolus**—Blockage of an artery of the lung by foreign matter such as fat, tumor, tissue, or a clot originating from a vein.
- Thrombophlebitis**—Inflammation of a vein with the formation of a thrombus or clot.

in arthroscopy include disposable paper gowns and drapes with adhesive backing. The surgeon may also place a tourniquet above the joint to temporarily block blood flow to the area during the arthroscopic exam.

General or **local anesthesia** may be used during arthroscopy. Local anesthesia is usually used because it reduces the risk of lung and heart complications and allows the patient to go home sooner. The local anesthetic may be injected in small amounts in multiple locations in skin and joint tissues in a process called infiltration. In other cases, the anesthetic is injected into the spinal cord or a main nerve supplying the area. This process is called a “block,” and it blocks all sensation below the main trunk of the nerve. For example, a femoral block anesthetizes the leg from the thigh down (its name comes from femur, the thigh-bone). Most patients are comfortable once the skin, muscles, and other tissues around the joint are numbed by the anesthetic; however, some patients are also given a sedative if they express **anxiety** about the procedure. (It’s important for the patient to remain still during the arthroscopic examination.)

General anesthesia, in which the patient becomes unconscious, may be used if the procedure may be unusually complicated or painful. For example, people who have relatively “tight” joints may be candidates for general anesthesia because the procedure may take longer and cause more discomfort.

### Aftercare

The portals are closed by small tape strips or stitches and covered with **dressings** and a bandage. The patient spends a short amount of time in the recovery room after arthroscopy. Most patients can go home after about an hour in the recovery room. Pain medication may be prescribed for a short period; however, many patients find various over-the-counter pain relievers sufficient.

Following the surgical procedure, the patient needs to be aware of the signs of infection, which include redness, warmth, excessive pain, and swelling.

The risk of infection increases if the incisions become wet too early following surgery. Because of this, it is good practice to cover the joint with plastic (for example, a plastic bag) while showering after arthroscopy.

The use of crutches is commonplace after arthroscopy, with progression to independent walking on an “as tolerated” basis by the patient. Generally, a **rehabilitation** program, supervised by a physical therapist, follows shortly after the arthroscopy to help the patient regain mobility and strength of the affected joint and limb.

### Risks

The incidence of complications is low compared to the high number of arthroscopic procedures performed every year. Possible complications include infection, swelling, damage to the tissues in the joint, **blood clots** in the leg veins (**thrombophlebitis**), leakage of blood into the joint (hemarthrosis), blood clots that move to the lung (pulmonary embolus), and injury to the nerves around the joint.

### Normal results

The goal of arthroscopy is to diagnose a joint problem causing pain and/or restrictions in normal joint function. For example, arthroscopy can be a useful tool in locating a tear in the joint surface of the knee or locating a torn ligament of the shoulder. Arthroscopic examination is often followed by arthroscopic surgery performed to repair the problem with appropriate arthroscopic tools. The final result is to decrease pain, increase joint mobility, and thereby improve the overall quality of the patient’s activities of daily living.

### Abnormal results

Less optimal results that may require further treatment include adhesive capsulitis. In this condition, the joint capsule that naturally forms around the joint becomes thickened, forming **adhesions**. This results in a stiff and less mobile joint. This problem is frequently corrected by manipulation and mobilization of the joint with the patient placed under general anesthesia.

### Resources

#### OTHER

Arthroscopy. MayoClinic.com. <http://www.mayoclinic.com/health/arthroscopy/MY00130/METHOD=print> (accessed November 23, 2010).

Jeffrey P. Larson RPT

Artificial insemination see **Infertility therapies**

## Asbestosis

### Definition

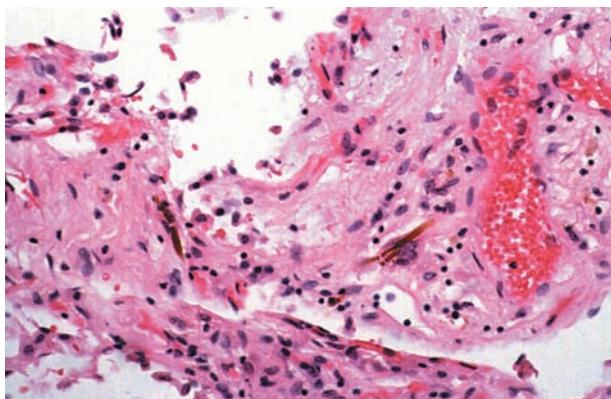
Asbestosis is chronic, progressive inflammation of the lung. It is not contagious.

### Description

Asbestosis is a consequence of prolonged exposure to large quantities of asbestos, a material once widely used in construction, insulation, and manufacturing. When asbestos is inhaled, fibers penetrate the breathing passages and irritate, fill, inflame, and scar lung tissue. In advanced asbestosis, the lungs shrink, stiffen, and become honeycombed (riddled with tiny holes).

Legislation has reduced use of asbestos in the United States, but workers who handle automobile brake shoe linings, boiler insulation, ceiling acoustic tiles, electrical equipment, and fire-resistant materials are still exposed to the substance. Asbestos is used in the production of paints and plastics. Significant amounts can be released into the atmosphere when old buildings or boats are razed or remodeled.

Asbestosis is most common in men over 40 who have worked in asbestos-related occupations. Smokers or heavy drinkers have the greatest risk of developing this disease. According to the Centers for Disease Control and Prevention, between 1999 and 2005, more than 18,000 Americans over the age of 25 died as a result of asbestosis. The death rate increased from 2,482 deaths in 1999 to 2,704 in 2005, an increase of 222 deaths. Men are diagnosed with mesothelioma more often than women, and males comprised 80.8 percent of mesothelioma deaths during this timeframe.



**Micrograph of asbestos fibers embedded in lung tissue.**  
(Custom Medical Stock Photo, Inc. Reproduced by permission.)

### KEY TERMS

**Asbestos**—A silicate (containing silica) mineral that occurs in a variety of forms; it is characterized by a fibrous structure and resistance to fire.

(a total of 14,591). White people comprised 95.1 percent of mesothelioma deaths, totaling 17,180. Age influenced the mortality rate, as those 75 years old and older comprised the majority of the patients who passed away from mesothelioma (8,858 total deaths). Deaths in patients age 44 or younger totaled 311, or 1.7 percent.

### Causes and symptoms

Occupational exposure is the most common cause of asbestosis, but the condition also strikes people who inhale asbestos fiber or who are exposed to waste products from plants near their homes. Family members can develop the disease as a result of inhaling particles of asbestos dust that cling to workers' clothes.

It is rare for asbestosis to develop in anyone who hasn't been exposed to large amounts of asbestos on a regular basis for at least 10 years. Symptoms of the disease do not usually appear until 15–20 years after initial exposure to asbestos.

The first symptom of asbestosis is usually **shortness of breath** following **exercise** or other physical activity. The early stages of the disease are also characterized by a dry **cough** and a generalized feeling of illness.

As the disease progresses and lung damage increases, shortness of breath occurs even when the patient is at rest. Recurrent respiratory infections and coughing up blood are common. So is swelling of the feet, ankles, or hands. Other symptoms of advanced asbestosis include chest **pain**, hoarseness, and restless sleep. Patients who have asbestosis often have clubbed (widened and thickened) fingers. Other potential complications include **heart failure**, collapsed (deflated) lung, and **pleurisy** (inflammation of the membrane that protects the lung).

### Diagnosis

Screening of at-risk workers can reveal lung inflammation and lesions characteristic of asbestosis. Patients' medical histories can identify occupations, hobbies, or other situations likely to involve exposure to asbestos fibers.

X rays can show shadows or spots on the lungs or an indistinct or shaggy outline of the heart that suggests the presence of asbestosis. Blood tests are used to measure concentrations of oxygen and carbon dioxide. **Pulmonary function tests** can be used to assess a patient's ability to inhale and exhale, and a computed tomography scan (CT) of the lungs can show flat, raised patches associated with advanced asbestosis.

## Treatment

The goal of treatment is to help patients breathe more easily, prevent colds and other respiratory infections, and control complications associated with advanced disease. Ultrasonic, cool-mist humidifiers or controlled coughing can loosen bronchial secretions.

Regular exercise helps maintain and improve lung capacity. Although temporary bed rest may be recommended, patients are encouraged to resume their regular activities as soon as they can.

Anyone who develops symptoms of asbestosis should see a family physician or lung disease specialist. A doctor should be notified if someone who has been diagnosed with asbestosis:

- coughs up blood
- continues to lose weight
- is short of breath
- has chest pain
- develops a sudden fever of 101°F (38.3°C) or higher
- develops unfamiliar, unexplained symptoms

## Prognosis

Asbestosis can't be cured, but its symptoms can be controlled. Doctors don't know why the health of some patients deteriorates and the condition of others remain the same, but believe the difference may be due to varying exposures of asbestos. People with asbestosis who smoke, particularly those who smoke more than one pack of cigarettes each day, are at increased risk for developing lung **cancer** and should be strongly advised to quit **smoking**.

## Prevention

Workers in asbestosis-related industries should have regular x rays to determine whether their lungs are healthy. A person whose lung x ray shows a shadow should eliminate asbestos exposure even if no symptoms of the condition have appeared.

Anyone who works with asbestos should wear a protective mask or a hood with a clean-air supply and

obey recommended procedures to control asbestos dust. Anyone who is at risk of developing asbestosis should:

- not smoke
- be vaccinated against influenza and pneumonia
- exercise regularly to maintain cardiopulmonary fitness
- avoid crowds and people who have respiratory infections

A person who has asbestosis should exercise regularly, relax, and conserve energy whenever necessary.

## Resources

### BOOKS

Craighead, John E., and A. R. Gibbs. *Asbestos and its Diseases*, New York: Oxford, 2008.

### ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, (202) 758-3355, (202) 452-1805, (800) 548-8252, info@lungusa.org, <http://www.lungusa.org/>.

Maureen Haggerty

**Ascariasis** see **Roundworm infections**

**Ascending cholangitis** see **Cholangitis**

**Ascending contrast phlebography** see  
**Venography**

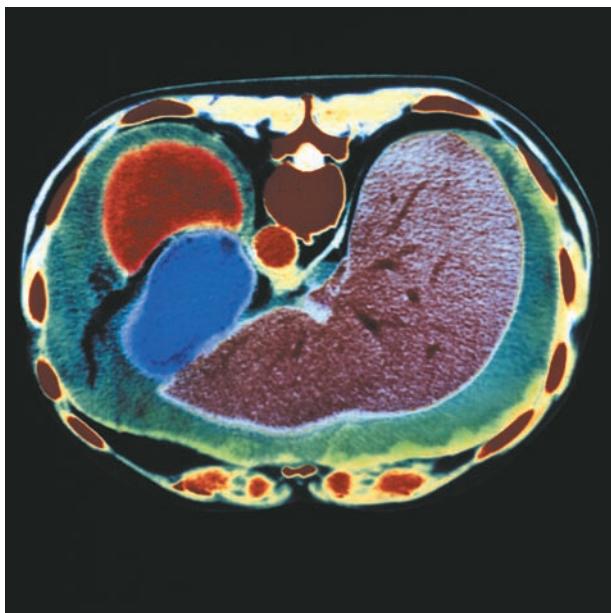
## Ascites

### Definition

Ascites is an abnormal accumulation of fluid in the abdomen.

### Description

Rapidly developing (acute) ascites can occur as a complication of trauma, perforated ulcer, **appendicitis**, or inflammation of the colon or other tube-shaped organ (**diverticulitis**). This condition can also develop when intestinal fluids, bile, pancreatic juices, or bacteria invade or inflame the smooth, transparent membrane that lines the inside of the abdomen (peritoneum). However, ascites is more often associated with **liver disease** and other long-lasting (chronic) conditions.



**A computed tomography (CT) scan of an axial section through the abdomen, showing ascites. At right is the liver occupying much of the abdomen; the stomach and spleen are also seen. Around these organs is fluid giving rise to this condition.** (Custom Medical Stock Photo, Inc. Reproduced by permission.)

### Types of ascites

**Cirrhosis**, which is responsible for 80% of all instances of ascites in the United States, triggers a series of disease-producing changes that weaken the kidney's ability to excrete **sodium** in the urine.

Pancreatic ascites develops when a cyst that has thick, fibrous walls (pseudocyst) bursts and permits pancreatic juices to enter the abdominal cavity.

Chylous ascites has a milky appearance caused by lymph that has leaked into the abdominal cavity. Although chylous ascites is sometimes caused by trauma, abdominal surgery, **tuberculosis**, or another peritoneal infection, it is usually a symptom of lymphoma or some other **cancer**.

Cancer causes 10% of all instances of ascites in the United States. It is most commonly a consequence of disease that originates in the peritoneum (peritoneal carcinomatosis) or of cancer that spreads (metastasizes) from another part of the body.

Endocrine and renal ascites are rare disorders. Endocrine ascites, sometimes a symptom of an endocrine system disorder, also affects women who are taking fertility drugs. Renal ascites develops when blood levels of albumin dip below normal. Albumin

### KEY TERMS

**Computed tomography scan (CT)**—An imaging technique in which cross-sectional x rays of the body are compiled to create a three-dimensional image of the body's internal structures.

**Interferon**—A protein formed when cells are exposed to a virus. Interferon causes other noninfected cells to develop translation inhibitory protein (TIP). TIP blocks viruses from infecting new cells.

**Paracentesis**—A procedure in which fluid is drained from a body cavity by means of a catheter placed through an incision in the skin.

**Systemic lupus erythematosus**—An inflammatory disease that affects many body systems, including the skin, blood vessels, kidneys, and nervous system. It is characterized, in part, by arthritis, skin rash, weakness, and fatigue.

**Ultrasonography**—A test using sound waves to measure blood flow. Gel is applied to a hand-held transducer that is pressed against the patient's body. Images are displayed on a monitor.

is the major protein in blood plasma. It functions to keep fluid inside the blood vessels.

### Causes and symptoms

#### Causes

The two most important factors in the production of ascites due to chronic liver disease are:

- Low levels of albumin in the blood that cause a change in the pressure necessary to prevent fluid exchange (osmotic pressure). This change in pressure allows fluid to seep out of the blood vessels.
- An increase in the pressure within the branches of the portal vein that run through liver (portal hypertension). Portal hypertension is caused by the scarring that occurs in cirrhosis. Blood that cannot flow through the liver because of the increased pressure leaks into the abdomen and causes ascites.

Other conditions that contribute to ascites development include:

- hepatitis
- heart or kidney failure
- inflammation and fibrous hardening of the sac that contains the heart (constrictive pericarditis)

Persons who have **systemic lupus erythematosus** but do not have liver disease or portal **hypertension** occasionally develop ascites. Depressed thyroid activity sometimes causes pronounced ascites. Inflammation of the pancreas (**pancreatitis**) rarely causes significant accumulations of fluid.

### Symptoms

Small amounts of fluid in the abdomen do not usually produce symptoms. Massive accumulations may cause:

- rapid weight gain
- abdominal discomfort and distention
- shortness of breath
- swollen ankles

### Diagnosis

Skin stretches tightly across an abdomen that contains large amounts of fluid. The navel bulges or lies flat, and the fluid makes a dull sound when the doctor taps the abdomen. Ascitic fluid may cause the flanks to bulge.

**Physical examination** generally enables doctors to distinguish ascites from **pregnancy**, intestinal gas, **obesity**, or ovarian tumors. Ultrasound or **computed tomography scans** (CT) can detect even small amounts of fluid. Laboratory analysis of fluid extracted by inserting a needle through the abdominal wall (diagnostic **paracentesis**) can help identify the cause of the accumulation.

### Treatment

Reclining minimizes the amount of salt the kidneys absorb, so treatment generally starts with bed rest and a low-salt diet. Urine-producing drugs (**diuretics**) may be prescribed if initial treatment is ineffective. The weight and urinary output of patients using diuretics must be carefully monitored for signs of :

- hypovolemia (massive loss of blood or fluid)
- azotemia (abnormally high blood levels of nitrogen-bearing materials)
- potassium imbalance
- high sodium concentration. If the patient consumes more salt than the kidneys excrete, increased doses of diuretics should be prescribed

Moderate-to-severe accumulations of fluid are treated by draining large amounts of fluid (large-volume paracentesis) from the patient's abdomen. This procedure is safer than diuretic therapy. It causes fewer complications and requires a shorter hospital stay.

Large-volume paracentesis is also the preferred treatment for massive ascites. Diuretics are sometimes used to prevent new fluid accumulations, and the procedure may be repeated periodically.

### Alternative treatment

Dietary alterations, focused on reducing salt intake, should be a part of the treatment. In less severe cases, herbal diuretics like dandelion (*Taraxacum officinale*) can help eliminate excess fluid and provide potassium. Potassium-rich foods like low-fat yogurt, mackerel, cantaloupe, and baked potatoes help balance excess sodium intake.

### Prognosis

The prognosis depends upon the condition that is causing the ascites. Carcinomatous ascites has a very bad prognosis. However, salt restriction and diuretics can control ascites caused by liver disease in many cases.

Therapy should also be directed towards the underlying disease that produces the ascites. Cirrhosis should be treated by abstinence from alcohol and appropriate diet. The new interferon agents maybe helpful in treating chronic hepatitis.

### Prevention

Modifying or restricting use of salt can prevent most cases of recurrent ascites.

### Resources

#### BOOKS

Beers, Mark H., Robert S. Porter, and Thomas V. Jones, eds. *The Merck Manual of Diagnosis and Therapy*. 18th ed. Whitehouse Station, NJ: Merck Research Laboratories, 2006.

#### OTHER

"Hepatic and Liver Disorders." *The Merck Page*. April 20, 1998. <http://www.merck.com>.

#### ORGANIZATIONS

American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, (212) 483-8179, <http://www.liverfoundation.org/>.

Maureen Haggerty

Ascorbic acid deficiency see **Scurvy**

ASD see **Atrial septal defect**

Asian American health see **Minority health**

Asian flu see **Influenza**

## Aspartate aminotransferase test

### Definition

The Aspartate aminotransferase (AST) test measures levels of AST, an enzyme released into the blood when certain organs or tissues, particularly the liver and heart, are injured. Aspartate aminotransferase is also known as serum glutamic oxaloacetic transaminase (SGOT).

### Purpose

The determination of AST levels aids primarily in the diagnosis of **liver disease**. In the past, the AST test was used to diagnose **heart attack** (myocardial infarction or MI) but more accurate blood tests have largely replaced it for cardiac purposes.

### Description

AST is determined by analysis of a blood sample, usually from taken from a venipuncture site at the bend of the elbow.

AST is found in the heart, liver, skeletal muscle, kidney, pancreas, spleen, lung, red blood cells, and brain tissue. When disease or injury affects these tissues, the cells are destroyed and AST is released into the bloodstream. The amount of AST is directly related to the number of cells affected by the disease or injury, but the level of elevation depends on the length of time that the blood is tested after the injury. Serum AST levels become elevated eight hours after cell injury, peak at 24-36 hours, and return to normal in three to seven days. If the cellular injury is chronic (ongoing), AST levels will remain elevated.

One of the most important uses for AST determination has formerly been in the diagnosis of a heart attack, or MI. AST can assist in determining the timing and extent of a recent MI, although it is less specific than creatine phosphokinase (CPK), CK-MB, myoglobin, troponins, and lactic dehydrogenase (LDH). Assuming no further cardiac injury occurs, the AST level rises within 6-10 hours after an acute attack, peaks at 12-48 hours, and returns to normal in three to four days. Myocardial injuries such as **angina** (chest pain) or **pericarditis** (inflammation of the pericardium, the membrane around the heart) do not increase AST levels.

AST is also a valuable aid in the diagnosis of liver disease. Although not specific for liver disease, it can be used in combination with other enzymes to monitor

### KEY TERMS

**Cirrhosis**—Disease of the liver caused by chronic damage to its cells.

**Myocardial infarction**—Commonly known as a heart attack. Sudden death of part of the heart muscle, characterized, in most cases, by severe, unremitting chest pain.

the course of various liver disorders. Chronic, silent hepatitis (**hepatitis C**) is sometimes the cause of elevated AST. In **alcoholic hepatitis**, caused by excessive alcohol ingestion, AST values are usually moderately elevated; in acute viral hepatitis, AST levels can rise to over 20 times normal. Acute extrahepatic (outside the liver) obstruction (e.g. gallstone), produces AST levels that can quickly rise to 10 times normal, and then rapidly fall. In cases of **cirrhosis**, the AST level is related to the amount of active inflammation of the liver. Determination of AST also assists in early recognition of toxic hepatitis that results from exposure to drugs toxic to the liver, like **acetaminophen** and cholesterol lowering medications.

Other disorders or diseases in which the AST determination can be valuable include acute **pancreatitis**, muscle disease, trauma, severe burn, and **infectious mononucleosis**.

### Preparation

The physician may require discontinuation of any drugs that might affect the test. These types include such drugs as antihypertensives (for treatment of high blood pressure), coumarin-type anticoagulants (blood-thinning drugs), digitalis, erythromycin (an antibiotic), **oral contraceptives**, and opiates, among others. The patient may also need to cut back on strenuous activities temporarily, because **exercise** can also elevate AST for a day or two.

### Risks

Risks for this test are minimal, but may include slight bleeding from the blood-drawing site, **fainting** or feeling lightheaded after venipuncture, or hematoma (blood accumulating under the puncture site).

### Normal results

Normal ranges for the AST are laboratory-specific, but can range from 3-45 units/L (units per liter).

## Abnormal results

Striking elevations of AST (400-4000 units/L) are found in almost all forms of acute hepatic necrosis, such as viral hepatitis and carbon tetrachloride **poisoning**. In alcoholics, even moderate doses of the analgesic acetaminophen have caused extreme elevations (1, 960-29, 700 units/L). Moderate rises of AST are seen in **jaundice**, cirrhosis, and metastatic carcinoma. Approximately 80% of patients with infectious mononucleosis show elevations in the range of 100-600 units/L.

## Resources

### BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Janis O. Flores

As for gender differences, AS appears to be three to four times more common in boys.

## Description

Children with AS learn to talk at the usual age and often have above-average verbal skills. They have normal or above-normal intelligence and the ability to take care of themselves. The distinguishing features of AS are problems with social interaction, particularly reciprocating and empathizing with the feelings of others; difficulties with nonverbal communication (e.g., facial expressions); peculiar speech habits that include repeated words or phrases and a flat, emotionless vocal tone; an apparent lack of "common sense," a fascination with obscure or limited subjects (e.g., doorknobs, railroad schedules, astronomical data, etc.) often to the exclusion of other interests; clumsy and awkward physical movements; and odd or eccentric behaviors (hand wringing or finger flapping; swaying or other repetitious whole-body movements; watching spinning objects for long periods of time).

## Risk factors

There is some indication that AS runs in families, particularly in families with histories of depression and **bipolar disorder**. Asperger noted that his initial group of patients had fathers with AS symptoms. Knowledge of the genetic profile as a risk factor continues to be limited, however.

## Causes and symptoms

About 50% of patients with Asperger syndrome have a history of oxygen deprivation during the birth process, which has led to the hypothesis that the syndrome is caused by damage to brain tissue before or during **childbirth**. Another cause that has been suggested is an organic defect in the functioning of the brain. Research studies have made no connection between Asperger's disorder and childhood trauma, **abuse** or neglect.

In young children, the symptoms of AS typically include problems picking up social cues and understanding the basics of interacting with other children. The child may want friendships but find him-or herself unable to make friends. Most children with Asperger's are diagnosed during the elementary school years because the symptoms of the disorder become more apparent at this point. They include:

- Poor pragmatic language skills. This phrase means that the child does not use the right tone or volume of voice for a specific context, and does not understand

## Demographics

According to the National Institute of Neurological Disorders and Stroke (NINDS), the rate of occurrence of AS is not well established. A conservative estimate is that two out of every 10,000 children have the disorder. In France, the INSERM (French National Health and Medical Research Institute) reports a prevalence of three children in 10,000. However further research is required to obtain precise AS prevalence data. In addition, no research has been done on the populations of developing countries, and no information is available about the incidence of the disorder in different racial or ethnic groups.

**Brain abnormalities associated with Asperger syndrome**

**Polymicrogyria (PMG)** is a developmental brain malformation characterized by an excessive number of small folds (gyri) on the surface of the brain.

**Macrogryria** is the congenital condition of having an enlarged brain.

Specific malformations that have been associated with Asperger syndrome include left frontal macrogryria, bilateral opercular polymicrogyria, left temporal lobe damage, and left parieto occipital hypoperfusion.

**Possible brain malformations associated with Asperger syndrome.** (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

that using humorous or slang expressions also depends on social context.

- Problems with hand–eye coordination and other visual skills
- Problems making eye contact with others
- Learning difficulties, which may range from mild to severe
- Tendency to become absorbed in a particular topic and not know when others are bored with conversation about it. At this stage in their education, children with AS are likely to be labeled as “nerds.”
- Repetitive behaviors. These include such behaviors as counting a group of coins or marbles over and over; reciting the same song or poem several times; buttoning and unbuttoning a jacket repeatedly; etc.

Adolescence is one of the most painful periods of life for young people with Asperger’s, because social interactions are more complex in this age group and require more subtle social skills. Some boys with AS become frustrated trying to relate to their peers and may become aggressive. Both boys and girls with the disorder are often quite naive for their age and easily

manipulated by “street-wise” classmates. They are also more vulnerable than most youngsters to peer pressure.

Little research has been done regarding adults with AS. Some have serious difficulties with social and occupational functioning, but others are able to finish their schooling, join the workforce, and marry and have families.

## Diagnosis

As of 2009, there are no blood tests or brain scans that can be used to diagnose AS. Until DSM-IV (1994), there was no “official” list of symptoms for the disorder, which made its diagnosis both difficult and inexact. Although most children with AS are diagnosed between five and nine years of age, many are not diagnosed until adulthood. Misdiagnoses are common; AS has been confused with such other neurological disorders as **Tourette syndrome**, or with Attention Deficit Disorder (ADD), **Oppositional Defiant Disorder** (ODD), or **Obsessive–Compulsive Disorder** (OCD). Some researchers think that AS overlaps with some types of learning disability, such

## KEY TERMS

**Autistic psychopathy**—Hans Asperger's original name for Asperger syndrome. It is still used occasionally as a synonym for the disorder.

**Gillberg's criteria**—A six-item checklist for Asperger syndrome developed by Christopher Gillberg, a Swedish researcher. It is widely used as a diagnostic tool.

**High-functioning autism (HFA)**—A subcategory of autistic disorder consisting of children diagnosed with IQs of 70 or higher.

**Nonverbal Learning Disability (NLD)**—A learning disability syndrome identified in 1989 that may overlap with some of the symptoms of Asperger syndrome.

**Pervasive developmental disorder (PDD)**—The term used by the American Psychiatric Association for individuals who meet some but not all of the criteria for autism.

as the Nonverbal Learning Disability (NLD) syndrome identified in 1989.

The inclusion of AS as a separate diagnostic category in DSM-IV was justified on the basis of a large international field trial of over a thousand children and adolescents. Nevertheless, the diagnosis of AS is also complicated by confusion with such other diagnostic categories as "high-functioning (IQ 70) autism," or HFA, and "schizoid personality disorder of childhood." With regard to the latter, AS is not an unchanging set of personality traits but has a developmental dimension. AS is distinguished from HFA by the following characteristics:

- later onset of symptoms (usually around three years of age)
- early development of grammatical speech; the AS child's verbal IQ is usually higher than performance IQ (the reverse being the case in autistic children)
- less severe deficiencies in social and communication skills
- presence of intense interest in one or two topics
- physical clumsiness and lack of coordination
- family is more likely to have a history of the disorder
- lower frequency of neurological disorders
- more positive outcome in later life

## DSM-IV criteria for Asperger syndrome

DSM-IV specifies six diagnostic criteria for AS:

- The child's social interactions are impaired in at least two of the following ways: markedly limited use of nonverbal communication; lack of age-appropriate peer relationships; failure to share enjoyment, interests, or accomplishment with others; lack of reciprocity in social interactions.
- The child's behavior, interests, and activities are characterized by repetitive or rigid patterns, such as an abnormal preoccupation with one or two topics, or with parts of objects; repetitive physical movements; or rigid insistence on certain routines and rituals.
- The patient's social, occupational, or educational functioning is significantly impaired.
- The child has normal age-appropriate language skills.
- The child has normal age-appropriate cognitive skills, self-help abilities, and curiosity about the environment.
- The child does not meet criteria for another specific PDD or schizophrenia.

## Other diagnostic scales and checklists

Other instruments that have been used to identify children with AS include Gillberg's criteria, a six-item list compiled by a Swedish researcher that specifies problems in social interaction, a preoccupying narrow interest, forcing routines and interests on the self or others, speech and language problems, nonverbal communication problems, and physical clumsiness; and the Australian Scale for Asperger Syndrome, a detailed multi-item questionnaire developed in 1996.

## Brain imaging findings

As of 2009, only a few structural abnormalities of the brain have been linked to AS. Findings include abnormally large folds in the brain tissue in the left frontal region, abnormally small folds in the operculum (a lid-like structure composed of portions of three adjoining brain lobes), and damage to the left temporal lobe. The first single photon emission tomography (SPECT) study of patient with AS found lower than normal blood supply in the left parietal area of the brain. Brain imaging studies on a larger sample of patients is the next stage of research.

## Treatment

As of 2009, there is no cure for AS and no prescribed regimen for all affected patients. Specific treatments are based on the individual's symptom pattern.

## Traditional

Individuals with Asperger syndrome often benefit from **psychotherapy**, particularly during adolescence, in order to cope with depression and other painful feelings related to their social difficulties. Treatment aims to help patients manage the major issues associated with the condition: lack of communication skills, obsessive routines, and physical clumsiness.

## Drugs

The drugs that are recommended most often for children with AS include psychostimulants (methylphenidate, pemoline), clonidine, or one of the **tricyclic antidepressants** (TCAs) for hyperactivity or inattention; **beta blockers**, neuroleptics, or lithium for anger or aggression; **selective serotonin reuptake inhibitors** (SSRIs) or TCAs for rituals and preoccupations; and SSRIs or TCAs for **anxiety** symptoms. One alternative herbal remedy that has been tried with AS patients is **St. John's wort**.

## Alternative

As of 2009, 26 clinical trials for the treatment of Asperger syndrome were being sponsored by the National Institutes of Health (NIH) and other agencies.

One study (NCT00464477) was recruiting parents of children with a pervasive developmental disorder (including **autism**, autistic spectrum disorder, PDD-NOS, Asperger syndrome, childhood disintegrative disorder, and Rett syndrome) to participate in a study seeking to determine potential causes of these disorders. Other trials are evaluating drugs for treatment. For example, N-acetylcysteine is being tested for the improvement of the behavior problems often associated with autism spectrum disorders (NCT00453180). The potential beneficial effect of DMSA, an oral chelating agent that removes mercury and other metals from the body, is also being investigated (NCT00376194), as well as the efficacy of risperidone in normalizing symptoms (NCT00352196). Other drugs being tested include aripiprazole (NCT00198055) and citalopram (NCT00086645). A cognitive behavioral therapy (CBT) program is also being evaluated for treating anxiety symptoms, social problems, and adaptive behavior deficits in children with Asperger syndrome (NCT00280670).

Clinical trial information is constantly updated by NIH and the most recent information on Asperger trials can be found at: <http://clinicaltrials.gov/ct2/results?term=Asperger+syndrome+>.

## Prognosis

AS is a lifelong but stable condition. The prognosis for children with AS is generally good as far as intellectual development is concerned, although few school districts are equipped to meet their special social needs. In addition, some researchers think that people with AS have an increased risk of becoming psychotic in adolescence or adult life.

## Prevention

Effective prevention of Asperger's disorder awaits further genetic mapping together with ongoing research in the structures and functioning of the brain.

## Resources

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- "What's Unique about Asperger's Disorder?" *Autism Society of America*. Information Page. [http://www.autism-society.org/site/PageServer?pagename=life\\_aspergers](http://www.autism-society.org/site/PageServer?pagename=life_aspergers) (accessed October 17, 2009)

## ORGANIZATIONS

- Autism Network International (ANI), P.O. Box 35448, Syracuse, NY, 13235-5448, [jisincla@syr.edu](mailto:jisincla@syr.edu), <http://www.ani.ac>.
- Autism Society of America, 7910 Woodmont Avenue, Suite 300, Bethesda, MD, 20814-3067 (301) 657-0881 (800) 3AUTISM (301) 657-0869, <http://www.autism-society.org>.

Global and Regional Asperger's Syndrome Partnership, 135

East 15th Street, New York, NY, 10003 (646) 242-4003, [info@grasp.org](mailto:info@grasp.org), <http://www.grasp.org>.

MAAP Services for Autism, Asperger Syndrome, and PDD, P.O. Box 524, Crown Point, IN, 46308 (219) 662-1311 (219) 662-0638, [info@maapservices.org](mailto:info@maapservices.org), <http://www.maapservices.org>.

National Institute of Mental Health (NIMH), 6001 Executive Blvd., Room 8184, MSC 9663, Bethesda, MD, 20892-9663 (301) 443-4513 (866) 415-8051 (301) 443-4279, [nimhinfo@nih.gov](mailto:nimhinfo@nih.gov), <http://www.nimh.nih.gov>.

National Organization for Rare Disorders (NORD), 55 Kenosia Avenue, Danbury, CT, 06813-1968 (203) 744-0100 (800) 999-NORD (203) 798-2291, [orphan@rarediseases.org](mailto:orphan@rarediseases.org), <http://www.rarediseases.org>.

Rebecca J. Frey PhD

Aspergilloma see **Aspergillosis**

## Aspergillosis

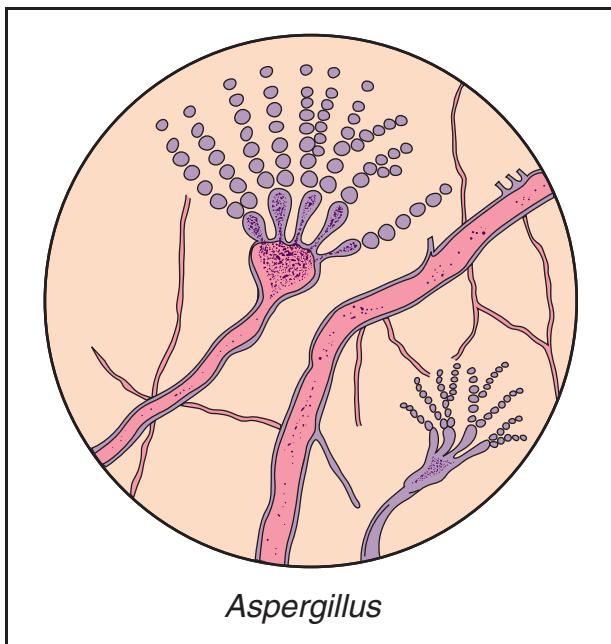
### Definition

Aspergillosis refers to several forms of disease caused by a fungus in the genus *Aspergillus*. Aspergillosis fungal infections can occur in the ear canal, eyes, nose, sinus cavities, and lungs. In some individuals, the infection can even invade bone and the membranes that enclose the brain and spinal cord (**meningitis**).

### Description

Aspergillosis is primarily an infection of the lungs caused by the inhalation of airborne spores of the fungus *Aspergillus*. Spores are the small particles that most fungi use to reproduce. Although virtually everyone is exposed to this fungus in their daily environment, it rarely causes disease. When *Aspergillus* does cause disease, however, it usually occurs in those individuals with weakened immune systems (immunocompromised) or who have a history of respiratory ailments. Because it does not present distinctive symptoms, aspergillosis is generally thought to be underdiagnosed and underreported. Furthermore, many patients with the more severe forms of aspergillosis tend to have multiple, complex health problems, such as **AIDS** or a blood disorder like leukemia, which can further complicate diagnosis and treatment.

Once considered particularly rare, the incidence of reported aspergillosis has risen somewhat with the development of more sophisticated methods of diagnosis and advances made in other areas of medicine, such as with



**Aspergillosis is an infection of the lungs caused by inhalation of airborne spores of the fungus *Aspergillus*.** (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

the increased use of certain chemotherapeutic and corticosteroid drugs that are extremely useful in treating various types of **cancer** but that decrease the individual's immune response, making them more susceptible to other diseases like aspergillosis.

Our advanced ability to perform tissue and organ transplants has also increased the number of people vulnerable to fungal infections. Transplant recipients, particularly those receiving bone marrow or heart transplants, are highly susceptible to *Aspergillus*, which may be circulating in the hospital air.

Aspergillosis can be a serious, potentially deadly threat for two primary reasons:

- Aspergillosis usually occurs in those individuals who are already ill or have weakened immune systems, such as patients who have undergone chemotherapy for cancer.
- None of the currently available antifungal drugs are reliably effective against *Aspergillus*.

### Causes and symptoms

Airborne *Aspergillus* spores enter the body primarily through inhalation but can also lodge in the ear or eye. Normally functioning immune systems are generally able to cope without consequent development of aspergillosis.

It is important to make distinctions between the various forms of aspergillosis, as the treatment and prognosis varies considerably among types. Aspergillosis as a diagnosis refers to three general forms:

- Allergic bronchopulmonary aspergillosis (ABPA) is seen in patients with long-standing asthma, particularly in patients taking oral corticosteroids for a long period of time. This is usually the least serious and most treatable form.
- Aspergilloma refers to the mass formed when fungal spores settle into or colonize areas of the lung that have been pitted and scarred as a result of tuberculosis or prior pneumonia. There are several available treatments, although the success rate varies with each treatment.
- Invasive fungal infection refers to rare cases in which the fungus spreads throughout the body via the blood stream and invades other organ systems. Once established, invasive fungal infections are extremely difficult to cure and, as a result, the associated death rate is extremely high.

### Diagnosis

Aspergillosis can be quite difficult to diagnose because the symptoms, such as coughing and **wheezing**, if present at all, are common to many respiratory disorders. Furthermore, blood and sputum cultures are not very helpful. The presence of *Aspergillus* is so common, even in asthmatics, that a positive culture alone is insufficient for a diagnosis. Other, potentially more useful, screening tools include examining the sample obtained after repeatedly washing the bronchial tubes of the lung with water (bronchial lavage), but examining a tissue sample (biopsy) is the most reliable diagnostic tool. Researchers are currently attempting to develop a practical, specific, and rapid blood test that would confirm *Aspergillus* infection.

Signs of ABPA include a worsening of bronchial **asthma** accompanied by a low-grade **fever**. Brown flecks or clumps may be seen in the sputum. **Pulmonary function tests** may show decreased blood flow, suggesting an obstruction within the lungs. Elevated blood levels of an antibody produced in response to *Aspergillus* and of certain immune system cells may indicate a specific allergic-type immune system response.

A fungal mass (aspergilloma) in the lung usually does not produce clear symptoms and is generally diagnosed when seen on chest x rays. However, 70% or more of patients spit up blood from the lungs (**hemoptysis**) at least once, and this may become repetitive and serious. Hemoptysis, then, is another indication that the patient may be suffering from an aspergilloma.

## KEY TERMS

**Antibody**—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

**Aspergilloma**—A ball or mass made of *Aspergillus* fungi that can form in the lungs of patients with suppressed immune systems.

**Bronchial lavage**—A procedure that involves repeatedly washing the inside of the bronchial tubes of the lung.

**Hemoptysis**—Spitting up blood from the lungs or sputum stained with blood.

**Immunocompromised**—A state in which the immune system is suppressed or not functioning properly.

**Meningitis**—Inflammation of the membranes covering the brain and spinal cord, called the meninges.

**Nebulizer**—A device that produces an extremely fine mist that is readily inhalable.

**Spores**—The small, thick-walled reproductive structures of fungi.

**Sputum**—Mucus and other matter coughed up from the airways.

In patients with lowered immune systems who are at risk for developing invasive aspergillosis, the physician may use a combination of **blood culture** with visual diagnostic techniques, such as **computed tomography scans** (CT) and radiography, to arrive at a likely diagnosis.

### Treatment

The treatment method selected depends on the form of aspergillosis. ABPA can usually be treated with many of the same drugs used to treat asthma, such as systemic **steroids**. Long-term therapy may be required, however, to prevent recurrence. Antifungal agents are not recommended in the treatment of ABPA. In cases of aspergilloma, it may become necessary to surgically remove or reduce the size of a fungal mass, especially if the patient continues to spit up blood. In aspergillosis cases affecting the nose and nasal sinuses, surgery may also be required.

In non-ABPA cases, the use of antifungal drugs may be indicated. In such cases, amphotericin B (Fungizone) is the first-line therapy. The prescribed dose will depend on the patient's condition but usually begins with a small test dose and then escalates. Less than one-third of patients are likely to respond to amphotericin B, and its side effects often limit its use. For patients who do not respond to oral amphotericin B, another option is a different formulation of the same drug called liposomal amphotericin B.

For patients who fail to respond or who cannot tolerate amphotericin B, another drug called itraconazole (Sporanox), given 400–600 mg daily, has also been approved. Treatment generally lasts about 3 months. Giving itraconazole can produce adverse reactions if prescribed in combination with certain other drugs by increasing the concentrations of both drugs in the

blood and creating a potentially life-threatening situation. Even **antacids** can significantly affect itraconazole levels. As a result, drug levels must be continually monitored to ensure that absorption is occurring at acceptable levels.

Two other methods of treatment are being studied: direct instillation of an antifungal agent into the lungs and administration of antifungals using a nebulizer. Instilling or injecting amphotericin B or itraconazole directly into the lung cavity or into the fungal ball (aspergilloma) itself has been helpful in stopping episodes of hemoptysis, but not in preventing future recurrences. Furthermore, many patients with aspergillomas are poor risks for surgery because their lung function is already compromised. As a result, instillation of a fungal agent should only be considered in those who have significant hemoptysis.

A popular method of treating some respiratory disorders is to add a liquid drug to another carrier liquid and aerosolize or produce a fine mist that can be inhaled into the lungs through a device called a nebulizer. However, this has not yet been shown to improve the patient's condition in cases of aspergillosis, possibly because the drug is not reaching the aspergilloma.

At this point, preventative therapy for aspergillosis is not suggested for susceptible individuals, primarily because overuse of the drugs used to fight fungal infections may lead to the development of drug-resistant aspergillosis against which current antifungal drugs are no longer effective.

### Prognosis

The likelihood of recovery from aspergillosis depends on any underlying medical conditions, the

patient's general health, and the specific type of aspergillosis. If the problem is based on an allergic response, as in ABPA, the patient will likely respond well to systemic steroids.

Patients who require **lung surgery**, especially those who have problems with coughing up blood, have a mortality rate of about 7-14%, and complications or recurrence may result in a higher overall **death** rate. However, by treating aspergilloma with other, non-surgical methods, that risk rises to 26%, making surgery a better option in some cases.

Unfortunately, the prognosis for the most serious form, invasive aspergillosis, is quite poor, largely because these patients have little resilience due to their underlying disorders. Death rates have ranged from about 50% in some studies to as high as 95% for bone-marrow recipients and patients with AIDS. The course of the illness can be rapid, resulting in death within a few months of diagnosis.

## Prevention

Fungal infection by *Aspergillus* presents a major challenge, particularly in the patient with a suppressed immune system (immunocompromised). Hospitals and government health agencies continually seek ways to minimize exposure for hospitalized patients. Practical suggestions are minimal but include moving leaf piles away from the house. Unfortunately, overall avoidance of this fungus is all but impossible because it is present in the environment virtually everywhere. Research efforts are being directed at enhancing patients' resistance to *Aspergillus* rather than trying to eliminate exposure to the fungus. Given the growing number of people with immune disorders or whose immune systems have been suppressed in the course of treating another disease, research and clinical trials for new antifungal agents will be increasingly important in the future.

## Resources

### OTHER

"Lung, Allergic and Immune Diseases: Mold Allergy: Prevention Techniques." National Jewish Medical and Research. <http://nationaljewish.org/main.html>.

Office of Rare Diseases (ORD) at National Institutes of Health, Bldg. 31, Rm. 1B03, Bethesda, MD 20892-2082. (301) 402-4336, <http://rarediseases.org>.

### ORGANIZATIONS

American College of Allergy, Asthma & Immunology, 85 West Algonquin Road, Suite 550, Arlington Heights, IL, 60005, (847) 427-1200, (847) 427-1294, mail [@acaai.org](http://acaai.org), <http://acaai.org>.

Jill S. Lasker

## Aspirin

### Definition

Aspirin is a medicine that relieves **pain** and reduces **fever**.

### Purpose

Aspirin is used to relieve many kinds of minor aches and pains—headaches, toothaches, muscle pain, menstrual cramps, the joint pain from arthritis, and aches associated with colds and flu. Some people take aspirin daily to reduce the risk of **stroke**, **heart attack**, or other heart problems.

### Description

Aspirin, also known as acetylsalicylic acid—is sold over the counter and comes in many forms, from the familiar white tablets to chewing gum and rectal suppositories. Coated, chewable, buffered, and extended release forms are available. Many other over-the-counter medicine contain aspirin. Alka-Seltzer Original Effervescent Antacid Pain Reliever, for example, contains aspirin for pain relief and sodium bicarbonate to relieve acid **indigestion**, **heartburn**, and sour stomach.

Aspirin belongs to a group of drugs called salicylates. Other members of this group include sodium salicylate, choline salicylate, and magnesium salicylate. These drugs are more expensive and no more effective than aspirin. However, they are a little easier on the stomach. Aspirin is quickly absorbed into the bloodstream and provides quick and relatively long-lasting pain relief. Aspirin also reduces inflammation. Researchers believe these effects come about because aspirin blocks the production of pain-producing chemicals called prostaglandins.

In addition to relieving pain and reducing inflammation, aspirin also lowers fever by acting on the part of the brain that regulates temperature. The brain then signals the blood vessels to widen, which allows heat to leave the body more quickly.

### Recommended dosage

#### Adults

**TO RELIEVE PAIN OR REDUCE FEVER.** One to two tablets every three to four hours, up to six times per day.

**TO REDUCE THE RISK OF STROKE.** One tablet four times a day or two tablets twice a day.

## KEY TERMS

**Diuretic**—Medicine that increases the amount of urine produced and relieves excess fluid buildup in body tissues. Diuretics may be used in treating high blood pressure, lung disease, premenstrual syndrome, and other conditions.

**Inflammation**—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

**NSAIDs**—Nonsteroidal anti-inflammatory drugs. Drugs such as ketoprofen and ibuprofen which relieve pain and reduce inflammation.

**Polyp**—A lump of tissue protruding from the lining of an organ, such as the nose, bladder, or intestine. Polyps can sometimes block the passages in which they are found.

**Prostaglandin**—A hormonelike chemical produced in the body. Prostaglandins have a wide variety of effects, and may be responsible for the production of some types of pain and inflammation.

**Reye's syndrome**—A life-threatening disease that affects the liver and the brain and sometimes occurs after a viral infection, such as flu or chickenpox. Children or teenagers who are given aspirin for flu or chickenpox are at increased risk of developing Reye's syndrome.

**Rhinitis**—Inflammation of the membranes inside the nose.

**Salicylates**—A group of drugs that includes aspirin and related compounds. Salicylates are used to relieve pain, reduce inflammation, and lower fever.

**TO REDUCE THE RISK OF HEART ATTACK.** Check with a physician for the proper dose and number of times per week aspirin should, if at all, be taken.

### Children

Check with a physician.

### Precautions

Aspirin, even children's aspirin, should never be given to children or teenagers with flu-like symptoms or **chickenpox**. Aspirin can cause **Reye's syndrome**, a life-threatening condition that affects the nervous system and liver. As many as 30% of children and teenagers who develop Reye's syndrome die. Those who survive may have permanent brain damage.

Check with a physician before giving aspirin to a child under 12 years for arthritis, rheumatism, or any condition that requires long-term use of the drug.

No one should take aspirin for more than 10 days in a row unless told to do so by a physician. Anyone with fever should not take aspirin for more than 3 days without a physician's consent. Do not to take more than the recommended daily dosage.

People in the following categories should not use aspirin without first checking with their physician:

- Pregnant women. Aspirin can cause bleeding problems in both the mother and the developing fetus. Aspirin can also cause the infant's weight to be too low at birth.
- Women who are breastfeeding. Aspirin can pass into breast milk and may affect the baby.

- People with a history of bleeding problems.
- People who are taking blood-thinning drugs, such as warfarin (Coumadin).
- People with a history of ulcers.
- People with a history of asthma, nasal polyps, or both. These people are more likely to be allergic to aspirin.
- People who are allergic to fenoprofen, ibuprofen, indomethacin, ketoprofen, meclofenamate sodium, naproxen, sulindac, tolmetin, or the orange food-coloring tartrazine. They may also be allergic to aspirin.
- People with AIDS or AIDS-related complex who are taking AZT (zidovudine). Aspirin can increase the risk of bleeding in these patients.
- People taking certain other drugs (discussed in Interactions).
- People with liver damage or severe kidney failure.

Aspirin should not be taken before surgery, as it can increase the risk of excessive bleeding. Anyone who is scheduled for surgery should check with his or her surgeon to find out how long before surgery to avoid taking aspirin.

Aspirin can cause stomach irritation. To reduce the likelihood of that problem, take aspirin with food or milk or drink a full 8-oz glass of water with it. Taking coated or buffered aspirin can also help. Be aware that drinking alcohol can make the stomach irritation worse.

Stop taking aspirin immediately and call a physician if any of these symptoms develop:

- ringing or buzzing in the ears
- hearing loss
- dizziness
- stomach pain that does not go away

Do not take aspirin that has a vinegary smell. That is a sign that the aspirin is too old and ineffective.

Because aspirin can increase the risk of excessive bleeding, do not take aspirin daily over long periods—to reduce the risk of stroke or heart attack, for example—unless advised to do so by a physician.

### Side effects

The most common side effects include **stomach-ache**, heartburn, loss of appetite, and small amounts of blood in stools. Less common side effects are **rashes**, **hives**, fever, vision problems, liver damage, thirst, stomach ulcers, and bleeding. People who are allergic to aspirin or those who have **asthma**, **rhinitis**, or polyps in the nose may have trouble breathing after taking aspirin.

### Interactions

Aspirin may increase, decrease, or change the effects of many drugs. Aspirin can make drugs such as methotrexate (Rheumatrex) and valproic acid (Depakote, Depakene) more toxic. If taken with blood-thinning drugs, such as warfarin (Coumadin) and dicumarol, aspirin can increase the risk of excessive bleeding. Aspirin counteracts the effects of other drugs, such as angiotensin-converting enzyme (ACE) inhibitors and **beta blockers**, which lower blood pressure, and medicines used to treat **gout** (probencid and sulfinpyrazone). Blood pressure may drop unexpectedly and cause **fainting** or **dizziness** if aspirin is taken along with nitroglycerin tablets. Aspirin may also interact with **diuretics**, diabetes medicines, other **non-steroidal anti-inflammatory drugs** (NSAIDs), seizure medications, and **steroids**. Anyone who is taking these drugs should ask his or her physician whether they can safely take aspirin.

### Resources

#### OTHER

Aspirin. PubMed Health, National Library of Medicine.  
<http://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0000802> (accessed November 23, 2010).

Nancy Ross-Flanigan

**AST** see **Aspartate aminotransferase test**

**Astemizole** see **Antihistamines**

## Asthma

### Definition

Asthma is a chronic (long-lasting) inflammatory disease of the airways. In those susceptible to asthma, this inflammation causes the airways to spasm and swell periodically so that the airways narrow. The individual then must wheeze or gasp for air. Obstruction to air flow either resolves spontaneously or responds to a wide range of treatments, but continuing inflammation makes the airways hyper-responsive to stimuli such as cold air, **exercise**, dust mites, pollutants in the air, and even **stress** and **anxiety**.

### Demographics

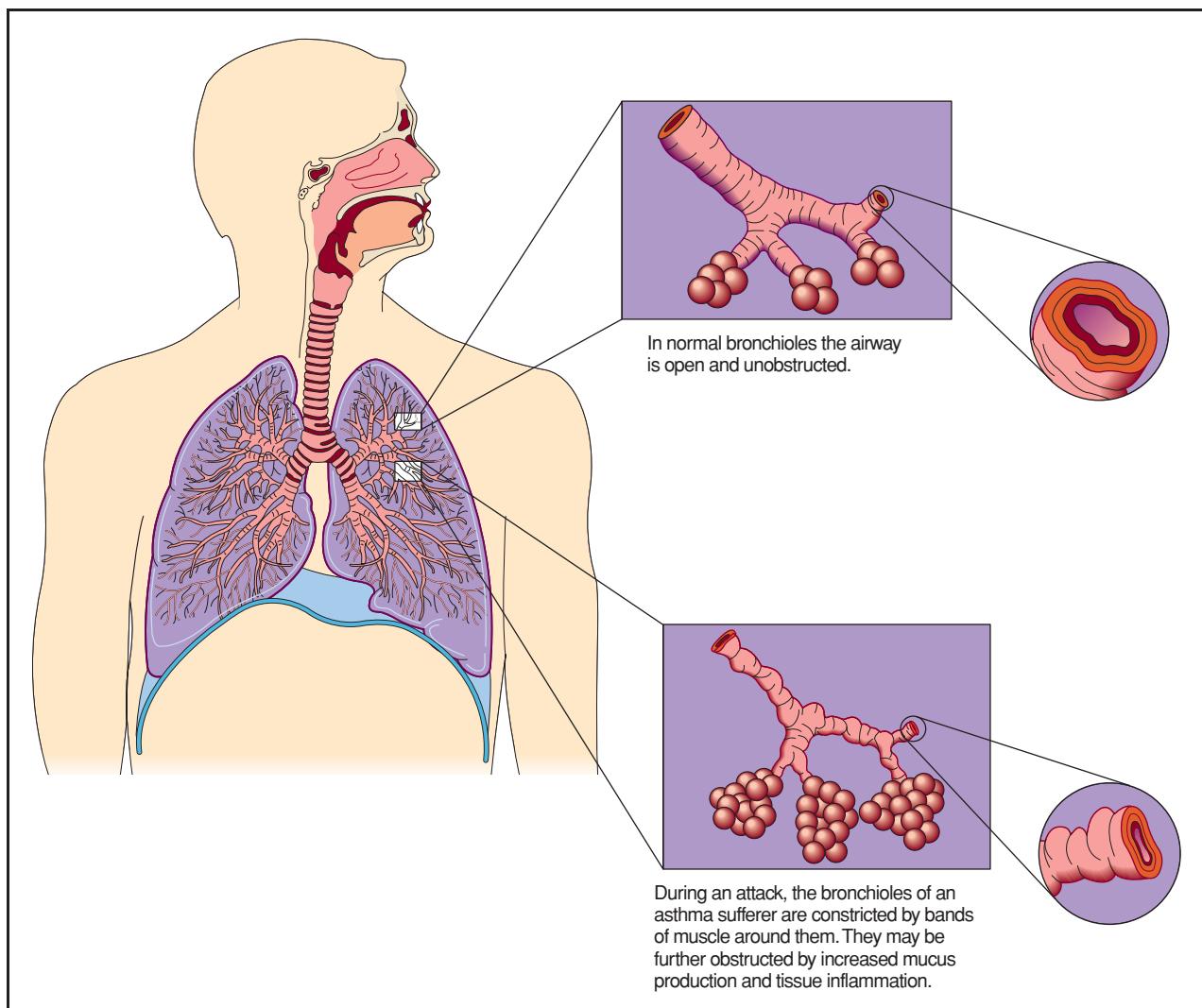
Asthma is common in industrialized countries. In the United States, it is estimated to affect between 10% and 15% of the population. This number appears to be both increasing, especially among children under age 6, while at the same time the disease is becoming more severe. Asthma is estimated to cause between 3,500 and 5,000 deaths annually in the United States. In 2007, it was responsible for 217,000 emergency room visits and 10.4 million office visits. Its estimated cost to the United States economy is about \$20 billion. Worldwide, asthma is estimated to affect 300 million people.

About two-thirds of all cases of asthma are diagnosed in people under age 18, but asthma also may first appear during adult years. More women than men are diagnosed with adult-onset asthma. While the symptoms may be similar, certain important aspects of asthma differ in children and adults.

### Description

The changes that take place in the lungs of people with asthma makes the airways (the “breathing tubes,” or bronchi and the smaller bronchioles) hyper-reactive to many different types of stimuli that do not affect healthy lungs. In an asthma attack, the muscle tissue in the walls of bronchi go into spasm, and the cells lining the airways swell and secrete mucus into the airways. Both these actions cause the bronchi to become narrowed (bronchoconstriction). As a result, an asthmatic person has to make a much greater effort to breathe in air and to expel it.

Cells in the bronchial walls, called mast cells, release certain substances that cause the bronchial muscle to contract and stimulate mucus formation. These substances, which include histamine and a group of chemicals called leukotrienes, also bring white blood cells into the area, which is a key part of the inflammatory response.



**A comparison of normal bronchioles and those of an asthma sufferer.** (Illustration by Hans & Cassady, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)

Many individuals with asthma are sensitized to react to such “foreign” substances as pollen, house dust mites, or animal dander; these substances are called allergens. On the other hand, asthma affects many individuals who are not allergic in this way.

#### Risk factors

Asthma is closely linked to **allergies**; about 75% of people with asthma also have allergies.

#### Child-onset asthma

About 9 million American children have been diagnosed with asthma. Approximately 20% of cases begin in the first year of life. When asthma begins in childhood, it often does so in a child who is likely, for genetic reasons,

to become sensitized to common allergens in the environment (an atopic person). When these children are exposed to dust mites, animal proteins (i.e., animal hair, dander), mold, or other potential allergens, they produce a type of antibody that is intended to engulf and destroy the foreign materials. This has the effect of making the airway cells sensitive to particular materials. Further exposure can lead rapidly to an asthmatic response. This condition, called atopy, is present in at least one-third and as many as one-half of the general population.

#### Adult-onset asthma

Allergies also may play a role when adults become asthmatic. Adults who develop asthma may be exposed

## KEY TERMS

**Allergen**—A foreign substance, such as mites in house dust or animal dander which, when inhaled, causes the airways to narrow and produces symptoms of asthma.

**Atopy**—A state that makes persons more likely to develop allergic reactions of any type, including the inflammation and airway narrowing typical of asthma.

**Beta blockers**—Drugs used to treat high blood pressure (hypertension) that limit the activity of

epinephrine, a hormone that increases blood pressure.

**Hypersensitivity**—The state where even a tiny amount of allergen can cause the airways to constrict and bring on an asthmatic attack.

**Spirometry**—A test using an instrument called a spirometer that shows how difficult it is for an asthmatic individual to breathe. It is used to determine the severity of asthma and to see how well it is responding to treatment.

to allergens in the workplace, such as certain forms of plastic, solvents, and wood dust. Other adults may be sensitive to **aspirin, nonsteroidal anti-inflammatory drugs** (NSAIDs, such as ibuprofen), or other drugs. Compared to childhood-onset asthma, adult-onset asthma tends to be more continuous, while childhood asthma often is marked by asthmatic episodes followed by asthma-free periods.

### *Exercise-induced asthma*

People who do not have allergies can still develop a form of asthma that is brought on by aerobic exercise. These episodes can last for several minutes and leave the individual gasping for breath. Some estimates suggest that 12–15% of Americans who do not have allergies are susceptible to exercise-induced asthma; rates of 40–90% have been reported in individuals who do have allergies. Inhaling cold air, aerobic exercise lasting more than 10 minutes, or shorter periods of very heavy aerobic exercise, tend to trigger an exercise-induced asthma attack in susceptible individuals. Polluted air and certain chemicals (e.g., chlorine in pools, herbicides on a playing field) appear to increase the likelihood of an asthma episodes in sensitive individuals.

### **Causes and symptoms**

In most cases, asthma is caused by inhaling an allergen to which the individual is hypersensitized. This sets off the chain of biochemical and tissue changes leading to airway inflammation, bronchoconstriction, and **wheezing**. Avoiding or at least minimizing exposure to asthma triggers is the most effective way of treating asthma, so it is helpful to identify which specific allergen or irritant is causing symptoms in a particular individual. Once asthma is present, symptoms may be triggered or aggravated if the

individual also has **rhinitis** (inflammation of the lining of the nose as from allergies) or **sinusitis** (sinus inflammation). When stomach acid passes back up the esophagus (acid reflux), this also may worsen asthma symptoms. A viral infection of the respiratory tract (e.g., a cold) also may trigger or worsen an asthmatic reaction. Aspirin, NSAIDs, and beta-blocker drugs also may worsen the symptoms of asthma.

The most common inhaled allergens that trigger asthma attacks are:

- animal dander
- mites in house dust
- fungi (molds) that grow indoors
- cockroach allergens
- pollen
- chemicals, fumes, or airborne industrial pollutants
- smoke

Inhaling tobacco smoke, either by **smoking** or being around people who are smoking, can irritate the airways and trigger an asthmatic attack. Air pollutants such as wood smoke can have a similar effect. In addition, three factors that regularly produce attacks in certain asthmatic individuals, and may sometimes be the sole cause of symptoms are:

- inhaling cold air (cold-induced asthma)
- exercise-induced asthma
- stress or a high level of anxiety

Wheezing is often obvious, but mild asthma attacks may be confirmed only when the physician listens to the individual's chest with a stethoscope. Besides wheezing and being short of breath, the individual may **cough** and/or may report a feeling of “tightness” in the chest. Wheezing is often loudest when the individual breathes out (exhales) in an attempt to expel air through the narrowed airways.

Some people with asthma are free of symptoms most of the time but occasionally may have episodes of **shortness of breath**. Others spend much of their time wheezing or have frequent bouts of shortness of breath until properly treated. Crying or laughing may bring on an attack. Severe episodes often develop when the individual has a viral respiratory tract infection or is exposed to a heavy load of an allergen or irritant (e.g., breathing in smoke from a campfire). Asthma attacks may last only a few minutes or can continue for hours or even days (a condition called status asthmaticus).

Being short of breath may cause an individual to become visibly anxious, sit upright, lean forward, and use the muscles of the neck and chest wall to help move air in and out of the lungs. The individual may be able to say only a few words at a time before stopping to take a breath. Confusion and a bluish tint to the skin are clues that the oxygen supply is seriously low and that emergency treatment is needed. In a severe attack that lasts for an extended period, some of the air sacs in the lung may rupture so that air collects within the chest. This makes it even harder for the lungs to exchange enough air.

## Diagnosis

The physician will ask about a family history of asthma or allergies. A diagnosis of asthma may be strongly suggested when typical signs and symptoms are present. Apart from listening to the individual's chest, the examiner should look for maximum chest expansion while taking in air. Hunched shoulders and contracted neck muscles are other signs of narrowed airways. **Nasal polyps** or increased amounts of nasal secretions often are noted in asthmatic individuals. Skin changes, such as **atopic dermatitis** or **eczema**, are indications that the individual is likely to allergies.

## Tests

A test called **spirometry** measures how rapidly air is exhaled and how much air is retained in the lungs. Repeating the test after the individual inhales a bronchodilator drug that widens the airways will show whether the airway narrowing is reversible, which is a very typical finding in asthma. Often individuals use a related instrument, called a peak flow meter, to keep track of asthma severity when at home.

It often is difficult to determine what is triggering asthma attacks. Allergy skin testing may be used, although an allergic skin response does not always mean that the allergen being tested is causing the asthma. The body's immune system produces specific antibody to fight off each allergen. Measuring the

amount of a specific antibody in the blood may indicate how sensitive the individual is to a particular allergen. If the diagnosis is still in doubt, the individual can inhale a suspect allergen while using a spirometer to detect airway narrowing. Spirometry also can be repeated after a bout of exercise when exercise-induced asthma is suspected. A **chest x ray** may be done to help rule out other lung disorders.

## Treatment

The goals of asthma treatment are to prevent troublesome symptoms, maintain lung function as close to normal as possible, and allow individuals to pursue their normal activities including those requiring exertion. Individuals should periodically be examined and have their lung function measured by spirometry to make sure that treatment goals are being met. The best drug therapy is that which controls asthmatic symptoms while causing few or no side effects. Many people with asthma are treated with a combination of long-acting drugs taken on a regular basis to help prevent asthma attacks and short-acting (quick relief) drugs given by inhaler to reduce the immediate symptoms of an attack.

## Drugs

The choice of initial drug treatment often depends on whether the asthma is classified as intermittent, mildly persistent, moderately persistent, or severely persistent, the age of the individual, other medical conditions that may be present, and other drugs the patient may be taking. It may take several attempts to find the best combination of drugs to control the asthma.

### BETA-RECEPTOR AGONISTS (BRONCHODILATORS).

These drugs, which relax the airways, often are the best choice for relieving sudden attacks of asthma and for preventing attacks of exercise-induced asthma. Some **bronchodilators**, such as albuterol (Ventolin, Proventil) and levalbuterol (Xopenex), act mainly in lung cells and have little effect on other organs. Bronchodilators occasionally may be taken orally (i.e., pills or liquid), but normally they are administered through inhalers. The inhaled drugs go directly into the lungs and cause fewer side effects. These drugs generally start acting within minutes, but their effects last only four to six hours.

Long-acting beta agonists (LABAs) have been developed that can last up to 12 hours. These include salmeterol (Serevent Diskus), fluticasone/salmeterol (Advair Diskus), arformoterol (Brovana), formoterol (Perforomist, Foradil), and budesonide/formoterol

(Symbacort). In December 2008, the United States Food and Drug Administration (FDA) issued a warning that LABAs may increase the chance of severe asthma episodes and asthma-caused **death**, but was divided on whether these drugs should be banned for use in children. As of early 2009, LABAs were not recommended as a first-line treatment for asthma or for use alone (i.e., without inhaled **steroids**) as an asthma treatment. The FDA strongly recommends that people taking LABAs discuss the risks and benefits with their physician in light of emerging information about their safety.

**LEUKOTRIENE RECEPTOR ANTAGONISTS.** The leukotriene receptor antagonists such as montelukast (Singulair), zafirlukast (Accolate), and Zyllo (zileuton) control inflammation of the airways by blocking the action of leukotrienes, which are chemicals involved in producing inflammation. These drugs are tablets taken by mouth on a regular basis to treat or prevent symptoms of asthma and exercise-induced asthma. In March 2008, the FDA released a preliminary warning that Singulair might cause behavior and mood changes, suicidal thinking and behavior, and **suicide**. The warning was preliminary, meaning a cause and effect relationship between these adverse reactions and the drug had not been definitely established, and that more information was needed. The FDA recommended that individuals taking Singulair or any other leukotriene receptor antagonist drug should be alert to these behavioral side effects but not stop taking these drugs until they had discussed their condition with a physician.

**CORTICOSTEROIDS.** These drugs, which resemble natural body hormones, block inflammation and are often effective in relieving symptoms of chronic asthma and preventing asthma episodes, but they generally are not used to treat asthma attacks once they have begun. Examples include fluticasone (Flovent), triamcinolone (Azmacort), and beclomethasone (Vanceril, Beclovent, QVAR) all of which are taken by inhalation. When **corticosteroids** are taken by inhalation over a long time, asthma attacks become less frequent as the airways become less sensitive to allergens. Prednisone (Deltasone, Orasone, Meticorten) is given by mouth (i.e., pills) to speed recovery after treatment of initial symptoms of an asthma attack and sometimes to treat chronic asthma.

Corticosteroids are strong drugs and usually can control even severe cases of asthma over the long term and maintain good lung function. Corticosteroids may cause numerous side effects, however, including bleeding from the stomach, loss of **calcium** from bones,

**cataracts** in the eye, and a diabetes-like state. Individuals using corticosteroids for lengthy periods also may have problems with wound healing, may gain weight, and may experience psychological problems. In children, growth may be slowed.

**OTHER DRUGS.** Cromolyn (Intal) and nedocromil (Tilade) are anti-inflammatory drugs that affect mast cells. They may be used as initial treatment to prevent asthmatic attacks. They may also prevent attacks when given before exercise or when exposure to an allergen cannot be avoided. To be effective, these drugs must be taken regularly even if there are no asthma symptoms. Anticholinergic drugs, such as atropine, may be useful in controlling severe attacks when added to an inhaled beta-receptor agonist. They help widen the airways and suppress mucus production.

#### *Managing asthmatic attacks*

A severe asthma attack should be treated as quickly as possible; professional emergency medical assistance may be needed, as an individual experiencing an acute attack may need to be given extra oxygen. Rarely is it necessary to use a mechanical ventilator to help the individual breathe. An inhaler, usually containing a beta-receptor agonist, is inhaled repeatedly or continuously. If the individual does not respond promptly and completely, a corticosteroid may be given. A course of corticosteroid therapy, given after the attack is over, may make a recurrence less likely.

Many asthma experts recommend a device called a “spacer” to be used along with metered-dose inhalers. The spacer is a tube or bellows-like device held in or around the mouth into which the metered-dose inhaler is puffed. This device enables more medication from a metered-dose inhaler to reach the lungs.

#### *Maintaining control*

Long-term asthma treatment is based on inhaling appropriate drugs using a special inhaler that meters the dose. Individuals must be instructed in proper use of an inhaler to be sure that it will deliver the right amount of drug. Once asthma has been controlled for several weeks or months, a physician may recommend that the patient gradually cut down on drug treatment. The last drug added usually is the first to be reduced. Individuals should be seen by their physician every one to six months, or as needed, depending on the frequency of asthma episodes.

School-age and older children may also be prescribed peak flow meters, simple devices which measure how easy or difficult it is for a person to exhale.

With home peak-flow monitoring, it is possible for many children with asthma to discern at an early stage that a flare-up is just beginning and adjust their medications appropriately.

Individuals with asthma do best when they have a written action plan to follow if symptoms suddenly become worse. This plan should address how to adjust their medication and when to seek medical help. A 2004 report found that individuals with self-management written action plans had fewer hospitalizations, fewer emergency department visits, and improved lung function. They also had a 70% lower mortality rate.

Referral to an asthma specialist should be considered if:

- a life-threatening asthma attack has occurred or if asthma is severe and persistent
- treatment for three to six months has not met its goals
- some other condition, such as nasal polyps or chronic lung disease, is complicating asthma treatment
- special tests, such as allergy skin testing or an allergen challenge, are needed
- intensive long-term corticosteroid therapy has been needed to control asthma.

### *Special populations*

**INFANTS AND YOUNG CHILDREN.** It is especially important to closely watch the course of asthma in young individuals. Treatment is cut down when possible, and if there is no clear improvement, treatment should be modified. Asthmatic children often need medication at school to control acute symptoms or to prevent exercise-induced attacks. Parents or guardians of these children should consult the school district on their drug policy in order to assure that a procedure is in place to permit their child to carry an inhaler. The health care provider should write an asthma treatment plan for the child's school. Proper management will usually allow a child to take part in play activities. Only as a last resort should activities be limited.

**THE ELDERLY.** Older persons often have other types of lung disease, such as chronic **bronchitis** or **emphysema**. These must be taken into account when treating asthma symptoms. Side effects from beta-receptor agonist drugs (including a speeding heart and tremor) may be more common in older individuals.

### *Alternative Treatments*

Alternative medicine tends to view asthma as the body's protective reaction to environmental agents and pollutants. As such, the treatment goal is often to restore balance to and strengthen the entire body and provide specific support to the lungs and to the immune and hormonal systems. Individuals with asthma can help by keeping a diary of asthma attacks in order to determine environmental and emotional factors that may be contributing to their condition.

Alternative treatments have minimal side effects, are generally inexpensive, and are convenient forms of self-treatment. They also can be used alongside allopathic (traditional drug treatments) treatments to improve their effectiveness and lessen their negative side effects.

**DIETARY AND NUTRITIONAL THERAPIES.** Some alternative practitioners recommend cutting down on or eliminating dairy products from the diet, as these increase mucus secretion in the lungs and are sources of **food allergies**. Other recommendations include avoiding processed foods, refined starches and sugars, and foods with artificial additives and sulfites. Beneficial **diets** should be high in fresh fruits, vegetables, and whole grains, and low in salt. Individuals with asthma should experiment with their diets to determine if food allergies are playing a role in their asthma. Some studies have shown that a sustained vegan diet can be effective in controlling asthma.

Individuals with asthma also should stay well hydrated by drinking plenty of water, as water helps to keep the passages of the lungs moist. Onions and garlic contain quercetin, a flavonoid (a chemical compound/biological response modifier) that inhibits the release of histamine, and should be a part of an asthmatic's diet. Quercetin is also available as a supplement and should be taken with a digestive enzyme to increase its absorption.

As nutritional therapy, **vitamins** A, C, and E have been touted as important treatments for asthma. Also, the B complex vitamins, particularly B<sub>6</sub> and B<sub>12</sub>, may be helpful for individuals with asthma, as well as magnesium, selenium, and an omega-3 fatty acid supplement such as flaxseed oil. A good multivitamin supplement also is recommended.

### *Herbal remedies*

Chinese medicine has traditionally used *ma huang* for asthma attacks. Ma huang contains ephedrine, a bronchodilator that was once used in many drugs. However, the FDA issued a ban on the sale of ephedra that took effect in April 2004 because it was shown to

raise blood pressure and stress the circulatory system, resulting in heart attacks and strokes for some users. Manufacturers of ephedra raised legal challenges to this decision. When the U. S. Supreme Court refused to hear these challenges in 2007, however, the ban on ephedra became permanent.

Another herbal product, ginkgo, has been shown to reduce the frequency of asthma attacks, and licorice is used in **traditional Chinese medicine** as a natural decongestant and expectorant. There are many formulas used in traditional Chinese medicine to prevent or ease asthma attacks, depending on the specific Chinese diagnosis given by the practitioner.

Other herbs used for asthma include lobelia, also called Indian tobacco; nettle, which contains a natural antihistamine; thyme, mullein, feverfew, passionflower, **saw palmetto** and Asian **ginseng**. Coffee and tea have been shown to reduce the severity of asthma attacks because **caffeine** works as a bronchodilator. Tea also contains minute amounts of theophylline, a drug used to treat asthma. Ayurvedic (traditional East Indian) medicine recommends the herb *Tylophora asthmatica*.

### *Mind/body approaches*

Mind/body medicine has demonstrated that psychological factors play a complex role in asthma. Emotional stress can trigger asthma attacks. Mind/body techniques strive to reduce stress and help asthma sufferers manage the psychological component of their condition. **Biofeedback** is a treatment method that uses monitors to reveal physiological information to patients, to teach relaxation and deep breathing methods that may help people with asthma. Some other mind/body techniques used for asthma include relaxation methods, **meditation**, **hypnotherapy**, mental imaging, **psychotherapy**, and visualization.

### *Yoga and breathing methods*

Some studies have shown that **yoga** significantly helps people with asthma by teaching exercises specifically designed to expand the lungs, promote deep breathing, and reduce stress. Pranayama is the yogic science of breathing, which includes hundreds of deep breathing techniques. These breathing exercises may be done daily as part of any treatment program for asthma, as they are an effective and inexpensive measure.

### *Controlled exercise*

Many people believe that people with asthma should not exercise. This belief is especially common among parents of children with asthma. In a 2004 study, researchers reported that 20% of children with asthma

do not get enough exercise. Many parents believe it is dangerous for their children with asthma to exercise, but physical activity benefits all children, including those with asthma. Parents should work with their children's healthcare providers and any coach or organized sport leader to carefully monitor the children's activities.

### *Acupuncture*

**Acupuncture** can be an effective treatment for asthma. It is used in traditional Chinese medicine along with dietary changes. **Acupressure** also can be used as a self-treatment for asthma attacks and prevention. The Lung 1 points, used to stimulate breathing, can be easily found on the chest. These are sensitive, often knotted spots on the muscles that run horizontally about an inch below the collarbone, and about two inches from the center of the chest. The points can be pressed in a circular manner with the thumbs, while the head is allowed to hang forward and the individual takes slow, deep breaths. **Reflexology** also uses particular acupressure points on the hands and feet that are believed to stimulate the lungs.

### *Other treatments*

Aromatherapists recommend eucalyptus, lavender, rosemary, and chamomile as fragrances that promote free breathing. In Japan, a common treatment for asthma is administering cold baths. This form of **hydrotherapy** has been demonstrated to open constricted air passages. Massage therapies such as **Rolfing** can help individuals with asthma as well, as they strive to open and increase circulation in the chest area. Homeopathy uses the remedies *Arsenicum album*, *Kali carbonicum*, *Natrum sulphuricum*, and *Aconite*.

### *Prognosis*

More than half of all asthma cases in children resolve by young adulthood, but chronic infection, pollution, cigarette smoke, and chronic allergen exposure are factors which make resolution less likely. Infants and toddlers who have persistent wheezing even without viral infections and those who have a family history of allergies are most likely to continue to have asthma into the school-age years.

Most individuals with asthma respond well once the proper drug or combination of drugs is found, and most asthmatics are able to lead relatively normal, active lives. A few individuals will have progressively more trouble breathing and run a risk of going into **respiratory failure**, for which they must receive intensive treatment. Asthma causes between 3,500 and 5,000 deaths in the United States each year.

## Prevention

Exposure to the common allergens and irritants that provoke asthmatic attacks often can be reduced or avoided by implementing the following:

- If the individual is sensitive to a family pet, remove the animal from the home. If this is not acceptable, keep the pet out of the bedroom (with the bedroom door closed), remove carpeting, and keep the animal away from upholstered furniture.
- To reduce exposure to dust mites, remove wall-to-wall carpeting, keep humidity low, and use special covers for pillows and mattresses. Reduce the number of stuffed toys and wash them weekly in hot water.
- If cockroach allergen is causing asthma attacks, killing the roaches using poison, traps, or boric acid is preferable to using sprayed pesticides. Avoid leaving food or garbage exposed to discourage re-infestation.
- Keep indoor air clean by vacuuming carpets once or twice a week (with the asthmatic individual absent). Avoid using humidifiers and use air conditioning during warm weather so that windows can be kept closed. Change heating and air conditioning filters regularly. High-efficiency particulate air (HEPA) filters are available that are very effective in removing allergens from household air.
- Avoid exposure to tobacco or wood smoke.
- Do not exercise outdoors when air pollution levels are high or when air is extremely cold.
- When asthma is related to exposure at work, take all precautions, including wearing a mask and, if necessary, arranging to work in a safer area. Occupational safety and health (OSHA) regulations limit exposure to certain pollutants and potential allergens in the workplace.

## Resources

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Morris, Michael. “Asthma.” eMedicine.com. June 30, 200 [August 18, 2009]. <http://emedicine.medscape.com/article/296301-overview>.

### ORGANIZATIONS

Allergy and Asthma Network: Mothers of Asthmatics (AANMA), 2751 Prosperity Ave., Suite 150, Fairfax,

VA, 22031 (800) 878-4403 (703) 573-7794, <http://www.aanma.org>.

American Academy of Allergy, Asthma, and Immunology (AAAAI), 555 East Wells Street, Suite 1100, Milwaukee, WI, 53202-3823 (414) 272-6071, <http://www.aaaai.org>.

American College of Allergy, Asthma, and Immunology, 85 West Algonquin Road, Suite 550, Arlington Heights, IL, 60005 (847) 427-1200, [mail@acaai.org](mailto:mail@acaai.org), <http://www.acaai.org>.

Asthma and Allergy Foundation of America, 1233 20th Street, NW, Suite 402, Washington, DC, 20036 (800) 7-ASTHMA or (800) 727-8462, [info@aafa.org](mailto:info@aafa.org), <http://www.aafa.org>.

National Institute of Allergy and Infectious Diseases Office of Communications and Government Relations, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612 (301) 496-5717 (866) 284-4107 or TDD: (800) 877-8339 (for hearing impaired) (301) 402-3573, <http://www3.niaid.nih.gov>.

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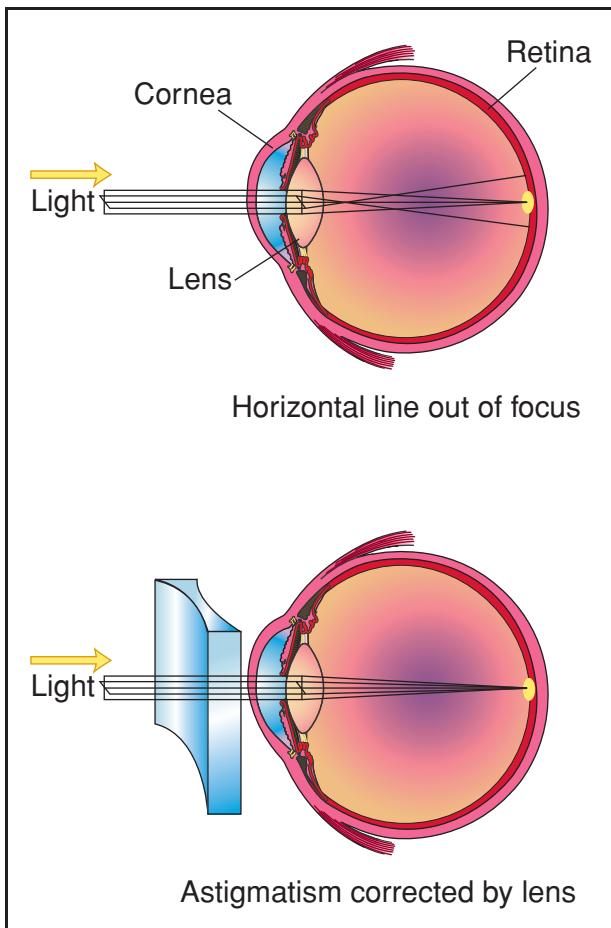
## Astigmatism

### Definition

Astigmatism is the result of an inability of the cornea to properly focus an image onto the retina. The result is a blurred image.

### Description

The cornea is the outermost part of the eye. It is a transparent layer that covers the colored part of the eye (iris), pupil, and lens. The cornea bends light and helps to focus it onto the retina where specialized cells (photo receptors) detect light and transmit nerve impulses via the optic nerve to the brain where the image is formed. The cornea is dome shaped. Any incorrect shaping of the cornea results in an incorrect focusing of the light that passes through that part of the cornea. The bending of light is called refraction and focusing problems with the cornea are called diseases of refraction or refractive disorders. Astigmatism is an image distortion that results from an improperly shaped cornea. Usually the cornea is spherically shaped, like a baseball. However, in astigmatism the cornea is elliptically shaped, more like a football. There is a long meridian and a short meridian. These two meridians generally have a constant curvature and are generally perpendicular to each



**Astigmatism can be treated by the use of cylindrical lenses.**  
**The lenses are shaped to counteract the shape of the sections of the cornea that are causing the difficulty.**  
*(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

other (regular astigmatism). Irregular astigmatism may have more than two meridians of focus and they may not be 90° apart. A point of light, therefore, going through an astigmatic cornea will have two points of focus, instead of one nice sharp image on the retina. This will cause the person to have blurry vision. What the blur looks like will depend upon the amount and the direction of the astigmatism. A person with nearsightedness (**myopia**) or farsightedness (**hyperopia**) may see a dot as a blurred circle. A person with astigmatism may see the same dot as a blurred oval or frankfurter-shaped blur.

Some cases of astigmatism are caused by problems in the lens of the eye. Minor variations in the curvature of the lens can produce minor degrees of astigmatism (lenticular astigmatism). In these patients, the cornea is usually normal in shape. Infants, as a group, have

## KEY TERMS

**Meridian**—A section of a sphere. For example, longitude or latitude on the globe. Or, on a clock, a section going through 12:00-6:00 or 3:00-9:00, etc.

**Refraction**—The turning or bending of light waves as the light passes from one medium or layer to another. In the eye it means the ability of the eye to bend light so that an image is focused onto the retina.

the least amount of astigmatism. Astigmatism may increase during childhood, as the eye is developing.

### Causes and symptoms

The main symptom of astigmatism is blurring. People can also experience headaches and eyestrain. Parents can notice that a child may have astigmatism when the child can see some part of a pattern or picture more clearly than others. For example, lines going across may seem clearer than lines going up and down.

Regular astigmatism can be caused by the weight of the upper eyelid resting on the eyeball creating distortion, surgical incisions in the cornea, trauma or scarring to the cornea, the presence of tumors in the eyelid, or a developmental factor. Irregular astigmatism can be caused by scarring or keratoconus. Keratoconus is a condition in which the cornea thins and becomes cone shaped. It usually occurs around **puberty** and is more common in women. Although the causes of keratoconus are unknown, it may be hereditary or a result of chronic eye rubbing, as in people with **allergies**. The center of the cone may not be in line with the center of the cornea. Diabetes can play a role in the development of astigmatism. High blood sugar levels can cause shape changes in the lens of the eye. This process usually occurs slowly and, often, is only noticed when the diabetic has started treatment to control their blood sugar. The return to a more normal blood sugar allows the lens to return to normal and this change is sometimes noticed by the patient as farsightedness. Because of this, diabetics should wait until their blood sugar is under control for at least one month to allow vision to stabilize before being measured for eyeglasses.

### Diagnosis

Patients seek treatment because of blurred vision. A variety of tests can be used to detect astigmatism

during the eye exam. The patient may be asked to describe the astigmatic dial, a series of lines that radiate outward from a center. People with astigmatism will see some of the lines more clearly than others. One diagnostic instrument used is the keratometer. This measures the curvature of the central cornea. It measures the amount and direction of the curvature. A corneal topographer can measure a larger area of the cornea. It can measure the central area and mid-periphery of the cornea. A keratoscope projects a series of concentric light rings onto the cornea. Misshapen areas of the cornea are revealed by noting areas of the light pattern that do not appear concentric on the cornea. Because these instruments are measuring the cornea, it is also important to have a refraction in case the lens is also contributing to the astigmatism. The refraction measures the optics or visual status of the eye and the result is the eyeglass prescription. The refraction is when the patient is looking at an eye chart and the doctor is putting different lenses in front of the patient's eyes and asks which one looks better.

## Treatment

Astigmatism can be treated by the use of cylindrical lenses. They can be in eyeglasses or **contact lenses**. The unit of measure describing the power of the lens system or lens is called the diopter (D). The lenses are shaped to counteract the shape of the sections of cornea that are causing the difficulty. Because the correction is in one direction, it is written in terms of the axis the correction is in. On a prescription, for example, it may say  $-1.00 \times 180^\circ$ . Cylinders correct astigmatism, minus spheres correct myopia, and plus spheres correct hyperopia.

There is some debate as to whether people with very small amounts of astigmatism should be treated. Generally, if visual acuity is good and the patient experiences no overt symptoms, treatment is not necessary. When treating larger amounts of astigmatism, or astigmatism for the first time, the doctor may not totally correct the astigmatism. The cylindrical correction in the eyeglasses may make the floor appear to tilt, thus making it difficult for the patient at first. Generally, the doctor will place lenses in a trial frame to allow the patient to try the prescription at the exam. It may take a week or so to get used to the glasses, however, if the patient is having a problem they should contact their doctor, who might want to recheck the prescription.

Contact lenses that are used to correct astigmatism are called toric lenses. When a person blinks, the contact lens rotates. In toric lenses, it is important for the lens to return to the same position each time. Lenses

have thin zones, or cut-off areas (truncated), or have other ways to rotate and return to the correct position. Soft toric lenses are available in a variety of prescriptions, materials, and even in tints. Patients should ask their doctors about the possibility of toric lenses.

In 1997, the Food and Drug Administration (FDA) approved laser treatment of astigmatism. Patients considering this should make sure the surgeon has a lot of experience in the procedure and discuss the possible side effects or risks with the doctor. In the case of keratoconus, a corneal transplant is performed if the astigmatism cannot be corrected with hard contact lenses.

## Prognosis

Astigmatism is a condition that may be present at birth. It may also be acquired if something is distorting the cornea. Vision can generally be corrected with eyeglasses or contact lenses. The major risks of surgery (aside from the surgical risks) are over and under correction of the astigmatism. There is no cure for over correction. Under correction can be solved by repeating the operation.

## Resources

### OTHER

Astigmatism. Merck Manual Online. [http://www.merckmanuals.com/home/sec20/ch225/ch225b.html#MMHE\\_20\\_225\\_01](http://www.merckmanuals.com/home/sec20/ch225/ch225b.html#MMHE_20_225_01) (accessed November 23, 2010).

John T. Lohr PhD

## Aston-Patterning

### Definition

Aston-Patterning is an integrated system of movement education, bodywork, ergonomic adjustments, and fitness training that recognizes the relationship between the body and mind for well being. It helps people who seek a remedy from acute or chronic **pain** by teaching them to improve postural and movement patterns.

### Purpose

Aston-Patterning assists people in finding more efficient and less stressful ways of performing the simple movements of everyday life to dissipate tension in the body. This is done through massage, alteration of the environment, and fitness training.

## JUDITH ASTON

Judith Aston was born in Long Beach, California. She graduated from University of California at Los Angeles with a B.A. and a M.F.A. in dance. Her interest in movement arose from working as a dancer. In 1963 Aston established her first movement education program for dancers, actors, and athletes at Long Beach City College.

Five years later, while recovering from injuries sustained during two consecutive automobile accidents, Aston met Ida Rolf, the developer of Rolfing. Aston began working for Rolf, teaching a movement education program called Rolf-Aston Structural Patterning that emphasized using the body with minimum effort and maximum precision.

In time, Rolf and Aston's views on movement diverged, and the partnership was dissolved in 1977. Aston formed her own company called the Aston Paradigm Corporation in Lake Tahoe, California. This company provides training and certification for Aston practitioners. She also began exploring how environmental conditions affect body movement, foreshadowing the ergonomic movement in the workplace that developed in the 1990s. Over time, Aston has expanded her movement work to include a fitness program for older adults. Today, Judith Aston serves as director of Aston Paradigm Corporation. She is the author of the books *Moving Beyond Posture—In Your Body on the Earth*, the *Aston Postural Assessment Workbook*, and the DVD *Aston's Walking the New Body*. More information on her current work can be found at <http://www.astonkinetics.com/>

### Description

Seeking to solve movement problems, Aston-Patterning helps individuals make the most of their own unique body types rather than trying to force them to conform to an ideal. Unlike **Rolfing**, it does not strive for linear symmetry. Rather, it works with asymmetry in the human body to develop patterns of alignment and movement that feel right to the individual. Aston introduced the idea of working in a three-dimensional spinal pattern. Aston-Patterning sessions have four general components:

- A personal history that helps the practitioner assess the client's needs.
- Pre-testing, in which the practitioner and the client explore patterns of movement and potential for improvement.
- Movement education and bodywork, including massage, myofacial release, and arthrokinetics to help release tension and make new movement patterns easier.

### KEY TERMS

**Rolfing**—Developed by Dr. Ida Rolf (1896–1979); a systematic approach to relieving stress patterns and dysfunctions in the body's structure through the manipulation of the highly pliant myofacial (connective) tissue. It assists the body in reorganizing its major segments into vertical alignment.

- Post-testing, when pre-testing movements are repeated, allowing the client to feel the changes that have taken place and integrate them into daily life.

Aston-Patterning requires more participation from the client than many bodywork techniques. The massage aspect of Aston-Patterning is designed around a three-dimensional, non-compressive touch that releases patterns of tension in the body. It is gentler than Rolfing. Myokinetics uses touch to release tension in the face and neck. Arthrokinetics addresses tension at bones and joints. This massage is accompanied by education about how new movement patterns may be established.

In addition to Aston-Patterning sessions, clients are helped to examine their environment for factors, such as seating or sleeping arrangements, that may limit their body function and introduce tension. Finally, they may choose to participate in the Aston fitness training program that includes loosening techniques based on self-massage, toning, stretching, and cardiovascular fitness.

### Preparations

No special preparation need be taken.

### Precautions

No special precautions are necessary when participating.

### Side effects

No undesirable side effects are reported. Usually, clients report a diminution of tension, improved body movement, and an enhanced feeling of well being.

### Research and general acceptance

Aston-Patterning is an outgrowth of Rolfing, which has been shown to be of benefit in a limited number of controlled studies. Little controlled research has been done on the either benefits or limitations of Aston-Patterning. Its claims have been neither proven nor disproved, although anecdotally

many clients report relief from pain and tension and improved body movement.

## Resources

### BOOKS

- Benjamin, Patricia J. *Tappan's Handbook of Healing Massage Techniques*. 5th ed. Upper Saddle River, NJ: Prentice Hall, 2009.
- Davis, Martha. *The Relaxation & Stress Reduction Workbook*. 6th ed. Sydney, Australia: ReadHowYouWant, 2009.
- Stewart, Nicola. *The Complete Body Massage Course: An Introduction to the Most Popular Massage Therapies*. London: Collins & Brown, 2010.
- Weintraub, Michael I., Ravinder Mamtani, and Marc S. Micozzi, eds. *Complementary and Integrative Medicine in Pain Management*. New York: Springer, 2008.

### ORGANIZATIONS

- Aston Kinetics, P.O. Box 3568, Incline Village, NV, 89450 (775) 831-8228, Astonpat@aol.com, <http://www.astonkinetics.com>.
- Benson-Henry Institute for Mind Body Medicine at Massachusetts General Hospital, 151 Merrimac Street, 4th Floor, Boston, MA, 02114 (617) 643-6090, <http://www.massgeneral.org/bhi>.
- The Center for Mindfulness in Medicine, Health Care and Society. Stress Reduction Clinic. University of Massachusetts Memorial Health Care., 55 Lake Ave. North, Worcester, MA, 01655 (508) 856-2656 (508) 856-1977, <http://www.umassmed.edu/cfm/>.

Tish Davidson AM  
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**Astrocytoma** see **Brain tumor**

**Ataxia** see **Movement disorders**

## Ataxia-telangiectasia

### Definition

Ataxia-telangiectasia (A-T), also called Louis-Bar syndrome, is a rare, genetic neurological disorder of childhood that progressively destroys part of the motor control area of the brain, leading to a lack of balance and coordination. A-T also affects the immune system and increases the risk of leukemia and lymphoma in affected individuals.

### Description

The disorder first appeared in the medical literature in the mid-1920s, but was not named specifically until 1957. The name is a combination of two

recognized abnormalities: ataxia (lack of muscle control) and telangiectasia (abnormal dilatation of capillary vessels that often result in tumors and red **skin lesions**). However, A-T involves more than just the sum of these two findings. Other associated A-T problems include immune system deficiencies, extreme sensitivity to radiation, and blood cancers.

Medical researchers initially suspected that multiple genes (the units responsible for inherited features) were involved. However, in 1995, mutations in a single large gene were identified as causing A-T. Researchers named the gene ATM for A-T, mutated. Subsequent research revealed that ATM has a significant role in regulating cell division. The symptoms associated with A-T reflect the main role of the AT gene, which is to induce several cellular responses to DNA damage, such as preventing damaged DNA from being reproduced. When the AT gene is mutated into ATM, the signaling networks are affected and the cell no longer responds correctly to minimize the damage.

A-T is very rare, but it occurs in every population world wide, with an estimated frequency of between 1/40,000 and 1/100,000 live births. But it is believed that many A-T cases, particularly those who die at a young age, are never properly diagnosed. Therefore, this disease may actually be much more prevalent. According to the A-T Project Foundation, an estimated 1% (2.5 million in the United States) of the general population carries defective A-T genes. Carriers of one copy of this gene do not develop A-T, but have a significantly increased risk of **cancer**. This makes the A-T gene one of the most important cancer-related genes identified to date.

### Causes and symptoms

The ATM gene is autosomal recessive, meaning the disease occurs only if a defective gene is inherited from both parents. Infants with A-T initially often appear very healthy. At around age two, ataxia and nervous system abnormalities becomes apparent. The root cause of A-T-associated ataxia is cell death in the brain, specifically the large branching cells of the nervous system (Purkinje's cells) which are located in the cerebellum. A toddler becomes clumsy, loses balance easily and lacks muscle control. Speech becomes slurred and more difficult, and the symptoms progressively worsen. Between ages two and eight, telangiectases, or tiny, red "spider" veins, appear on the cheeks and ears and in the eyes.

By age 10-12, children with A-T can no longer control their muscles. Immune system deficiencies become common, and affected individuals are extremely sensitive to radiation. Immune system deficiencies vary between individuals but include lower-than-normal levels of proteins that function as antibodies

## KEY TERMS

**Angioma**—A tumor (such as a hemangioma or lymphangioma) that mainly consists of blood vessels or lymphatic vessels.

**Antibody**—Any of a large number of proteins produced by specialized blood cells after stimulation by an antigen and that act specifically against the antigen in an immune response.

**Antigen**—Any substance (such as a toxin or enzyme) capable of stimulating an immune response in the body.

**Ataxia**—The inability to control voluntary muscle movement, most frequently resulting from disorders in the brain or spinal cord.

**Autosomal**—Relating to any of the chromosomes except for X and Y, the sex chromosomes.

**Cerebellum**—The part of the brain responsible for coordination of voluntary movements.

**Gamma-globulin**—An extract of human blood that contains antibodies.

**Immune response**—A response from the body to an antigen that occurs when the antigen is identified as foreign and that induces the production of antibodies and lymphocytes capable of destroying the antigen or making it harmless.

**Immunoglobulin**—A protein in the blood that is the component part of an antibody.

**Leukemia**—A cancer of blood cells characterized by the abnormal increase in the number of white blood cells in the tissues. There are many types of leukemias and they are classified according to the type of white blood cell involved.

**Lymphoma**—A blood cancer in which lymphocytes, a variety of white blood cells, grow at an unusually rapid rate.

**Mutation**—Any change in the hereditary material of genes.

**Purkinje's cells**—Large branching cells of the nervous system.

**Recessive**—Producing little or no phenotypic effect when occurring in heterozygous condition with a contrasting allele.

**Telangiectases**—Spidery red skin lesions caused by dilated blood vessels.

**Telangiectasia**—Abnormal dilation of capillary blood vessels leading to the formation of telangiectases or angiomas.

**Thymus**—A gland located in the front of the neck that coordinates the development of the immune system.

(immunoglobulins) and white blood cells (blood cells not containing “iron” proteins). The thymus gland, which aids in development of the body’s immune system, is either missing or has developed abnormally. Intelligence is normal, but growth may be retarded owing to immune system or hormonal deficiencies. Individuals with A-T are also sometimes afflicted with diabetes, prematurely graying hair, and difficulty swallowing. As the children grow older, the immune system becomes weaker and less capable of fighting infection. In the later stages, recurrent respiratory infections and blood cancers, such as leukemia or lymphoma, are common.

### Diagnosis

Diagnosis relies on recognizing the hallmarks of A-T: progressive ataxia and telangiectasia. However, this may be difficult as ataxia symptoms do appear prior to telangiectasia symptoms by several years. Other symptoms can vary between individuals; for example, 70% of individuals with A-T have a high incidence of respiratory infection, 30%

do not. The identification of the ATM gene raises hopes that screening, and perhaps treatment, may be possible.

### Treatment

There is currently no cure for A-T, and treatment focuses on managing the individual’s multiple symptoms. **Physical therapy** and **speech therapy** can help the patient adjust to ataxia. Injections of **gamma globulin**, or extracts of human blood that contain antibodies, are used to strengthen the weakened immune system. High-dose vitamin administrations may also be prescribed. Research continues in many countries to find effective treatments. Individuals and families living with this disorder may benefit from attending support groups.

### Prognosis

A-T is a fatal condition. Children with A-T become physically disabled by their early teens and typically die by their early 20s, usually from the

associated blood cancers and malignancies. In very rare cases, individuals with A-T may experience slower progression and a slightly longer life span, surviving into their 30s. A-T carriers have a five-fold higher risk than non-carriers of developing certain cancers, especially **breast cancer**.

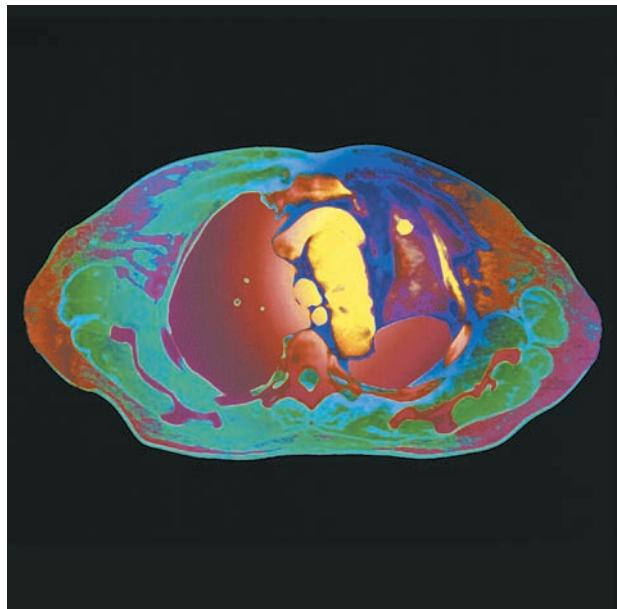
## Prevention

Medical researchers are investigating methods for screening individuals who may be carriers of the defective gene. Prenatal testing for A-T is possible but not done routinely, because commercial screening tests have yet to be developed.

## Resources

### OTHER

Ataxia-telangiectasia. National Institute of Diabetes and Digestive and Kidney Diseases, NIH. [http://www.ninds.nih.gov/disorders/a\\_t/a\\_t.htm](http://www.ninds.nih.gov/disorders/a_t/a_t.htm) (accessed November 23, 2010).



A computed tomography (CT) scan through a patient's chest. The collapsed lung appears at the right of the image. (Photo Researchers, Inc.)

## Atelectasis

### Definition

Atelectasis is a collapse of lung tissue affecting part or all of one lung. This condition prevents normal oxygen absorption to healthy tissues.

### Description

Atelectasis can result from an obstruction (blockage) of the airways that affects tiny air sacs called alveoli. Alveoli are very thin-walled and contain a rich blood supply. They are important for lung function, since their purpose is the exchange of oxygen and carbon dioxide. When the airways are blocked by a mucous "plug," foreign object, or tumor, the alveoli are unable to fill with air and collapse of lung tissue can occur in the affected area. Atelectasis is a potential complication following surgery, especially in individuals who have undergone chest or abdominal operations resulting in associated abdominal or chest **pain** during breathing. Congenital atelectasis can result from a failure of the lungs to expand at birth. This congenital condition may be localized or may affect all of both lungs.

### Causes and symptoms

Causes of atelectasis include insufficient attempts at respiration by the newborn, bronchial obstruction, or absence of **surfactant** (a substance secreted by alveoli that maintains the stability of lung tissue by reducing the surface tension of fluids that coat the lung). This lack of surfactant reduces the surface area available for effective gas exchange causing it to collapse if severe. Pressure on the lung from fluid or air can cause atelectasis as well as obstruction of lung air passages by thick mucus resulting from various infections and lung diseases. Tumors and inhaled objects can also cause obstruction of the airway, leading to atelectasis.

Anyone undergoing chest or abdominal surgery using **general anesthesia** is at risk to develop atelectasis, since breathing is often shallow after surgery to avoid pain from the surgical incision. Any significant decrease in airflow to the alveoli contributes to pooling of secretions, which in turn can cause infection. Chest injuries causing shallow breathing, including fractured ribs, can cause atelectasis. Common symptoms of atelectasis include **shortness of breath** and decreased chest wall expansion. If atelectasis only affects a small area of the lung, symptoms are usually minimal. If the condition affects a large area of the lung and develops quickly, the individual may turn blue (cyanotic) or pale, have extreme shortness of breath, and feel a stabbing pain

## KEY TERMS

**Alveoli**—Tiny air sacs in the lungs where gas exchange takes place between alveolar air and pulmonary blood within the capillaries

**Bronchial**—Relating to the air passages to and from the lungs including the bronchi and the bronchioles.

**Bronchoscopy**—A procedure in which a hollow, flexible tube is inserted into the airway to allow visual examination of the larynx, trachea, bronchi, and bronchioles. It is also used to collect specimens for biopsy or culturing and to remove airway obstructions.

**Incentive spirometer**—A breathing device that provides feedback on performance to encourage deep breathing.

**Mucus**—A thin, slippery film secreted by the mucous membranes and glands.

**Postural drainage**—Techniques to help expel excess mucus by specific positions of the body (that decrease the effects of gravity) combined with manual percussion and vibration over various parts of the lung.

**Surfactant**—A substance secreted by the alveoli in the lungs that reduces the surface tension of lung fluids, allowing gas exchange and helping maintain the elasticity of lung tissue.

**Tumor**—An abnormal growth of tissue resulting from uncontrolled, progressive multiplication of cells.

on the affected side. **Fever** and increased heart rate may be present if infection accompanies atelectasis.

### Diagnosis

To diagnose atelectasis, a doctor starts by recording the patient's symptoms and performing a thorough **physical examination**. When the doctor listens to the lungs through a stethoscope (auscultation), diminished or bronchial breath sounds may be heard. By tapping on the chest (percussion) while listening through the stethoscope, the doctor can often tell if the lung is collapsed. A **chest x ray** that shows an airless area in the lung confirms the diagnosis of atelectasis. If an obstruction of the airways is suspected, a computed tomography scan (CT) or **bronchoscopy** may be performed to locate the cause of the blockage.

### Treatment

If atelectasis is due to obstruction of the airway, the first step in treatment is to remove the cause of the blockage. This may be done by coughing, suctioning, or bronchoscopy. If a tumor is the cause of atelectasis, surgery may be necessary to remove it. **Antibiotics** are commonly used to fight the infection that often accompanies atelectasis. In cases where recurrent or long-lasting infection is disabling or where significant bleeding occurs, the affected section of the lung may be surgically removed.

### Prognosis

If atelectasis is caused by a thick mucus "plug" or inhaled foreign object, the patient usually recovers

completely when the blockage is removed. If it is caused by a tumor, the outcome depends on the nature of the tumor involved. If atelectasis is a result of surgery, other post-operative conditions and/or complications affect the prognosis.

### Prevention

When recovering from surgery, frequent repositioning in bed along with coughing and deep breathing are important. Coughing and breathing deeply every one to two hours after any surgical operation with general anesthesia is recommended. Breathing exercises and the use of breathing devices, such as an incentive spirometer, may also help prevent atelectasis. Although smokers have a higher risk of developing atelectasis following surgery, stopping **smoking** six to eight weeks before surgery can help reduce the risk. Increasing fluid intake during respiratory illness or after surgery (by mouth or intravenously) helps lung secretions to remain loose. Increasing humidity may also be beneficial.

Postural drainage techniques can be learned from a respiratory therapist or physical therapist and are a useful tool for anyone affected with a respiratory illness that could cause atelectasis. Because **foreign objects** blocking the airway can cause atelectasis, it is very important to keep small objects that might be inhaled away from young children.

### ORGANIZATIONS

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-

0105, (301) 592-8573, (240) 629-3246, http://www.nhlbi.nih.gov.

Jeffrey P. Larson RPT

Atenolol see **Beta blockers**

who have not responded to other medical therapy and on some individuals who are candidates for balloon **angioplasty** or **coronary artery bypass graft surgery**. It is sometimes performed to remove plaque that has built up after a coronary artery bypass graft surgery. Artherectomy may also be performed on the carotid arteries leading to the brain or on certain vertebral arteries.

## Atherectomy

### Definition

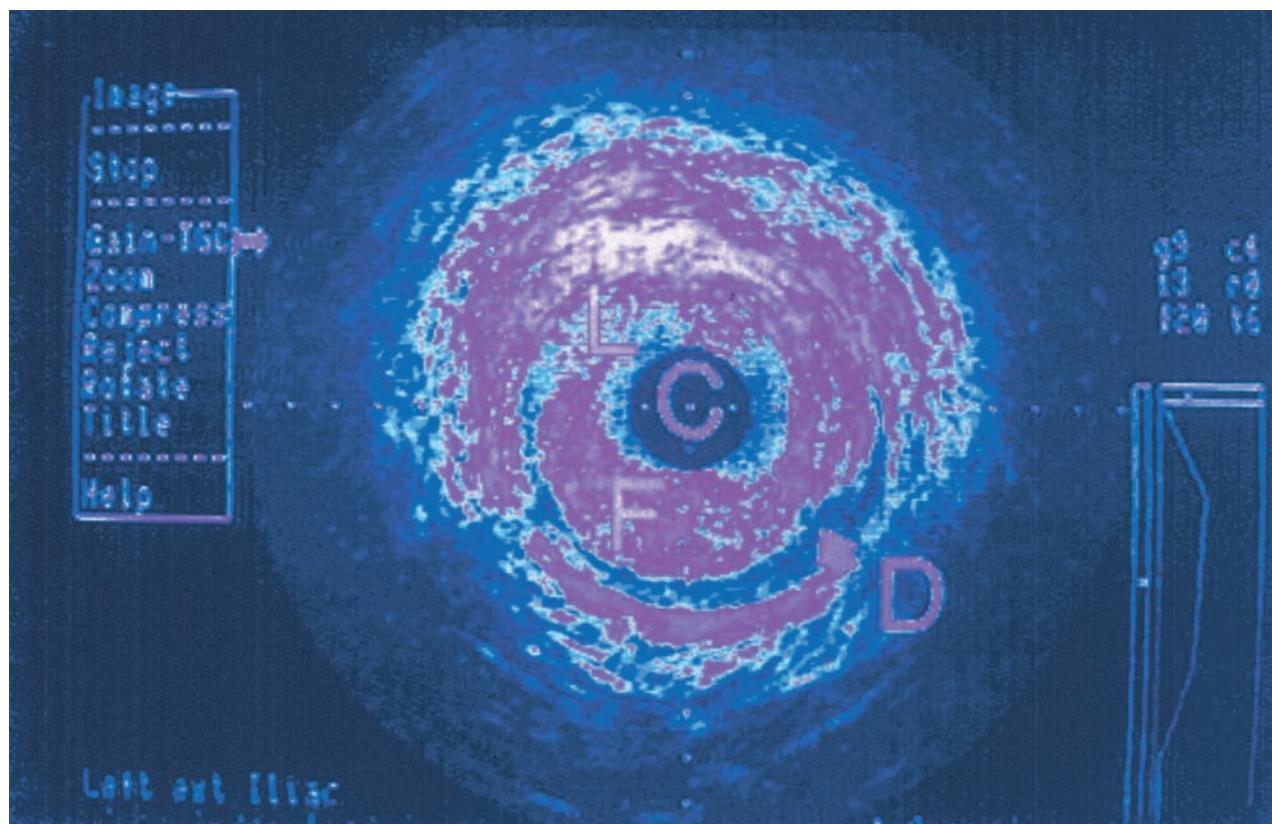
Atherectomy is a procedure to open blocked arteries or vein grafts by using a device on the end of a catheter to cut or shave away atherosclerotic plaque blocking the flow of blood.

### Purpose

Atherectomy is performed on the coronary arteries to restore the flow of oxygen-rich blood to the heart, to relieve chest **pain**, and to prevent heart attacks. It may be done on patients with chest pain

### Description

Atherectomy uses a catheter inserted into the artery that has at its tip either a rotating device that reams out the artery, a device that shaves the plaque away, or a laser that vaporizes the plaque. At the beginning of the procedure, medications are administered to control blood pressure, dilate the coronary arteries, and prevent **blood clots**. The patient is awake but sedated. The catheter is inserted into an artery in the groin, leg, or arm, and threaded through the blood vessels into the blocked artery. The cutting head or laser is positioned against the plaque and activated, and the plaque is ground up and suctioned out or vaporized.



In this digitized ultrasound of a blood vessel, C is the catheter, D is the dissection, and F is the artherosclerotic flap. (Custom Medical Stock Photo, Inc. Reproduced by permission.)

## KEY TERMS

**Atherosclerotic plaque**—A deposit of fat and other substances that accumulate in the lining of the artery wall.

**Balloon angioplasty**—A surgical procedure in which a balloon catheter is used to flatten plaque against an artery wall.

**Catheter**—A long, thin, flexible tube that can be inserted into a vein and moved through the cardiovascular system.

**Carotid artery**—An artery located in the neck.

**Coronary arteries**—These are the first arteries to branch off the aorta (the large artery leaving the heart). The coronary arteries surround the heart like a crown,

coming out of the aorta, arching down over the top of the heart, dividing into two branches, and taking oxygen-rich blood to the heart muscle. Blockage of these arteries can cause atherosclerosis and heart attack.

**Electrocardiogram (ECG, EKG)**—A test that records the electrical activity of the heart using small electrode patches attached to the skin on the chest.

**Plaque**—Fatty material that is deposited on the inside of the arterial wall.

**Stent**—A device made of expandable, metal mesh that is placed (by using a balloon catheter) at the site of a narrowing artery; the stent stays in place to keep the artery open.

In some patients, artherectomy can be an alternative to coronary bypass surgery. It is significantly less painful, less costly, and has a much shorter recovery time than bypass surgery. The location(s), degree of blockage, and general health status of the individual are all factors in deciding whether artherectomy is the most appropriate procedure.

The types of artherectomy are directional, rotational, transluminal extraction and laser artherectomy extraction. Directional artherectomy was the first type approved, but is no longer commonly used; it scrapes plaque into an opening in one side of the catheter. Rotational artherectomy uses a high-speed rotating shaver to grind up plaque. Transluminal extraction uses a device that cuts plaque off vessel walls and vacuums it into a bottle. It is used to clear bypass grafts. Laser artherectomy uses a laser to break up and vaporize the plaque. In some patients, a balloon angioplasty may be done and a stent inserted after successful artherectomy.

Performed in a **cardiac catheterization** lab, artherectomy can be used instead of, or along with, balloon angioplasty. Artherectomy is successful about 95% of the time; however, plaque forms again in 20–30% of patients.

### Precautions

Atherectomy should not be performed when the plaque is located where blood vessels divide into branches, when plaque is angular or inside an angle of a blood vessel, on patients with weak vessel walls, on ulcerated or calcium-hardened lesions, or on blockages through which a guide wire will not pass. Laser artherectomy has less successful outcomes in

individuals with diabetes or renal failure, and usually is not the procedure of choice for these patients.

### Preparation

The day before artherectomy, the patient takes medication to prevent blood clots and may be asked to bathe and shampoo with an antiseptic skin cleaner.

### Aftercare

After the procedure, the patient spends several days in the hospital's cardiac monitoring area. For at least 20 minutes, pressure is applied to a dressing on the insertion site. For the first hour, an electrocardiogram (ECG) and close monitoring are conducted; vital signs are checked every 15 minutes. Pain medication is then administered. The puncture site is checked once an hour or more. For most of the first 24 hours, the patient remains in bed.

### Risks

Chest pain is the most common complication of artherectomy. Other common complications are injury to the blood vessel lining, plaque that re-forms, the development of blood clots, and bleeding at the site of catheter insertion. More serious but less frequent complications are blood vessel holes, blood vessel wall tears, or reduced blood flow through the artery.

### Resources

#### OTHER

Atherosclerosis Atherectomy. Cleveland Clinic.  
Undated [accessed January 21, 2010].

[http://my.clevelandclinic.org/services/atherectomy/vs\\_atherosclerosis\\_atherectomy.aspx](http://my.clevelandclinic.org/services/atherectomy/vs_atherosclerosis_atherectomy.aspx)

Schoenstadt, Arthur. Atherectomy Procedure. eMedTV  
<http://heart-disease.emedtv.com/atherectomy/atherectomy-procedure.html> [accessed January 21, 2010].

#### ORGANIZATIONS

American Heart Association, 7272 Greenville Avenue, Dallas, TX, 75231 (800) 242-8721, <http://www.americanheart.org>.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105 (301) 592-8573; TTY: (240) 629-3255 (240) 629-3246, [nhlbiinfo@nhlbi.nih.gov](mailto:nhlbiinfo@nhlbi.nih.gov), <http://www.nhlbi.nih.gov>.

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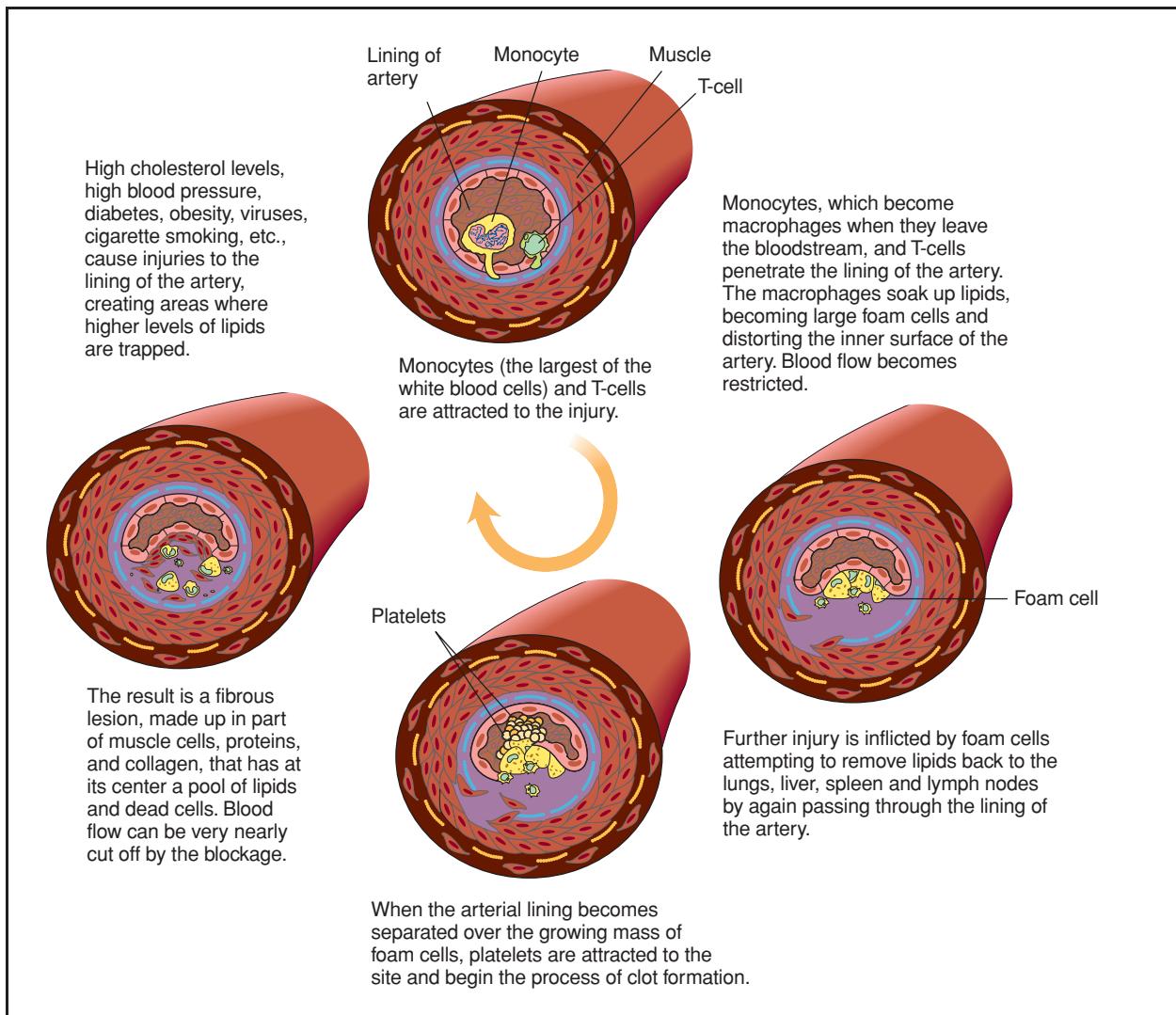
## Atherosclerosis

### Definition

Atherosclerosis is the buildup of a waxy plaque on the inside of blood vessels. In Greek, *athere* means *gruel*, and *skleros* means *hard*. Atherosclerosis is often called arteriosclerosis. Arteriosclerosis (from the Greek *arteria*, meaning *artery*) is a general term for hardening of the arteries. Arteriosclerosis can occur in several forms, including atherosclerosis.

### Demographics

Atherosclerosis is a slow, progressive condition that may occur anywhere in the body but it usually



The progression of atherosclerosis. (Illustration by Hans & Cassady, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)

## KEY TERMS

**Arteriosclerosis**—Hardening of the arteries. It includes atherosclerosis, but the two terms are often used synonymously.

**Cholesterol**—A fat-like substance that is made by the human body and eaten in animal products. Cholesterol is used to form cell membranes and process hormones and vitamin D. High cholesterol levels contribute to the development of atherosclerosis.

**HDL Cholesterol**—About one-third or one-fourth of all cholesterol is high-density lipoprotein cholesterol. High levels of HDL, nicknamed

“good” cholesterol, decrease the risk of atherosclerosis.

**LDL Cholesterol**—Low-density lipoprotein cholesterol is the primary cholesterol molecule. High levels of LDL, nicknamed “bad” cholesterol, increase the risk of atherosclerosis

**Plaque**—A deposit of fatty and other substances that accumulates in the lining of the artery wall.

**Triglyceride**—A fat that comes from food or is made from other energy sources in the body. Elevated triglyceride levels contribute to the development of atherosclerosis.

affects large and medium sized arteries. It can begin in the late teens, but it usually takes decades to cause symptoms. Some people experience rapidly progressing atherosclerosis during their thirties, others during their fifties or sixties. Over time, the buildup of the waxy plaque can cause narrowing of coronary arteries in the heart. Atherosclerosis, (the narrowing of coronary arteries due to this plaque buildup), causes more than 90% of heart attacks.

Due to the slow, progressive, and often times asymptomatic nature of the condition, it is difficult to accurately determine the frequency of atherosclerosis, but the estimated prevalence is that approximately 4.6 million people in the United States are managing various clinical manifestations of this disease.

### Description

Atherosclerosis, a progressive process largely responsible for heart disease, is a type of arteriosclerosis or hardening of the arteries. An artery is made up of several layers: an inner lining called the endothelium, an elastic membrane that allows the artery to expand and contract, a layer of smooth muscle, and a layer of connective tissue. Arteriosclerosis is a broad term that includes a hardening of the inner and middle layers of the artery. It can be caused by normal **aging**, by high blood pressure, and by diseases such as diabetes. Atherosclerosis is a type of arteriosclerosis that affects only the inner lining of an artery. It is characterized by plaque deposits that block the flow of blood.

Plaque is made of fatty substances, cholesterol, waste products from the cells, **calcium**, and fibrin, a stringy material that helps clot blood. The plaque formation process stimulates the cells of the artery wall to

produce substances that accumulate in the inner layer. Fat builds up within these cells and around them, and they form connective tissue and calcium. The inner layer of the artery wall thickens, the artery's diameter is reduced, and blood flow and oxygen delivery are decreased. Plaques can rupture or crack open, causing the sudden formation of a blood clot (thrombosis). Atherosclerosis can cause a **heart attack** if it completely blocks the blood flow in the heart (coronary) arteries. It can cause a **stroke** if it completely blocks the brain (carotid) arteries. Atherosclerosis can also occur in the arteries of the neck, kidneys, thighs, and arms, causing kidney failure or **gangrene** and amputation.

### Causes and symptoms

Atherosclerosis is complex. Its exact cause is still unknown. It is thought that atherosclerosis is caused by a response to damage to the endothelium from high cholesterol, high blood pressure, and cigarette **smoking**. A person who has all three of these risk factors is eight times more likely to develop atherosclerosis than is a person who has none. Physical inactivity, diabetes, and **obesity** are also risk factors for atherosclerosis. High levels of the amino acid **homocysteine** and abnormal levels of protein-coated fats called lipoproteins also raise the risk of **coronary artery disease**. These substances are the targets of much current research. The role of **triglycerides**, another fat that circulates in the blood, in forming atherosclerotic plaques is unclear. High levels of triglycerides are often associated with diabetes, obesity, and low levels of high-density lipoproteins (HDL cholesterol). The more HDL (“good”) cholesterol, in the blood, the less likely is coronary artery disease. These risk factors

are all modifiable. Non-modifiable risk factors are heredity, sex, and age.

#### Risk factors that can be changed:

- Cigarette/tobacco smoke—Smoking increases both the chance of developing atherosclerosis and the chance of dying from coronary heart disease. Second hand smoke may also increase risk.
- High blood cholesterol—Cholesterol, a soft, waxy substance, comes from foods such as meat, eggs, and other animal products and is produced in the liver. Age, sex, heredity, and diet affect cholesterol. Total blood cholesterol is considered high at levels above 240 mg/dL and borderline at 200–239 mg/dL. High-risk levels of low-density lipoprotein (LDL) cholesterol begin at 130–159 mg/dL.
- High triglycerides—Most fat in food and in the body takes the form of triglycerides. Blood triglyceride levels above 400 mg/dL have been linked to coronary artery disease in some people. Triglycerides, however, are not nearly as harmful as LDL cholesterol.
- High blood pressure—Blood pressure of 140 over 90 or higher makes the heart work harder, and over time, both weakens the heart and harms the arteries.
- Physical inactivity—Lack of exercise increases the risk of atherosclerosis.
- Diabetes mellitus—The risk of developing atherosclerosis is seriously increased for diabetics and can be lowered by keeping diabetes under control. Most diabetics die from heart attacks caused by atherosclerosis.
- Obesity—Excess weight increases the strain on the heart and increases the risk of developing atherosclerosis even if no other risk factors are present.

#### Risk factors that cannot be changed:

- Heredity—People whose parents have coronary artery disease, atherosclerosis, or stroke at an early age are at increased risk. The high rate of severe hypertension among African-Americans puts them at increased risk.
- Sex—Before age 60, men are more likely to have heart attacks than women. After age 60, the risk is equal among men and women.
- Age—Risk is higher in men who are 45 years of age and older and women who are 55 years of age and older.

Symptoms differ depending upon the location of the atherosclerosis.

- In the coronary (heart) arteries: Chest pain, heart attack, or sudden death.

- In the carotid (brain) arteries: Sudden dizziness, weakness, loss of speech, or blindness.
- In the femoral (leg) arteries: Disease of the blood vessels in the outer parts of the body (peripheral vascular disease) causes cramping and fatigue in the calves when walking.
- In the renal (kidney) arteries: High blood pressure that is difficult to treat.

## Diagnosis

Physicians may be able to make a diagnosis of atherosclerosis during a physical exam by means of a stethoscope and gentle probing of the arteries with the hand (palpation). More definite tests are **electrocardiography**, **echocardiography** or ultrasonography of the arteries (for example, the carotids), radionuclide scans, and **angiography**.

An electrocardiogram shows the heart's activity. Electrodes covered with conducting jelly are placed on the patient's body. They send impulses of the heart to a recorder. The test takes about 10 minutes and is performed in a physician's office. Exercise electrocardiography (**stress test**) is conducted while the patient exercises on a treadmill or a stationary bike. It is performed in a physician's office or an exercise laboratory and takes 15–30 minutes.

Echocardiography, cardiac ultrasound, uses sound waves to create an image of the heart's chambers and valves. A technician applies gel to a handheld transducer, presses it against the patient's chest, and images are displayed on a monitor. This technique cannot evaluate the coronary arteries directly. They are too small and are in motion with the heart. Severe coronary artery disease, however, may cause abnormal heart motion that is detected by echocardiography. Performed in a cardiology outpatient diagnostic laboratory, the test takes 30–60 minutes. Ultrasonography is also used to assess arteries of the neck and thighs.

Radionuclide angiography and thallium (or sestamibi) scanning enable physicians to see the blood flow through the coronary arteries and the heart chambers. Radioactive material is injected into the bloodstream. A device that uses gamma rays to produce an image of the radioactive material (gamma camera) records pictures of the heart. Radionuclide angiography is usually performed in a hospital's nuclear medicine department and takes 30–60 minutes. Thallium scanning is usually done after an exercise stress test or after injection of a vasodilator, a drug to enlarge the blood vessels, like dipyridamole (Persantine). Thallium is injected, and the scan is done then and again four

hours (and possibly 24 hours) later. Thallium scanning is usually performed in a hospital's nuclear medicine department. Each scan takes 30-60 minutes.

Coronary angiography is the most accurate diagnostic method and the only one that requires entering the body (invasive procedure). A cardiologist inserts a catheter equipped with a viewing device into a blood vessel in the leg or arm and guides it into the heart. The patient has been given a contrast dye that makes the heart visible to x rays. Motion pictures are taken of the contrast dye flowing through the arteries. Plaques and blockages, if present, are well defined. The patient is awake but has been given a sedative. Coronary angiography is performed in a **cardiac catheterization** laboratory and takes from 30 minutes to two hours.

## Treatment

Treatment includes lifestyle changes, lipid-lowering drugs, percutaneous transluminal coronary **angioplasty**, and coronary artery bypass surgery. Atherosclerosis requires lifelong care.

Patients who have less severe atherosclerosis may achieve adequate control through lifestyle changes and drug therapy. Many of the lifestyle changes that prevent disease progression—a low-fat, low-cholesterol diet, losing weight (if necessary), exercise, controlling blood pressure, and not smoking—also help prevent the disease.

Most of the drugs prescribed for atherosclerosis seek to lower cholesterol. Many popular lipid-lowering drugs can reduce LDL-cholesterol by an average of 25-30% when combined with a low-fat, low-cholesterol diet. Lipid-lowering drugs include bile acid resins, “statins” (drugs that effect HMG-CoA reductase, an enzyme that controls the processing of cholesterol), niacin, and fibric acid derivatives such as gemfibrozil (Lobid). **Aspirin** helps prevent thrombosis and a variety of other medications can be used to treat the effects of atherosclerosis.

Percutaneous transluminal coronary angioplasty and bypass surgery are invasive procedures that improve blood flow in the coronary arteries. Percutaneous transluminal coronary angioplasty (coronary angioplasty) is a non-surgical procedure in which a catheter tipped with a balloon is threaded from a blood vessel in the thigh into the blocked artery. The balloon is inflated, compresses the plaque to enlarge the blood vessel, and opens the blocked artery. Coronary angioplasty is performed by a cardiologist in a hospital and generally requires a hospital stay of one or two days. It is successful about 90% of the time, but for one-third of patients the artery narrows again within six

months. It can be repeated and a “stent” may be placed in the artery to help keep it open (see below).

In coronary artery bypass surgery (bypass surgery), a detour is built around the blockage with a healthy vein or artery, which then supplies oxygen-rich blood to the heart. It is major surgery appropriate for patients with blockages in two or three major coronary arteries or severely narrowed left main coronary arteries, and for those who have not responded to other treatments. It is performed in a hospital under **general anesthesia** and uses a heart-lung machine. About 70% of patients experience full relief; about 20% partial relief.

Three other semi-experimental surgical procedures may be used to treat atherosclerosis. In **atherectomy**, a cardiologist shaves off and removes strips of plaque from the blocked artery. In laser angioplasty, a catheter with a laser tip is inserted to burn or break down the plaque. A metal coil called a stent may be permanently implanted to keep a blocked artery open.

## Alternative treatment

Alternative therapies that focus on diet and lifestyle can help prevent, retard, or reverse atherosclerosis. Herbal therapies that may be helpful include: hawthorn (*Crataegus laevigata*), notoginseng root (*Panax notoginseng*), garlic (*Allium sativum*), ginger (*Zingiber officinale*), hot red or chili peppers, yarrow (*Achillea millefolium*), and alfalfa (*Medicago sativum*). Relaxation techniques including **yoga**, **meditation**, **guided imagery**, **biofeedback**, and counseling and other “talking” therapies may also be useful to prevent or slow the progress of the disease. Dietary modifications focus on eating foods that are low in fats (especially saturated fats), cholesterol, sugar, and animal proteins and high in fiber and **antioxidants** (found in fresh fruits and vegetables). Liberal use of onions and garlic is recommended, as is eating raw and cooked fish, especially cold-water fish like salmon. Smoking, alcohol, and stimulants like coffee should be avoided. **Chelation therapy**, which uses **anticoagulant drugs** and nutrients to dissolve plaque and flush it through the kidneys, is controversial. Long-term remedies can be prescribed by specialists in **ayurvedic medicine**, which combines diet, herbal remedies, relaxation and exercise, and homeopathy.

## Prognosis

Atherosclerosis can be successfully treated but not cured. Recent clinical studies have shown that atherosclerosis can be delayed, stopped, and even reversed by aggressively lowering LDL cholesterol. New diagnostic techniques enable physicians to identify and treat

atherosclerosis in its earliest stages. New technologies and surgical procedures have extended the lives of many patients who would otherwise have died.

## Prevention

A healthy lifestyle—eating right, regular exercise, maintaining a healthy weight, not smoking, and controlling hypertension—can reduce the risk of developing atherosclerosis, help keep the disease from progressing, and sometimes cause it to regress.

- Eat right—A healthy diet reduces excess levels of LDL cholesterol and triglycerides. It includes a variety of foods that are low in fat and cholesterol and high in fiber; plenty of fruits and vegetables; and limited sodium. Fat should comprise no more than 30%, and saturated fat no more than 8–10%, of total daily calories according to the American Heart Association. Cholesterol should be limited to about 300 milligrams per day and sodium to about 2,400 milligrams. The “Food Guide” Pyramid developed by the U.S. Departments of Agriculture and Health and Human Services provides daily guidelines: 6–11 servings of bread, cereal, rice, and pasta; 3–5 servings of vegetables; 2–4 servings of fruit; 2–3 servings of milk, yogurt, and cheese; and 2–3 servings of meat, poultry, fish, dry beans, eggs, and nuts. Fats, oils, and sweets should be used sparingly. Mono-unsaturated oils, like olive and rapeseed (Canola) are good alternatives to use for cooking.
- Exercise regularly—Aerobic exercise can lower blood pressure, help control weight, and increase HDL (“good”) cholesterol. It may keep the blood vessels more flexible. Moderate to intense aerobic exercise lasting about 30 minutes (or three 10-minute exercise periods) four or more times per week is recommended, according to the Centers for Disease Control and Prevention and the American College of Sports Medicine. Aerobic exercise includes walking, jogging, and cycling, active gardening, climbing stairs, or brisk housework. A physician should be consulted before exercise if a person has atherosclerosis or is at increased risk for it.
- Maintain a desirable body weight—Losing weight can help reduce total and LDL cholesterol, reduce triglycerides, and boost HDL cholesterol. It may also reduce blood pressure. Eating right and exercising are two key components in maintaining a desirable body weight.
- Do not smoke or use tobacco—Smoking has many adverse effects on the heart but quitting can repair damage. Ex-smokers face the same risk of heart disease as non-smokers within five to 10 years of quitting. Smoking is the worst thing a person can do to their heart and lungs.

• Seek treatment for hypertension—High blood pressure can be controlled through lifestyle changes—reducing sodium and fat, exercising, managing stress, quitting smoking, and drinking alcohol in moderation—and medication. Drugs that provide effective treatment are: diuretics, beta blockers, sympathetic nerve inhibitors, vasodilators, angiotensin converting enzyme (ACE) inhibitors, and calcium antagonists. Hypertension usually has no symptoms so it must be checked to be known. Like cholesterol, hypertension is called a “silent killer.”

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“Nutrition Fact Sheet: Dietary Cholesterol.” *Northwestern University Feinberg School of Medicine*. July 28, 2007 [cited April 3, 2010]. <http://www.feinberg.northwestern.edu/nutrition/factsheets/cholesterol.html>

### ORGANIZATIONS

American Heart Association (National Center), 7272 Greenville Avenue, Dallas, TX, 75231 (800) 242-872, <http://www.americanheart.org>.

Centers for Disease Control and Prevention (CDC), Division for Heart

Disease and Stroke Prevention, 4770 Buford Hwy NE, Atlanta, GA, 30341-3717, (770) 488-2424, [www.cdc.gov/cholesterol/faqs.htm](http://www.cdc.gov/cholesterol/faqs.htm).

Council for Responsible Nutrition, 1828 L Street, NW, Suite 900, Washington, DC, 20036-5114 (202) 776-7929 (202) 204-7980 <http://www.crnusa.org>.

National Heart Lung and Blood Institute (NHLBI), P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, [www.nhlbi.nih.gov](http://www.nhlbi.nih.gov).

USDA National Agricultural Library, Food and Nutrition Information Center, [Nutrition.gov](http://Nutrition.gov), 10301 Baltimore Avenue, Beltsville, MD, 20705-2351, <http://www.nutrition.gov>.

Lori DeMilto  
Laura Jean Cataldo RN, Ed.D.

**Athetosis see Movement disorders**



**Athlete's foot fungus on bottom of patient's foot.** (Custom Medical Stock Photo, Inc. Reproduced by permission.)

## Athlete's foot

### Definition

A common fungus infection between the toes in which the skin becomes itchy and sore, cracking and peeling away. Athlete's foot (also known as *tinea pedis* or foot ringworm) can be treated, but it can be tenacious and difficult to clear up completely.

### Description

Athlete's foot is a very common condition of itchy, peeling skin on the feet. In fact, it's so common that most people will have at least one episode at least once in their lives. It's less often found in women and children under age 12. (Symptoms that look like



**Athlete's foot fungus on toes of patient.** (Custom Medical Stock Photo, Inc. Reproduced by permission.)

athlete's foot in young children most probably are caused by some other skin condition.)

Because the fungi grow well in warm, damp areas, they flourish in and around swimming pools, showers, and locker rooms. *Tinea pedis* got its common name because the infection was common among athletes who often used these areas.

### Causes and symptoms

Athlete's foot is caused by a fungal infection that most often affects the fourth and fifth toe webs. *Trichophyton rubrum*, *T. mentagrophytes*, and *Epidermophyton floccosum*, the fungi that cause athlete's foot, are unusual in that they live exclusively on dead body tissue (hair, the outer layer of skin, and nails). The fungus grows best in moist, damp, dark places with poor ventilation. The problem doesn't occur among people who usually go barefoot.

Many people carry the fungus on their skin. However, it will only flourish to the point of causing athlete's foot if conditions are right. Many people believe athlete's foot is highly contagious, especially in public swimming pools and shower rooms. Research has shown, however, that it is difficult to pick up the infection simply by walking barefoot over a contaminated damp floor. Exactly why some people develop the condition and others don't is not well understood.

Sweaty feet, tight shoes, synthetic socks that don't absorb moisture well, a warm climate, and not drying the feet well after swimming or bathing, all contribute to the overgrowth of the fungus.

Symptoms of athlete's foot include itchy, sore skin on the toes, with scaling, cracking, inflammation, and blisters. Blisters that break, exposing raw patches of

tissue, can cause **pain** and swelling. As the infection spreads, **itching** and burning may get worse.

If it's not treated, athlete's foot can spread to the soles of the feet and toenails. Stubborn toenail infections may appear at the same time, with crumbling, scaling and thickened nails, and nail loss. The infection can spread further if patients scratch and then touch themselves elsewhere (especially in the groin or under the arms). It's also possible to spread the infection to other parts of the body via contaminated bed sheets or clothing.

## Diagnosis

Not all foot **rashes** are athlete's foot, which is why a physician should diagnose the condition before any remedies are used. Using nonprescription products on a rash that is not athlete's foot could make the rash worse.

A dermatologist can diagnose the condition by **physical examination** and by examining a preparation of skin scrapings under a microscope. This test, called a KOH preparation, treats a sample of tissue scraped from the infected area with heat and potassium hydroxide (KOH). This treatment dissolves certain substances in the tissue sample, making it possible to see the fungi under the microscope.

## Treatment

Athlete's foot may be resistant to medication and should not be ignored. Simple cases usually respond well to antifungal creams or sprays (clotrimazole, ketoconazole, miconazole nitrate, sulconazole nitrate, or tolnaftate). If the infection is resistant to topical treatment, the doctor may prescribe an oral antifungal drug.

Untreated athlete's foot may lead to a secondary bacterial infection in the skin cracks.

## Alternative treatment

A footbath containing cinnamon has been shown to slow down the growth of certain molds and fungi, and is said to be very effective in clearing up athlete's foot. To make the bath:

- heat four cups of water to a boil
- add eight to 10 broken cinnamon sticks
- reduce heat and simmer five minutes
- remove and let the mixture steep for 45 minutes until lukewarm
- soak feet

Other herbal remedies used externally to treat athlete's foot include: a foot soak or powder containing goldenseal (*Hydrastis canadensis*); tea tree oil

(*Melaleuca spp.*); or calendula (*Calendula officinalis*) cream to help heal cracked skin.

## Prognosis

Athlete's foot usually responds well to treatment, but it is important to take all medication as directed by a dermatologist, even if the skin appears to be free of fungus. Otherwise, the infection could return. The toenail infections that may accompany athlete's foot, however, are typically very hard to treat effectively.

## Prevention

Good personal hygiene and a few simple precautions can help prevent athlete's foot. To prevent spread of athlete's foot:

- wash feet daily
- dry feet thoroughly (especially between toes)
- avoid tight shoes (especially in summer)
- wear sandals during warm weather
- wear cotton socks and change them often if they get damp
- don't wear socks made of synthetic material
- go barefoot outdoors when possible
- wear bathing shoes in public bathing or showering areas
- use a good quality foot powder
- don't wear sneakers without socks
- wash towels, contaminated floors, and shower stalls well with hot soapy water if anyone in the family has athlete's foot.

## Resources

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Williams, Hywel C., et al. *Evidence-based Dermatology*. Malden, MA: Oxford; Blackwell/BMJ Books, 2008.

### ORGANIZATIONS

American Podiatric Medical Association, 9312 Old Georgetown Road, Bethesda, MD, 20814-1621, (301) 581-9200, <http://www.apma.org>.

Carol A. Turkington

## Athletic heart syndrome

### Definition

Athletic heart syndrome is the adaptation of an athlete's heart in response to the physiologic stresses of strenuous physical training. It can be difficult to

distinguish a significant medical condition from an athletic heart.

## Description

The heart adapts to physical demands by enlarging, especially the left ventricle. Enlargement increases the cardiac output, the amount of blood pumped with each beat of the heart. The exact type of adaptation depends on the nature of the physical demand. There are two types of demand, static and dynamic. Static demand involves smaller groups of muscles under extreme resistance for brief period. An example is weight lifting. Dynamic training involves larger groups of muscles at lower resistance for extended periods of time. Examples are aerobic training and tennis. Cardiac enlargement is associated with dynamic training. The heart's response to static training is hypertrophy, thickening of the muscle walls of the heart. As the wall of the heart adapts, there are changes in the electrical conducting system of the heart. Because of the larger volume of blood being pumped with each heart beat, the heart rate when at rest decreases below the normal level for nonathletes.

Sudden unexpected **death** (SUD) is the death of an athlete, usually during or shortly after physical activity. Often, there is no warning that the person will experience SUD, although in some cases, warning signs appear which cause the person to seek medical advice. Importantly, cases of death occurring during physical activity are not caused by athletic heart syndrome, but by undiagnosed heart disorders.

## Causes and symptoms

Athletic heart syndrome is the consequence of a normal adaptation by the heart to increased physical activity. The changes in the electrical conduction system of the heart may be pronounced and diagnostic, but should not cause problems. In the case of SUD, other heart problems are involved. In 85-97% of the cases of SUD, an underlying structural defect of the heart has been noted.

## Diagnosis

The changes in the heart beat caused by the electrical conduction system of the heart are detectable on an electrocardiogram. Many of the changes seen in athletic heart syndrome mimic those of various heart diseases. Careful examination must be made to distinguish heart disease from athletic heart syndrome.

## Prognosis

The yearly rate for occurrence of SUD in people less than 35 years of age is less than 7 incidents per 100,000. Of all SUD cases, only about 8% are **exercise** related. On a national basis, this means that each year approximately 25 athletes experience SUD. In persons over age 35, the incidence of SUD is approximately 55 in 100,000, with only 3% of the cases occurring during exercise.

## Resources

### BOOKS

Fuster, Valentin, et al. *Hurst's the Heart*. 12th ed. New York: McGraw Hill Professional, 2007.

John T. Lohr PhD

## Atkins diet

### Definition

The Atkins diet is a high-protein, high-fat, and very low-carbohydrate regimen. It emphasizes meat, cheese, and eggs, while discouraging foods such as bread, pasta, fruit, and sugar. It is a form of ketogenic diet.

### Purpose

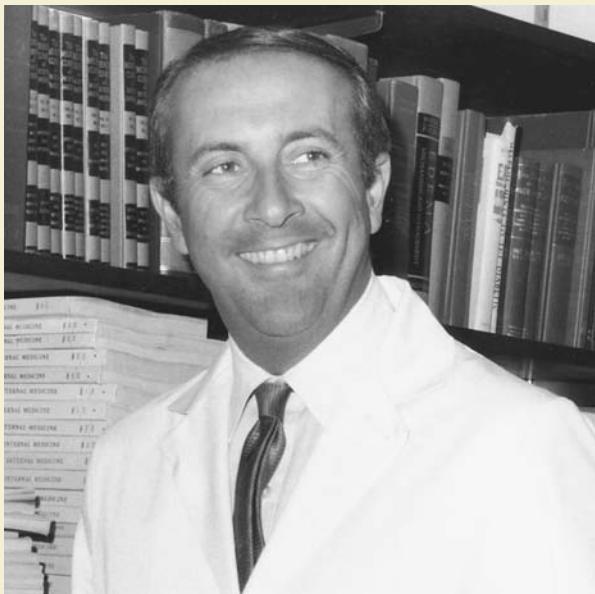
The primary benefit of the diet is rapid and substantial weight loss. By restricting carbohydrate intake, the body will burn more fat stored in the body. Since there are no limits on the amount of calories or quantities of foods allowed on the diet, there is little hunger between meals. According to Atkins, the diet can alleviate symptoms of conditions such as **fatigue**, irritability, headaches, depression, and some types of joint and muscle **pain**.

### Description

The regimen is a low-carbohydrate, or ketogenic diet, characterized by initial rapid weight loss, usually due to water loss. Drastically reducing the amount of carbohydrate intake causes liver and muscle glycogen loss, which has a strong but temporary diuretic effect. Long-term weight loss occurs because with a low amount of carbohydrate intake, the body burns stored fat for energy.

The four-step diet starts with a two-week induction program designed to rebalance an individual's metabolism. Unlimited amounts of fat and protein are allowed

## DR. ROBERT C. ATKINS (1930–2003)



(AP Images.)

Dr. Robert C. Atkins graduated from the University of Michigan in 1951 and received his medical degree from Cornell University Medical School in 1955 with a specialty

in cardiology. As an internist and cardiologist he developed the Atkins Diet in the early 1970s. The diet is a ketogenic diet—a high protein, high fat, and very low carbohydrate regimen resulting in ketosis. It emphasizes meat, cheese, and eggs, while discouraging foods such as bread, pasta, fruit, and sugar. It first came to public attention in 1972 with the publication of *Dr. Atkins' Diet Revolution*. The book quickly became a bestseller but unlike most other fad diet books, this one has remained popular. At last count, it had been reprinted 28 times and sold more than 10 million copies worldwide. Atkins authored a number of other books on his diet theme, including *Dr. Atkins' New Diet Revolution* (1992), *Dr. Atkins' Quick and Easy New Diet Cookbook* (1997), and *The Vita-Nutrient Solution: Nature's Answer to Drugs* (1998).

Atkins saw about 60,000 patients in his more than 30 years of practice. He also appeared on numerous radio and television talk shows, had his own syndicated radio program, *Your Health Choices*, and authored the monthly newsletter *Dr. Atkins' Health Revelations*. Atkins received the World Organization of Alternative Medicine's Recognition of Achievement Award and was named the National Health Federation's Man of the Year. He was the director of the Atkins Center for Complementary Medicine, which he founded in the early 1980s, until his death in 2003. The company bearing his name continues to develop books and products that support his ideas on nutrition and dieting.

but carbohydrate intake is restricted to 20 grams per day. Foods allowed include butter, oil, meat, poultry, fish, eggs, cheese, and cream. The daily amount of carbohydrates allowed equals about three cups of salad vegetables, such as lettuce, cucumbers, and celery.

The second stage is for ongoing weight loss. It allows 20–40 grams of carbohydrates a day. When the individual is about 10 pounds from their desired weight, they begin the pre-maintenance phase. This gradually adds one to three servings a week of high carbohydrate foods, such as a piece of fruit or slice of whole-wheat bread. When the desired weight is reached, the maintenance stage begins. It allows 40–60 grams of carbohydrates per day.

Opinion from the general medical community remains mixed on the Atkins diet. There have been no significant long-term scientific studies on the diet. A number of leading medical and health organizations, including the American Medical Association, American Dietetic Association (ADA), and the American Heart Association oppose it. It is drastically different than the dietary intakes recommended by the U.S. Department of

Agriculture and the National Institutes of Health. Much of the opposition is because the diet is lacking in some **vitamins** and nutrients, and because it is high in fat. In a hearing before the U.S. Congress on February 24, 2000, an ADA representative called the Atkins diet “hazardous” and said it lacked scientific credibility.

### Preparations

No advance preparation is needed to go on the diet. However, as with most **diets**, it is generally considered appropriate to consult with a physician and to have a physical evaluation before starting such a nutritional regimen. The evaluation should include blood tests to determine levels of cholesterol, **triglycerides**, glucose, insulin, and uric acid. A glucose tolerance test is also recommended.

### Precautions

Adherence to the Atkins diet can result in vitamin and mineral deficiencies. In his books, Atkins

## KEY TERMS

**Biotin**—A B complex vitamin, found naturally in yeast, liver, and egg yolks.

**Carbohydrates**—Neutral compounds of carbon, hydrogen, and oxygen found in sugar, starches, and cellulose.

**Hypertension**—Abnormally high arterial blood pressure, which if left untreated can lead to heart disease and stroke.

**Ketogenic diet**—A diet that supplies an abnormally high amount of fat, and small amounts of carbohydrates and protein.

**Ketosis**—An abnormal increase in ketones in the body, usually found in people with uncontrolled diabetes mellitus.

**Pantetheine**—A growth factor substance essential in humans, and a constituent of coenzyme A.

**Triglycerides**—A blood fat lipid that increases the risk for heart disease.

recommends a wide-range of **nutritional supplements**, including a multi-vitamin. Among his recommendations, Atkins suggests the following daily dosages: 300-600 micrograms (mcg) of chromium picolinate, 100-400 milligrams (mg) of pantetheine, 200 mcg of selenium, and 450-675 mcg of biotin.

The diet is not recommended for lacto-ovo vegetarians, since it cannot be done as successfully without protein derived from animal products. Also, vegans cannot follow this diet, since a vegan diet is too high in carbohydrates, according to Atkins. Instead, he recommends vegetarians with a serious weight problem give up **vegetarianism**, or at least include fish in their diet.

### Side effects

According to Atkins, the diet causes no adverse side effects. Many health care professionals disagree. In a fact sheet for the Healthcare Reality Check Web site ([www.hcrc.org](http://www.hcrc.org)), Ellen Coleman, a registered dietitian and author, said the diet may have serious side effects for some people. She said complications associated with the diet include ketosis, **dehydration**, electrolyte loss, **calcium** depletion, weakness, **nausea**, and kidney problems. “It is certainly riskier for overweight individuals with medical problems such as heart disease, **hypertension**, **kidney disease**, and diabetes than

it is for overweight people with no health problems,” she said.

People with diabetes taking insulin are at risk of becoming hypoglycemic if they do not eat appropriate carbohydrates. Also, persons who **exercise** regularly may experience low energy levels and muscle fatigue from low carbohydrate intake.

### Resources

#### BOOKS

Westman, Eric C., Stephen D. Phinney, and Jeff Volek *The New Atkins for a New You: The Ultimate Diet for Shredding Weight and Feeling Great Forever*. New York: Simon & Schuster, 2010.

Ken R. Wells

## Atopic dermatitis

### Definition

**Eczema** is a general term used to describe a variety of conditions that cause an itchy, inflamed skin rash. Atopic **dermatitis**, a form of eczema, is a non-contagious disorder characterized by chronically inflamed skin and sometimes intolerable **itching**.

### Description

Atopic dermatitis refers to a wide range of diseases that are often associated with **stress** and allergic disorders that involve the respiratory system, like **asthma** and hay fever. Although atopic dermatitis can appear at any age, it is most common in children and young adults. Symptoms usually abate before the age of 25 and do not affect the patient’s general health.

About one in ten babies develop a form of atopic dermatitis called infantile eczema. Characterized by skin that oozes and becomes encrusted, infantile eczema most often occurs on the face and scalp. The condition usually improves before the child’s second birthday, and medical attention can keep symptoms in check until that time.

When atopic dermatitis develops after infancy, inflammation, blistering, oozing, and crusting are less pronounced. The patient’s sores become dry, turn from red to brownish-gray, and skin may thicken and become scaly. In dark-skinned individuals, this condition can cause the complexion to lighten or darken. Itching associated with this condition is usually worst at night. It can be so intense that patients scratch until their sores bleed, sometimes causing scarring and infection.



**A close-up view of atopic dermatitis in the crook of the elbow of a 12-year-old patient.** (Custom Medical Stock Photo, Inc. Reproduced by permission.)

Atopic dermatitis affects about 3% of the population of the United States, and about 80% of the people who have the condition have one or more relatives with the same condition or a similar one. Symptoms tend to be most severe in females. Atopic dermatitis can erupt on any part of the skin, and crusted, thickened patches on the fingers, palms, or the soles of the feet can last for years. In teenagers and young adults, atopic dermatitis often appears on one or more of the following areas:

- elbow creases
- backs of the knees
- ankles
- wrists
- face
- neck
- upper chest
- palms and between the fingers

## KEY TERMS

**Corticosteroid**—A steroid hormone produced by the adrenal gland or as a synthetic compound that reduces inflammation, redness, rashes, and irritation.

**Dermatitis**—Inflammation of the skin.

## Causes and symptoms

While allergic reactions often trigger atopic dermatitis, the condition is thought to be the result of an inherited over-active immune system or a genetic defect that causes the skin to lose abnormally large amounts of moisture. The condition can be aggravated by a cycle that develops in which the skin itches, the patient scratches, the condition worsens, the itching worsens, the patient scratches, etc. This cycle must be broken by relieving the itching to allow the skin time to heal. If the skin becomes broken, there is also a risk of developing skin infections which, if not recognized and treated promptly, can become more serious.

Symptoms of atopic dermatitis include the following:

- an itchy rash and dry, thickened skin on areas of the body where moisture can be trapped
- continual scratching
- chronic fatigue, caused when itching disrupts sleep

An individual is more at-risk for developing the condition if there is a personal or family history of atopic dermatitis, hay fever, asthma, or other **allergies**. Exposure to any of the following can cause a flare-up:

- hot or cold temperatures
- wool and synthetic fabrics
- detergents, fabric softeners, and chemicals
- use of drugs that suppress immune-system activity

Certain foods, such as peanuts, cow's milk, eggs, and fish, can trigger symptoms of atopic dermatitis. A small percentage of patients with atopic dermatitis find that their symptoms worsen after having been exposed to dust, feather pillows, rough-textured fabrics, or other materials to which dust adheres.

## Diagnosis

Diagnosis of atopic dermatitis is usually based on the patient's symptoms and personal and family health history. Skin tests do not generally provide reliable information about this condition.

## Treatment

Atopic dermatitis cannot be cured, but the severity and duration of symptoms can be controlled. A dermatologist should be consulted when symptoms first appear, and is likely to recommend warm baths to loosen encrusted skin, followed by applications of petroleum jelly or vegetable shortening to prevent the skin's natural moisture from escaping.

Externally applied (topical) **steroids** or preparations containing coal tar can relieve minor itching, but coal tar has an unpleasant odor, stains clothes, and may increase skin-cancer risk. Excessive use of steroid creams in young children can alter growth. Pregnant women should not use products that contain coal tar. Topical steroids can cause itching, burning, **acne**, permanent stretch marks, and thinning and spotting of the skin. Applying topical steroids to the area around the eyes can cause glaucoma.

Oral **antihistamines**, such as diphenhydramine (Benadryl), can relieve symptoms of allergy-related atopic dermatitis. More concentrated topical steroids are recommended for persistent symptoms. A mild tranquilizer may be prescribed to reduce stress and help the patient sleep, and **antibiotics** are used to treat secondary infections.

Cortisone ointments should be used sparingly, and strong preparations should never be applied to the face, groin, armpits, or rectal area. Regular medical monitoring is recommended for patients who use cortisone salves or lotions to control wide-spread symptoms. Oral cortisone may be prescribed if the patient does not respond to other treatments, but patients who take the medication for more than two weeks have a greater-than-average risk of developing severe symptoms when the treatment is discontinued.

Allergy shots rarely improve atopic dermatitis and sometimes aggravate the symptoms. Since **food allergies** may trigger atopic dermatitis, the doctor may suggest eliminating certain foods from the diet if other treatments prove ineffective.

If symptoms are extremely severe, ultraviolet **light therapy** may be prescribed, and a wet body wrap recommended to help the skin retain moisture. This technique, used most often with children, involves sleeping in a warm room while wearing wet pajamas under dry clothing, rain gear, or a nylon sweatshirt. The patient's face may be covered with wet gauze covered by elastic **bandages**, and his or her hands encased in wet socks covered by dry ones.

A physician should be notified if the condition is widespread or resists treatment, or the skin oozes, becomes encrusted, or smells, as this may indicate an infection.

## Alternative treatment

Alternative therapies can sometimes bring relief or resolution of atopic dermatitis when conventional therapies are not helping. If the condition becomes increasingly widespread or infected, a physician should be consulted.

Helpful alternative treatments for atopic dermatitis may include:

- Taking regular brisk walks, followed by bathing in warm water sprinkled with essential oil of lavender (*Lavandula officinalis*); lavender oil acts as a nerve relaxant for the whole body including the skin
- Supplementing the diet daily with zinc, fish oils, vitamin A, vitamin E, and evening primrose oil (*Oenothera biennis*)—all good sources of nutrients for the skin
- Reducing or eliminating red meat from the diet
- Eliminating or rotating potentially allergic foods such as cow's milk, peanuts, wheat, eggs, and soy
- Implementing stress reduction techniques in daily life.

Herbal therapies also can be helpful in treating atopic dermatitis. Western herbal remedies used in the treatment of this condition include burdock (*Arctium lappa*) and *Ruta* (*Ruta graveolens*). Long-term herbal therapy requires monitoring and should be guided by an experienced practitioner.

Other alternative techniques that may be useful in the treatment of atopic dermatitis include:

- Acupressure (acupuncture without needles) to relieve tension that may trigger a flare
- Aromatherapy, using essential oils like lavender, thyme (*Thymus vulgaris*), jasmine (*Jasminum officinale*) and chamomile (*Matricaria recutita*) in hot water, to add a soothing fragrance to the air
- Shiatsu massage and reflexology, performed by licensed practitioners, to alleviate symptoms by restoring the body's natural balance
- Homeopathy, which may temporarily worsen symptoms before relieving them, should be supervised by a trained alternative healthcare professional
- Hydrotherapy, which uses water, ice, liquid, and steam, to stimulate the immune system
- Juice therapy to purify the liver and relieve bowel congestion
- Yoga to induce a sense of serenity.

## Prognosis

Atopic dermatitis is unpredictable. Although symptoms occur less often with age and sometimes disappear altogether, they can recur without warning. Atopic dermatitis lowers resistance to infection and increases the risk of developing **cataracts**. Sixty percent of patients with atopic dermatitis will experience flares and remissions throughout their lives.

## Prevention

Research has shown that babies weaned from breast milk before they are four months old are almost three times more likely than other babies to develop recurrent eczema. Feeding eggs or fish to a baby less than one year old can activate symptoms, and babies should be shielded from such irritants as mites, molds, pet hair, and smoke.

Possible ways to prevent flare-ups include the following:

- eliminate activities that cause sweating
- lubricate the skin frequently
- avoid wool, perfumes, fabric softeners, soaps that dry the skin, and other irritants
- avoid sudden temperature changes

A doctor should be notified whenever any of the following occurs:

- fever or relentless itching develop during a flare
- an unexplained rash develops in someone who has a personal or family history of eczema or asthma
- inflammation does not decrease after seven days of treatment with an over-the-counter preparation containing coal tar or steroids
- a yellow, tan, or brown crust or pus-filled blisters appear on top of an existing rash
- a person with active atopic dermatitis comes into contact with someone who has cold sores, genital herpes, or another viral skin disease

## ORGANIZATIONS

American Academy of Dermatology, PO Box 4014,  
Schaumburg, IL, 60168-4014, (847) 240-1859, (866)  
503-SKIN (7546), <http://www.aad.org>.

Maureen Haggerty

## Atrial ectopic beats

### Definition

Atrial ectopic beats (AEB) refers to a contraction of the upper heart chamber which occurs before it would be expected. Atrial ectopic beats are also known as premature atrial beats, premature atrial complex (PAC), or atrial extrasystole.

### Description

An AEB is usually a harmless disturbance in the normal rhythm of the heart. It can occur only occasionally, in a regular pattern, or several may occur in sequence and then disappear. Most often, the person is unaware of the event.

### Causes and symptoms

As people age, extra beats tend to happen more frequently even in perfectly healthy individuals. AEB may be triggered or increased by **stress**, **caffeine**, **smoking**, and some medicines. Cold remedies containing ephedrine or pseudoephedrine have been known to increase the incidence of atrial ectopic beats. AEB may also be the result of an enlarged atria, lung disease, or the result of reduced blood supply to that area of the heart.

If a person is aware of the event, the first symptom of AEB is usually a feeling that the heart has skipped or missed a beat. This is often accompanied by a feeling that the heart is thumping or pounding in the chest. The thumping or pounding is caused by the fact that when there is an AEB, the pause before the next beat is usually longer than normal. The next beat must be stronger than usual to pump the accumulated blood out of the chamber.

### Diagnosis

Diagnosis of AEB is often suspected on the basis of the patient's description of the occurrence. An electrocardiogram (ECG) can confirm the diagnosis. An ECG shows the heart beat as three wave forms. The first wave is called P, the second is called QRS, and the last is T. An atrial ectopic beat will show up on the ECG as a P wave that occurs closer than usual to the preceding T wave.

### Treatment

Atrial ectopic beats do not usually require treatment. If treatment is necessary because the beats occur

frequently and cause intolerable discomfort, the doctor may prescribe medication.

### Prognosis

Occasional AEB usually have no significance. If they increase in frequency, they can lead to atrial tachycardia or fibrillation and to a decrease in cardiac output.

### Prevention

AEB cannot usually be prevented. Aggravating factors can be addressed, like excessive stimulants and uncontrolled pulmonary disorders.

### ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Dorothy Elinor Stonely

Atrial extrasystole see **Atrial ectopic beats**

## KEY TERMS

**Arrhythmia**—A variation in the normal rhythm of the heart beat. Atrial fibrillation and flutter are two types of arrhythmia.

**Atria**—The two small upper chambers of the heart that receive blood from the lungs and the body.

**Stroke**—A brain attack caused by a sudden disruption of blood flow to the brain, in this case because of a blood clot.

**Ventricles**—The two large lower chambers of the heart that pump blood to the lungs and to the rest of the body.

chambers, beat irregularly but not as fast as the atria. When the atria fibrillate, blood that is not completely pumped out can pool and form a clot. In atrial flutter, the heart beat is usually very fast but steady. The atria beat faster than the ventricles.

Atrial fibrillation often occurs in people with various types of heart disease. Atrial fibrillation may also result from an inflammation of the heart's covering (**pericarditis**), chest trauma or surgery, pulmonary disease, and certain medications. Atrial fibrillation is more common in older people; about 10% of people over the age of 75 have it. Atrial flutter and fibrillation usually occur in people with hypertensive or coronary heart disease and other types of heart disorders.

### Causes and symptoms

In most cases, the cause of atrial fibrillation and flutter can be found, but often it cannot. Causes of these heart beat abnormalities include:

- many types of heart disease
- stress and anxiety
- caffeine
- alcohol
- tobacco
- diet pills
- some prescription and over-the-counter medications
- open heart surgery

Symptoms, when present, include:

- a fluttering feeling in the chest
- a pulse that feels like the heart is skipping, racing, jumping, or is irregular
- low energy

- a faint or dizzy feeling
- pressure or discomfort in the chest
- shortness of breath
- anxiety

## Diagnosis

A doctor can sometimes hear these arrhythmias using an instrument (a stethoscope) to listen to the sounds within the chest. Atrial fibrillation and flutter are usually diagnosed through **electrocardiography** (EKGs), an exercise-stress test, a 24-hour Holter EKG monitor, or a telephone cardiac monitor. An EKG shows the heart's activity and may reveal a lack of oxygen (**ischemia**). Electrodes covered with conducting jelly are placed on the patient's chest, arms, and legs. The electrodes send impulses of the heart's activity through a monitor (called an oscilloscope) to a recorder that traces the pattern of the impulses onto paper. The test takes about 10 minutes and is performed in a doctor's office. The **exercise-stress test** measures how the heart and blood vessels respond to work when the patient is exercising on a treadmill or a stationary bike. This test is performed in a doctor's office within an exercise laboratory and takes 15-30 minutes.

In 24-hour EKG (Holter) monitoring, the patient wears a small, portable tape recorder connected to disks on his/her chest that record the heart's rhythm during normal activities. An EKG called transtelephonic monitoring identifies arrhythmias that occur infrequently. Like **Holter monitoring**, transtelephonic monitoring continues for days or weeks and enables patients to send the EKG via telephone to a monitoring station when an arrhythmia is felt, or to store the information in the recorder and transmit it later. Doctors can also use high-frequency sound waves (**echocardiography**) to determine the structure and function of the heart. This diagnostic method is often helpful to evaluate for underlying heart disease.

## Treatment

Atrial fibrillation and flutter are usually treated with medications and/or electrical shock (**cardioversion**). In some cases, removal of a small portion of the heart (ablation), implantation of a pacemaker or a cardioverter defibrillator, or maze surgery is needed.

If the heart rate cannot be quickly controlled, electrical cardioversion may be used. Cardioversion, the electric shock to the chest wall, is usually performed emergencies. This device briefly suspends the heart's activity and allows it to return to a normal rhythm.

Ablation destroys the heart tissue that causes the arrhythmia. The tissue can be destroyed by catheterization or surgery. Radiofrequency **catheter ablation**, performed in a **cardiac catheterization** laboratory, can cure atrial flutter and control the heart rate in atrial fibrillation. The patient is awake but sedated. A thin tube called a catheter is inserted into a vein and is threaded into the heart. At the end of the catheter, a device maps the electrical pathways of the heart. A cardiologist, a doctor specializing in the heart, uses this map to identify the pathway(s) causing the arrhythmia, and then eliminates it (them) with bursts of high-frequency radio waves. Surgical ablation is performed in an operating room under **general anesthesia**. Computerized mapping techniques are combined with a cold probe to destroy arrhythmia-causing tissue. Ablation is generally successful. When ablation is used for atrial fibrillation, it is usually followed by implantation of a pacemaker as well as drug therapy.

A pacemaker is a battery-powered device about the size of a matchbox that is surgically implanted near the collarbone to regulate the heart beat. Lead wires threaded to the right side of the heart supply electrical energy to pace the atria and ventricles. The implantable cardioverter defibrillator is a treatment for serious arrhythmias. The battery-powered device senses an abnormal heart rhythm and automatically provides electrical shock(s). The shock(s) suspends heart activity and then allows the heart to initiate a normal rhythm. Wire electrodes on the device are attached to the heart. Some of the electrodes are attached to the outside of the heart and some are attached to the inside of the heart through veins. The newest implantable cardioverter defibrillators can be implanted in the chest wall and do not require open chest surgery. These devices weigh less than 10 oz. and generally last seven or eight years. An implantable cardioverter defibrillator is usually used with drug therapy, but the amount medication is reduced. In maze surgery, often the last resort, surgeons create a maze of stitches (stitches) that help the heart's electrical impulses travel effectively.

Most of the drugs used for treatment have potential side effects and should be carefully monitored by a doctor. The goal of treatment is to control the rate and rhythm of the heart and to prevent the formation of **blood clots**. If the arrhythmia is caused by heart disease, the heart disease will also be treated. The American Heart Association recommends aggressive treatment.

A digitalis drug, most commonly **digoxin**, is usually prescribed to control the heart rate. Digitalis

drugs slow the heart's electrical impulses, helping to restore the normal rate and rhythm. These drugs also increase the ability of the heart's muscular layer to contract and pump properly. Beta blockers and **calcium channel blockers** can also be used for this purpose. Beta blockers slow the speed of electrical impulses through the heart. Some calcium channel blockers dampen the heart's response to erratic electrical impulses.

To prevent blood clots, **aspirin** or warfarin (Coumadin) is administered. Warfarin, however, has potential bleeding side effects, especially in older patients. Amiodarone is fairly effective for atrial flutter. This drug is often able to maintain the heart's proper rhythm and can also help control the heart rate when the flutter occurs.

## Prognosis

Patients with atrial fibrillation and flutter can live a normal life for many years as long as the arrhythmia is controlled and serious blood clots are prevented.

## Prevention

Atrial fibrillation and flutter can sometimes be prevented when the cause can be identified and controlled. Depending on the cause, prevention could include:

- treating the underlying heart disease
- reducing stress and anxiety
- reducing or stopping consumption of caffeine, alcohol, or tobacco
- discontinuing diet pills or other medications (over-the-counter or prescription)

## ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, <http://www.nhlbi.nih.gov>.

Texas Heart Institute. Heart Information Service, MC 3-116, PO Box 20345, Houston, TX, 77225, (832) 355-4011, (800) 292-2221, <http://www.texasheart.org>.

Lori De Milto

Atrial flutter see **Atrial fibrillation and flutter**

# Atrial septal defect

## Definition

An atrial septal defect is an abnormal opening in the wall separating the left and right upper chambers (atria) of the heart.

## Description

During the normal development of the fetal heart, there is an opening in the wall (the septum) separating the left and right upper chambers of the heart. Normally, this opening closes before birth, but if it does not, the child is born with a hole between the left and right atria. This abnormal opening is called an atrial septal defect and causes blood from the left atrium to flow into the right atrium.

Different types of atrial septal defects can occur, and they are classified according to where in the separating wall they are found. The most commonly found atrial septal defect occurs in the middle of the atrial septum and accounts for about 70% of all atrial septal defects. Abnormal openings can form in the upper and lower parts of the atrial septum as well.

## Causes and symptoms

Abnormal openings in the atrial septum occur during fetal development and are twice as common in females as in males. These abnormalities can go unnoticed if the opening is small, producing no abnormal symptoms. If the defect is big, large amounts of blood flowing from the left to the right atrium will cause the right atrium to swell to hold the extra blood.

People born with an atrial septal defect can have no symptoms through their twenties, but by age 40, most people with this condition have symptoms that can include **shortness of breath**, rapid abnormal beating of the atria (**atrial fibrillation**), and eventually **heart failure**.

## Diagnosis

Atrial septal defects can be identified by various methods. Abnormal changes in the sound of the heart beats can be heard when a doctor listens to the heart with a stethoscope. In addition, a **chest x ray**, an electrocardiogram (ECG, an electrical printout of the heartbeats), and an echocardiogram (a test that uses sound waves to form a detailed image of the heart) can also be used to identify this condition.

An atrial septal defect can also be diagnosed by using a test called **cardiac catheterization**. This test involves inserting a very thin tube (catheter) into the

## KEY TERMS

**Cardiac catheterization**—A test that involves having a tiny tube inserted into the heart through a blood vessel.

**Dacron**—A synthetic polyester fiber used to surgically repair damaged sections of heart muscle and blood vessel walls.

**Echocardiogram**—A test that uses sound waves to generate an image of the heart, its valves, and chambers.

heart's chambers to measure the amount of oxygen present in the blood within the heart. If the heart has an opening between the atria, oxygen-rich blood from the left atrium enters the right atrium. Through cardiac catheterization, doctors can detect the higher-than-normal amount of oxygen in the heart's right atrium, right ventricle, and the large blood vessels that carry blood to the lungs, where the blood would normally subsequently get its oxygen.

### Treatment

Atrial septal defects often correct themselves without medical treatments by the age of two. If this does not happen, surgery is done by sewing the hole closed, or by sewing a patch of Dacron material or a piece of the sac that surrounds the heart (the pericardium), over the opening.

Some patients can have the defect fixed by having an clam-shaped plug placed over the opening. This plug is a man-made device that is put in place through a catheter inserted into the heart.

### Prognosis

Individuals with small defects can live a normal life, but larger defects require surgical correction. Less than 1% of people younger than 45 years of age die from corrective surgery. Five to ten percent of patients can die from the surgery if they are older than 40 and have other heart-related problems. When an atrial septal defect is corrected within the first 20 years of life, there is an excellent chance for the individual to live normally.

### ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, Review.personal.info@heart.org.

Dominic De Bellis PhD

Atrioventricular block see **Heart block**

Attapulgite see **Antidiarrheal drugs**

## Attention deficit hyperactivity disorder (ADHD)

### Definition

Attention deficit hyperactivity disorder (ADHD) is a developmental disorder characterized by distractibility, hyperactivity, impulsive behaviors, and the inability to remain focused on tasks or activities.

### Description

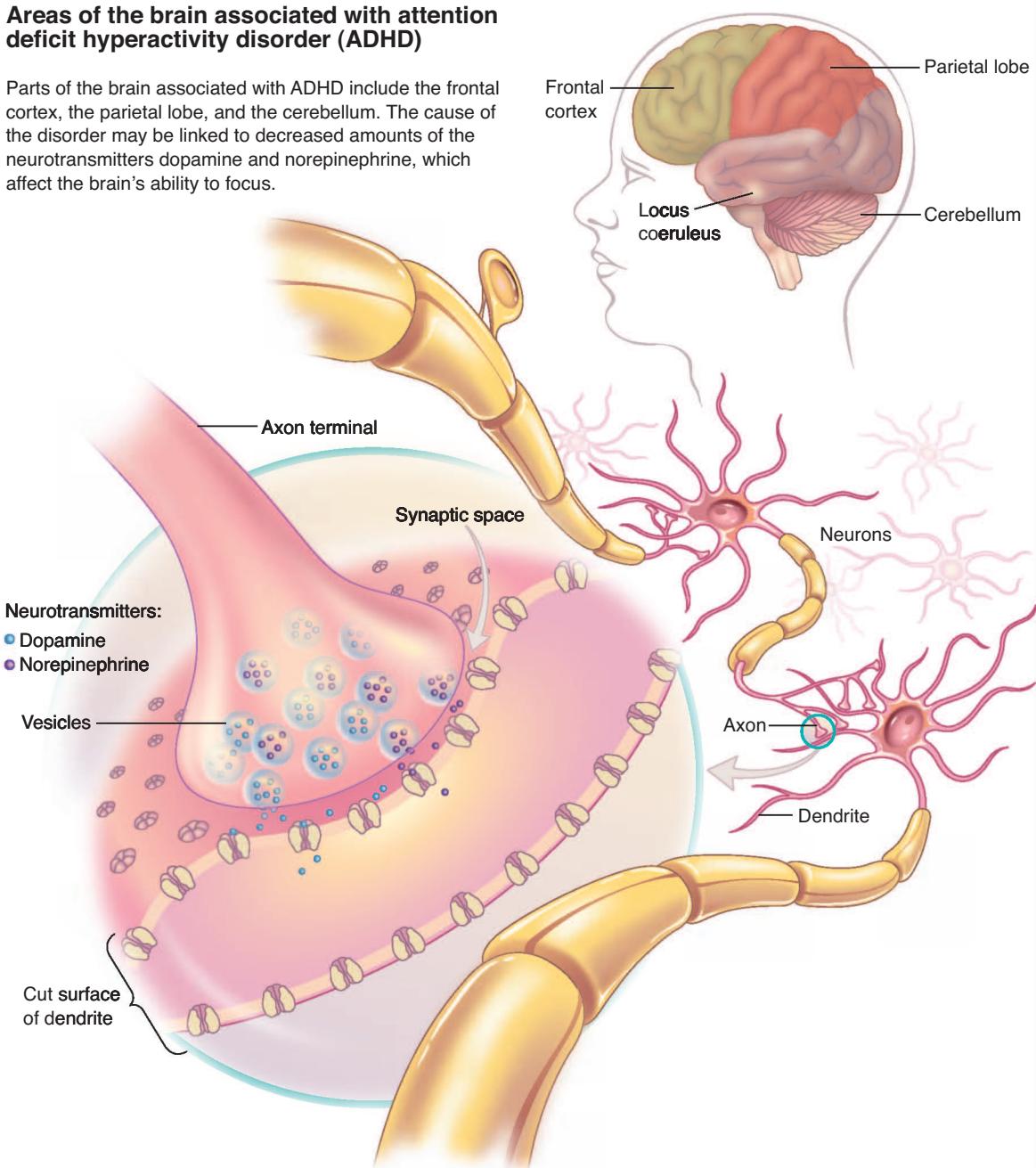
ADHD, also called hyperkinetic disorder (HKD) outside of the United States, is the most commonly diagnosed neurological disorder in children. It is estimated to affect 3–7% of school-age children in the United States and is 3–5 times more common in boys than in girls, although in adults, the ratio of males to females is closer to 2 to 1. Worldwide, diagnosed rates of ADHD range from less than 1% in Great Britain (which has stringent standards for diagnosis) to 12%. ADHD is a disorder of childhood; symptoms must begin before age 7, although they may continue into adulthood. Although childhood ADHD has been studied extensively, less information is available on adult ADHD. Studies on adults have produced a wide range of sometimes conflicting results. These studies report that anywhere from 30–80% of children with ADHD continue to have symptoms into adulthood. One reason for the wide range of findings is that the hyperactive component of the disorder often becomes less noticeable as individuals mature and develop more self-control.

Three types of ADHD are recognized by the American Psychiatric Association and outlined in the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revised (DSM-IV-TR)*:

- predominately hyperactive. This is characterized by excessive physical activity (e.g., constant fidgeting, inability to stay seated, inability to engage in quiet play) and impulsive behaviors (e.g., interrupting, difficulty waiting in line).
- predominately inattentive. This is characterized by inability to pay close attention to detail, stay on task, and organize tasks. This form of ADHD

### Areas of the brain associated with attention deficit hyperactivity disorder (ADHD)

Parts of the brain associated with ADHD include the frontal cortex, the parietal lobe, and the cerebellum. The cause of the disorder may be linked to decreased amounts of the neurotransmitters dopamine and norepinephrine, which affect the brain's ability to focus.



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## Drugs used to treat ADHD

Brand name (generic name)	Possible side effects
Adderall (amphetamine and dextroamphetamine)	Dizziness, loss of appetite, nervousness, restlessness
Dexedrine (dextroamphetamine sulfate)	Excessive stimulation, restlessness
Ritalin (methylphenidate hydrochloride)	Insomnia, loss of appetite, nervousness

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sometimes is referred to as attention deficit disorder (ADD).

- combined hyperactive and inattentive. This combines an inappropriately high activity level with a high level of distractibility.

## Causes and symptoms

Although the exact causes of ADHD are not known, it is clear that specific parts of the brain are involved including the frontal cortex, parietal lobe, and possibly the cerebellum. Functional magnetic resonance imaging (fMRI) studies comparing the brains of children with ADHD and those without the disorder show that children with ADHD have weaker brain activation of the frontal area when responding to tasks that require inhibition. Researchers believe that this is related to an imbalance in certain neurotransmitters (the chemicals in the brain that carry messages between nerve cells). Deficits in the neurotransmitters dopamine and norepinephrine are strongly suggested. One characteristic of drugs used to treat ADHD is that they make dopamine and/or norepinephrine more available in the brain. ADHD also appears to have a hereditary component. Children with a parent or sibling with ADHD are 2–8 times more likely to develop the disorder. Scientists have suggested at least 20 genes that may make a person more vulnerable to ADHD or contribute to the disorder in some way.

A widely publicized study conducted by Dr. Ben Feingold in the early 1970s suggested that **allergies** to certain foods and food additives caused the characteristic hyperactivity of ADHD children. Although some children may have adverse reactions to certain foods that can affect their behavior (for example, a rash might temporarily cause a child to be distracted from other tasks), carefully controlled follow-up studies have uncovered no link between **food allergies** and ADHD. Another popularly held misconception

about food and ADHD is that the consumption of sugar causes hyperactive behavior. Again, studies have shown no link between sugar intake and ADHD. It is important to note, however, that a nutritionally balanced diet is important for normal development in all children.

Children with ADHD have short attention spans, becoming easily distracted or frustrated with tasks. Although they may be quite intelligent, their lack of focus frequently results in poor grades and difficulties in school. ADHD children act impulsively, taking action first and thinking later. They are constantly moving, running, climbing, squirming, and fidgeting, but often have trouble with motor skills and, as a result, may be physically clumsy and awkward. Their clumsiness may extend to the social arena, where they are sometimes shunned due to their impulsive and intrusive behavior.

## Diagnosis

There is no single test for ADHD. Psychiatrists and other mental health professionals use the criteria listed in the *DSM-IV-TR* as a guideline for determining the presence of the disorder. A diagnosis of ADHD requires the presence of at least six of the following symptoms of inattention or six or more symptoms of hyperactivity and impulsivity combined. These symptoms must occur before age 7, be present in at least two different environments (e.g., home and school) for at least 6 months, and not be attributable to any other developmental or mental health disorder.

### Inattention:

- Often fails to pay close attention to detail or makes careless mistakes in schoolwork or other activities
- Often has difficulty sustaining attention in tasks or activities
- Often does not appear to listen when spoken to
- Often does not follow through on instructions and does not finish tasks
- Often has difficulty organizing tasks and activities
- Often avoids or dislikes tasks that require sustained mental effort (e.g., homework)
- Often loses things necessary for tasks (e.g., books, tools).
- Often is easily distracted
- Often is forgetful in daily activities

### Hyperactivity:

- Fidgets with hands or feet or squirms in seat
- Does not remain seated when expected to

## KEY TERMS

**Conduct disorder**—A behavioral and emotional disorder of childhood and adolescence. Children with a conduct disorder act inappropriately, infringe on the rights of others, and violate societal norms.

**Dopamine**—A neurotransmitter and the precursor of norepinephrine.

**Nervous tic**—A repetitive, involuntary action, such as the twitching of a muscle or repeated blinking.

**Neurotransmitter**—One of a group of chemicals secreted by a nerve cell (neuron) to carry a chemical

message to another nerve cell, often as a way of transmitting a nerve impulse. Examples of neurotransmitters include acetylcholine, dopamine, serotonin, and norepinephrine.

**Norepinephrine**—A hormone released by nerve cells and the adrenal medulla that causes constriction of blood vessels. Norepinephrine also functions as a neurotransmitter.

**Oppositional defiant disorder**—A disorder characterized by hostile, deliberately argumentative, and defiant behavior toward authority figures.

- Runs or climbs excessively when inappropriate (in adolescents and adults, feelings of restlessness)
- Has difficulty playing quietly

Impulsivity:

- Blurs out answers before the question has been completed
- Has difficulty waiting (e.g., to take turns, to stand in line)
- Interrupts and/or intrudes on others

The first step in determining if a child has ADHD is to consult with a pediatrician. The pediatrician can make an initial evaluation of the child's developmental maturity compared to other children in his or her age group. The physician also can perform a comprehensive **physical examination** to rule out any organic causes of ADHD symptoms, such as an overactive thyroid, vision problems, or hearing problems.

If no organic problem is found, a psychologist, psychiatrist, neurologist, neuropsychologist, or learning specialist typically is consulted to perform a comprehensive ADHD assessment. A complete medical, family, social, psychiatric, and educational history is compiled from existing medical and school records and from interviews with parents and teachers. Interviews may also be conducted with the child, depending on his or her age. Along with these interviews, several clinical inventories may also be used, such as the Conners Rating Scales (Teacher's Questionnaire and Parent's Questionnaire), Child Behavior Checklist (CBCL), and the Barkley Home Situation Questionnaire. These inventories provide valuable information on the child's behavior in different settings and situations. In addition, the Wender Utah Rating Scale has been adapted for use in diagnosing ADHD in adults. Continuous Performance Tests, which involve tasks

performed on a computer, may support a diagnosis of attention deficit type ADHD but by themselves are not diagnostic.

As many as 50–60% of people diagnosed with ADHD also meet the diagnostic criteria for another major psychiatric disorder such as **anxiety disorders**, depression, antisocial personality disorder, **substance abuse** disorder, or **conduct disorder**. These individuals also have a high likelihood of having a learning disorder. A complete and comprehensive psychiatric assessment is critical to differentiate ADHD from other mood and behavioral disorders.

In the United States, public schools are required by federal law to offer free ADHD testing upon request. A pediatrician also can provide a referral to a psychologist or pediatric psychiatrist for ADHD assessment. Parents should check with their insurance plans to see if these services are covered.

### Treatment

The use of stimulant drugs has proved to be the most effective treatment for ADHD. These drugs generally increase the availability of neurotransmitters in the brain. Drug therapy must be highly individualized with the benefits balanced against the risk of undesirable side effects. Dextroamphetamine (Dexedrine), dextroamphetamine/amphetamine mixture (Adderall), methylphenidate (Ritalin, Metadate), and dexmethylphenidate (Focalin) are common stimulant drug treatments. These drugs are available in both immediate release and extended release forms. Atomoxetine (Strattera) is a nonstimulant norepinephrine reuptake inhibitor. Its effect is to make the norepinephrine the brain produces remain in the brain longer, thus increasing the amount of norepinephrine available.

The use of pemoline (Cylert) to treat ADHD was stopped in 2005 because the United States Food and Drug Administration (FDA) ruled that the risk of liver damage outweigh the benefits of this drug.

Stimulant drugs may have adverse side effects in some children and that may make them inappropriate choices. These side effects include loss of appetite, **insomnia**, mood disturbance, **headache**, and gastrointestinal distress. Tics may also appear and should be monitored carefully. Psychotic reactions are among the more severe side effects. There is some evidence that long-term use of stimulant medication may interfere with physical growth and weight gain. Some experts feel that these effects are ameliorated by “medication breaks” over school vacations or weekends. Increasingly, there is concern about use of long-term stimulant medications in very young children.

In the past children who did not respond well to stimulant therapy often were given **tricyclic antidepressants** such as desipramine (Norpramin, Pertofrone) and imipramine (Tofranil). By 2009, these drugs were rarely used because they have a much higher risk of causing serious side effects including and cardiac arrhythmia (irregular heartbeat that can be life threatening). Other medications prescribed for ADHD therapy include buproprion (Wellbutrin) and venlafaxine (Effexor), both atypical, non-tricyclic antidepressants. Clonidine (Catapres) and guanfacine (Tenex), both systemic antihypertensive (blood pressure lowering) medications, also have been used to control aggression and hyperactivity in some ADHD children, although these drugs can have serious side effects if taken with methylphenidate (Ritalin). A child’s response to medication will change with age and maturation, so ADHD symptoms should be monitored and prescriptions adjusted accordingly.

It is important that drug treatment be carefully monitored and not be used exclusively in the management of ADHD. Behavior modification is often used in conjunction with drug therapy. Behavior modification uses a reward system to reinforce good behavior and task completion and can be implemented both in the classroom and at home. A tangible reward such as a sticker may be given to the child every time he or she completes a task or behaves in an acceptable manner. A chart system may be used to display the stickers and visually illustrate the child’s progress. When a certain number of stickers are collected, the child may trade them in for a bigger reward such as a trip to the zoo or a day at the beach. The reward system stays in place until the good behavior becomes ingrained.

A variation of this technique, **cognitive-behavioral therapy**, works to decrease impulsive behavior by getting the child to recognize the connection between thoughts and behavior. Behavior is changed by changing negative thinking patterns.

Individual **psychotherapy** may help ADHD children build self-esteem, give them a place to discuss their worries and anxieties, and help them gain insight into their behavior and feelings. **Family therapy** also may be beneficial in helping family members develop coping skills and in working through feelings of guilt or anger parents may be experiencing.

### Alternative treatment

A number of alternative treatments exist for ADHD. Although there is a lack of controlled studies to prove their efficacy, proponents report that they are successful in controlling symptoms in some ADHD patients. Nevertheless, none of these treatments meet the standards of safety and effectiveness required by conventional medicine. Some of the more popular alternative treatments include:

- EEG (electroencephalograph) biofeedback. By measuring brainwave activity and teaching the ADHD patient which type of brainwave is associated with attention, EEG biofeedback attempts to train patients to generate the desired brainwave activity.
- Dietary therapy. Based in part on the Feingold food allergy diet, dietary therapy focuses on a nutritional plan that is high in protein and complex carbohydrates and free of white sugar and salicylate-containing foods such as strawberries, tomatoes, and grapes.
- Herbal therapy. Herbal therapy uses a variety of natural remedies to address the symptoms of ADHD, such as ginkgo (*Ginkgo biloba*) for memory and mental sharpness and chamomile (*Matricaria recutita*) extract for calming. The safety of herbal remedies has not been demonstrated in controlled studies. For example, it is known that ginkgo may affect blood coagulation, but controlled studies have not yet evaluated the risk of the effect.
- Homeopathic medicine. The theory of homeopathic medicine is to treat the whole person at a core level. Constitutional homeopathic care requires consulting with a well-trained homeopath who has experience working with ADD and ADHD individuals.

### Prognosis

Approximately 70–80% of ADHD patients treated with stimulant medication experience significant relief from symptoms at least in the short term. About half of all ADHD children seem to “outgrow”

symptoms of the disorder in adolescence or early adulthood; the other half retain some or all symptoms of ADHD as adults. Some children diagnosed with ADHD also develop a conduct disorder. For those adolescents who have both ADHD and a conduct disorder, as many as 25% go on to develop antisocial personality disorder and the criminal behavior, substance abuse, and high rate of **suicide** attempts that frequently accompany this psychiatric disorder.

Untreated, ADHD negatively affects a child's social and educational performance and can seriously damage his or her sense of self-esteem. ADHD children have impaired relationships with their peers, and may be looked upon as social outcasts. They may be perceived as slow learners or troublemakers in the classroom. Siblings and even parents may develop resentful feelings towards the ADHD child.

Each child should have an individual educational plan that outlines modifications to the regular mode of instruction that will facilitate the child's academic performance. Teachers need to consider the needs of the ADHD child when giving instructions, making sure that they are well paced with cues to remind the child of each one. They must also understand the origins of impulsive behavior—that the child is not deliberately trying to ruin a lesson or activity by acting unruly. Teachers should be structured, comfortable with the remedial services the child may need, and able to maintain good lines of communication with the parent.

Specialists should devise a series of compensatory strategies that will enable the child to cope with his or her attentional or activity challenges. These strategies might include simple things like checklists of things to do before handing in assignments (name on top, check spelling, etc.), putting a clock on the child's desk to help structure time for activities, or covering the pictures on a page until the child has read the words so that he is not distracted.

Special assistance may not be limited to educational settings. Families frequently need help in coping with the demands and challenges of the ADHD child. Inattention, shifting activities every five minutes, difficulty completing homework and household tasks, losing things, interrupting, not listening, breaking rules, constant talking, boredom, and irritability can take a toll on any family.

Parents may not understand how attention regulation or impulsivity affect daily functioning, and they might not be trained in the kind of techniques that help ADHD children manage their behavior. Siblings may be resentful of what the ADHD child seems to "get away with" or the inordinate amount of attention he

or she receives. The ADHD child may be resentful of the younger sibling who is more accomplished at school or never seems to get in any trouble. Family interaction patterns may set up vicious cycles that become destructive and difficult to break.

Support groups for families with any ADHD member are increasingly available through school districts and health care providers. Community colleges frequently offer courses in discipline and behavior management. Counseling services are available to complement any type of pharmacological treatment that the family obtains for its member. There are also a number of popular books that are informative and helpful. Some of these are listed below.

## Resources

### BOOKS

- Alexander-Roberts, Colleen. *The AD/HD Parenting Handbook: Practical Advice for Parents From Parents*, 2nd ed. Lanham: Taylor Trade Pub., 2006.
- Brynie, Faith Hickman. *ADHD: Attention-Deficit Hyperactivity Disorder*. Minneapolis: Twenty-First Century Books, 2008.
- Conners, Keith, C. *Attention Deficit Hyperactivity Disorder in Children and Adolescents: The Latest Assessment and Treatment Strategies*, 4th ed. Kansas City, MO: Compact Clinicals, 2008.
- McBurnett, Keith, and Linda Pfiffner, eds. *Attention Deficit Hyperactivity Disorder: Concepts, Controversies, New Directions*. New York: Informa Healthcare, 2008.

### PERIODICALS

- Dennis, Tanya, et al. "Attention Deficit Hyperactivity Disorder: Parents' and Professionals' Perceptions." *Community Practitioner* 81.3 (March 2008):24-29.
- Chen, Mandy, Carla M. Seipp, and Charlotte Johnston. "Mothers' and Fathers' Attributions and Beliefs in Families of Girls and Boys with Attention-Deficit/Hyperactivity Disorder." *Child Psychiatry and Human Development* 39.1 (March 2008):85-100.

### OTHER

- "Attention Deficit Hyperactivity Disorder." *MedlinePlus*. January 12, 2009 [cited November 20, 2009]. <http://www.nlm.nih.gov/medlineplus/attentiondeficithyperactivitydisorder.html>.
- "Attention Deficit Hyperactivity Disorder." *National Institute of Mental Health*. January 9, 2009 [cited November 20, 2009]. <http://www.nimh.nih.gov/health/publications/adhd/summary.shtml>.
- Soreff, Stephen and Kiki D. Chang. "Attention Deficit Hyperactivity Disorder." *eMedicine.com*. August 12, 2008 [cited November 20, 2009]. <http://emedicine.medscape.com/article/289350-overview>.

## ORGANIZATIONS

Attention Deficit Disorder Association (ADDA), P.O. Box 7557, Wilmington, DE, 19803-9997, (800) 939-1019, adda@jmoadmin.com, <http://www.add.org>.  
 Children and Adults with Attention Deficit Disorder (CHADD), 8181 Professional Place, Suite 150, Landover, MD, 20785, (301) 306-7070, (800) 233-4050, Conference@chadd.org, <http://www.chadd.org>.

Tish Davidson AM  
Teresa G. Odle  
Laura Jean Cataldo RN, Ed.D.

Attention deficit disorder see **Attention deficit hyperactivity disorder (ADHD)**

Atypical mycobacterial infections see **Mycobacterial infections, atypical**

Atypical pneumonia see **Mycoplasma infections**

screening programs, for example in grade schools, to detect hearing problems in children. It is also used in the doctor's office or hospital audiology department to diagnose hearing problems in children, adults, and the elderly. With correct diagnosis of a person's specific pattern of hearing impairment, the right type of therapy, which might include **hearing aids**, corrective surgery, or **speech therapy**, can be prescribed.

## Precautions

Testing with audiometry equipment is simple and painless. No special precautions are required.

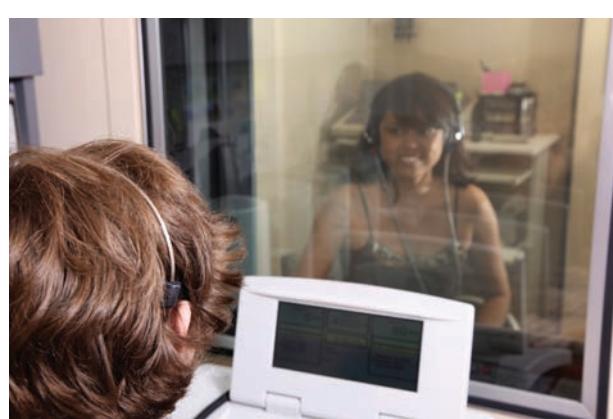
## Description

A trained audiologist (a specialist in detecting hearing loss) uses an audiometer to conduct audiometry testing. This equipment emits sounds or tones, like musical notes, at various frequencies, or pitches, and at differing volumes or levels of loudness. Testing is usually done in a soundproof testing room.

The person being tested wears a set of headphones that blocks out other distracting sounds and delivers a test tone to one ear at a time. At the sound of a tone, the patient holds up a hand or finger to indicate that the sound is detected. The audiologist lowers the volume and repeats the sound until the patient can no longer detect it. This process is repeated over a wide range of tones or frequencies from very deep, low sounds, like the lowest note played on a tuba, to very high sounds, like the ping-pong of a triangle. Each ear is tested separately. It is not unusual for levels of sensitivity to sound to differ from one ear to the other.

A second type of audiometry testing uses a headband rather than headphones. The headband is worn with small plastic rectangles that fit behind the ears to conduct sound through the bones of the skull. The patient being tested senses the tones that are transmitted as vibrations through the bones to the inner ear. As with the headphones, the tones are repeated at various frequencies and volumes.

The results of the audiometry test may be recorded on a grid or graph called an audiogram. This graph is generally set up with low frequencies or tones at one end and high ones at the other end, much like a piano keyboard. Low notes are graphed on the left and high notes on the right. The graph also charts the volume of the tones used; from soft, quiet sounds at the top of the chart to loud sounds at the bottom. Hearing is measured in units called decibels. Most of the sounds associated with normal speech patterns are generally spoken in the range of 20-50 decibels. An



An audiologist conducts a hearing test on a young girl.  
 (© iStockPhoto/Barbara Sauder.)

## KEY TERMS

**Audiogram**—A chart or graph of the results of a hearing test conducted with audiographic equipment. The chart reflects the softest (lowest volume) sounds that can be heard at various frequencies or pitches.

**Decibel**—A unit of measure for expressing the loudness of a sound. Normal speech is typically spoken in the range of about 20-50 decibels.

**Otoscope**—A hand-held instrument with a tiny light and a funnel-shaped attachment called an ear speculum, which is used to examine the ear canal and eardrum.

adult with normal hearing can detect tones between 0-20 decibels.

Speech audiometry is another type of testing that uses a series of simple recorded words spoken at various volumes into headphones worn by the patient being tested. The patient repeats each word back to the audiologist as it is heard. An adult with normal hearing will be able to recognize and repeat 90-100% of the words.

### Preparation

The ears may be examined with an otoscope prior to audiometry testing to determine if there are any blockages in the ear canal due to ear wax or other material.

### Normal results

A person with normal hearing will be able to recognize and respond to all of the tone frequencies administered at various volumes in both ears by the audiometry test. An adult with normal hearing can detect a range of low and high pitched sounds that are played as softly as between nearly 0-20 decibels. Normal speech is generally spoken in the range of 20-50 decibels.

### Abnormal results

Audiometry test results are considered abnormal if there is a significant or unexplained difference between the levels of sound heard between the two ears, or if the person being tested is unable to hear in the normal range of frequencies and volume. The pattern of responses displayed on the audiogram can be used by the audiologist to identify if a significant

hearing loss is present and if the patient might benefit from hearing aids or corrective surgery.

## Resources

### OTHER

“How to Read Your Hearing Test.” *Hearing Alliance of America*. <http://www.earinfo.com>.

“Understanding Your Audiogram.” *The League for the Hard of Hearing*. <http://www.lhh.org>.

### ORGANIZATIONS

American Academy of Audiology, 11730 Plaza America Drive, Suite 300, Reston, VA, 20190, (703) 790-8631, (800) 222-2336, <http://www.audiology.org/>.

Audiology Awareness Campaign, 1 Windsor Cove, Suite 305, Columbia, SC, 29223, (803) 765-0680, (800) 445-8629, [info@audiologyawareness.com](mailto:info@audiologyawareness.com), <http://www.audiologyawareness.com>.

Altha Roberts Edgren

## Auditory integration training

### Definition

Auditory integration training, or AIT, is one specific type of music/auditory therapy based upon the work of French otolaryngologists Dr. Alfred Tomatis and Dr. Guy Berard.

### Origins

The premise upon which most auditory integration programs are based is that distortion in how things are heard contributes to commonly seen behavioral or **learning disorders** in children. Some of these disorders include attention deficit/hyperactive disorder (**ADHD**), **autism**, **dyslexia**, and central auditory processing disorders (**CAPD**). Training the patient to listen can stimulate central and cortical organization.

Auditory integration is one facet of what audiologists call central auditory processing. The simplest definition of central auditory processing, or CAP, is University of Buffalo Professor of Audiology Jack Katz's, which is: “What we do with what we hear.” Central auditory integration is actually the perception of sound, including the ability to attend to sound, to remember it, retaining it in both the long- and short-term memory, to be able to listen to sound selectively, and to localize it.

Guy Berard developed one of the programs commonly used. Berard's auditory integration training consists of twenty half-hour sessions spent listening

to musical sounds via a stereophonic system. The music is random, with filtered frequencies, and the person listens through earphones. These sound waves vibrate and exercise structures in the middle ear. This is normally done in sessions twice a day for 10 days.

Alfred Tomatis is also the inventor of the Electronic Ear. This device operates through a series of filters, and reestablishes the dominance of the right ear in hearing. The basis of Tomatis' work is a series of principles that follow:

- The most important purpose of the ear is to adapt sound waves into signals that charge the brain.
- Sound is conducted via both air and bone. It can be considered something that nourishes the nervous system, either stimulating or destimulating it.
- Just as seeing is not the same as looking, hearing is not the same as listening. Hearing is passive. Listening is active.
- A person's ability to listen affects all language development for that person. This process influences every aspect of self-image and social development.
- The capacity to listen can be changed or improved through auditory stimulation using musical and vocal sounds at high frequencies.
- Communication begins in the womb. As early as the beginning of the second trimester, fetuses can hear sounds. These sounds literally cause the brain and nervous system of the baby to develop.

## Description

A quartet of CAP defects have been identified that can unfavorably alter how each person processes sound. Among these are:

- Phonetic decoding, a problem that occurs when the brain incorrectly decodes what is being heard. Sounds are unrecognizable, often because the person speaking talks too fast.
- Tolerance-fading memory, a condition with little or poor tolerance for background sounds.
- Auditory integration involves a person's ability to put together things heard with things seen. Characteristically there are long response delays and trouble with phonics, or recognizing the symbols for sounds.
- The fourth problem area, often called auditory organization, overlaps the previous three. It is characterized by disorganization in handling auditory and other information.

Certain audiological tests are carried out to see if the person has a CAP problem, and if so, how severe it is. Other tests give more specific information regarding the nature of the CAP problem. They include:

## ALFRED TOMATIS (1920–2001)

Internationally renowned French otolaryngologist, psychologist, educator and inventor Alfred Tomatis perceived the importance of sound and hearing early in his career. He took his degree as a Doctor of Medicine from the University of Paris and specialized in ear, nose and throat medicine. The son of two opera singers, Tomatis early in his career treated some of his parents' fellow opera singers. From these experiences with the sound of music, he developed the principle that has come to be known as the Tomatis Effect, i.e. that the human voice can only sing what it hears.

Tomatis has been called the Einstein of the ear. It was his research that made the world aware that the ears of an infant in utero are already functioning at four and half months of age. Just as the umbilical cord provides nourishment to the unborn infant's body, Tomatis postulated that the sound of the mother's voice is also a nutrient heard by the fetus. This sound literally charges and stimulates the growth of the brain.

Tomatis took this further, into the realm of language. Tomatis concluded that the need to communicate and to be understood are among our most basic needs. He was a pioneer in perceiving that language problems convert into social problems for people. "Language is what characterizes man and makes him different from other creatures," Tomatis is quoted as saying. The techniques he developed to teach people how to listen effectively are internationally respected tools used in the treatment of autism, attention-deficit disorder, and other learning disabilities.

His listening program, the invention of the Electronic Ear, and his work with the therapeutic use of sound and music for the past fifty years have made Tomatis arguably the best known and most successful ear specialist in the world. There are more than two hundred Tomatis Centers worldwide, treating a vast variety of problems related to the ability to hear. Tomatis died in December of 2001.

- Puretone air-conduction threshold testing, which measures peripheral hearing loss. If loss is found, then bone-conduction testing, or evaluation of the vibration of small bones in the inner ear, is also carried out.
- Word discrimination scores (WDS) determines a person's clarity in hearing ideal speech. This is done by presenting 25–50 words at 40 decibels above the person's average sound threshold in each ear. Test scores equal the percentage of words heard correctly.
- Immittance testing is made up of two parts, assessing the status of, and the protective mechanisms of the middle ear.
- Staggered sporadic word (SSW) testing delivers 40 compound words in an overlapping way at 50 decibels above threshold to each ear of the person being

tested. This test provides expanded information that makes it possible to break down CAP problems into the four basic types.

- Speech in noise discrimination (SN) testing is similar to Staggered Sporadic Word testing except that other noise is also added and the percentage correct in quiet is compared with that correct when there is added noise.
- Phonemic synthesis (PS) determines serious learning problems. The types of errors made in sounding out written words or associating written letters with the sounds they represent help in determining the type and severity of CAP problems.

### Purpose

Upon completion of an auditory integration training program, the person's hearing should be capable of perceiving all frequencies at, or near, the same level. Total improvement from this therapy, in both hearing and behavior, can take up to one year.

### Research and general acceptance

Auditory integration training is based upon newly learned information about the brain. Though brain structures and connections are predetermined, probably by heredity, another factor called *plasticity* also comes into play. Learning, we now know, continues from birth to **death**. Plasticity is the ability of the brain to actually change its structuring and connections through the process of learning.

Problems with auditory processing are now viewed as having a wide-reaching ripple effect on our society. It is estimated that 30–40% of children starting school have language-learning skills that can be described as poor. CAP difficulties are a factor in several different learning disabilities. They affect not only academic success, but also nearly every aspect of societal difficulties. One example to illustrate this is a 1989 University of Buffalo study where CAP problems were found to be present in a surprising 97% of youth inmates in an upstate New York corrections facility.

### Resources

#### OTHER

- Cooper, Rachel. "What is Auditory Integration Training?" December 2000. <http://www.vision3d.com/adhd>.
- Dejean, Valerie. *About the Tomatis Method*, 1997. Tomatis Auditory Training Spectrum Center, Bethesda, MD.
- The Spectrum Center. "Auditory Integration and Alfred Tomatis." December 2000. <http://listeningtraining.com>.

Joan Schonbeck

**Australia antigen-associated hepatitis** see  
**Hepatitis B**

## Autism

### Definition

Autism is a complex developmental disorder distinguished by difficulties with social interaction, verbal and nonverbal communication, and behavioral problems, including repetitive behaviors and narrow focus of interest.

### Demographics

Estimates suggest that about 1 of every 110 children in the United States are affected by autism. Autism is almost four times more likely to be diagnosed in males. Autism is a disorder that is found worldwide. In the United Kingdom, one out of every 100 children have autism, with over half a million total diagnosed in the United Kingdom as of 2007. In China, one in every 1,000 children is diagnosed with autism. In India, the rate of incidence is 1 in



An autistic student draws a picture while sitting at a table at his school. (BURGER/PHANIE/Photo Researchers, Inc.)

## Prevalence of Autism Spectrum Disorders

- On average, an estimated 1 in 110 children in the United States have an Autism Spectrum Disorder (ASD).
- Of the roughly 4 million babies born in the United States each year, approximately 36,500 of those children will eventually be diagnosed with an ASD. If the prevalence rate has stayed constant during the past 20 years, then 730,000 individuals between the ages of 0 to 21 born in the United States currently have an ASD.
- ASDs occur in all racial, ethnic, and socioeconomic groups, but are on average 4 to 5 times more likely to occur in boys than in girls.
- Studies in Asia, Europe, and North America have identified a prevalence of ASDs in 0.6% to more than 1% of individuals.
- Approximately 13% of children have a developmental disability, ranging from mild speech and language impairments to more severe disorders such as cerebral palsy and autism.

SOURCE: Centers for Disease Control and Prevention, "Autism Spectrum Disorders (ASDs): Data & Statistics." Available online at: <http://www.cdc.gov/ncbdd/autism/data.html> (accessed August 18, 2010).

(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

every 250 children. In Mexico, two to six in every 1,000 children are autistic. Autism is not specific to any one socio-economic, ethnic, or racial group.

## Description

Classic autism is one of several disorders categorized as autism spectrum disorders (ASD). Other ASDs include **Asperger syndrome**, Rett syndrome, childhood disintegrative disorder, and pervasive developmental disorder. As of 2010, the classification of autism and autism spectrum disorders is being re-evaluated by the American Psychiatric Association for revision in the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders (DSM)*. It has been proposed that Asperger syndrome be eliminated as a diagnosis and pervasive developmental disorder not otherwise specified (PPD-NOS) be classified as autism spectrum disorder. This proposal is controversial and as of 2010 remained unresolved. *DSM-V* will be published in 2012.

Autism usually manifests before a child is three years old and it continues throughout his/her lifetime. The severity of the condition varies between individuals, ranging from the most severe (extremely unusual, repetitive, self-injurious, and aggressive behavior) to very mild. No one autistic child is alike in the manifestation of their symptoms so treatment options must be devised to treat each autistic child individually. Autism cannot be cured but is treatable. With early

diagnosis and intensive therapy, autistic children may be able to lead healthy, full lives.

## Risk factors

There appears to be a strong genetic basis for autism. Family studies have shown that identical twins are more likely to both be diagnosed with autism than twins who are fraternal (not genetically identical). In a family with one autistic child, the chance of having another child with autism is about one in 20 or approximately 5%, much higher than in the general population.

Other risk factors associated with autism include:

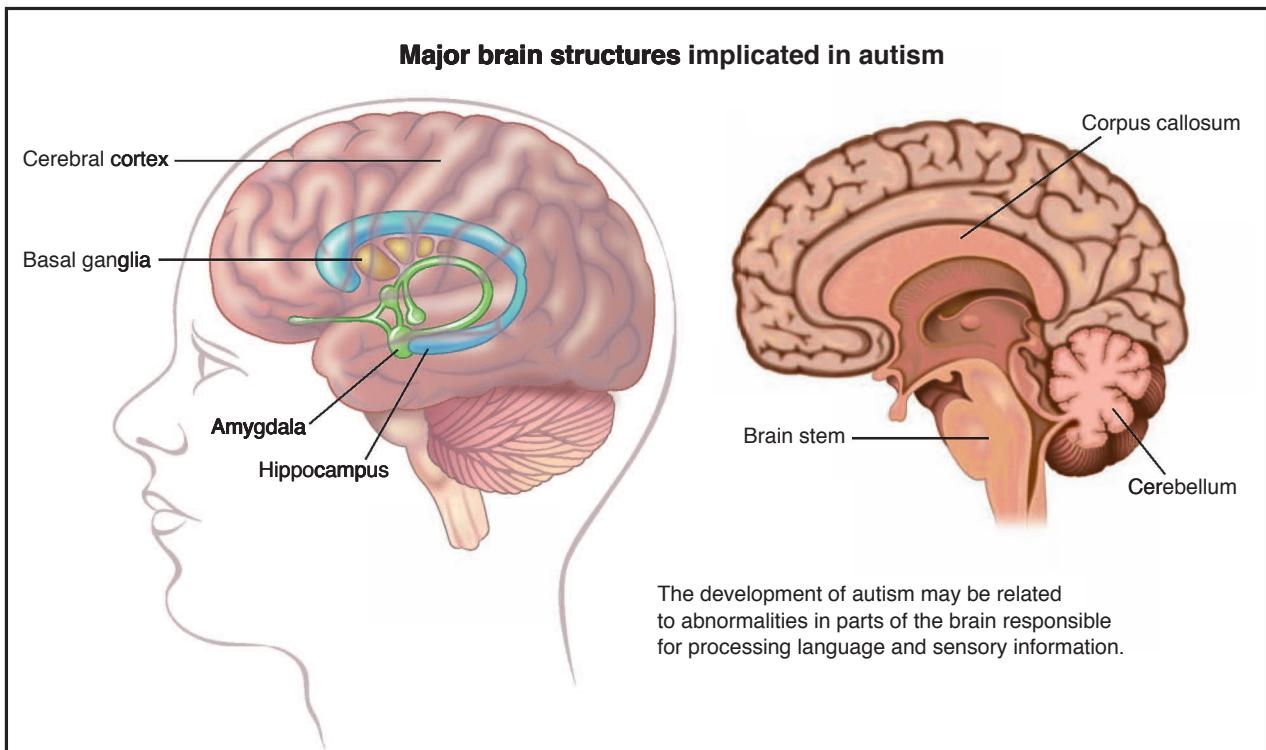
- Gender. Boys are almost four times more likely to be diagnosed with autism than girls.
- Paternal age. Children born of fathers over age 40 have a greater chance of developing autism than children born to younger fathers. The age of the mother appears to have no effect on autism.
- Certain disorders and diseases. Children who have fragile X syndrome, tuberous sclerosis, Tourette syndrome, and epilepsy are more likely to have autism.

## Causes and symptoms

Researchers know that autism is a complex brain disorder that affects the way the brain uses or transmits information. Studies have implicated several causes for the disorder including genetic errors and possible environmental triggers, but more investigation is needed. Studies have found abnormalities in several parts of the brain that are believed to have occurred during fetal development. The problem may be centered in the parts of the brain responsible for processing language and information from the senses.

Profound problems with social interaction are the most common symptoms of autism and the most visible. Autistic children have different ways of learning and experiencing the world around them. Often autistic children have more acute reactions to sensory stimulation such as sound and touch. This results in avoidance of eye contact, physical contact, and often times an aversion to music and other sounds. It is perhaps the way autistic children experience their world that causes difficulties with social interaction, language, and nonverbal communication.

Human beings are social and social interaction is present from birth onward. Children with autism have difficulty making social connections. A developmental milestone is when an infant can follow an object or person with his/her gaze. Autistic children tend to



The development of autism may be related to abnormalities in parts of the brain responsible for processing language and sensory information.

(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

avoid eye contact altogether. They do not actively cuddle or hug but rather they passively accept physical contact or they shy away from it. They may become rigid or flaccid when they are held, cry when picked up, and show little interest in human contact. Such a child does not lift his/her arms in anticipation of being picked up. The child may appear to have formed no attachment to his/her parents, and does not learn typical childhood games, such as "peek-a-boo."

Autistic children do not readily learn social cues. They do not know when or how to react to specific social situations or exchanges. Because of this, autistic children tend to look at and respond to different situations similarly. They do not understand that others have different perspectives and, therefore, autistic children seem to lack empathy.

Because of their problems socially and the inability to translate social interactions appropriately, autistic children seem to have uncontrolled emotional outbursts, expressing themselves in a manner that does not suit the specific social situation of the moment.

#### **Language problems**

Verbal communication problems vary greatly for autistic children. Some children do not speak at all.

Some will only use one or two words at a time. Some autistic children may develop vocabulary only to lose it. Other autistic children may develop an extensive vocabulary; however, they have difficulty sustaining a natural, "back-and-forth" conversation. Autistic children tend to talk in a sing-song voice or more robotically without emotional inflections. Often autistic children do not take body language into consideration and they take what is being said quite literally. Because of their impinged language skills and the inability to express their needs, autistic children seem to act inappropriately to get what they need. They may grab something without asking or blurt out statements.

#### **Restricted interests and activity**

Language and social problems inhibit social play for autistic children. Autistic children do not engage in imaginative play and role playing. They focus on repetition, some focusing on a subject of interest very intensely.

Autistic children often stick to a rigid daily routine. Any variance to the routine may be upsetting to them and result in an extreme emotional response. Repetitive physical behaviors such as rocking, spinning, and arm flapping are also characteristic of

## KEY TERMS

**Antidepressants**—A type of medication that is used to treat depression; it is also sometimes used to treat autism.

**Asperger syndrome**—Children who have autistic behavior but no problems with language and no clinically significant cognitive delay.

**Fragile X syndrome**—A genetic condition related to the X chromosome that affects mental, physical and sensory development.

**Major tranquilizers**—The family of drugs that includes the psychotropic or neuroleptic drugs, sometimes used to help autistic people. They carry significant risk of side effects, including Parkinsonism and movement disorders, and should be prescribed with caution.

**Opiate blockers**—A type of drug that blocks the effects of natural opiates in the system. This makes some people, including some people

with autism, appear more responsive to their environment.

**Phenylketonuria (PKU)**—An enzyme deficiency present at birth that disrupts metabolism and causes brain damage. This rare inherited defect may be linked to the development of autism.

**Rubella**—Also known as German measles. When a woman contracts rubella during pregnancy, her developing infant may be damaged. One of the problems that may result is autism.

**Stimulants**—A class of drugs, including Ritalin, used to treat people with autism. They may make children calmer and better able to concentrate, but they also may limit growth or have other side effects.

**Tuberous sclerosis**—A genetic disease that causes skin problems, seizures, and mental retardation. Autism occurs more often in individuals with tuberous sclerosis.

autism. The repetitive behaviors are often self-soothing responses to sensory stimulation from the outside world.

### Sensory problems

The sensory world poses a real problem to many autistic children, who seem overwhelmed by their own senses. A child with autism may ignore objects or become obsessed with them, continually watching the object or the movement of his or her fingers over it. Some children with autism may react to sounds by banging their head or flapping their fingers. Some high-functioning autistic adults who have written books about their childhood experiences report that sounds were often excruciatingly painful to them, forcing them to withdraw from their environment or try to cope by withdrawing into their own world of sensation and movement.

### Diagnosis

There is no medical test for diagnosing autism. Diagnosis is made after careful observation and screening by parents, caregivers, and physicians. Early diagnosis is beneficial in treating the symptoms of autism. Some early warning signs are:

- avoiding eye contact
- avoiding physical contact such as hugs
- inability to play make-believe

- not pointing out interesting objects
- not responding to conversation directed at him/her
- practicing excessively repetitive behaviors
- repeating words or phrases
- losing skills and/or language after learning them

Once parents feel there is a problem or their pediatrician has identified developmental problems during well-baby check-ups, they can seek out a developmental pediatrician for further diagnosis. There are several screening tests used. They are:

- Childhood Autism Rating Scale (CARS)—a test based on a 15 point scale where specific behaviors are observed by the physician.
- Checklist for Autism in Toddlers (CHAT)—a test to detect autism in 18-month olds that utilizes questionnaires filled out by both the parents and the pediatrician.
- Autism Screening Questionnaire—a 40-item questionnaire for diagnosing children four and older.
- Screening Test for Autism in Two-Year-Olds—a direct observation of three skill areas including play, motor imitation, and joint attention.

Some children have a few of the symptoms of autism, but not enough to be diagnosed with the “classical” form of the condition. Children who have autistic behavior but no problems with language may be diagnosed with Asperger syndrome by using the

Autism Spectrum Screening Questionnaire, the Australian Scale for Asperger syndrome, or the Childhood Asperger Syndrome Test. The American Psychiatric Association may eliminate the diagnosis of Asperger syndrome in 2012. Children who have no initial symptoms but who begin to show autistic behavior as they get older might be diagnosed with childhood disintegrative disorder (CDD), another autistic spectrum disorder. It is also important to rule out other problems that seem similar to autism.

## Treatment

Because the symptoms of autism can vary greatly from one person to the next, there is not a single treatment that works for every person. A spectrum of interventions including behavioral and educational training, diet and **nutrition**, alternative medicine and therapies, and medication should be utilized and fine-tuned to treat the individual. The most strongly recommended treatment option is behavioral and educational training. Early intervention and treatment is key to helping autistic children grow into productive adults.

### ***Educational and behavioral treatment***

Several educational and behavioral treatments are:

- Applied Behavior Analysis (ABA)
- speech therapy
- occupational therapy, including sensory integration therapy
- social skills therapy, including play therapy

Typically, behavioral techniques are used to help the child respond and decrease symptoms. This might include positive reinforcement to boost language and social skills. This training includes structured, skill-oriented instruction designed to improve social and language abilities. Training needs to begin as early as possible, since early intervention appears to positively influence brain development.

Most autistic children respond to intervention at home as well as at school. Schools focus on areas where the child may be delayed, such as in speech or socialization. As autistic children grow and move to different phases of childhood and adolescence, parents in collaboration with educators and physicians need to adapt the treatment to best suit the needs of their autistic child.

## ***Medication***

No single medication treats symptoms of autism; however, some medications have been used to combat specific needs in autistic children. Drugs can control **epilepsy**, which affects up to 20% of people with autism. Medication can also treat **anxiety**, depression, and hyperactivity. Medication must be individualized and adjusted as the child develops.

Five types of drugs are sometimes prescribed to help the behavior problems of people with autism are:

- stimulants, such as methylphenidate (Ritalin)
- antidepressants, such as fluvoxamine (Luvox)
- opiate blockers, such as naltrexone (ReVia)
- antipsychotics
- tranquilizers

In 2010, news of use of the drug memantine (used in Alzheimer's patients for nearly a decade in the U.S.) being used in a study conducted by Dr. Michael Amen at Ohio State University involving children with autism was reported. The wisdom is, that given their similarities (a malfunction in the brain involving a chemical called glutamate which impacts the patient's speech and interaction) the drug may help in autism, too. Most drugs for autism only focus on lessening symptoms like hyperactivity or repetitive actions. The study was designed to try and help communication, one of the core issues of autism.

## ***Alternative treatment***

Some parents report success with megavitamin therapy. Some studies have shown that vitamin B<sub>6</sub> with magnesium improves eye contact and speech and lessens tantrum behavior. Vitamin B<sub>6</sub> causes fewer side effects than other medications and is considered safe when used in appropriate doses. However, not many health practitioners advocate its use in the treatment of autism, citing that the studies showing its benefit were flawed.

### ***DMG (dimethylglycine)***

This compound, available in many health food stores, is legally classified as a food, not a vitamin or drug. Some researchers claim that it improves speech in children with autism. Those who respond to this treatment will usually do so within a week. Again, many doctors do not feel that the studies are adequate to promote this treatment.

## Diet

Many parents have seen beneficial affects from a gluten-free and casein-free diet. Gluten is a substance found in the seeds of cereal plants such as wheat, barley, oats, and rye. Casein is a protein found in milk. Often people have sensitivities to these substances without realizing it. Many foods contain these substances as an ingredient; however, there are growing numbers of gluten-free and casein-free foods available for people that would like to eliminate them from their **diets**. Parents interested in using diet as a treatment should discuss with their child's doctor how to initiate an elimination diet.

## Exercise

One researcher found that vigorous **exercise** (20 minutes or longer, three or four days a week) seems to decrease hyperactivity, aggression, self-injury and other autistic symptoms.

## Prognosis

Autism is treatable but not curable. With appropriate treatments adjusted to suit the autistic child as he/she grows up, the symptoms of autism improve. Today, parents and caregivers are focused on providing the best therapies possible in order for autistic children to develop to their highest potential. Because the incidence of autism seems to be increasing at a rapid rate worldwide, enough so that the CDC has voiced concern about its prevalence, there is more awareness of autism and more ongoing research efforts. People with autism have a normal life expectancy and with proper intervention they can lead full lives.

## Prevention

Until the cause of autism is discovered, prevention is not possible.

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- Autism Resource Center. American Academy of Child and Adolescent Psychiatry, July 2009. <http://www.aacap.org/cs/Autism.ResourceCenter>

## ORGANIZATIONS

- Autism Research Institute/Autism Resource Center, 4182 Adams Avenue, San Diego, CA, 92116 English: (866) 366-3361; Spanish: (877) 644-1184 ext. 5 (619) 563-6840, <http://www.autism.com>.
- Autism Society of America, 4340 East-West Hwy, Suite 350, Bethesda, MD (301) 657-0881 (800) 3-AUTISM [(800) 328-8476], <http://www.autismsource.org>.
- Autism Speaks, 2 Park Avenue, 11th Floor, New York, NY, 10016 (212) 252-8584 (212) 252-8676, contactus @autismspeaks.org, <http://www.autismspeaks.org>.

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Autograft see **Skin grafting**

## Autoimmune disorders

### Definition

Autoimmune disorders are conditions in which a person's immune system attacks the body's own cells, causing tissue destruction.

### Description

Autoimmunity is accepted as the cause of a wide range of disorders, and it is suspected to be responsible for many more. Autoimmune diseases are classified as either general (systemic), in which the autoimmune reaction takes place simultaneously in a number of tissues, or organ specific, in which the autoimmune reaction targets a single organ. According to the American Autoimmune Related Diseases Association, 50 million Americans have an autoimmune disease. Individuals may, and often do, have more than one autoimmune disorder. Autoimmune diseases are more common in women than in men.

Autoimmune disorders include the following:

- Systemic lupus erythematosus. A general autoimmune disease is one in which antibodies attack a number of different tissues. The disease recurs

## KEY TERMS

**Antibody**—A protein normally produced by the immune system to fight infection or rid the body of foreign material. The material that stimulates the production of antibodies is called an antigen. Specific antibodies are produced in response to each different antigen and can only inactivate that particular antigen.

**Paresthesia**—A prickly, tingling, or burning sensation on the skin.

periodically and is seen mainly in young and middle-aged women.

- **Rheumatoid arthritis.** Occurs when the immune system attacks and destroys the tissues that line bone joints and cartilage. The disease occurs throughout the body, although some joints may be more affected than others.
- **Goodpasture's syndrome.** Occurs when antibodies are deposited in the membranes of both the lung and kidneys, causing both inflammation of kidney glomerulus (glomerulonephritis) and lung bleeding. It is typically a disease of young males.
- **Grave's disease.** Caused by an antibody that binds to specific cells in the thyroid gland, causing them to produce excessive amounts of thyroid hormone.
- **Hashimoto's thyroiditis.** Caused by an antibody that binds to cells in the thyroid gland. Unlike in Grave's disease, however, this antibody's action results in less thyroid hormone being produced.
- **Pemphigus vulgaris.** A group of autoimmune disorders that affect the skin.
- **Myasthenia gravis.** A condition in which the immune system attacks a receptor on the surface of muscle cells, preventing the muscle from receiving nerve impulses and resulting in severe muscle weakness.
- **Scleroderma.** Also called CREST syndrome or progressive systemic sclerosis, scleroderma affects the connective tissue.
- **Autoimmune hemolytic anemia.** Occurs when the body produces antibodies that target red blood cells.
- **Autoimmune thrombocytopenic purpura.** Disorder in which the immune system targets and destroys blood platelets.
- **Polymyositis and dermatomyositis.** Immune disorders that affect the neuromuscular system.

- **Pernicious anemia.** Disorder in which the immune system attacks the lining of the stomach in such a way that the body cannot metabolize vitamin B<sub>12</sub>.
- **Sjögren's syndrome.** Occurs when the exocrine glands are attacked by the immune system, resulting in excessive dryness.
- **Ankylosing spondylitis.** Immune system induced degeneration of the joints and soft tissue of the spine.
- **Vasculitis.** A group of autoimmune disorders in which the immune system attacks and destroys blood vessels.
- **Type I diabetes mellitus.** Appears to be caused by an antibody that attacks and destroys the islet cells of the pancreas, which produce insulin.
- **Amyotrophic lateral sclerosis.** Also called Lou Gehrig's disease. An immune disorder that causes the death of neurons, which leads to progressive loss of muscular control.
- **Guillain-Barre syndrome.** Also called infectious polyneuritis. A rare disorder that sometimes occurs after an infection or an immunization, Guillain-Barre syndrome affects the myelin sheath that covers nerve cells. It causes progressive muscle weakness and paralysis.
- **Multiple sclerosis.** An autoimmune disorder that may involve a virus, it affects the central nervous system, causing loss of coordination and muscle control.
- **Celiac disease (sprue).** A disease in which the body's reaction to gluten (most commonly found in wheat) causes damage to the intestines that results in poor absorption of nutrients.

### Causes and symptoms

To further understand autoimmune disorders, it is helpful to understand the workings of the immune system. The purpose of the immune system is to defend the body against attack by infectious microbes (e.g., bacteria, viruses, fungi) and foreign materials (e.g., chemicals, poisons). When the immune system attacks a foreign invader, it is very specific—a particular immune system cell will only recognize and target one type of invader. To function properly, the immune system must not only develop this specialized knowledge of individual invaders, but it must also learn how to recognize and not destroy cells that belong to the body itself.

Every cell carries protein markers on its surface that identify it in one of two ways: what kind of cell it is (e.g. nerve cell, muscle cell, blood cell, etc.) and to whom that cell belongs. These markers are called major histocompatibility complexes (MHCs). When

functioning properly, cells of the immune system will not attack any cell with markers identifying it as belonging to the body. Conversely, if the immune system cells do not recognize a cell as “self,” they attach themselves to it and put out a signal that the body has been invaded. This in turn stimulates the production of substances such as antibodies that disable and destroy the foreign particles. In case of autoimmune disorders, the immune system cannot distinguish between “self” cells and invader cells. As a result, the same destructive operation is carried out on the body’s own cells that would normally be carried out on bacteria, viruses, and other such harmful foreign material.

The reasons why immune systems become dysfunctional and fail to recognize the body’s own cells is not well understood. However, most researchers agree that a combination of genetic susceptibility, environmental, and hormonal factors play a role in developing autoimmunity. Researchers also hypothesize that autoimmunity may be triggered by several different mechanisms as follows:

- A substance that is normally sequestered in one part of the body, and therefore not usually exposed to the immune system, is released into the bloodstream where it is attacked.
- The immune system may mistake a component of the body for a similar foreign component.
- Cells of the body may be altered in some way, either by drugs, infection, or other environmental factors, so that they are no longer recognizable as “self” to the immune system.
- The immune system itself may be damaged, such as by a genetic mutation, and therefore becomes dysfunctional.

The symptoms of autoimmune disorders vary. See specific disorder topics for more complete information. A short summary of symptoms is as follows: include:

- Systemic lupus erythematosus. Symptoms include fever, chills, fatigue, weight loss, skin rashes (particularly the classic “butterfly” rash on the face), vasculitis, polyarthralgia, patchy hair loss, sores in the mouth or nose, lymph-node enlargement, gastric problems, and, in women, irregular periods. About half of those who experience lupus develop cardio-pulmonary problems, and some may develop urinary problems. Lupus can also effect the central nervous system, causing seizures, depression, and psychosis.
- Rheumatoid arthritis. Initially this disorder may be characterized by a low-grade fever, loss of appetite, weight loss, and generalized pain in the joints. The

joint pain then becomes more specific, usually beginning in the fingers, then spreading to other areas, such as the wrists, elbows, knees, and ankles. As the disease progresses, joint function diminishes sharply and deformities occur, particularly the characteristic “swan’s neck” curling of the fingers.

- Goodpasture’s syndrome. Symptoms are similar to that of iron deficiency anemia, including fatigue and pallor. Symptoms involving the lungs may range from a cough that produces bloody sputum to outright hemorrhaging. Symptoms involving the urinary system include blood in the urine and/or swelling.
- Grave’s disease. This disease is characterized by an enlarged thyroid gland, weight loss without loss of appetite, sweating, heart palpitations, nervousness, and an inability to tolerate heat.
- Hashimoto’s thyroiditis. This disorder generally displays few symptoms.
- Pemphigus vulgaris. This disease is characterized by blisters and deep lesions on the skin.
- Myasthenia gravis. Characterized by fatigue and muscle weakness that at first may be confined to certain muscle groups, but then may progress to the point of paralysis, myasthenia gravis patients often have expressionless faces as well as difficulty chewing and swallowing. If the disease progresses to the respiratory system, artificial respiration may be required.
- Scleroderma. This disorder usually is preceded by Raynaud’s phenomenon. Symptoms that follow include pain, swelling, and stiffness of the joints, and the skin takes on a tight, shiny appearance. The digestive system also becomes involved, resulting in weight loss, appetite loss, diarrhea, constipation, and distention of the abdomen. As the disease progresses, the heart, lungs, and kidneys become involved, and malignant hypertension (high blood pressure) causes death in approximately 30% of cases.
- Autoimmune hemolytic anemia. May be acute or chronic. Symptoms include fatigue and abdominal tenderness due to an enlarged spleen.
- Autoimmune thrombocytopenic purpura. Characterized by pinhead-size red dots on the skin, unexplained bruises, bleeding from the nose and gums, and blood in the stool.
- Polymyositis and dermatomyositis. In polymyositis, symptoms include muscle weakness, particularly in the shoulders or pelvis, which prevents the patient from performing everyday activities. In dermatomyositis, the same muscle weakness is accompanied by a rash that appears on the upper body, arms, and

fingertips. A rash may also appear on the eyelids, and the area around the eyes may become swollen.

- Pernicious anemia. Signs of pernicious anemia include weakness, sore tongue, bleeding gums, and tingling in the extremities. Because the disease causes a decrease in stomach acid, nausea, vomiting, loss of appetite, weight loss, diarrhea, and constipation are possible. Also, because vitamin B<sub>12</sub> is essential for the nervous system function, its deficiency brought about by the disease can result in a host of neurological problems, including weakness, lack of coordination, blurred vision, loss of fine motor skills, loss of the sense of taste, ringing in the ears, and loss of bladder control.
- Sjögren's syndrome. Characterized by excessive dryness of the mouth and eyes.
- Ankylosing spondylitis. Generally begins with lower back pain that progresses up the spine. The pain may eventually become crippling.
- Vasculitis. Symptoms depend upon the group of veins affected and can vary greatly.
- Type I diabetes mellitus. Characterized by fatigue and an inability to break down glucose, resulting in abnormally high level of glucose in the blood (hyperglycemia).
- Amyotrophic lateral sclerosis. First signs are stumbling and difficulty climbing stairs. Later, muscle cramps and twitching may be observed as well as weakness in the hands making fastening buttons or turning a key difficult. Speech may become slowed or slurred. There may also be difficulty swallowing. As respiratory muscles atrophy, there is increased danger of aspiration or lung infection.
- Guillain-Barre syndrome. Muscle weakness in the legs occurs first, then the arms and face. Paresthesia is often present. This disorder affects both sides of the body and may involve paralysis of the muscles that control breathing.
- Multiple sclerosis. Like Amyotrophic lateral sclerosis, the first symptom may be clumsiness. Weakness or exhaustion is often reported, as well as blurry or double vision. The individual may experience dizziness, depression, loss of bladder control, and muscle weakness so severe that the patient is confined to a wheelchair.
- Celiac disease. Damage to the lining of the small intestine causes immediate difficulties in digesting food that result in diarrhea, gas, and cramps, and long-term symptoms of vitamin and mineral deficiencies, anemia, osteoporosis, and weight loss.

## Diagnosis

A variety of tests are involved in the diagnosis of autoimmune disorders, depending on the particular disease such as blood tests, **cerebrospinal fluid analysis**, electromyogram (measures muscle function), and **magnetic resonance imaging** of the brain. Usually, these tests determine the location and extent of damage or involvement. They also are useful in charting progress of the disease and as baselines for treatment.

The principle tool, however, for authenticating autoimmune disease is antibody testing. Such tests involve measuring the level of antibodies found in the blood and determining if they react with specific antigens (protein triggers) that would give rise to an autoimmune reaction. An elevated amount of antibodies indicates that a general immune reaction is occurring. Since elevated antibody levels also are seen in common infections, infections must be ruled out as the cause for the increased antibody levels.

Antibodies can also be typed by class. There are five classes of antibodies, and they can be separated in the laboratory. The class IgG is usually associated with autoimmune diseases. Unfortunately, IgG class antibodies are also the main class of antibody seen in normal immune responses.

The most useful antibody tests involve introducing the patient's antibodies to samples of his or her own tissue, usually thyroid, stomach, liver, and kidney tissue. If antibodies bind to the "self" tissue, this is diagnostic for an autoimmune disorder. Antibodies from a person without an autoimmune disorder would not react to "self" tissue.

## Treatment

Treatment of autoimmune diseases is specific to the disease, and usually focuses on alleviating or preventing symptoms rather than correcting the underlying cause. For example, if a gland involved in an autoimmune reaction is not producing a hormone, for example insulin, administration of that hormone is required. Administration of a hormone, however, will not restore the function of the gland damaged by the autoimmune disease.

The other aspect of treatment is controlling the inflammatory and proliferative nature of the immune response. This generally is accomplished with two types of drugs. Corticosteroid compounds (e.g., prednisone) are used to control inflammation. There are

many different **corticosteroids**, each having undesirable side effects, especially with long-term use.

The proliferative nature of the immune response is controlled with immunosuppressive drugs (e.g., azathioprine, chlorambucil, cyclophosphamide, methotrexate). These drugs work by inhibiting the replication of cells and, therefore also suppress non-immune cells, leading to side effects such as anemia (too few red blood cells). In addition, other drugs may be used to treat symptoms of specific disorders.

Another approach is the use of drugs such as entanercept (Enbrel), imfliximab (Remicade), and adalimumab (Humira) that block the action of tumor necrosis factor (TNF). TNF is a substance that can cause inflammation in the body. These drugs have proved very effective in relieving symptoms in people with **rheumatoid arthritis**. However, in June 2008, the United States Food and Drug Administration (FDA) began investigating whether these drugs, especially when administered long term to younger patients, caused an increase in **cancer**, especially lymphoma (cancer of the lymph tissue). As of 2009, the data on potential cancer risks related to these drugs was confusing and difficult to assess because many patients who developed cancer were taking other drugs in addition to TNFs.

## Prognosis

Prognosis depends upon the pathology of each autoimmune disease.

## Prevention

Though the mechanisms involved in how these diseases affect the body are known, it is still unclear why the body turns on itself, thus most autoimmune disorders cannot be prevented. Since more women than men are affected by some of these disorders (e.g., lupus), some researchers are looking into hormones as a factor that may be controlled to prevent or slow certain autoimmune disorders. This, **gene therapy**, and drugs that target specific immune system cells may help prevent or treat autoimmune disorders in the future.

## Resources

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## ORGANIZATIONS

American Autoimmune Related Diseases Association, Inc., 22100 Gratiot Avenue, East Detroit, MI, 48021, (586) 776-3900, (586) 776-3903, <http://www.aarda.org>.

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Autoimmune hepatitis see **Hepatitis, autoimmune**

Autologous transfusion see **Transfusion**

Autologous transplant see **Bone marrow transplantation**

Automatic implantable cardioverter-defibrillator see **Implantable cardioverter-defibrillator**

## Autopsy

### Definition

An autopsy is a postmortem assessment or examination of a body to determine the cause of **death**. An autopsy is performed by a physician trained in pathology.

### Purpose

Most autopsies advance medical knowledge and provide evidence for legal action. Medically, autopsies determine the exact cause and circumstances of death, discover the pathway of a disease, and provide valuable information to be used in the care of the living. When foul play is suspected, a government coroner or medical examiner performs autopsies for legal use. This branch of medical study is called forensic medicine. Forensic specialists investigate deaths resulting from violence or occurring under suspicious circumstances.

Benefits of research from autopsies include the production of new medical information on diseases such as **toxic shock syndrome**, acquired **immunodeficiency** syndrome (**AIDS**). **Organ donation**, which can potentially save the lives of other patients, is also another benefit of autopsies.

## KEY TERMS

**Acquired immunodeficiency syndrome (AIDS)**—A group of diseases resulting from infection with the human immunodeficiency virus (HIV). A person infected with HIV gradually loses immune function, becoming less able to resist ailments and cancers, resulting in eventual death.

**Computed tomography scan (CT scan)**—The technique used in diagnostic studies of internal bodily structures in the detection of tumors or brain aneurysms. This diagnostic test consists of a computer analysis of a series of cross-sectional scans made along a single axis of a bodily structure or tissue that is used to construct a three-dimensional image of that structure.

**Creutzfeld-Jakob disease**—A rare, often fatal disease of the brain, characterized by gradual dementia and loss of muscle control that occurs most often in middle age and is caused by a slow virus.

**Hepatitis**—Inflammation of the liver, caused by infectious or toxic agents and characterized by jaundice, fever, liver enlargement, and abdominal pain.

**Magnetic resonance imaging (MRI)**—A diagnostic tool that utilizes nuclear magnetic energy in the production of images of specific atoms and molecular structures in solids, especially human cells, tissues, and organs.

**Postmortem**—After death.

### Precautions

When performed for medical reasons, autopsies require formal permission from family members or the legal guardian. (Autopsies required for legal reasons when foul play is suspected do not need the consent of next of kin.) During the autopsy, very concise notes and documentation must be made for both medical and legal reasons. Some religious groups prohibit autopsies.

### Description

An autopsy can be described as the examination of a deceased human body with a detailed exam of the person's remains. This procedure dates back to the Roman era when few human dissections were performed; autopsies were utilized, however, to determine the cause of death in criminal cases. At the beginning of the procedure the exterior body is examined and then the internal organs are removed and studied. Some pathologists argue that more autopsies are performed than necessary. However, recent studies show that autopsies can detect major findings about a person's condition that were not suspected when the person was alive. And the growing awareness of the influence of genetic factors in disease has also emphasized the importance of autopsies.

Despite the usefulness of autopsies, fewer autopsies have been performed in the United States during the past 10-20 years. A possible reason for this decline is concern about malpractice suits on the part of the treating physician. Other possible reasons are that hospitals are performing fewer autopsies because of the expense or because modern technology, such as

CT scans and **magnetic resonance imaging**, can often provide sufficient diagnostic information. Nonetheless, federal regulators and pathology groups have begun to establish new guidelines designed to increase the number and quality of autopsies being performed.

Many experts are concerned that if the number of autopsies increases, hospitals may be forced to charge families a fee for the procedure as autopsies are not normally covered by insurance companies or Medicare. Yet, according to several pathologists, the benefit of the procedure for families and doctors does justify the cost. In medical autopsies, physicians remain cautious to examine only as much of the body as permitted according to the wishes of the family. It is important to note that autopsies can also provide peace of mind for the bereaved family in certain situations.

### Preparation

If a medical autopsy is being performed, written permission is secured from the family of the deceased

### Aftercare

Once the autopsy has been completed, the body is prepared for final arrangements according to the family's wishes

### Risks

There are some risks of disease transmission from the deceased. In fact, some physicians may refuse to do autopsies on specific patients because of a fear of

contracting diseases such as AIDS, hepatitis, or Creutzfeld-Jakob disease.

### Normal results

In most situations the cause of death is determined from the procedure of an autopsy without any transmission of disease.

### Abnormal results

Abnormal results would include inconclusive results from the autopsy and transmission of **infectious disease** during the autopsy.

#### ORGANIZATIONS

American Medical Association, 515 N. State St., Chicago, IL, 60654, (800) 621-8335, <http://www.ama-assn.org/>.

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cases of avian flu in humans had occurred in Asia or Africa.

### Description

There are three types of influenza viruses called types A, B, and C. Only influenza A viruses causes serious, widespread illness in humans. Several different strains or subtypes of influenza A virus cause infection in humans. Other subtypes of influenza A cause disease in birds, pigs, horses, ferrets, whales, and seals. In most cases, the subtypes that cause disease in one species do not spread the disease to other species.

Bird flu was first identified in Italy more than 100 years ago. Avian influenza viruses can infect both domestic and wild birds including chickens, ducks, geese, turkeys, swans, pheasants, and quail. Although the disease is often fatal in domestic birds (e.g., chickens, turkeys), it often causes less severe illness in wild birds; wild ducks are natural reservoirs of infection. Infected wild birds shed large quantities of virus in their feces, but often appear to be relatively unaffected by flu symptoms. During migration, infected wild birds encounter other wild and domestic birds, such as chickens, and spread the disease to them. The virus then kills a large percentage of domestic birds, along with some species of wild birds. There are several subtypes of avian influenza virus, but the one of most concern to human health is called H5N1. Under most circumstances avian influenza viruses do not infect humans.

## Avian flu

### Definition

Avian **influenza**, known more casually as bird flu, is an **infectious disease** caused by a family of viruses that normally infect birds. Beginning in 1997, a subtype of avian influenza known as Avian influenza A (H5N1), has infected and caused a small number of deaths in humans.

### Demographics

The avian H5N1 influenza virus was first isolated in terns (migratory shore birds) in South Africa in 1961. The virus is highly contagious and sometimes fatal in birds; it did not appear to cause disease in humans until 1997. In that year in Hong Kong, H5N1 bird flu caused 18 confirmed cases of severe respiratory disease in humans, of which six were fatal. All but one of the individuals diagnosed with bird flu in Hong Kong had close contact with infected poultry. The exception was a case in which the disease was transmitted from child to parent but spread no further.

As of May 2009, there have been 421 laboratory-confirmed cases of H1N1 avian influenza in humans. Of these, 257 (about 60%) were fatal. The disease can affect people of all ages, genders, and ethnicities. Almost all individuals who have developed avian flu were in close contact with infected birds; only a few contracted the disease from extended contact with a sick family member. As of May 2009, all confirmed

### *Understanding the avian influenza virus*

Influenza viruses are protein sacks with a core of eight loosely connected genes. Two proteins spike up from the surface of the virus. The most plentiful protein is called haemagglutinin (H). The other surface protein is neuraminidase (N). The job of these proteins is to hook the influenza virus on to the surface of a cell in the animal it has infected and then help get the virus's genes inside that cell. Once inside, the virus genes take over the host cell and reprogram it to make thousands of copies of the virus.

There are many subtypes of influenza A viruses. These are identified by a series of letters and numbers that refer to two surface proteins, H and N. There are 16 known types of H proteins and nine known types of N proteins of influenza. The structure of the genes in the influenza virus allows these viruses to mutate (change) very rapidly. Many combinations of the two proteins can result from these mutations, each representing a new subtype of influenza A.

According to the United States Centers for Disease Control and Prevention (CDC) 15 different Influenza A subtypes can infect birds. Normally the subtypes of influenza that infect birds do not harm human, although some can infect pigs. However, the avian influenza virus called H5N1 has mutated in such a way that it is able to infect humans.

### ***Humans and bird flu***

When H5N1 avian flu was first discovered to infect humans in Hong Kong in 1997, it was feared that the disease, now called bird flu, would sweep through the community and kill thousands the way another subtype of influenza had swept across the world in 1918 and 1919. That influenza pandemic killed between 20 and 100 million people on six continents. To prevent this, Hong Kong health authorities had ordered all poultry be killed. Within three days, about 1.5 million birds in Hong Kong were destroyed to prevent further spread of the disease. Hong Kong, a relatively small island, was able to contain the infection.

The next outbreak of avian flu in humans was reported in Asia. From November 2003 through March 2004, a handful of human cases of bird flu were found in China, Vietnam, and Thailand. Meanwhile avian flu was epidemic among the bird populations in Japan, Thailand, Lao People's Democratic Republic (formerly Laos), China, and Indonesia. Millions of birds died from avian flu as the disease spread throughout Southeast Asia, and many of these countries reported a small number of human infections. By 2009, the disease had spread to some parts of the Middle East and Northern Africa, where Egypt and Djibouti reported some human cases. As of mid-2009, more than three-quarters of all laboratory-confirmed cases of avian flu in humans had occurred in Southeast Asia; none had been reported in North or South America, or Australia.

### ***Risk factors***

People at greatest risk of contracting avian flu are those who live or work closely with poultry. Potentially vulnerable people included those working on poultry on farms, in poultry processing plants, and live bird markets. Individuals living with a family member who has avian flu are also at risk of developing the disease. Avian flu does not spread easily to humans, and many people who are exposed to infected birds do not get sick.

## **KEY TERMS**

**Pandemic**—The occurrence of a disease that in a short time infects a large percentage of the population over a wide geographical area.

**Secondary or opportunistic infection**—An infection by a microbe that occurs because the body is weakened by a primary infection caused by a different kind of microbe.

### **Causes and symptoms**

An influenza virus that birds carry in their intestines causes Avian flu. The virus spreads as infected birds excrete saliva, nasal secretions, and feces. Birds vulnerable to the flu become infected when they come into contact with the excretions or surfaces contaminated by the viruses.

Birds that survive the H5N1 infection can excrete the virus for at least 10 days. This allows the H5N1 strain to spread through bird-to-bird contact from wild birds to domestic birds on farms and in live bird markets. The virus can also spread in surfaces including manure, bird feed, equipment, vehicles, egg flats, and crates, and the clothing and shoes of people who are exposed to the virus. Influenza is a respiratory disease. People must inhale the virus or carry it on their hands to their nose, eyes, or mouth to become sick. People cannot get the disease by eating properly cooked poultry.

In general, people who contract bird flu have symptoms similar to seasonal human influenza including **fever**, **cough**, **sore throat**, and aching muscles. Other symptoms included eye infections (**conjunctivitis**), **pneumonia**, acute respiratory distress, and viral pneumonia. Influenza weakens the respiratory system and leaves the lungs more vulnerable to infection. Many people with flu die from pneumonia caused by a secondary bacterial infection. Bacteria are able to grow in the lungs because the body's defenses have been weakened by the flu virus.

### **Diagnosis**

The symptoms of avian flu and human flu are very similar. A physician may suspect avian influenza if an individual showing flu-like symptoms has been in close contact with poultry in an infected area. Nevertheless, laboratory testing is needed to confirm a diagnosis of avian influenza. Symptoms normally develop within 7 days of infection.

## Tests

Diagnostic tests for human flu are rapid and reliable, according to the World Health Organization (WHO). International laboratories within WHO's global network have high-security facilities and experienced staff to test samples of suspected avian flu sent from around the world. Test methods include a viral culture that analyzes a blood sample and swabbings from the nose or throat. Other testing can be done on respiratory secretions.

In April 2009, the United States Food and Drug Administration (FDA) approved a rapid detection test for the H5N1 strain of bird flu. The test is manufactured by Arbor Vita Corporation of California. All it requires is a swab from the nose or throat of an ill individual. This new test produces results in about 40 minutes. Previous bird flu tests took at minimum four hours to complete.

## Treatment

### Drugs

Some anti-viral drugs appear to be partially effective against avian flu viruses if they are administered promptly, usually within 48 hours after the start of symptoms. These drugs do not cure flu, but lessen its symptoms and duration. In the United States, four drugs have been approved by the U.S. Food and Drug Administration (FDA) for the treatment of influenza A viruses in otherwise healthy adults. These are amantadine (Symmetrel), rimantadine (Flumadine), oseltamivir (Tamiflu), and zanamivir (Relenza). Research indicates that the avian H5N1 virus is resistant to amantadine and rimantadine, therefore, the drugs of choice for treating bird flu are oseltamivir and zanamivir.

**Antibiotics** may be needed to treat secondary bacterial infections. **Acetaminophen** may be used to control fever and reduce aches.

### Alternative

In March of 2005, people in South Korea began eating more kimchi to ward off avian flu infection, according to the reports from the British Broadcasting Company and other news organizations. The public turned to the spicy vegetable dish after scientists at Seoul National University announced that kimchi aided in the recovery of 11 out of 13 infected chickens. The scientists fed the birds an extract of kimchi, a dish made by fermenting cabbage with red peppers, radishes, and large amounts of garlic and ginger. A week later, all but two birds showed signs of recovery. The researchers acknowledged that their study was unscientific. At that time, they were not sure how or why kimchi was related

to the recovery. However, the announcement led people to again regard kimchi as a health remedy.

## Home remedies

Much of the treatment for influenza is supportive and consists bed rest, drinking plenty of fluids to stay hydrated, and using a humidifier to relieve nasal congestion and ease breathing.

## Prognosis

About 60% of individuals who develop avian influenza die. The rest normally recover completely.

## Prevention

Although avian influenza has been confirmed in fewer than 500 individuals worldwide, scientists at WHO, the CDC, and public health agencies of many other countries are concerned about the deadly consequences that could occur if H5N1 mutated into a virus subtype that could spread easily from one human to another. A strain of bird flu spread by human-to-human contact could cause an influenza pandemic and sicken millions. WHO and CDC experts believe that the question is not if another influenza epidemic will occur, but when it will happen and how severe it will be. For this reason, prevention strategies and pandemic planning are extremely important.

In the United States, the CDC is among the organizations preparing for a possible outbreak of bird flu in humans. In addition to laboratories equipped to test for bird flu, the CDC recommends precautions to prevent the spread of flu and other respiratory infections. Precautionary measures include restricting bird from coming into the United States from infected countries, testing poultry for avian flu viruses, and euthanizing infected birds. People with symptoms of respiratory infection are advised to cover their mouths or use facial tissues when coughing or sneezing. After coughing or sneezing, individuals should wash their hands well with soap and water, alcohol-based hand rub, or antiseptic handwash.

As of 2009, bird flu was primarily a risk for people in infected areas who work with poultry. People working with birds in locations such as commercial poultry facilities, veterinary offices, and live bird markets should wear protective clothing. That equipment includes boots, coveralls, face masks, gloves, and headgear, according to the United States Department of Agriculture (USDA).

Furthermore, poultry producers should implement security measures to prevent the outbreak of a highly pathogenic virus. Those actions include

keeping flocks away from wild or migratory birds and providing clothing and disinfectant facilities for employees. Plastic crates are recommended for use at live bird markets because they are easier to clean than wood crates. Cleaning and disinfecting areas are also important for preventing an outbreak. Infected birds must be quarantined or destroyed.

In July 2007, The United States Food and Drug Administration approved the first vaccine for use against H5N1 bird flu. In addition, many governments around the world have stockpiled antiviral medications that can rapidly be made available should a serious influenza outbreak occur.

## Resources

### BOOKS

- Greger, Michael. *Bird Flu: A Virus of Our Own Hatching*. New York: Lantern Books, 2006.  
 Siegel, Marc. *Bird Flu: Everything You Need to Know About the Next Pandemic*. Hoboken, NJ: Wiley, 2006.  
 Swayne, David E., ed. *Avian Influenza*. Ames, IA: Blackwell Pub., 2008.

### OTHER

- Centers for Disease Control and Prevention. Avian Influenza (Bird Flu): What You Should Know. [May 4, 2009], <http://www.cdc.gov/flu/avian>  
 Medline Plus. Bird Flu. Continuously updated [May 4, 2009], <http://www.nlm.nih.gov/medlineplus/birdflu.html>

### ORGANIZATIONS

- National Institute of Allergy and Infectious Diseases Office of Communications and Government Relations, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-6612 (301) 496-5717 (866) 284-4107 or TDD: (800)877-8339 (for hearing impaired) (301) 402-3573, <http://www3.niaid.nih.gov>.  
 United States Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333 (404) 639-3534 800-CDC-INFO (800-232-4636). TTY: (888) 232-6348, [inquiry@cdc.gov](mailto:inquiry@cdc.gov), <http://www.cdc.gov>.  
 World Health Organization, Avenue Appia 20, 1211 Geneva 27, Switzerland +22 41 791 21 11 +22 41 791 31 11, [info@who.int](mailto:info@who.int), <http://www.who.int>.

Tish Davidson A.M.

## Aviation medicine

### Definition

Also known as aerospace medicine, flight medicine, or space medicine, aviation medicine is a medical

specialty that focuses on the physical and psychological conditions associated with flying and space travel.

### Purpose

Since flying airplanes and spacecraft involves great risk and physical demands, such as changes in gravity and oxygen, pilots and astronauts need medical experts to protect their safety and the public's safety.

### Description

#### Pressure changes

In the United States, the Federal Aviation Administration (FAA) requires all pilots who fly above 14,500 ft (4,420 m) to be prepared for pressure changes caused by lower oxygen levels at high altitude. Pilots must either have a pressurized cabin or access to an oxygen mask. Without these protections, they could experience hypoxia, or **altitude sickness**. Hypoxia reduces the amount of oxygen in the brain, causing such symptoms as **dizziness**, **shortness of breath**, and mental confusion. These symptoms could cause the pilot to lose control of the plane. Hypoxia can be treated with **oxygen therapy**.

Rapid altitude increases and decreases can cause **pain** because there is an air pocket in the middle portion of the ear. To equalize pressure in the ear, physicians typically advise pilots and passengers to clear their sinuses by plugging their nose and blowing until the eardrums "pop." Other options include yawning, swallowing or chewing gum. For people with a cold or a severely blocked middle ear, the use of **decongestants**, **antihistamines**, or nasal sprays may help. Without taking steps to equalize pressure, the tympanic membrane could rupture, causing **hearing loss**, vertigo, dizziness, and **nausea**.

#### Gravity's impact

Fighter pilots who fly high-performance jets can experience health problems during rapid acceleration and when executing tight turns at high speed. During these moves, a pilot experiences extreme gravity conditions that can pull blood away from the brain and heart and into the lower body. This can cause the pilot to have tunnel vision or pass out. To prevent these potentially deadly situations, the military requires fighter pilots to wear special flight suits, or G suits, which have compartments that fill with air or fluid to keep blood from pooling in the lower body.

Some pilots, like the Blue Angels, use a technique called the **Valsalva Maneuver** instead of G suits to

## KEY TERMS

**G suits**—Special flight suits, worn by fighter pilots, which have compartments that fill with air or fluid to keep blood from pooling in the lower body during rapid acceleration and tight turns.

**Hypoxia**—Hypoxia, or altitude sickness, reduces the amount of oxygen in the brain causing such symptoms as dizziness, shortness of breath, and mental confusion.

**Tympanic membrane**—A structure in the middle ear that can rupture if pressure in the ear is not equalized during airplane ascents and descents.

**Valsalva Maneuver**—Pilots grunt and tighten their abdominal muscles to prevent black outs during high-performance flying.

prevent black outs during high-performance flying. The Valsalva Maneuver involves grunting and tightening the abdominal muscles to stop blood from collecting in the wrong parts of the body.

**PREVENTIVE CARE.** Since any routine health problem that affects a pilot could mean the loss of hundreds of lives, aviation medicine specialists who work for commercial airlines and the military take special care to educate pilots about proper diet, **exercise** and preventive health tools. For example, physicians may frequently screen pilots for vision changes caused by **glaucoma** or **cataracts**. They also will check for hearing loss and encourage the pilot to wear earplugs or headphones to buffer engine noise. To monitor for heart disease, physicians will check blood pressure and may order diagnostic tests such as an ECG or **stress test**.

### **Motion sickness**

Many people experience nausea, vertigo, and disorientation when they first arrive in space. This is caused by changes in the fluid in the inner ear, which is sensitive to gravity and affects our sense of spatial orientation. The symptoms typically ease after several days, but often recur when the astronaut returns to Earth. To treat this condition, physicians give astronauts **motion sickness** medication, such as lorazepam.

### **Bone and muscle loss**

In zero-gravity conditions, astronauts lose bone and muscle mass. On earth, the natural resistance of

gravity helps build stronger muscles and bones during normal weight-bearing activities like walking or even sitting at a desk. In space, however, astronauts must work harder to prevent bone and muscle loss. Exercise is an important treatment. Crew members may use an exercise cycle or resistive rubber bands to stay in shape. Physicians also may give them medication to prevent bone loss and prescribe **nutritional supplements**, such as a mixture of essential amino acids and carbohydrates, to limit muscle atrophy.

### **Radiation**

Another health threat to space travelers is radiation. Harmful rays can alter the DNA in human cells and cause **cancer**. Excess radiation also can weaken the immune system. To prevent these problems, physicians may give astronauts nutritional supplements. For example, research has shown that n-3 fatty acids found in fish oil reduce DNA damage.

### **Cardiovascular issues**

When astronauts return to earth after a long mission, they tend to feel dizzy and black out. Scientists are concerned about this dilemma because it could be dangerous if the crew members need to make an emergency exit. One way to prevent this problem, which is caused by a drop in blood pressure, is to have the astronauts drink extra fluids and increase salt intake to increase blood volume. Physicians also may prescribe medication that causes blood vessels to contract. As another precaution, astronauts also put on protective flight suits, or G suits, before they re-enter the earth's atmosphere.

### **Resources**

#### **OTHER**

Federal Aviation Administration Office of Aerospace Medicine. [http://www.faa.gov/about/office\\_org/headquarters\\_offices/avs/offices/aam/cami/](http://www.faa.gov/about/office_org/headquarters_offices/avs/offices/aam/cami/).

National Aeronautics and Space Administration Aerospace Medicine. <http://spacelink.msfc.nasa.gov>.

Society of USAF Flight Surgeons Online Catalog. <http://www.sousaffs.org/default.php>.

#### **ORGANIZATIONS**

Aerospace Medical Association, 320 South Henry Street, Alexandria, VA, 22314-3579, (703) 739-2240, (703) 739-9652, [inquiries@asma.org](mailto:inquiries@asma.org), <http://www.asma.org>.

National Space Biomedical Research Institute, One Baylor Plaza, NA-425, Houston, TX, 77030, (713) 798-7412, (713) 798-7413, [info@nsbri.org](mailto:info@nsbri.org), <http://www.nsbri.org>.

Wright State University, Division of Aerospace Medicine, 3640 Col. Glenn Highway, Dayton, OH, 45435, (937)

7751400, (937) 775-1403, betty.somers@wright.edu,  
http://www.med.wright.edu/asm.

Melissa Knopper

AVM see **Arteriovenous malformations**

Avoidant personality disorder see  
**Personality disorders**

Avulsions see **Wounds**

## Ayurvedic medicine

### Definition

Ayurvedic medicine is a system of healing that originated in ancient India. In Sanskrit, *ayur* means life or living, and *veda* means knowledge, so Ayurveda has been defined as the “knowledge of living” or the “science of longevity.” Ayurvedic medicine utilizes diet, **detoxification** and purification techniques, herbal and mineral remedies, **yoga**, breathing exercises, **meditation**, and **massage therapy** as holistic healing methods. Ayurvedic medicine is widely practiced in modern India and has been steadily gaining followers in the West.

### Purpose

According to the original texts, the goal of Ayurveda is prevention as well as promotion of the body’s own capacity for maintenance and balance. Ayurvedic treatment is non-invasive and non-toxic, so it can be used safely as an alternative therapy or alongside conventional therapies. Ayurvedic physicians claim that their methods can also help stress-related, metabolic, and chronic conditions. Ayurveda has been used to treat **acne**, **allergies**, **asthma**, **anxiety**, **arthritis**, **chronic fatigue syndrome**, colds, **colitis**, **constipation**, depression, diabetes, flu, heart disease, **hypertension**, immune problems, inflammation, **insomnia**, nervous disorders, **obesity**, skin problems, and ulcers.

Ayurvedic physicians seek to discover the roots of a disease before it gets so advanced that more radical treatments are necessary. Thus, Ayurveda seems to be limited in treating severely advanced conditions, traumatic injuries, acute **pain**, and conditions and injuries requiring invasive surgery. Ayurvedic techniques have also been used alongside **chemotherapy** and surgery to assist patients in recovery and healing.

### Description

#### Origins

Ayurvedic medicine originated in the early civilizations of India some 3,000-5,000 years ago. It is mentioned in the *Vedas*, the ancient religious and philosophical texts that are the oldest surviving literature in the world, which makes Ayurvedic medicine the oldest surviving healing system. According to the texts, Ayurveda was conceived by enlightened wise men as a system of living harmoniously and maintaining the body so that mental and spiritual awareness could be possible. Medical historians believe that Ayurvedic ideas were transported from ancient India to China and were instrumental in the development of Chinese medicine.

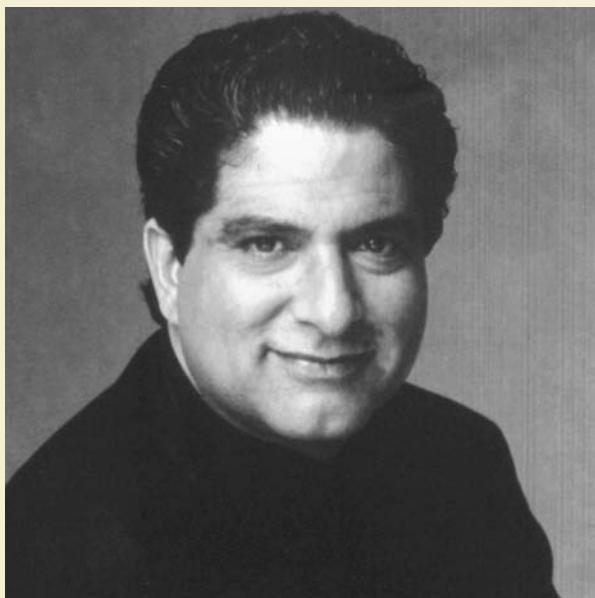
Today, Ayurvedic medicine is used by 80% of the population in India. Aided by the efforts of Deepak Chopra and the Maharishi, it has become an increasingly accepted alternative medical treatment in America during the last two decades. Chopra is an M.D. who has written several bestsellers based on Ayurvedic ideas. He also helped develop the Center for Mind/Body Medicine in La Jolla, California, a major Ayurvedic center that trains physicians in Ayurvedic principles, produces herbal remedies, and conducts research and documentation of its healing techniques.

#### Key ideas

To understand Ayurvedic treatment, it is necessary to have an idea how the Ayurvedic system views the body. The basic life force in the body is *prana*, which is also found in the elements and is similar to the Chinese notion of *chi*. As Swami Vishnudevananda, a yogi and expert, put it, “Prana is in the air, but is not the oxygen, nor any of its chemical constituents. It is in food, water, and in the sunlight, yet it is not vitamin, heat, or light-rays. Food, water, air, etc., are only the media through which the prana is carried.”

In Ayurveda, there are five basic elements that contain prana: earth, water, fire, air, and ether. These elements interact and are further organized in the human body as three main categories or basic physiological principles in the body that govern all bodily functions known as the *doshas*. The three doshas are *vata*, *pitta*, and *kapha*. Each person has a unique blend of the three doshas, known as the person’s *prakriti*, which is why Ayurvedic treatment is always individualized. In Ayurveda, disease is viewed as a state of imbalance in one or more of a person’s doshas, and an Ayurvedic physician strives

## DEEPAK CHOPRA (1946– )



(AP Images.)

Deepak Chopra was born in India and studied medicine at the All India Institute of Medical Science. He left his home for the United States in 1970 and completed residencies in internal medicine and endocrinology. He went on to teaching posts at major medical institutions—Tufts University and Boston University schools of medicine—while establishing a very successful private practice. By the time he was thirty-five, Chopra had become chief of staff at New England Memorial Hospital.

to adjust and balance them, using a variety of techniques.

The vata dosha is associated with air and ether, and in the body promotes movement and lightness. Vata people are generally thin and light physically, dry-skinned, and very energetic and mentally restless. When vata is out of balance, there are often nervous problems, hyperactivity, sleeplessness, lower back pains, and headaches.

Pitta is associated with fire and water. In the body, it is responsible for metabolism and digestion. Pitta characteristics are medium-built bodies, fair skin, strong digestion, and good mental concentration. Pitta imbalances show up as anger and aggression and stress-related conditions like **gastritis**, ulcers, liver problems, and hypertension.

Disturbed by Western medicine's reliance on medication, he began a search for alternatives and discovered one in the teachings of the Maharishi Mahesh Yogi, an Indian spiritualist who had gained a cult following in the late sixties teaching Transcendental Meditation (TM). Chopra began practicing TM fervently and eventually met the Maharishi. In 1985 Chopra established the Ayurvedic Health Center for Stress Management and Behavioral Medicine in Lancaster, Massachusetts, where he began his practice of integrating the best aspects of Eastern and Western medicine.

In 1993, he published *Creating Affluence: Wealth Consciousness in the Field of All Possibilities*, and the enormously successful best seller, *Ageless Body, Timeless Mind*. In the latter he presents his most radical thesis: that aging is not the inevitable deterioration of organs and mind that we have been traditionally taught to think of it as. It is a process that can be influenced, slowed down, and even reversed with the correct kinds of therapies, almost all of which are self-administered or self-taught. He teaches that applying a regimen of nutritional balance, meditation, and emotional clarity characterized by such factors as learning to easily and quickly express anger, for instance, can lead to increased lifespans of up to 120 years.

Chopra, along with David Simon, M.D., opened the Chopra Center for Wellbeing in 1996, offering people experiences in physical healing, emotional freedom, and higher states of consciousness. Located in Carlsbad, California, the center offers a wide variety of programs, retreats, and teacher training programs that integrate the healing arts of the East with modern Western medicine. <http://www.chopra.com/>

The kapha dosha is associated with water and earth. People characterized as kapha are generally large or heavy with more oily complexions. They tend to be slow, calm, and peaceful. Kapha disorders manifest emotionally as greed and possessiveness, and physically as obesity, **fatigue**, **bronchitis**, and sinus problems.

### Diagnosis

In Ayurvedic medicine, disease is always seen as an imbalance in the dosha system, so the diagnostic process strives to determine which doshas are underactive or overactive in a body. Diagnosis is often taken over a course of days in order for the Ayurvedic physician to most accurately determine what parts of the body are being affected. To diagnose problems, Ayurvedic physicians often use long questionnaires

Ayurvedic body types (doshas)			
	Vata	Pitta	Kapha
Physical characteristics	Thin Prominent features Cool, dry skin Constipation Cramps	Average build Fair, thin hair Warm, moist skin Ulcers, heartburn, and hemorrhoids Acne	Large build Wavy, thick hair Pale, cool, oily skin Obesity, allergies, and sinus problems High cholesterol
Emotional characteristics	Moody Vivacious Imaginative Enthusiastic Intuitive	Intense Quick tempered Intelligent Loving Articulate	Relaxed Not easily angered Affectionate Tolerant Compassionate
Behavioral characteristics	Unscheduled sleep and meal times Nervous disorders Anxious	Orderly Structured sleep and meal times Perfectionist	Slow, graceful Long sleeper and slow eater Procrastinator

(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

and interviews to determine a person's dosha patterns and physical and psychological histories. Ayurvedic physicians also intricately observe the pulse, tongue, face, lips, eyes, and fingernails for abnormalities or patterns that they believe can indicate deeper problems in the internal systems. Some Ayurvedic physicians also use laboratory tests to assist in diagnosis.

### Treatment

Ayurvedic treatment seeks to re-establish balance and harmony in the body's systems. Usually the first method of treatment involves some sort of detoxification and cleansing of the body, in the belief that accumulated toxins must be removed before any other methods of treatment will be effective. Methods of detoxification include therapeutic **vomiting**, **laxatives**, medicated **enemas**, **fasting**, and cleansing of the sinuses. Many Ayurvedic clinics combine all of these cleansing methods into intensive sessions known as *panchakarma*. Panchakarma can take several days or even weeks and they are more than elimination therapies. They also include herbalized oil massage and herbalized **heat treatments**. After purification, Ayurvedic physicians use herbal and mineral remedies to balance the body as well. Ayurvedic medicine contains a vast knowledge of the use of herbs for specific health problems.

Ayurvedic medicine also emphasizes how people live their lives from day to day, believing that proper lifestyles and routines accentuate balance, rest, diet, and prevention. Ayurveda recommends yoga as a form of **exercise** to build strength and health, and also advises massage therapy and self-massage as

ways of increasing circulation and reducing **stress**. Yogic breathing techniques and meditation are also part of a healthy Ayurvedic regimen, to reduce stress and improve mental energy.

Of all treatments, though, diet is one of the most basic and widely used therapy in the Ayurvedic system. An Ayurvedic diet can be a very well planned and individualized regimen. According to Ayurveda, there are six basic tastes: sweet, sour, salty, pungent, bitter, and astringent. Certain tastes and foods can either calm or aggravate a particular dosha. For instance, sweet, sour, and salty decrease vata problems and increase kapha. Sour, salty, and pungent can increase pitta. After an Ayurvedic physician determines a person's dosha profile, they will recommend a specific diet to correct imbalances and increase health. The Ayurvedic diet emphasizes primarily vegetarian foods of high quality and freshness, tailored to the season and time of day. Cooling foods are eaten in the summer and heating ones in the winter, always within a person's dosha requirements. In daily routine, the heaviest meal of the day should be lunch, and dinner should be eaten well before bedtime, to allow for complete digestion. Also, eating meals in a calm manner with proper chewing and state of mind is important, as is combining foods properly and avoiding overeating.

### Cost

Costs of Ayurvedic treatments can vary, with initial consultations running anywhere from \$40 to over \$100, with follow-up visits costing less. Herbal treatments may cost from \$10 to \$50 per month, and are often available from health food or bulk herb stores.

## KEY TERMS

- Dosha**—One of three constitutional types, either vata, pitta, or kapha, found in Ayurvedic medicine.
- Meditation**—Technique of calming the mind.
- Panchakarma**—Intensive Ayurvedic cleansing and detoxification program.
- Prakriti**—An individual's unique dosha pattern.
- Prana**—Basic life energy found in the elements.
- Yoga**—System of body and breathing exercises.

Some clinics offer panchakarma, the intensive Ayurvedic detoxification treatment, which can include overnight stays for up to several weeks. The prices for these programs can vary significantly, depending on the services and length of stay. Insurance reimbursement may depend on whether the primary physician is a licensed M.D.

## Preparations

Ayurveda is a mind/body system of health that contains some ideas foreign to the Western scientific model. Those people considering Ayurveda should approach it with an open mind and willingness to experiment. Also, because Ayurveda is a whole-body system of healing and health, patience and discipline are helpful, as some conditions and diseases are believed to be brought on by years of bad health habits and require time and effort to correct. Finally, the Ayurvedic philosophy believes that each person has the ability to heal themselves, so those considering Ayurveda should be prepared to bring responsibility and participation into the treatment.

## Precautions

An Ayurvedic practitioner should always be consulted.

## Side effects

During Ayurvedic detoxification programs, some people report fatigue, muscle soreness, and general sickness. Also, as Ayurveda seeks to release mental stresses and psychological problems from the patient, some people can experience mental disturbances and depression during treatment, and psychological counseling may be part of a sound program.

## Research and general acceptance

Because Ayurveda had been outside the Western scientific system for years, research in the United States is new. Another difficulty in documentation arises because Ayurvedic treatment is very individualized; two people with the same disease but different dosha patterns might be treated differently. Much more scientific research has been conducted over the past several decades in India. Much research in the United States is being supported by the Maharishi Ayur-Ved organization, which studies the Ayurvedic products it sells and its clinical practices.

Some Ayurvedic herbal mixtures have been proven to have high antioxidant properties, much stronger than **vitamins A, C, and E**, and some have also been shown in laboratory tests to reduce or eliminate tumors in mice and to inhibit **cancer** growth in human lung tumor cells. In a 1987 study at MIT, an Ayurvedic herbal remedy was shown to significantly reduce **colon cancer** in rats. Another study was performed in the Netherlands with Maharishi Ayur-Ved products. A group of patients with chronic illnesses, including asthma, chronic bronchitis, hypertension, **eczema**, **psoriasis**, constipation, **rheumatoid arthritis**, headaches, and non-insulin dependent **diabetes mellitus**, were given Ayurvedic treatment. Strong results were observed, with nearly 80% of the patients improving and some chronic conditions being completely cured.

Other studies have shown that Ayurvedic therapies can significantly lower cholesterol and blood pressure in stress-related problems. Diabetes, acne, and allergies have also been successfully treated with Ayurvedic remedies. Ayurvedic products have been shown to increase short-term memory and reduce headaches. Also, Ayurvedic remedies have been used successfully to support the healing process of patients undergoing chemotherapy, as these remedies have been demonstrated to increase immune system activity.

## Resources

### BOOKS

Lad, Vasant. *The Complete Book of Ayurvedic Home Remedies*. London: Piatkus, 2006.

### OTHER

"Inside Ayurveda: An Independent Journal of Ayurvedic Health Care." P.O. Box 3021, Quincy, CA 95971. <http://www.insideayurveda.com>.

### ORGANIZATIONS

American Institute of Vedic Studies, P.O. Box 8357, Santa Fe, NM, 87504-8357, [pvshastri@aol.com](mailto:pvshastri@aol.com), <http://www.vedanet.com/>.

Ayurveda Holistic Center, Bayville, Long Island, New York, NY, (516) 759-7731, <http://www.Ayurvedahc.com>.  
Ayurvedic and Naturopathic Medical Clinic., 2115 112th Ave NE, Bellevue, WA, 98004-2946, (425) 453-8022, (425) 453-1408, <http://www.ayurvedicscience.com>.  
Ayurvedic Institute, 11311 Menaul, NE, Albuquerque, NM, 87112, (505) 291-9698, (505) 294-7572, <http://www.ayurveda.com>.  
Bastyr University of Natural Health Sciences, 14500 Juanita Dr. N.E., Kenmore, WA, 98028, <http://www.bastyr.edu/>.  
Center for Mind/Body Medicine, 5225 Connecticut Ave. NW, Suite 145, Washington, DC, 20015, (202) 966-7338, (202) 966-2589, [center@cmbm.org](mailto:center@cmbm.org), <http://www.cmbm.org>.

National Institute of Ayurvedic Medicine, 584 Milltown Road, Brewster, NY, 10509, (845) 278-8700, (845) 278-8215, [ayurveda@niam.com](mailto:ayurveda@niam.com).  
Rocky Mountain Institute of Yoga and Ayurveda, P.O. Box 1091, Boulder, CO, 80306, (303) 443-6923, [info@rmiya.org](mailto:info@rmiya.org), <http://www.rmiya.org>.

Douglas Dupler MA

Azithromycin see **Erythromycins**

AZT see **Antiretroviral drugs**

# B

B-cell count see **Lymphocyte typing**

## Babesiosis

### Definition

Babesiosis is an infection of red blood cells caused by the single-celled parasite, *Babesia microti*, which is spread to humans by a tick bite.

### Description

Babesiosis is a rare, tick-transmitted disease that is caused most often by the single-celled parasite *Babesia microti*. By 1995, fewer than 500 cases of babesiosis had been reported in the United States. The disease occurs primarily in New England and New York, especially on the coastal islands. However, cases have occurred in other parts of the United States. Because of tick activity, the risk for babesiosis is highest during June and July.

Ticks are small, blood-sucking arachnids. Although some ticks carry disease-causing organisms, most do not. *Babesia microti* is spread to humans through the bite of the tick *Ixodes scapularis* (also called *Ixodes dammini*). *Ixodes scapularis*, called the “blacklegged deer tick,” usually feeds on deer and mice. A tick picks up the parasites by feeding on an infected mouse and then passes them on by biting a new host, possibly a human. To pass on the parasites, the tick must be attached to the skin for 36–48 hours. Once in the bloodstream, *Babesia microti* enters a red blood cell, reproduces by cell division, and destroys the cell, causing anemia. Humans infected with *Babesia microti* produce antibodies that can be helpful in diagnosing the infection.

### Causes and symptoms

*Babesia microti* live and divide within red blood cells, destroying the cells and causing anemia. The majority of people who are infected have no visible symptoms. In those who become ill, symptoms appear one to six weeks following the tick bite. Because the ticks are small, many patients have no recollection of a tick bite. The symptoms are flu-like and include tiredness, loss of appetite, **fever**, drenching sweats, and muscle **pain**. **Nausea, vomiting, headache**, shaking chills, blood in the urine, and depression can occur.

Persons who are over 40 years old, have had their spleen removed (splenectomized), and/or have a serious disease (**cancer**, **AIDS**, etc.) are at a greater risk for severe babesiosis. In severe cases of babesiosis, up to 85% of the blood cells can be infected. This causes a serious, possibly fatal, blood deficiency.

### Diagnosis

Babesiosis can be diagnosed by examining a blood sample microscopically and detecting the presence of *Babesia microti* within the blood cells. The blood can also be checked for the presence of antibodies to the parasite.

### Treatment

In serious cases, babesiosis is treated with a combination of clindamycin (Cleocin) and quinine. Clindamycin is given by injection and quinine is given orally three to four times a day for four to seven days. To reduce the number of parasites in the blood, severely ill patients have been treated with blood transfusions.

### Prognosis

Otherwise healthy patients will recover completely. Babesiosis may last several months without treatment and is a severe, potentially fatal disease in splenectomized patients.

## KEY TERMS

**Anemia**—A below normal number of red blood cells in the bloodstream.

**Parasite**—An organism that lives upon or within another organism.

### Prevention

The only prevention for babesiosis is to minimize exposure to ticks by staying on trails when walking through the woods, avoiding tall grasses, wearing long sleeves and tucking pant legs into socks, wearing insect repellent, and checking for ticks after an outing. Remove a tick as soon as possible by grasping the tick with tweezers and gently pulling. Splenectomized people should avoid northeastern coastal regions during the tick season.

### Resources

#### OTHER

*Mayo Clinic Online.* <http://www.mayoclinic.com> (accessed November 18, 2010).

Belinda Rowland, PhD

Bach flower remedies see **Flower remedies**

## Bacillary angiomatosis

### Definition

A life-threatening but curable infection that causes an eruption of purple lesions on or under the skin that resemble **Kaposi's sarcoma**. The infection, which occurs almost exclusively in patients with **AIDS**, can be a complication of **cat-scratch disease**.

### Description

Bacillary angiomatosis is a re-emerging bacterial infection that is identical or closely related to one that commonly afflicted thousands of soldiers during World War I. Today, the disease, caused by two versions of the same bacteria, is linked to homeless AIDS patients and to those afflicted with cat-scratch disease.

The infection is rarely seen today in patients who don't have HIV. According to the U.S. Centers for Disease Control and Prevention (CDC), an HIV patient

diagnosed with bacillary angiomatosis is considered to have progressed to full-blown AIDS.

### Causes and symptoms

Scientists have recently isolated two varieties of the *Bartonella* bacteria as the cause of bacillary angiomatosis: *Bartonella* (formerly *Rochalimaeaquintana*) and *B. henselae* (cause of cat-scratch disease).

*B. quintana* infection is known popularly as **trench fever** and is the infection associated with body lice that sickened European troops during World War I. Lice carry the bacteria, and can transmit the infection to humans. The incidence of trench **fever** was believed to have faded away with the end of World War I. It was not diagnosed in the United States until 1992, when 10 cases were reported among homeless Seattle men.

The related bacteria *B. henselae* was first identified several years ago as the cause of cat-scratch fever. It also can lead to bacillary angiomatosis in AIDS patients. Bacillary angiomatosis caused by this bacteria is transmitted to AIDS patients from cat fleas.

These two different types of bacteria both cause bacillary angiomatosis, a disease that is characterized by wildly proliferating blood vessels that form tumor-like masses in the skin and organs. The nodules that appear in bacillary angiomatosis are firm and don't turn white when pressed. The lesions can occur anywhere on the body, in numbers ranging from one to 100. They are rarely found on palms of the hands, soles of the feet, or in the mouth. As the number of lesions increase, the patient may develop a high fever, sweats, chills, poor appetite, **vomiting**, and weight loss. If untreated, the infection may be fatal.

In addition to the basic disease process, the two different types of bacteria cause some slightly different symptoms. Patients infected with *B. henselae* also experience blood-filled cysts within the liver and abnormal liver function, whereas *B. quintana* patients may have tumor growths in the bone.

### Diagnosis

This life-threatening but curable infection is often misdiagnosed, because it may be mistaken for other conditions (such as Kaposi's sarcoma). A blood test developed in 1992 by the CDC detects antibodies to the bacteria. It can be confirmed by reviewing symptoms, history and negative tests for other diseases that cause swollen lymph glands. It isn't necessary to biopsy a small sample of the lymph node unless there is a question of **cancer** of the lymph node or some other disease.

## KEY TERMS

**Cat-scratch disease**—An infectious disease caused by bacteria transmitted by the common cat flea that causes a self-limiting, mild infection in healthy people.

**Kaposi's sarcoma**—A malignant condition that begins as soft brown or purple lesions on the skin and occurs most often in men with AIDS.

### Treatment

Recent research indicates that **antibiotics** used to treat other HIV opportunistic infections can both prevent and treat bacillary angiomatosis. Treatment is usually given until the lesions disappear, which typically takes three or four weeks. A severely affected lymph node or blister may have to be drained, and a heating pad may help swollen, tender lymph glands. **Acetaminophen** (Tylenol) may relieve **pain**, aches, and fever over 101 °F (38.3 °C).

### Prognosis

In most cases, prompt antibiotic treatment in patients with AIDS cured the infection caused by either variety of the bacteria, and patients may resume normal life. Early diagnosis is crucial to a cure.

### Prevention

Studies suggest that antibiotics may prevent the disease. Patients also should be sure to treat cats for fleas.

### Resources

#### PERIODICALS

Koehler, J. E. "Zoonoses: Cats, Fleas and Bacteria." *Journal of the American Medical Association* 271 (1994): 531-535.

Carol A. Turkington

Bacillary dysentery see **Shigellosis**

Bacitracin see **Antibiotics, topical**

## Bacteremia

### Definition

Bacteremia is an invasion of the bloodstream by bacteria.

### Description

Bacteremia occurs when bacteria enter the bloodstream. This may occur through a wound or infection, or through a surgical procedure or injection. Bacteremia may cause no symptoms and resolve without treatment, or it may produce **fever** and other symptoms of infection. In some cases, bacteremia leads to **septic shock**, a potentially life-threatening condition.

### Risk factors

Any opening through the skin and/or body orifices that allows for the entrance of bacteria into the body places an individual, particularly those with a compromised immune system, at increased risk for the development of bacteremia.

Conditions that increase the chances of developing bacteremia include:

- immune suppression, either due to HIV infection or drug therapy that suppresses the immune system
- antibiotic therapy, which changes the balance of bacterial types in the body
- prolonged or severe illness
- alcoholism or other drug abuse
- malnutrition
- diseases or drug therapy that cause ulcers in the intestines, e.g., chemotherapy for cancer

### Causes and symptoms

#### Causes

Several types of bacteria live on the surface of the skin or colonize the moist linings of the urinary tract, lower digestive tract, and other internal surfaces. These bacteria are normally harmless as long as they are kept in check by the body's natural barriers and the immune system. People in good health with strong immune systems rarely develop bacteremia. However, when bacteria are introduced directly into the circulatory system, especially in a person who is ill or undergoing aggressive medical treatment, the immune system may not be able to cope with the invasion, and symptoms of bacteremia may develop. For this reason, bacteremia is most common in people who are already affected by or being treated for some other medical problem. In addition, medical treatment may bring a person in contact with new types of bacteria that are more invasive than those already residing in that person's body, further increasing the likelihood of bacterial infection.

## KEY TERMS

**Colostomy**—Surgical creation of an artificial anus on the abdominal wall by cutting into the colon and bringing it up to the surface.

**Gastrostomy**—Surgical creation of an artificial opening into the stomach through the abdominal wall to allow tube feeding.

**Jejunostomy**—Surgical creation of an opening to the middle portion of the small intestine (jejunum), through the abdominal wall.

**Septic shock**—A life-threatening drop in blood pressure caused by bacterial infection.

Common immediate causes of bacteremia include:

- drainage of an abscess, including an abscessed tooth
- urinary tract infection, especially in the presence of a bladder catheter
- decubitus ulcers (pressure sores)
- intravenous procedures using unsterilized needles, including IV drug use
- prolonged IV needle placement
- use of ostomy tubes, including gastrostomy (surgically making a new opening into the stomach), jejunostomy (surgically making an opening from the abdominal wall into the jejunum), and colostomy (surgically creating an artificial opening into the colon)

The bacteria most likely to cause bacteremia include members of the *Staphylococcus*, *Streptococcus*, *Pseudomonas*, *Haemophilus*, and *Esherichia* (*E. coli*) genera.

### Symptoms

Symptoms of bacteremia may include:

- fever over 101°F (38.3°C)
- chills
- malaise
- abdominal pain
- nausea
- vomiting
- diarrhea
- anxiety
- shortness of breath
- confusion

Not all of these symptoms may be present. In the elderly, confusion may be the only prominent symptom.

Bacteremia may lead to septic shock, whose symptoms include decreased consciousness, rapid heart and breathing rates, and multiple organ failures.

## Diagnosis

### Tests

Bacteremia is diagnosed by culturing the blood for bacteria. Samples may need to be tested several times over several hours. Blood analysis may also reveal an elevated number of white blood cells.

## Treatment

Bacteremia may cause no symptoms, but may be discovered through a blood test for another condition. In this situation, it may not need to be treated, except in patients especially at risk for infection, such as those with heart valve defects or whose immune systems are suppressed.

## Drugs

Prompt antibiotic therapy usually succeeds in clearing bacteria from the bloodstream. Recurrence may indicate an undiscovered site of infection. Untreated bacteria in the blood may spread, causing infection of the heart (**endocarditis** or **pericarditis**) or infection of the covering of the central nervous system (**meningitis**).

Blood pressure is monitored closely; a decline in blood pressure may indicate the onset of septic shock.

## Prognosis

If detected and treated promptly, most individuals recover from bacteremia. However, in individuals whose immune systems are compromised, it is critical that the condition be treated promptly and aggressively so that it does not progress to **sepsis** or septic shock, which can lead to **death** even if treatment is initiated.

## Prevention

Bacteremia can be prevented by preventing the infections that often precede it. Good personal hygiene such as effective hand-washing, especially during viral illness, may reduce the risk of developing bacterial infection. Treating bacterial infections quickly and thoroughly can minimize the risk of spreading infection. During medical procedures, the burden falls on medical professionals to minimize the number and duration of invasive procedures, to reduce patients' exposure to

sources of bacteria when being treated, and to use scrupulous technique.

## Resources

### PERIODICALS

Lee, A., S. Mirrett, L.B. Reller, and M.P. Weinstein. "Detection of Bloodstream Infections in Adults. How Many Blood Cultures Are Needed?" *Journal of Clinical Microbiology* 45, no. 11 (2007): 3546–48.

Richard Robinson  
Melinda Granger Oberleitner  
RN, DNS, APRN, CNS

Bacterial meningitis see **Meningitis**

## KEY TERMS

**Anaerobic bacteria**—Bacteria that do not require oxygen, found in low concentrations in the vagina.

**Vaginal discharge**—Discharge of secretions from the cervical glands of the vagina; normally clear or white.

- having a new sex partner or multiple sex partners
- stress
- douching
- using an intrauterine device (IUD) for contraception

BV is not transmitted through toilet seats, bedding, swimming pools, or touching of objects. Women who have not had sexual intercourse rarely have BV. BV is not considered an STD, although it does appear to act like an STD in women who have sex with women.

The main symptom of BV is a thin, watery or foamy, white (milky) or gray vaginal discharge with an unpleasant, foul, fish-like or musty odor. The odor is sometimes stronger after a woman has sex, when the semen mixes with the vaginal secretions. Burning or pain during urination can also be present with BV. Itching on the outside of the vagina and redness can also occur, but are seen less frequently. However, many women with BV do not exhibit any symptoms.

## Diagnosis

BV is diagnosed through an examination of the vagina by a health care provider. A woman who suspects that she may have BV should not douche or use a feminine hygiene spray before the appointment with the health care provider. Laboratory tests are conducted on a sample of the vaginal fluid to see if the bacteria present are those associated with BV. The health care provider may also check to see if there is decreased vaginal acidity. Potassium hydroxide, when added to a vaginal discharge sample, enhances vaginal odors and allows the health care provider to determine if the odor is fishy or foul.

## Treatment

In a few cases, BV might clear up without treatment. However, all women with symptoms of BV should be treated to relieve symptoms and to avoid the development of complications such as **pelvic inflammatory disease** (PID). In most cases, male partners are not

## Causes and symptoms

Bacteria that dominate the vaginal flora in a BV infection include *Gardnerella vaginalis* or *Mobiluncus*, although other bacteria, such as *Escherichia coli* from the rectum have also been shown to cause the disease. The overgrowth of these harmful bacteria are at the expense of the protective bacteria lactobacilli, which secrete a natural disinfectant, hydrogen peroxide, that maintains the healthy, normal balance of vaginal microorganisms. The factors that upset the normal balance of bacteria in the vagina are not well understood; however, the following activities or behaviors that have been associated with BV include:

treated, but female sexual partners should be examined to see if they have BV and require treatment.

BV is treated with prescription **antibiotics** such as metronidazole or clindamycin creams or oral metronidazole (both are antibiotics that can also be used by pregnant women, although at different doses). Metronidazole kills anaerobic bacteria but does not harm the protective lactobacilli. Drinking alcohol should be avoided when taking metronidazole, for this medicine can cause severe **nausea and vomiting** when combined with alcohol.

For postmenopausal women, in addition to the use of antibiotics, the health care provider may also prescribe estrogen suppositories or topical cream to thicken and lubricate vaginal tissues. Sexual activity should be avoided during treatment; a condom should be used if the woman does have sexual intercourse. The woman should be tested after treatment to ensure that the infection has been cured.

### Alternative treatment

Supplement therapies are available in addition to the use of prescription medicines to ease recovery.

#### *Herbal therapies*

Fresh garlic (*Allium sativum*) has antibacterial properties and can be added to a woman's diet. A fresh, peeled garlic wrapped in gauze can also be inserted into the vagina to help treat BV. The insert should be changed twice daily.

To soothe itching or irritation of the vaginal tissues, a woman can bathe the tissues in an infusion of fresh chickweed (*Stellaria media*). The infusion is made by pouring one cup of boiling water on one to two teaspoons of the herb, steeping for five minutes, and allowing the mixture to cool before use.

### Prognosis

- Pregnant women with BV often have babies of low birth weight (less than 5.5 pounds) or who are premature.
- Bacteria that cause BV may also cause pelvic inflammatory disease (PID), an infection of the uterus and fallopian tubes. The risk of a woman with BV developing PID is higher after the woman undergoes surgical procedures such as a hysterectomy or an abortion. PID can result in infertility and can also increase the risk of an ectopic pregnancy.
- BV may increase the risk of a woman becoming infected with HIV, the virus that causes AIDS.

- A woman with BV and HIV is more likely to pass HIV to her sexual partner.
- BV increases the chance that a woman will contract other STDs, such as chlamydia and gonorrhea.

BV can be successfully treated with antibiotics.

### Prevention

Since the development of BV often appears to be associated with sexual activities, recommended ways to avoid BV include:

- practicing abstinence
- delaying having sex for the first time, as younger people who have sex are more likely to contract BV and STDs
- limiting the number of sexual partners
- having a sexual relationship with only one partner who does not have an STD
- practicing safer sex, which means using a condom every time when having sex

Other ways to prevent BV include:

- discontinuing the use of tampons for six months
- practicing good hygiene by wiping from front to back (away from the vagina) after bowel movements to avoid spreading bacteria from the rectum to the vagina
- wearing cotton panties and panty hose with a cotton crotch and avoiding tight or latex clothing to keep the vagina cool and dry
- avoiding the use of perfumed soaps and feminine sprays
- lowering stress levels
- avoiding douching, as douching removes some of the normal bacteria in the vagina that protects women from infection
- finishing the course of antibiotic treatment, even if the symptoms are relieved, to prevent reoccurrence of the disease
- routinely being tested for BV during regular gynecological examinations

Some physicians recommend that all women who have a **hysterectomy** or an abortion be treated for BV, to reduce the risk of developing PID.

### Resources

#### BOOKS

- Hollier, Lisa M., and George D. Wendel. *Infectious Diseases in Women*. Philadelphia: Saunders, 2008.  
*Introduction to Bacterial Vaginosis: A Roundtable Discussion*. Woodcliff Lake, NJ: Advanstar Communications, 2007.

**OTHER**

3M National Vaginitis Association. *Women's Guide to Vaginal Infections*. Brochure available for download: [www3.3m.com/pdas-nva/cons\\_addrssources.html](http://www3.3m.com/pdas-nva/cons_addrssources.html)

**ORGANIZATIONS**

American College of Obstetricians and Gynecologists, PO Box 96920, Washington, DC, 20090-6920, (202) 638-5577, <http://www.acog.org>.  
 American Social Health Association, P.O. Box 13827, Research Triangle Park, NC, 27709, (919) 361-8400, (919) 361-8425, <http://www.ashastd.org>.

Judith Sims

Bacteroides infection see **Anaerobic infections**

## Bad breath

### Definition

Bad breath, sometimes called halitosis, is an unpleasant odor of the breath.

### Description

Bad breath is likely to be experienced by most adults at least occasionally. Bad breath, either real or imagined, can have a significant impact on a person's social and professional life.

### Causes and symptoms

Bad breath can be caused by a number of problems. Oral diseases, fermentation of food particles in the mouth, sinus infections, and unclean dentures can all contribute to mouth odor. Many non-oral diseases, such as lung infections, kidney failure, or severe **liver disease**, can also cause bad breath, though rarely. Many people think that bad breath can originate in the stomach or intestines; this is extremely rare. The esophagus is usually collapsed and closed, and, although a belch may carry odor up from the stomach, the chance of bad breath being caused from air continually escaping from the stomach is remote. Cigarette smoke can cause bad breath, not only in the cigarette smoker, but also in one who is constantly exposed to secondhand smoke.

### Diagnosis

The easiest way to determine if one has bad breath is to ask someone who is trustworthy and discrete. This is usually not too difficult. Another, more

## KEY TERMS

**Halitosis**—The medical term for bad breath.

private, method of determining if one has bad breath is to lick one's wrist, wait until it dries, then smell the area. Scraping the rear area of the tongue with a plastic spoon, then smelling the spoon, is another method one can use to assess bad breath.

### Treatment

The most effective treatment of bad breath is to treat the cause. Poor **oral hygiene** can be improved by regular brushing and flossing, as well as regular dental checkups. Gentle brushing of the tongue should be part of daily oral hygiene. In addition to good oral hygiene, the judicious use of mouthwash is helpful. Mouth dryness, experienced at night or during **fasting**, or due to certain medications and medical conditions, can contribute to bad breath. Dryness can be avoided by drinking adequate amounts of water. Chewing gum may be beneficial.

As mentioned, some medications, such as some high blood pressure medications, can cause **dry mouth**. If this problem is significant, a medication change, under the supervision of one's health care provider, may improve the dry-mouth condition. Oral or sinus infections, once diagnosed, can be treated medically, usually with **antibiotics**. Lung infections and kidney or liver problems will, of course, need medical treatment.

### Alternative treatment

Depending on the cause, a multitude of alternative therapeutic remedies can be used. For example, **sinusitis** can be treated with steam inhalation of essential oils and/or herbs.

### Prognosis

Most bad breath can be treated successfully with good oral hygiene and/or medical care. Occasionally, for patients who feel that these therapies are unsuccessful, some delusional or obsessive behavior pattern might pertain, and mental health counseling may be appropriate.

### ORGANIZATIONS

American Dental Association, 211 E. Chicago Ave., Chicago, IL, 60611-2678, (312) 440-2500, <http://www.ada.org>.  
 American Medical Association, 515 N. State St., Chicago, IL, 60654, (800) 621-8335, <http://www.ama-assn.org>.

Joseph Knight, PA

## Balance and coordination tests

### Definition

Balance is the ability to maintain a position. Coordination is the capacity to move through a complex set of movements. Balance and coordination depend on the interaction of multiple body organs and systems including the eyes, ears, brain and nervous system, cardiovascular system, and muscles. Tests or examination of any or all of these organs or systems may be necessary to determine the causes of loss of balance, **dizziness**, or the inability to coordinate movement or activities.

### Purpose

Tests of balance and coordination, and the examination of the organs and systems that influence



**A patient sits on a ball, working on his balance. He wears a belt so that the physical therapist can catch him if he loses balance. (Custom Medical Stock Photo, Inc. Reproduced by permission.)**

### KEY TERMS

**Meniere's disease**—An abnormality of the inner ear that causes dizziness, ringing in the ears, and hearing loss.

balance and coordination, can help to identify causes of dizziness, **fainting**, falling, or incoordination.

### Precautions

Tests for balance and coordination should be conducted in a safe and controlled area where patients will not experience injury if they become dizzy or fall.

### Description

Assessment of balance and coordination can include discussion of the patient's medical history and a complete **physical examination** including evaluation of the heart, head, eyes, and ears. A slow pulse or heart rate, or very low blood pressure may indicate a circulatory system problem, which can cause dizziness or fainting. During the examination, the patient may be asked to rotate the head from side to side while sitting up or while lying down with the head and neck extended over the edge of the examination table. If these tests produce dizziness or a rapid twitching of the eyeballs (**nystagmus**), the patient may have a disorder of the inner ear, which is responsible for maintaining balance.

An examination of the eyes and ears may also give clues to episodes of dizziness or incoordination. The patient may be asked to focus on a light or on a distant point or object, and to look up, down, left, and right moving only the eyes while the eyes are examined. Problems with vision may, in themselves, contribute to balance and coordination disturbances, or may indicate more serious problems of the nervous system or brain function. **Hearing loss**, fluid in the inner ear, or ear infection might indicate the cause of balance and coordination problems.

Various physical tests may also be used. A patient may be asked to walk a straight line, stand on one foot, or touch a finger to the nose to help assess balance. The patient may be asked to squeeze or push against the doctor's hands, to squat down, to bend over, stand on tiptoes or stand on their heels. Important aspects of these tests include holding positions for a certain number of seconds, successfully repeating movements a certain number of times, and repeating the test accurately with eyes closed. The patient's reflexes may also

be tested. For example, the doctor may tap on the knees, ankles, and elbows with a small rubber mallet to test nervous system functioning. These tests may reveal muscle weakness or nervous system problems that could contribute to incoordination.

## Preparation

No special preparation is required prior to administration of balance and coordination tests. The patient may be asked to disrobe and put on an examination gown to make it easier for the doctor to observe muscles and reflex responses.

## Aftercare

No special aftercare is generally required, however, some of the tests may cause episodes of dizziness or incoordination. Patients may need to use caution in returning to normal activities if they are experiencing any symptoms of dizziness, lightheadedness, or weakness.

## Risks

These simple tests of balance and coordination are generally harmless.

## Normal results

Under normal conditions, these tests will not cause dizziness, loss of balance, or incoordination.

## Abnormal results

The presence of dizziness, lightheadedness, loss of coordination, unusual eye movements, muscle weakness, or impaired reflexes are abnormal results and may indicate the problem causing the loss of balance or incoordination. In some cases, additional testing may be needed to diagnose the cause of balance or coordination problems.

## ORGANIZATIONS

EAR Foundation of Arizona, 668 North 44th Street, Suite 300, Phoenix, AZ, 85008, (602) 685-1050, (602) 239-5117, melissa@earfoundationaz.com, <http://www.earfoundationaz.com>.

Vestibular Disorders Association (VEDA), P.O. Box 4467, Portland, OR, 97208-4467, (503) 229-8064, (800) 837-8428, <http://www.vestibular.org>.

Altha Roberts Edgren

## Balanitis

### Definition

Balanitis is an inflammation of the head and foreskin of the penis.

### Description

Balanitis generally affects uncircumcised males. These are men who have a foreskin, which is the “hood” of soft skin that partially covers the head of the penis. In balanitis, the head and foreskin become red and inflamed. (In circumcised men, who lack a foreskin, these symptoms only affect the tip of the penis.) The condition often occurs due to the fungus *Candida albicans*, the same organism that causes vaginal yeast infections in women. Balanitis (which is also referred to as balanoposthitis) can be caused by a variety of other fungal or bacterial infections, or may occur due to a sensitivity reaction to common chemical agents.

Uncircumcised men are more at risk for balanitis due to the presence of the foreskin. The snug fit of the foreskin around the top of the penis tends to create a damp, warm environment that encourages the growth of microorganisms. Most of the organisms associated with balanitis are already present on the penis, but in very small numbers. However, if the area between the head and foreskin is not cleansed thoroughly on a regular basis, these organisms can multiply and lead to infection.

Diabetes can increase the risk of developing the condition.

### Causes and symptoms

Balanitis is usually a result of poor hygiene—for example, neglecting to bathe for several days. A failure to properly wash (or rinse) the area between the head and foreskin can lead to the development of fungal or bacterial infections that cause the condition. In other cases, balanitis may occur due to an allergic reaction: some men may be sensitive to chemicals found in harsh soaps, laundry detergents, or contraceptive creams. Men who contract a sexually transmitted disease (STD) such as trichomoniasis may also develop symptoms.

The symptoms of balanitis are limited to the foreskin and head of the penis (in circumcised men, only the head is affected). These include redness, inflammation, **pain**, discharge, sore or itchy skin, and difficulty retracting the foreskin.

## KEY TERMS

**Acidophilus**—A bacteria believed to combat yeast infections.

**Circumcision**—The surgical removal of the foreskin.

**Urethral stricture**—A narrowing of the urethra (urine tube).

## Diagnosis

Balanitis is usually diagnosed based on a brief **physical examination**. This may be conducted by your regular health care provider or by a urologist, the type of doctor who specializes in such disorders. The doctor may take a sample of the discharge (if any) to determine the nature of the possible infection. A urine test may be recommended to evaluate glucose (sugar) levels in the urine. Balanitis treatment is typically covered by medical insurance.

## Treatment

The treatment of balanitis depends on the specific cause, which can vary from case to case. **Antibiotics** are used to treat bacterial infections, while topical antifungals such as clotrimazole can combat balanitis caused by *Candida*. If an allergic reaction is causing symptoms, the goal is to identify the chemical agent responsible. Ointments or creams may be used to ease skin irritation.

No matter what the cause, it is important to thoroughly clean the penis on a daily basis in order to alleviate symptoms. If the condition keeps occurring, or if the inflammation is interfering with urination, **circumcision** may be advised.

## Alternative treatment

According to practitioners of alternative medicine, certain herbs may be effective in controlling or preventing yeast infections—a common cause of balanitis. These remedies include garlic, calendula, and goldenseal. Eating yogurt that contains acidophilus may also help to clear up a *Candida* infection.

## Prognosis

Most cases go away quickly once the cause is identified and treated. However, regular bouts of balanitis can result in urethral stricture.

## Prevention

Proper hygiene is the best way to avoid balanitis. Circumcision is sometimes performed to prevent repeated cases.

## Resources

### BOOKS

Tanagho, Emil A., Jack W McAninch, and Donald Ridgeway Smith. *Smith's General Urology*. New York: McGraw-Hill Medical, 2008.

### ORGANIZATIONS

U.S. National Library of Medicine, 8600 Rockville Pike, Bethesda, MD, 20894, (888) 346-3656, <http://www.nlm.nih.gov>.

Greg Annussek

## Balanitidiasis

### Definition

Balanitidiasis is an **infectious disease** produced by a single-celled microorganism (protozoan) called *Balantidium coli* that infects the digestive tract. It is primarily a disease of the tropics, although it is also found in cooler, temperate climates. Most persons with balantidiasis do not exhibit any noticeable symptoms (asymptomatic), but a few individuals will develop **diarrhea** with blood and mucus and an inflamed colon (**colitis**).

### Description

Balanitidiasis is caused by *Balantidium coli*, a parasitic protozoan that infects the large intestine. *B. coli* is the largest and only protozoan, having cilia or hair-like structures, that is capable of causing disease in humans. Balantidiasis occurs most commonly in areas with poor sanitation and in settings where humans live in close contact with pigs, sheep, or goats.

### Causes and symptoms

Balanitidiasis is transmitted primarily by eating food or drinking water that has been contaminated by human or animal feces containing *B. coli* cysts. During its life cycle, this organism exists in two very different forms: the infective cyst or capsuled form, which cannot move but can survive outside the human body because of its thick, protective covering; and the disease-producing form, the trophozoite, which although capable of moving, cannot survive once excreted in the feces and, therefore, cannot infect others. In the digestive tract, the

## KEY TERMS

**Asymptomatic**—Persons who carry a disease and are usually capable of transmitting the disease but who do not exhibit symptoms of the disease are said to be asymptomatic.

**Biopsy**—The removal of a tissue sample for diagnostic purposes.

**Ciliated**—Covered with short, hair-like protrusions, like *B. coli* and certain other protozoa. The cilia or hairs help the organism to move.

**Colitis**—An inflammation of the large intestine that occurs in some cases of balantidiasis. It is marked by cramping pain and the passing of bloody mucus.

**Protozoan**—A single-celled, usually microscopic organism, such as *B. coli*, that is eukaryotic and, therefore, different from bacteria (prokaryotic).

**Sigmoidoscopy**—A procedure in which a thin, flexible, lighted instrument, called a sigmoidoscope, is used to visually examine the lower part of the large intestine.

cysts are transported to the intestine where the walls of the cysts are broken open by digestive secretions, releasing the mobile trophozoites. Once released within the intestine, the trophozoites multiply by feeding on intestinal bacteria or by invading the lining of the large intestine. Within the lining of the large intestine, the trophozoites secrete a substance that destroys intestinal tissue and creates sores (ulcers) or abscesses. Trophozoites eventually form new cysts that are carried through the digestive tract and excreted in the feces. Under favorable temperature and humidity conditions, the cysts can survive in soil or water for weeks to months, ready to begin the cycle again.

Most individuals with balantidiasis have no noticeable symptoms. Even though these individuals may not feel ill, they are still capable of infecting others by person-to-person contact or by contaminating food or water with cysts that others may ingest, for example, by preparing food with unwashed hands.

The most common symptoms of balantidiasis are chronic diarrhea or severe colitis with abdominal cramps, **pain**, and bloody stools. Complications may include intestinal perforation in which the intestinal wall becomes torn, but the organisms do not spread to other parts of the body in the blood stream.

### Diagnosis

Diagnosis of balantidiasis, as with other similar diseases, can be complicated, partly because symptoms may or may not be present. A diagnosis of balantidiasis may be considered when a patient has diarrhea combined with a possible history of recent exposure to **amebiasis** through travel, contact with infected persons, or anal intercourse.

Specifically, a diagnosis of balantidiasis is made by finding *B. coli* cysts or trophozoites in the patient's stools or by finding trophozoites in tissue samples (biopsy)

taken from the large bowel. A diagnostic blood test has not yet been developed.

### *Stool examination*

This test involves microscopically examining a stool sample for the presence of cysts and/or trophozoites of *B. coli*.

### *Sigmoidoscopy*

To take a tissue sample from the large intestine, a procedure called a **sigmoidoscopy** is performed. During a sigmoidoscopy, a thin, flexible instrument is used to visually examine the intestinal lining and obtain small tissue specimens.

### Treatment

Patients with balantidiasis are treated with prescription medication, typically consisting of a ten-day course of either tetracycline or metronidazole. Alternative drugs that have proven effective in treating balantidiasis include iodoquinol or paromomycin.

### Prognosis

Although somewhat dependent on the patient's overall health, in general, the prognosis for most patients with balantidiasis is good. Severely infected patients occasionally die as a result of a tear in the intestinal wall (intestinal perforation) and consequent loss of blood.

### Prevention

There are no immunization procedures or medications that can be taken prior to potential exposure to prevent balantidiasis. Moreover, people who have had the disease can become reinfected. Prevention requires

effective personal and community hygiene. Specific safeguards include the following:

- Purification of drinking water. Water can be purified by filtering, boiling, or treatment with iodine.
- Proper food handling. Measures include protecting food from contamination by flies, cooking food properly, washing one's hands after using the bathroom and before cooking or eating, and avoiding foods that cannot be cooked or peeled when traveling in countries with high rates of balantidiasis.
- Careful disposal of human feces.
- Monitoring the contacts of balantidiasis patients. The stools of family members and sexual partners of infected persons should be tested for the presence of cysts or trophozoites.

## Resources

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Rebecca J. Frey, PhD

Baldness see **Alopecia**

Balloon angioplasty see **Angioplasty**

## KEY TERMS

**Cardiac catheterization**—A technique used to evaluate the heart and fix certain problems. Catheterization is far less invasive than traditional surgery.

**Stenosis**—The narrowing of any valve, especially one of the heart valves or the opening into the pulmonary artery from the right ventricle.

**Valve**—Tissue in the passageways between the heart's upper and lower chambers that controls passage of blood and prevents regurgitation.

perform and less successful in treating narrowing of the aortic valve.

## Description

Balloon valvuloplasty is a procedure in which a thin tube (catheter) that has a small deflated balloon at the tip is inserted through the skin in the groin area into a blood vessel, and then is threaded up to the opening of the narrowed heart valve. The balloon is inflated, which stretches the valve open. This procedure cures many valve obstructions. It is also called balloon enlargement of a narrowed heart valve.

The procedure is performed in a **cardiac catheterization** laboratory and takes up to four hours. The patient is usually awake, but is given **local anesthesia** to make the area where the catheter is inserted numb. After the site where the catheter will be inserted is prepared and anesthetized, the cardiologist inserts a catheter into the appropriate blood vessel, then passes a balloon-tipped catheter through the first catheter. Guided by a video monitor and an x ray, the physician slowly threads the catheter into the heart. The deflated balloon is positioned in the valve opening, then is inflated repeatedly. The inflated balloon widens the valve's opening by splitting the valve leaflets apart. Once the valve is widened, the balloon-tipped catheter is removed. The other catheter remains in place for 6 to 12 hours because in some cases the procedure must be repeated.

## Preparation

For at least six hours before balloon valvuloplasty, the patient will have to avoid eating or drinking anything. An intravenous line is inserted so that medications can be administered. The patient's groin area is shaved and cleaned with an antiseptic. About an hour before the procedure, the patient is given an oral sedative such as diazepam (Valium).

## Aftercare

After balloon valvuloplasty, the patient is sent to the recovery room for several hours, where he or she is monitored for vital signs (such as pulse and breathing) and heart sounds. An electrocardiogram, which is a record of the electrical impulses in the heart, is done. The leg in which the catheter was inserted is temporarily prevented from moving. The skin condition is monitored. The insertion site, which will be covered by a sandbag, is observed for bleeding until the catheter is removed. Intravenous fluids will be given to help eliminate the x-ray dye; intravenous blood thinners or other medications to dilate the coronary arteries may be given. **Pain** medication is available.

For at least 30 minutes after removal of the catheter, direct pressure is applied to the site of insertion; after this a pressure dressing will be applied. Following discharge from the hospital, the patient can usually resume normal activities. After balloon valvuloplasty lifelong follow-up is necessary because valves sometimes degenerate or narrowing recurs, making surgery necessary.

## Risks

Balloon valvuloplasty can have serious complications. For example, the valve can become misshapen so that it doesn't close completely, which makes the condition worse. **Embolism**, where pieces of the valve break off and travel to the brain or the lungs, is another possible risk. If the procedure causes severe damage to the valve leaflets, immediate surgery is required. Less frequent complications are bleeding and hematoma (a local collection of clotted blood) at the puncture site, abnormal heart rhythms, reduced blood flow, **heart attack**, heart puncture, infection, and circulatory problems.

## ORGANIZATIONS

American Heart Association National Center, 7272 Greenville Avenue, Dallas, TX, 75231, (800) 242-8721, [Review.personal.info@heart.org](mailto:Review.personal.info@heart.org).

Lori De Milto

Bancroftian filariasis see **Elephantiasis**

## Bandages and dressings

### Definition

Bandages and dressings are both used in wound management. A bandage is a piece of cloth or other material used to bind or wrap a diseased or injured part

of the body. Usually shaped as a strip or pad, bandages are either placed directly against the wound or used to bind a dressing to the wound. A dressing can consist of a wide range of materials, sometimes containing medication, placed directly against the wound.

### Purpose

The purposes served by dressings include protecting **wounds**; promoting healing; and providing, retaining, or removing moisture. Bandages can be used to hold dressings in place, to relieve **pain**, and generally to make the patient comfortable. Elastic bandages are useful to provide ongoing pressure on wounds such as **varicose veins**, fractured ribs, and swollen joints.

### Description

In recent years, there have been tremendous advances in the design and composition of bandages and dressings. The field is becoming increasingly complex, and there are numerous reports of health care workers applying inappropriate products. Wound-care materials come in a wide variety of product classes, including the following:

- Alginate dressings. These are derived from brown seaweed and contain calcium alginate, which turns into a sodium alginate gel when it comes in contact with wound fluid. They are available as pads or ropes.
- Biosynthetic dressings. These are composites of biological (often animal-derived) and synthetic materials such as polymers.
- Collagen dressings. These are made from collagen, a protein obtained from cowhide, cattle tendons, or birds. They are available as particles or gels.
- Composite dressings. These are similar to plastic adhesive strips and include an adhesive border, a non-adhesive or semi-adhesive surface that is applied to the wound, an absorbent layer, and a bacterial barrier.
- Contact layers. A low-adherent layer of perforated or woven polymer material designed to stop a secondary absorbent dressing from sticking to the surface of a wound.
- Gauze. This woven fabric of absorbent cotton is available in a number of formats and materials, including cotton or synthetic, non-impregnated, and impregnated with water, saline, or other substances. Gauze is sold as surgical swabs, sheets, rolls, pads, sponges, and ribbon.
- Growth factors. These short-chain proteins affect specific target cells. They exist naturally in humans,

- and can be transplanted from one part of the body to another or manufactured outside the body.
- Hydrocolloid dressings. Used for leg ulcers, minor burns, pressure sores and traumatic injuries, these self-adhesive dressings form a gel as they absorb fluid from the wound. They consist of materials such as sodium carboxymethylcellulose (an absorbent), pectin, and gelatin that are attached to a foam sheet or a thin polyurethane film.
- Hydrofibers. Similar in appearance to cotton, carboxymethylcellulose fibers turn into a gel when they come into contact with wound fluid. They are available as ribbons or pads and are highly absorbent.
- Hydrogels. These are sold as sheets and in gel form, and are primarily used to supply moisture to wounds. Depending on the state of the tissue, they can either absorb fluid or moisten the wound. An electrically conductive aloe vera gel is available to provide electrotherapy to wounds.
- Hydropolymers. These foamed-gel products consist of multiple layers. The surface layer is designed to expand to fill the contours of a wound and, at the same time, draw away fluids.
- Leg compression/wrapping products. These are designed to apply external pressure to improve blood flow and resolve chronic edema in the feet and legs. They are available in a broad range of formats, including stockings, compression bandages, or pneumatic pump.
- Polyurethane foam dressings. These are sheets of foamed polymer solutions with small open chambers that draw fluids away from the wound. Some of these foam products offer adhesive surfaces. They are available as sheets and rolls, as well as in various other formats suitable for packing wounds.
- Skin substitutes. Also known as allografts or skin equivalents, these are obtained from human cells cultured and expanded *in vitro* from neonatal foreskins.
- Superabsorbents. These are particles, hydropolymers, or foams that act like the material inside diapers, with a high capacity for rapid absorption.
- Transparent films. These consist of a thin, clear polyurethane sheet that, on one side, has a special adhesive that does not stick to moist surfaces like those found on a wound. They prevent bacteria and fluids from entering the wound through the dressing, but allow limited circulation of oxygen.
- Wound fillers. These can be bought as powders or pastes, or in strands or beads. They are used to fill wounds and also absorb wound fluid.
- Wound pouches. Equipped with a special collection system for wounds that have a high flow of secretion,

they are designed to contain odors and to be easily drained.

- Other assorted wound-care products. These include adhesive bandages, surgical tapes, adhesive skin closures, surgical swabs, paste bandages, specialty absorptive dressings, support bandages, retention bandages, elasticized tubular bandages, lightweight elasticized tubular bandages, foam-padded elasticized tubular bandages, and plain stockinettes.

Just as there is a large selection of bandage and dressing products to choose from, there is also a broad range of applications for these products:

- Alginate dressings are used on wounds that exude moderate to heavy amounts of fluid. They are useful for packing wounds, although strip-packing gauze may be preferable for deeper wounds because it is easier to retrieve. Common applications of alginate dressings include treatment of acute surgical wounds, leg ulcers, sinuses, and pressure sores. These dressings should not be used on third-degree burns. Neither are they advisable for wounds that are dry or are secreting only small amounts of fluid, because their powerful absorbing capability may dry out the wound. These are primary dressings that need be covered by a secondary dressing.
- Biosynthetic dressings are used on burns and other wounds. Another application is as a temporary dressing for skin autograft sites. Some persons may be allergic to these dressing materials.
- Collagen dressings are believed to hasten wound repair and are often used on stubborn wounds. They are most effective on wounds that contain no dead tissue. Collagen dressings should not be used in dry wounds, third-degree burns, or on any patient who is sensitive to bovine (cow) products.
- Composite dressings are sometimes used alone, sometimes in combination with other dressings. Deep wounds should first be packed with wound-filler material. These dressings should not be cut, and are not recommended for use on third-degree burns.
- Contact layers are designed for use in clean wounds that contain no dead tissue. They are not recommended for infected, shallow, or dry wounds, or on third-degree burns.
- Gauze is used to pack wounds, and also for debridement and wicking. It is especially desirable for packing deep wounds. When using gauze to pack wounds, a loose packing technique is preferred.
- Growth factors. These have highly specific applications against such conditions as diabetic foot ulcers involving disease of the peripheral nerves. Growth factors are heat sensitive and often require

refrigeration. These are not recommended for persons with benign or malignant tumors.

- Hydrocolloid dressings are used for leg ulcers, minor burns, pressure sores, and traumatic injuries. Because they are not painful to remove, hydrocolloid dressings are often employed in pediatric wound management. Because of their absorbent capabilities, they are used on wounds that are secreting light to moderate amounts of fluid.
- Hydrofibers are highly absorbent, so they are particularly useful for wounds that are draining heavily. For this reason, they are not recommended for dry wounds or wounds with little secretion, because they may result in dehydration. Hydrofibers should not be used as surgical sponges or on third-degree burns.
- Hydrogels are often used on wounds that contain dead tissue, on infected surgical wounds, and on painful wounds. They should not be used on wounds with moderate to heavy secretions. As with all dressings, it is important to check and follow the directions of the manufacturer. In the case of hydrogels, directions on some products indicate they are not to be used on third-degree burns.
- Hydropolymers are typically used on wounds with minimal to moderate drainage. They are not indicated for dry wounds or third-degree burns.
- Leg compression/wrapping products are used to increase blood flow and reduce edema in the lower extremities of the body. A medical doctor should be consulted before using these products on people with edema. In many cases, topical dressings are used under these products.
- Polyurethane foam dressings are very absorbent and are typically used on wounds with moderate to heavy secretions. They should not be used on third-degree burns or on wounds that are not draining or that have sinuses or tunneling.
- Skin substitutes are a relatively new product category, approved for treating venous leg ulcers. It is often advisable to cut slits in the artificial skin, so that wound secretions underneath do not lift the newly applied skin.
- Superabsorbents are employed on wounds that are secreting heavily, or in applications requiring extended wear. A packing material is commonly employed under this product. Superabsorbents should not be used on third-degree burns or wounds that are either dry or have minimal secretions.
- Transparent films are often employed as a secondary cover for another, primary dressing. They are used on superficial wounds and on intact skin at risk of

## KEY TERMS

**Debridement**—Removing dead or nonviable tissue from a wound.

**Edema**—Swelling of body tissues, caused by collection of excess fluid.

**Electrotherapy**—The treatment of body tissues by passing electrical currents through them, stimulating the nerves and muscles.

**Sinus**—In the context of wound management, a narrow hollow in the body extending from an infected area to the surface of the skin.

**Stockinette**—A soft elastic material used for bandages and clothing for infants.

infection. It is important to remove transparent films very carefully to avoid damaging fragile skin.

- Wound fillers are primary dressings that are usually used in conjunction with other, secondary dressings. Wound fillers are considered appropriate for shallow wounds with little or moderate secretions. They are not appropriate for use in third-degree burns or in dry wounds. They are similarly not recommended for wounds with tunnels or sinuses.
- Wound pouches are useful in treating wounds with high volumes of secretion. They are not suitable for dry wounds.

Recommended intervals between dressing changes vary widely among product classes. The materials used in some dressings require that they be changed several times a day. Others can remain in place for one week. Manufacturer's directions should be consulted and followed.

## Preparation

Wounds require appropriate cleaning, **debridement**, closure, and medication before bandages and dressings are applied.

Determining the cause of wounds is often very important, especially the cause of chronic wounds such as skin ulcers. A physician should be advised of any signs of infection or other changes in a wound. Signs of infection may include redness around the wound site, **fever**, red streaks extending from the wound, yellow drainage from the wound, or a mal odor noted at the wound site.

Wound-care nursing is a rapidly advancing field that requires considerable training, clinical experience, and

judgment, causing some observers to predict that it will eventually develop into an advanced practice nursing or a specialty-based practice. Increasingly, the demands on wound-care nurses are expected to require that they undertake graduate studies. For all nurses working in the field, ongoing education is a must to keep up with new knowledge, technologies, and techniques. Numerous organizations and institutions offer continuing education courses in wound care management.

## Results

Wounds that receive appropriate and timely care are most likely to heal in an acceptable manner.

## Resources

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### OTHER

- National Library of Medicine. <http://www.nlm.nih.gov/medlineplus/firstaidemergencies.html>.  
 Woundcare.com. <http://www.woundcare.com/>.

### ORGANIZATIONS

- American Academy of Family Physicians, 11400 Tomahawk Creek Parkway, Leawood, KS, 66211-2672, (913) 906-6000, [fp@aafp.org](mailto:fp@aafp.org), <http://www.aafp.org>.  
 American College of Physicians, 190 N. Independence Mall West, Philadelphia, PA, 19106-1572, (215) 351-2600, (800) 523-1546, x2600, <http://www.acponline.org>.

American Medical Association, 515 N. State Street, Chicago, IL, 60610, (312) 464-5000, <http://www.ama-assn.org>.

American Nurses Association, 600 Maryland Avenue, SW, Suite 100 West, Washington, DC, 20024, (800) 274-4262, <http://www.nursingworld.org>.

American Red Cross National Headquarters, 2025 E St. NW, Washington, DC, 20006, (202) 303-4498, <http://www.redcross.org>.

Wound, Ostomy, and Continence Nurses Society, 1550 South Coast Highway, Suite #201, Laguna Beach, CA, 92651, (888) 224-9626, <http://www.wocn.org>.

L. Fleming Fallon, Jr., MD, DrPH  
 Laura Jean Cataldo, RN, Ed.D.

Bang's disease see **Brucellosis**

## Barbiturate-induced coma

### Definition

A barbiturate-induced **coma**, or barb coma, is a temporary state of unconsciousness brought on by a controlled dose of a barbiturate drug, usually pentobarbital or thiopental.

### Purpose

Barbiturate comas are used to protect the brain during major brain surgery, such as the removal of **arteriovenous malformations** or aneurysms. Coma may also be induced to control intracranial **hypertension** caused by brain injury.

### Precautions

Barbiturate-induced comas are used when conventional therapy to reduce intracranial hypertension has failed. Barbiturate dosing is geared toward burst suppression—that is, reducing brain activity as measured by **electroencephalography**. This reduction in brain activity has to be balanced against the potential side effects of **barbiturates**, which include allergic reactions and effects on the cardiovascular system.

### Description

One of the greatest hazards associated with brain injury is intracranial hypertension. Brain injury may be caused by an accidental **head injury** or a medical condition, such as **stroke**, tumor, or infection. When the brain is injured, fluids accumulate in the brain, causing

## KEY TERMS

**Aneurysm**—A bulge or sack-like projection from a blood vessel.

**Arteriovenous malformation**—An abnormal tangle of arteries and veins in which the arteries feed directly into the veins without a normal intervening capillary bed.

**Diuretic agent**—A drug that increases urine output.

**Electroencephalography**—The recording of electrical potentials produced by the brain. These potentials indicate brain activity.

**Hyperventilation**—A respiratory therapy involving deeper and/or faster breathing to keep the carbon dioxide pressure in the blood below normal.

**Intracranial hypertension**—Abnormally high blood pressure within the skull.

**Osmotherapy**—Intravenous injection or oral administration of an agent that induces dehydration. The goal of dehydration is to reduce the amount of accumulated fluid in the brain.

**Steroid**—A type of drug used to reduce swelling.

it to swell. The skull does not allow for the expansion of the brain; in effect, the brain becomes compressed.

If the pressure does not abate, oxygenated blood may not reach all areas of the brain. Also, the brain tissue may be forced against hard, bony edges on the interior of the skull. In either case, the brain tissue may die, causing permanent brain damage or **death**.

Barbiturates reduce the metabolic rate of brain tissue, as well as the cerebral blood flow. With these reductions, the blood vessels in the brain narrow, decreasing the amount of swelling in the brain. With the swelling relieved, the pressure decreases and some or all brain damage may be averted.

Controversy exists, however, over the benefits of using barbiturates to control intracranial hypertension. Some studies have shown that barbiturate-induced coma can reduce intracranial hypertension but does not necessarily prevent brain damage. Furthermore, the reduction in intracranial hypertension may not be sustained.

### Preparation

Inducing a barbiturate coma is usually kept in reserve for cases in which conventional treatments for controlling intracranial hypertension have failed. Before coma is induced, intracranial hypertension may be treated by hyperventilation; by facilitation of blood flow from the brain; by decompressive surgical procedures, such as draining excess fluids from under the skull or from the chambers within the brain (ventricles); or by drug therapy, including osmotherapy, diuretic agents, or **steroids**.

### Risks

An estimated 25% of barbiturate-induced comas are accompanied by severe side effects. The side effects of barbiturates, especially the depressive effect on the cardiovascular system, can be too risky for some patients.

Other side effects include impaired gastrointestinal motility and impaired immune response and infection. Since barbiturates depress activity in the brain, measurements of brain activity may be unreliable. Careful monitoring of the patient is required to ensure nutritional needs are being met and to guard against complications, such as lung infection, fevers, or deep vein **blood clots**.

### Normal results

In many patients who do not respond to conventional therapy, barbiturate-induced coma can achieve the necessary control of intracranial hypertension.

### Resources

#### PERIODICALS

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Julia Barrett

Barbiturate withdrawal see **Withdrawal syndromes**

## Barbiturates

### Definition

Barbiturates are mood-altering, central nervous system depressant medicines.

### Purpose

Also known as sedative-hypnotic drugs, barbiturates make people relaxed, calm, and sleepy. They are sometimes used to control seizures (convulsions) and to produce **coma** following **head injury** or brain surgery.

## KEY TERMS

**Adrenal glands**—Two glands located next to the kidneys. The adrenal glands produce the hormones epinephrine and norepinephrine and the corticosteroid (cortisone-like) hormones.

**Anemia**—A lack of hemoglobin, the compound in blood that carries oxygen from the lungs throughout the body and brings waste carbon dioxide from the cells to the lungs, where it is released.

**Central nervous system**—The brain and spinal cord.

**Hallucination**—A false or distorted perception of objects, sounds, or events that seems real. Hallucinations usually result from drugs or mental disorders.

**Hypnotic**—A medicine that causes sleep.

**Porphyria**—A disorder in which porphyrins build up in the blood and urine.

**Porphyrin**—A type of pigment found in living things, such as chlorophyll, which makes plants green, and hemoglobin, which makes blood red.

**Sedative**—Medicine that has a calming effect and may be used to treat nervousness or restlessness.

**Seizure**—A sudden attack, spasm, or convulsion.

**Withdrawal symptoms**—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug to which he or she has become dependent.

These medicines are habit forming and should be used for only short periods of time to treat **anxiety** or sleeplessness.

### Description

Barbiturates are available only with a physician's prescription and are sold in capsule, tablet, liquid, and injectable forms. Some commonly used barbiturates are phenobarbital, secobarbital (Seconal), pentobarbital (Nembutal), and amobarbital (Amytal).

### Recommended dosage

Recommended dosage depends on the barbiturate used and other factors such as the patient's age and the condition for which the medicine is being taken. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

### Precautions

Always take barbiturates as directed. Never take larger or more frequent doses.

Barbiturates may add to the effects of alcohol and other drugs that produce drowsiness or depress the central nervous system, like **antihistamines**, cold medicines, over-the-counter sleep aids, medicine for seizures or convulsions, tranquilizers, **pain** relievers, and **muscle relaxants**.

People who have been taking barbiturates for long periods of time should not stop taking them suddenly, as they may develop withdrawal symptoms like nervousness, or even convulsions. These medicines should be discontinued gradually.

Taking an overdose of barbiturates or combining barbiturates with alcohol or other **central nervous system depressants** can cause unconsciousness and even **death**. Anyone who shows signs of an overdose or a reaction to combining barbiturates with alcohol or other drugs should get emergency medical help. Signs of overdose include:

- severe drowsiness
- shallow or slow breathing
- slurred speech
- loss of balance or staggering gait
- slow heartbeat and low blood pressure
- confusion
- generalized weakness

Barbiturates may change the results of certain medical tests. Before having medical tests, anyone taking these drugs should alert the health care professional in charge.

Drowsiness, lightheadedness or lack of muscular coordination from barbiturates can last many hours. Anyone who takes these drugs should not drive or use potentially dangerous machines until they find out how the drugs affect them.

Barbiturates may cause physical or mental dependence when taken over long periods of time. Signs of dependence include:

- the need to take increasing doses of the medicine to get the same effect
- a strong desire to keep taking the medicine
- withdrawal symptoms, such as anxiety, nausea or vomiting, convulsions, trembling, or sleep problems when the medicine is stopped

Children, older adults, or people who are seriously ill may be especially sensitive to the effects of barbiturates, increasing the risks of confusion, drowsiness, or even excitement.

**ALLERGIES.** Anyone who has had unusual reactions to barbiturates in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

**PREGNANCY.** Taking barbiturates during **pregnancy** increases the chance of **birth defects** and may cause other problems such as prolonged labor and withdrawal effects in babies following birth. Pregnant women who must take barbiturates for serious or life-threatening conditions should thoroughly discuss with their physicians the benefits and risks of taking this medicine.

**BREASTFEEDING.** Barbiturates pass into breast milk and may cause problems such as drowsiness, breathing problems, or slow heartbeat in nursing babies whose mothers take the medicine.

**OTHER MEDICAL CONDITIONS.** Before using barbiturates, people with any of these medical problems should make sure their physicians are aware of their conditions:

- alcohol or drug abuse
- depression
- hyperactivity (in children)
- pain
- kidney disease
- liver disease
- diabetes
- overactive thyroid
- underactive adrenal gland
- chronic lung diseases such as asthma or emphysema
- severe anemia
- acute, intermittent porphyria

**USE OF CERTAIN MEDICINES.** Taking barbiturates with certain other drugs may affect the way the drugs work or may increase the chance of side effects from either or both drugs.

## Side effects

The most common side effects are **dizziness**, lightheadedness, drowsiness, and clumsiness or unsteadiness. These problems usually go away as the body adjusts to the drug and do not require medical treatment unless they persist or interfere with normal activities.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine immediately:

- slow pulse or low blood pressure
- fainting
- fever
- muscle or joint pain
- sore throat
- tightness in the chest or chest pain
- wheezing
- skin problems such as rash, hives, or red, thickened, or scaly skin
- bleeding sores on the lips
- sores or painful white spots in the mouth
- swollen eyelids, face, or lips

In addition, check with a physician as soon as possible if confusion, depression, or unusual excitement occur after taking barbiturates.

Patients who take barbiturates for a long time or at high doses may notice side effects for some time after they stop taking the drug. These effects usually appear within 8–16 hours after the patient stops taking the medicine. Check with a physician if these or other troublesome symptoms occur after stopping treatment with barbiturates:

- dizziness, lightheadedness, or faintness
- anxiety or restlessness
- hallucinations
- vision problems
- nausea and vomiting
- seizures (convulsions)
- muscle twitches or trembling hands
- weakness
- sleep problems, nightmares, or increased dreaming

Other side effects may occur. Anyone who has unusual symptoms during or after treatment with barbiturates should get in touch with his or her physician.

## Interactions

Birth control pills may not work properly when taken while barbiturates are being taken. To prevent pregnancy, use additional methods of birth control while taking barbiturates.

The drugs that may interact with barbiturates include:

- Medicines that depress the central nervous system, such as those used for treating allergies, colds, or hay fever,

as well as sedatives, tranquilizers, pain medicines, muscle relaxants, and over-the-counter sleep aids.

- Barbiturates reduce the effects of warfarin (Coumadin).
- The effects of beta-adrenergic blocking drugs like metaprolol (Lopressor) and propanalol (Inderal) are reduced by barbiturates.
- Barbiturates reduce the effects of antipsychosis drugs like clozapine (Clozaril).
- The effects of adrenocorticoid steroid medications, like cortisone, are reduced by barbiturates.
- Antiseizure medicines such as valproic acid (Depakote and Depakene) and carbamazepine (Tegretol) may increase the effects of barbiturates.
- Barbiturates may reduce the effectiveness of tetracycline antibiotics.
- The effects of felodipine (Plendil) may be decreased by barbiturates.
- Phenobarbital may decrease the effectiveness of drugs taken internally to treat fungal infections, like griseofulvin (Grifulvin). Separating the time of administering the drugs may help reduce this effect.
- Barbiturates may reduce the effectiveness of nifedipine (Procardia).
- Barbiturates may reduce the effectiveness of quinidine.
- Barbiturates may reduce the effectiveness of amino-phylline used to treat asthma.

Barbiturates may also interact with other medicines. When this happens, the effects of one or both drugs may change or the risk of side effects may be increased. Anyone who takes barbiturates should let the physician know all other medicines he or she is taking.

The list above does not include every drug that may interact with barbiturates. Be sure to check with a physician or pharmacist before combining barbiturates with any other prescription or nonprescription (over-the-counter) medicine.

## Resources

### PERIODICALS

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## Bariatric surgery

### Definition

Bariatric surgeries are surgical weight-loss procedures that reduce or bypass the stomach or small intestine so that severely overweight people can achieve significant and permanent weight loss.

### Purpose

**Obesity** is the second leading cause of preventable **death** in the United States. It is linked to an increased likelihood of developing over twenty different diseases and disorders including high blood pressure (**hypertension**), type 2 diabetes, heart disease, **stroke**, deep vein **blood clots**, fatty **liver disease**, **sleep apnea**, **heartburn**, **gastroesophageal reflux disease** (GERD), gallstone disease, arthritis, **colon cancer**, breathing problems, and depression. According to the National Institutes of Health, in 2008 32.7% of Americans were overweight, 34% were obese and just under 6% were severely or morbidly obese.

Obesity is defined by the body mass index (BMI). This calculation compares weight to height. Adults age 20 and older are evaluated as follows:

- BMI below 18.5: Underweight
- BMI 18.5–24.9: Normal weight
- BMI 25.0–29.9: Overweight
- BMI 30 and above: Obese
- BMI 40 and above: Morbidly or severely obese

Bariatric surgery is performed only on severely overweight people who have a BMI greater than 40 or are at least 100 pounds over their ideal weight. This level of obesity often is referred to as morbid obesity since it can result in many serious, and potentially deadly, health problems. Bariatric surgery is performed only on people whose risk of complications from surgery is outweighed by the need to lose weight to prevent health complications and for whom supervised weight-loss and **exercise** programs have repeatedly failed. Bariatric surgery, however, does not make people thin. Most people lose about 60% of their excess weight through this treatment. Changes in diet and exercise still are required to maintain a normal weight.

### Description

Weight loss through surgery can be achieved either by operations that restrict the amount of food the stomach can hold (restrictive surgery), reduce the amount of nutrients that are absorbed (malabsorptive surgery), or some combination of the two. Both approaches are

used in the United States, each with its advantages and disadvantages.

Bariatric surgery usually is performed in a hospital by a surgeon who has experience with **obesity surgery** or at a center that specializes in the procedure. **General anesthesia** is used, and the operation takes 2–3 hours. The hospital stay lasts about a week. In all weight-loss surgeries, the experience and skill of the surgeon affects the success of the procedure. Individuals should select a surgeon and hospital with this in mind.

Insurers may consider bariatric surgery elective surgery and not cover it under their policies. If they do cover weight-loss surgery, extensive documentation of the necessity for surgery may be required. Approval from the insurer should be sought before this operation is performed.

### **Restriction Surgery**

Restriction surgery is the most common type of bariatric surgery performed in the United States. The normal, unrestricted stomach can hold about 6 cups (48 oz or 1.5 L) of food. With restriction surgery, the capacity of the stomach is reduced to about 1–3 oz (30–90 mL). Adjustable gastric band, or Lap-Band surgery, achieves restriction by placing a saline (salt water) filled bag around the stomach, pinching off a portion of it, and leaving only a small pouch at the top. The exit to the pouch is narrowed so that the rate at which the pouch empties is slowed. Because the pouch is so small, the individual can only eat about half a cup of food at a time without feeling nauseated.

Advantages of the adjustable gastric band are:

- This is the safest surgical weight-loss procedure.
- Recovery time is rapid compared to other weight-loss surgeries.
- A port in the skin allows access to the saline bag. The size of the stomach pouch opening can be adjusted without additional surgery by adjusting the pressure in the saline band.
- No part of the digestive system is removed; digestion continues normally just with much smaller amounts of food.
- People having this surgery do not feel hungry because stretch sensors in the wall of the stomach tell the brain that the stomach is full.
- Weight loss averages 50–65% of the excess body weight during the first two years.
- Obesity-related health problems are substantially reduced as weight is lost.
- The band can be removed. The surgery is reversible because no part of the digestive system was changed.
- The procedure is often covered by Medicare.

Disadvantages of the adjustable gastric band are:

- Individuals must relearn how to eat. The band requires that they eat five or six very small meals a day. They will vomit if too much food is consumed at once.
- The individual must learn to chew food well, eat slowly, and drink liquids between rather than with meals.
- There is a small risk that the band will slip and surgery will be required to fix or remove it.
- The individual must commit to eating a healthy diet in order to maintain weight loss. High-calorie foods such as milkshakes can cause weight gain; weight loss is less than with malabsorptive surgeries.
- This surgery was approved by the United States Food and Drug Administration (FDA) in 2001. Long-term effects are being studied.

A second type of restrictive surgery is vertical banded gastroplasty (VBG), also known as stomach stapling. This surgery is performed less often than Lap-Band surgery. With VBG, part of the stomach is stapled and banded shut making it smaller, so that individuals feel full sooner. The advantage of VBG is that the procedure is quick and has few complications. Disadvantages are that average weight loss is less than with other weight-loss surgeries, and staples can pull out allowing small leaks between the stomach and the abdomen to develop. Infection is possible, but rare (less than 1%). This procedure is usually not covered by Medicare.

A third restrictive surgery is vertical sleeve **gastrectomy** (VSG), also called sleeve gastrectomy, vertical gastrectomy, greater curvature gastrectomy, parietal gastrectomy, and longitudinal gastrectomy. In this procedure, a portion of the stomach is surgically removed, and the remainder of the stomach remains attached to the small intestine.

This procedure may be considered as an alternative for morbidly obese individuals whose health does not permit them to safely undergo Roux-en-Y malabsorption surgery. Advantages of this surgery are that it permanently removes a portion of the stomach that produces ghrelin, an appetite-stimulating hormone. In addition, the capacity of the stomach is reduced to about one ounce, and nutrient absorption problems do not occur because the stomach continues to be normally connected to the small intestine; no part of the intestine is bypassed. Disadvantages of this surgery are that few surgeons perform it, some insurers consider it experimental and will not cover its costs, and the part of the stomach that remains can stretch, allowing greater food capacity with the risk of weight gain.

Intragastric balloon placement is a fourth type of restriction technique, although it technically is not bariatric surgery. The procedure is available in Europe,

## KEY TERMS

**Fat-soluble vitamin**—A vitamin that dissolves in and can be stored in body fat or the liver.

**Gastroesophageal reflux disease (GERD)**—A condition where gastric juice from the stomach backs up into the bottom of the esophagus and causes irritation, inflammation, or erosion of the cells lining the esophagus.

**Heartburn**—A pain in the center of the chest behind the breastbone caused by the contents of the stomach backflowing (refluxing) into the lower end of the esophagus and causing irritation.

**Mineral**—An inorganic substance found in the earth that is necessary in small quantities for the body to maintain health. Examples: zinc, copper, iron.

**Morbidly obese**—Defines a person who is 100 lb (45 kg) (or more than 50%) overweight and has a body mass index above 40.

**Osteoporosis**—A condition found in older individuals in which bones decrease in density and become fragile and more likely to break. It can be caused by lack of vitamin D and/or calcium in the diet.

**Sleep apnea**—A sleep disorder in which breathing stops briefly then resumes on its own. These pauses can occur many times each night, resulting in poor quality of sleep.

**Type 2 diabetes**—Sometimes called adult-onset diabetes, this disease prevents the body from properly using glucose (sugar), but can often be controlled with diet and exercise.

**Vitamin**—A nutrient that the body needs in small amounts to remain healthy but that the body cannot manufacture for itself and must acquire through diet.

South America, Mexico, Canada, and Australia. It is in clinical trials in the United States. This procedure involves placing a silicon balloon in the stomach and inflating it to fill up part of the stomach so that the individual feels full sooner. An advantage of the intragastric balloon is that it can be placed in the stomach and removed without surgery. Intraoperative balloons are intended for temporary use (about 6 months) and are for use in conjunction with a managed program of weight control. Approval for this type of restriction weight loss in the United States, which is not technically bariatric surgery, is not expected before 2010.

### *Malabsorptive surgery*

Malabsorptive surgery, also called **gastric bypass** surgery, creates an alternate route for food through the digestive system so that the food bypasses part of the intestine and fewer nutrients are absorbed. In practice, malabsorptive surgery is combined with some type of restrictive surgery so that less food is also moving through the digestive tract.

The most common type of gastric bypass surgery is Roux-en-Y gastric bypass. In this surgery, a small stomach pouch is created by stapling and banding the stomach. Next, a Y-shaped piece of intestine is attached to the pouch on one end, and the jejunum, or second part of the small intestine, on the other. This allows food to bypass the duodenum, or first part of the intestine where many calories and nutrients are absorbed. The

food then continues normally through the rest of the small intestine and the large intestine.

The great advantage of Roux-en Y gastric bypass is that individuals lose on average 60–70% of their excess weight and are able to maintain the weight loss for 10 years or more. As a result, most obesity-related health problems are substantially reduced or cured when weight is lost and weight loss maintained. In the United States Medicare often will pay for this surgery.

Roux-en-Y surgery has some serious disadvantages. These are:

- This surgery is more difficult for the surgeon than restrictive surgeries and involves permanently altering the digestive system.
- Many vitamins and minerals are absorbed in the part of the small intestine bypassed by this surgery. The individual must commit to a lifetime of taking nutritional supplements to prevent serious vitamin and mineral deficiencies.
- Tearing, bleeding, and infection at the sites where the cuts and reconnections were made are potentially fatal complications.
- Dumping syndrome may occur in response to meals high in sugar. Dumping occurs when food moves too fast through the intestine and causes symptoms of nausea, bloating, weakness, sweating, fainting, and diarrhea.

Billroth-pancreatic diversion (BPD), another type of malabsorptive surgery, bypasses an even longer section

of the small intestine. In BPD, about two-thirds of the stomach is surgically removed, leaving a pouch that can hold about 3 cups of food. A bypass is then created to the ileum, or final portion of the small intestine. In all, about 9 ft (3 m) of intestine are bypassed. As a result, many fewer calories and nutrients are absorbed. The main advantage of BPD is the large amount of excess weight—between 75% and 80%—that is lost over the first two years and the health benefits that this loss brings. In the United States, Medicare often will pay for this surgery.

Disadvantages are the same as for Roux-en Y-surgery, but nutrient deficiencies are greater. Because fat is poorly digested as a result of this surgery, bowel movements are frequent and stools are especially foul smelling.

## Precautions

Bariatric surgery should not be performed unless a patient meets the following criteria:

- has a BMI of 40 or above or BMI of 35 and is at high risk for serious obesity-related health problems
- has been unsuccessful in serious attempts lose weight
- well-informed and has realistically considered the risks and benefits of the procedure
- has made a commitment to the lifelong changes in eating habits that are required after surgery
- will keep follow-up and nutritional counseling appointments; understands that lifelong medical follow-up is likely to be necessary
- has met with a psychologist or psychiatrist and is emotionally stable

Bariatric surgery is not appropriate for people who have substance addictions or who have psychological disorders. Other considerations in choosing candidates for obesity surgery include the general health of the person and his or her willingness to comply with follow-up treatment.

## Preparation

After patients are carefully selected as appropriate for obesity surgery, they receive standard preoperative blood and urine tests and meet with an anesthesiologist to discuss how their health may affect the administration of anesthesia. Pre-surgery counseling is required to help patients anticipate what to expect after the operation.

## Aftercare

Immediately after the operation, most patients are restricted to a liquid diet for 2–3 weeks; however, some

may remain on it for up to 12 weeks. Patients then move on to a diet of pureed food for about a month, and after about two months most can tolerate solid food.

Restrictive surgeries pose few special nutritional concerns, but malabsorptive surgeries require both a specialized diet for several months after surgery and a lifelong commitment to taking **nutritional supplements**. Individuals having bariatric surgery receive both psychological and nutritional counseling before and after surgery.

## *Post-surgical recovery diet*

After gastric bypass or BPD, the individual does not eat anything for one or two days, giving the bowel time to rest. During this time, all **nutrition** is given intravenously. Once the individual begins eating, he or she will follow a schedule similar to the one below:

- Liquids such as juice, broth, milk, or diluted cooked cereal for two or three days.
- Pureed foods that have the texture of baby food for two or three weeks while the stomach heals. These foods must be smooth and contain no chunks.
- Soft foods such as ground meat and soft-cooked fruits and vegetables for about eight weeks.
- Regular food can be eaten in very small amounts. Most people begin by eating six tiny meals a day. These meals should be high in protein. Food must be chewed thoroughly. Liquids are drunk between meals, not with them. Vitamin and mineral supplements are essential.

## *Lifelong nutritional supplementation*

People who have gastric bypass surgery or BPD need extensive nutritional counseling and must take vitamin and mineral supplements for the rest of their lives. Most iron and **calcium** is absorbed in the duodenum, the first part of the intestine that is bypassed by these operations. Calcium deficiency can lead to **osteoporosis**, and iron deficiency can cause anemia.

In BPD, only 25% of the fat in food is absorbed because so much of the small intestine is bypassed. The fat-soluble **vitamins** A, D, E, and K are absorbed along with fat. When the body absorbs too little fat, inadequate amounts of these fat-soluble vitamins are absorbed, so dietary supplements containing these vitamins must be taken. Other vitamins that may not be absorbed in adequate amounts are vitamin B12, **folic acid**, and vitamin B1 (thiamine). Research published in the journal *Neurology* in March 2007 found that a very small number of people developed a brain disorder called Wernicke encephalopathy 4–12 weeks after bariatric surgery. This disorder is caused by a deficiency of

vitamin B1. Most of the people who developed the disorder had failed to take their vitamin supplements as prescribed after surgery.

Patients are expected to work on changing their eating and exercise habits to assist in weight loss. Most people eat 3–4 small meals a day once they return to solid food. Eating too quickly or too much after obesity surgery can cause **nausea and vomiting** as well as intestinal “dumping,” a condition in which undigested food is shunted too quickly into the small intestine, causing **pain, diarrhea, weakness, and dizziness**.

## Risks

As in any abdominal surgery, there is always a risk of excessive bleeding, infection, and allergic reaction to anesthesia. Specific risks associated with obesity surgery include leaking or stretching of the pouch and loosening of the gastric staples. Although the average death rate associated with this procedure is less than 1%, the rate varies from center to center, ranging from 0–4%. Long-term failure rates can reach 50%, sometimes making additional surgery necessary. Other complications of obesity surgery include an intolerance to foods high in fats, **lactose intolerance**, bouts of **vomiting, diarrhea, and intestinal discomfort**.

Studies suggest that gastric bypass surgery complications increase with age, weight, and male gender. Patients age 55 and older experienced more complications than younger patients, and male patients are more likely to have life-threatening complications than female patients, particularly those who were more severely obese.

## Normal results

Most people who have surgery for obesity lose anywhere from 50–80% of their excess weight. However, quite a few put pounds back on beginning several years after surgery. The main reason for weight gain is noncompliance with their nutrition and exercise plan. Also, over time the size of the stomach pouch in restrictive surgeries tends to stretch, allowing people to eat more and still feel comfortable. On the positive side, people who lose weight through surgery almost always see great improvement in any obesity-related diseases they have.

Weight-loss surgery does have some serious risks. Complications include slipping of the band in Lap-Band surgery, failure of the staples in VBG, infection, dumping syndrome in malabsorptive surgery, and an increased risk of **gallstones** and abdominal hernias. The risk of death is less than 1% in gastric bypass surgery and 2.5–5% in BPD. About 20% of people who have VBG surgery need a second operation to correct problems

arising from the procedure. **Pregnancy**, although possible, also presents some special nutritional risks to women who have had weight loss surgery. Bariatric surgery is not a magic weight-loss operation, and success also depends on the patient’s willingness to exercise and eat low-calorie foods. When deciding whether to have a surgical weight-loss procedure, the expected benefits must outweigh the risks of continued obesity.

## Resources

### BOOKS

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“Weight loss Surgery.” MedlinePlus. January 19, 2010. <http://www.nlm.nih.gov/medlineplus/weightlossurgery.html>

### ORGANIZATIONS

American Society for Metabolic and Bariatric Surgery, 100 SW 75th Street, Gainesville, FL, 32607, (352) 331-4900, (352) 331-4975info@asmbs.org, <http://www.asmbs.org>.

The Obesity Society, 8630 Fenton Street, Suite 814, Silver Spring, MD, 20910, (301) 563-6526, (301) 563-6595, <http://www.obesity.org>.

Weight-Control Information Network (WIN), 1 WIN Way, Bethesda, MD, 20892-3665, (202) 828-1025 (877) 946-4627 Fax: (202) 828-1028win@info.niddk.nih.gov, <http://win.niddk.nih.gov>.

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## Barium enema

### Definition

A barium enema, also known as a lower GI (gastrointestinal) exam, is a test that uses x-ray examination to view the large intestine. There are two types of tests: the

single-contrast technique, where barium sulfate is injected into the rectum to gain a profile view of the large intestine, and the double-contrast (or “air contrast”) technique, where air and barium are inserted into the rectum.

## Purpose

A barium enema may be performed for a variety of reasons. One reason may be to help in screening for or diagnosing colon and **rectal cancer** (colorectal cancer). Detection of polyps (benign growths in the tissue lining the colon and rectum), diverticula (pouches pushing out from the colon), and structural changes in the large intestine can be confirmed by the barium enema. The double-contrast barium enema is an effective method for detecting small tumors, early inflammatory disease, and bleeding caused by ulcers. **Colonoscopy**, which uses a thin, flexible, fiber-optic device to visualize the colon and rectum, has largely replaced the barium enema in diagnosing these diseases in many countries; however, colonoscopy is more expensive to perform.

A doctor’s decision to perform a barium enema is based on a patient’s history of altered bowel habits. These can include **diarrhea**, **constipation**, lower abdominal **pain**, or patient reports of blood, mucus, or pus in the stool. Colorectal cancer screening is recommended for healthy people over age 50 every five to 10 years. In 2010, colorectal cancer was the second leading cause of cancer-related **death** in the United States. Those who have a close relative with colorectal cancer, or who have had a precancerous polyp, are considered to be at an increased risk for the disease and should be screened more frequently by their doctor for possible abnormalities. In the United States, this screening is most often done by a colonoscopy, although it can also be done by using a barium enema.

## Description

Twenty-four hours before the barium enema, the patient will begin following a bowel-cleansing regimen that involves restricted diet and administration of **laxatives**. To begin a barium enema, the doctor will have the patient lie on their back facing upward (supine) on a tilting radiographic table so that x rays of the abdomen can be taken. The film is then reviewed by a radiologist, who assesses if the colon has been adequately cleansed of stool during the pre-procedure prep process. After being assisted into a different position, a well-lubricated rectal tube is inserted through the anus. This tube allows the physician or the assisting health care provider to slowly administer the barium into the intestine. While this filling process is closely monitored, the patient must keep the

## KEY TERMS

**Barium sulfate**—A barium compound used during a barium enema to block the passage of x rays during the exam.

**Bowel lumen**—The space within the intestine.

**Colonoscopy**—A procedure in which the colon is cleansed and a lighted fiber optic instrument is inserted through the anus to allow the physician to view the entire length of the colon and detect abnormalities in the colon lining including polyps and ulcers.

**Diverticula**—A diverticulum of the colon is a sac or pouch in the colon wall that is usually asymptomatic (without symptoms) but may cause difficulty if it becomes inflamed. Diverticula is the plural of diverticulum.

**Diverticulitis**—A condition of the diverticulum of the intestinal tract, especially in the colon, where inflammation may cause distended sacs and pain.

**Diverticulosis**—A condition in which the colon (large intestine) develops a number of outpouchings or sacs.

**Megacolon**—Abnormally large colon associated with some chronic intestine disorders.

**Sigmoidoscopy**—A visual examination of the rectum and sigmoid (lower) colon using a sigmoidoscope, also known as proctosigmoidoscopy.

**Ulcerative colitis**—A type of inflammatory bowel disease in which ulceration or erosion of the lining of the colon occur.

anus tightly contracted against the rectal tube so that the position is maintained and the barium is prevented from leaking out. This step is emphasized to the patient because inaccuracy may occur if the barium leaks. A rectal balloon also may be inflated to help the patient retain the barium. The table may be tilted or the patient may be moved to different positions to aid in the filling process. The patient may experience cramping pains or the urge to defecate. The patient will be instructed to take slow, deep breaths through the mouth to ease any discomfort.

As the barium fills the colon, x rays of the abdomen are taken to distinguish significant findings. There are several ways to perform a barium enema. In one method, shortly after filling, the rectal tube is removed and the patient expels as much of the barium as possible. In another method, the tube will remain in place, and the barium will move through that tube. A thin

film of barium remains in the intestine, and then, in a double contrast enema, air is slowly injected through the rectum to expand the bowel lumen. Usually no x-ray films will be taken until after the air is injected. Multiple films generally are obtained by a radiologist; then, additional films are made by a technologist.

## Preparation

To conduct the most accurate barium enema test, the patient must follow a prescribed diet and **bowel preparation** instructions before the test. This preparation commonly includes restricted intake of dairy products and a liquid diet for 24 hours before the test, in addition to drinking large amounts of water or clear liquids 12–24 hours before the test. Patients may also be given laxatives to help empty the bowel and be asked to give themselves a cleansing enema.

## Aftercare

Patients should follow several steps immediately after undergoing a barium enema, including:

- Drinking plenty of fluids to help counteract the dehydrating effects of bowel preparation and the test.
- Taking time to rest. A barium enema and the bowel preparation taken before it can be exhausting.
- Administering a cleansing enema, if directed, to eliminate any remaining barium. Lightly colored stools will be prevalent for the next 24–72 hours following the test.

## Risks

While a barium enema is considered a safe screening and diagnostic test, it can cause complications in certain people. The following indications should be kept in mind before a barium enema is performed:

- Those who have a rapid heart rate, severe ulcerative colitis, toxic megacolon, or a presumed perforation in the intestine should not undergo a barium enema.
- The test should be performed very cautiously if the patient has a blocked intestine, ulcerative colitis, diverticulitis, or severe bloody diarrhea.
- Complications that may be caused by the test include perforation of the colon, water intoxication, barium granulomas (inflamed nodules), and allergic reaction. However, these conditions are all very rare.

## Normal results

When patients undergo single-contrast **enemas**, their intestines are steadily filled with barium to differentiate markings of the colon. Normal results display

uniform filling of the colon. As the barium is expelled, the intestinal walls collapse. A normal result on the x ray after defecation will show the intestinal lining as having a standard, feathery appearance.

The double-contrast enema expands the intestine, which is already lined with a thin layer of barium, using air to display a detailed image of the mucosal pattern. Varying positions taken by the patient allow the barium to collect on the dependent walls of the intestine by way of gravity. In a healthy patient, the walls will have a uniform, standard appearance.

## Abnormal results

A barium enema will show abnormalities on an x ray that may aid in the diagnosis of several different conditions. Most colon cancers occur in the rectosigmoid region, or on the upper part of the rectum and adjoining portion of the sigmoid colon. However, they can also be detected with a **sigmoidoscopy**. Further, an enema can identify other early signs of cancer.

Identification of polyps, **diverticulosis**, and inflammatory disease such as **diverticulitis** and ulcerative **colitis** may be made through a barium x ray. Some cases of acute **appendicitis** also may be apparent by viewing this x ray, although acute appendicitis is usually diagnosed clinically, or by computed tomography (CT) scan.

## Resources

### OTHER

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### ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (404) 320-3333, (800) ACS-2345, <http://www.cancer.org>.

Colon Cancer Alliance, 1200 G Street NW, Ste 800, Washington, DC, 20005, (202) 434-8980 (877) 422-2030 (866) 304-9075, <http://www.ccalliance.org>.

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Barium swallow see **Upper GI exam**

Barlow’s syndrome see **Mitral valve prolapse**

## Bartholin's gland cyst

### Definition

A Bartholin's gland cyst is a swollen fluid-filled lump that develops from a blockage of one of the Bartholin's glands, which are small glands located on each side of the opening to the vagina. Bartholin's gland cysts and abscesses are commonly found in women of reproductive age, developing in approximately 2% of all women.

### Description

The Bartholin's glands are located in the lips of the labia that cover the vaginal opening. The glands (normally the size of a pea) provide moisture for the vulva area. A Bartholin's gland cyst may form in the gland itself or in the duct draining the gland. A cyst normally does not cause **pain**, grows slowly, and may go away without treatment. It usually ranges in size from 0.4-1.2 in. (1–3 cm), although some may grow much larger.

If infected, a Bartholin's gland cyst can form an **abscess** that will increase in size over several days and is very painful. In order to heal, a Bartholin's gland cyst usually must be drained.

### Causes and symptoms

A Bartholin's gland cyst occurs if the duct becomes blocked for any reason, such as infection, injury, or chronic inflammation. Very rarely a cyst is caused by **cancer**, which usually occurs only in women over the age of 40. In many cases, the cause of a Bartholin's gland cyst is unknown.

Symptoms of an uninfected Bartholin's gland cyst include a painless lump on one side of the vulva area (most common symptom) and redness or swelling in the vulva area.

Symptoms of an abscessed Bartholin's gland include:

- pain that occurs with walking, sitting, physical activity, or sexual intercourse
- fever and chills
- increased swelling in the vulva area over a two- to four-day period
- drainage from the cyst, normally occurring four to five days after the swelling starts

Abscesses may be caused by sexually transmitted bacteria, such as those causing chlamydial or gonococcal infections, while others are caused by bacteria

normally occurring in the vagina. Over 60 types of bacteria have been found in Bartholin's gland abscesses.

### Diagnosis

A Bartholin's gland cyst or abscess is diagnosed by a gynecological **pelvic exam**. If the cyst appears to be infected, a culture is often performed to identify the type of bacteria causing the abscess.

### Treatment

Treatment for this condition depends on the size of the cyst, whether it is painful, and whether the cyst is infected.

If the cyst is not infected, treatment options include:

- watchful waiting by the woman and her health care professional
- soaking of the genital area with warm towel compresses
- soaking of the genital area in a sitz bath
- use of nonprescription pain medication to relieve mild discomfort

If the Bartholin's gland is infected, there are several treatments available to treat the abscess, including:

- soaking of the genital area in a sitz bath
- treatment with antibiotics
- use of prescription or nonprescription pain medication
- incision and drainage; i.e., cutting into the cyst and draining the fluid (not usually successful, as the cyst often reoccurs)
- placement of a drain (Word catheter) in the cyst for two to four weeks so fluid can drain and prevent reoccurrence of the cyst
- marsupialization
- window operation
- use of a carbon dioxide laser to open the cyst and heat the cyst wall tissue so that the cyst cannot form a sac and reoccur
- incision and drainage, followed by treatment with silver nitrate to burn the cyst wall so the cyst cannot form a sac and reoccur
- removal of the entire Bartholin's gland cyst, if the cyst has reoccurred several times after use of other treatment methods

During surgical treatment, the area will be numbed with a local anesthetic to reduce pain. **General anesthesia** may be used for treatment of an abscess, as the procedure can be painful.

In a pregnant woman, surgical treatment of cysts that are asymptomatic should be delayed until after delivery to avoid the possibility of excessive bleeding.

## KEY TERMS

**Marsupialization**—Cutting out a wedge of the cyst wall and putting in stitches so the cyst cannot reoccur.

**Sitz bath**—A warm bath in which just the buttocks and genital area soak in water; used to reduce pain and aid healing in the genital area.

**Window operation**—Cutting out a large oval-shaped piece of the cyst wall and putting in stitches to create a window so the cyst cannot reoccur.

**Word catheter**—A small rubber catheter with an inflatable balloon tip that is inserted into a stab incision in the cyst, after the contents of the cyst have been drained.

However, if the Bartholin's gland is infected and must be drained, **antibiotics** and **local anesthesia** are generally considered safe.

If the cyst is caused by cancer, the gland must be excised, and the woman should be under the care of a gynecologist familiar with the treatment of this type of cancer.

### Alternative treatment

If a Bartholin's gland cyst has no or mild symptoms, or has opened on its own to drain, a woman may decide to use watchful waiting, warm sitz baths, and nonprescription pain medication. If symptoms become worse or do not improve, a health care professional should then be consulted.

Infected Bartholin's glands should be evaluated and treated by a health care professional.

### Prognosis

A Bartholin's gland cyst should respond to treatment in a few days. If an abscess requires surgery, healing may take days to weeks, depending on the size of the abscess and the type of surgical procedure used. Most of the surgical procedures, except for incision and drainage, should be effective in preventing recurring infections.

### Prevention

There are few ways to prevent the formation of Bartholin's gland cysts or abscesses. However, as a Bartholin's gland abscess may be caused by a sexually transmitted disease, the practice of safe sex is recommended. Using good hygiene (e.g., wiping front to back after a bowel movement) is also recommended to prevent bacteria from the bowels from contaminating the vaginal area.

### Resources

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Judith Sims

*Bartonella bacilliformis* infection see  
**Bartonellosis**

## Bartonellosis

### Definition

Bartonellosis is an infectious bacterial disease with an acute form (which has a sudden onset and short course) and a chronic form (which has more gradual onset and longer duration). The disease is transmitted by sandflies and occurs in western South America. Characterized by a form of red blood cell deficiency (**hemolytic anemia**) and **fever**, the potentially fatal acute form is called Oroya fever or Carrion's disease. The chronic form is identified by painful **skin lesions**.

### Description

The acute form of the disease gets its name from an outbreak that occurred in 1871 near La Oroya, Peru. More than 7,000 people perished. Some survivors later developed a skin disease, called verruga peruana (Peruvian **warts**). These skin lesions were observed prior to the 1871 outbreak—perhaps as far back as the pre-Columbian era—but a connection to Oroya fever was unknown. In 1885, a young medical researcher, Daniel Carrion, inoculated himself with blood from a lesion to study the course of the skin disease. When he became ill with Oroya fever, the connection became apparent.

## KEY TERMS

**Acute**—Referring to the course of a disease, or a phase of a disease, the short-term experience of prominent symptoms.

**Chronic**—Referring to the course of a disease, or a phase of a disease, the long-term experience of prominent symptoms.

**Erythrocytes**—Red blood cells.

**Hemolytic anemia**—A form of erythrocyte deficiency caused by the destruction of the red blood cells.

**Host**—The organism that harbors or nourishes another organism (parasite). In bartonellosis, the person infected with *Bartonella bacilliformis*.

**Vector**—An organism, such as insects or rodents, that can transmit disease to humans.

Oroya fever is often called Carrion's disease in honor of his fatal experiment.

The bacteria, *Bartonella bacilliformis*, was isolated by Alberto Barton in 1909, but wasn't identified as the cause of the fever until 1940. The *Bartonella* genus includes at least 11 bacteria species, four of which cause human diseases, including **cat-scratch disease** and **bacillary angiomatosis**. However, bartonellosis refers exclusively to the disease caused by *B. bacilliformis*. The disease is limited to a small area of the Andes Mountains in western South America; nearly all cases have been in Peru, Colombia, and Ecuador. A large outbreak involving thousands of people occurred in 1940–41, but bartonellosis has since occurred sporadically. Control of sandflies, the only known disease carrier (vector), has been credited with managing the disease.

### Causes and symptoms

Bartonellosis is transmitted by the nocturnal sandfly and arises from infection with *B. bacilliformis*. The sandfly, *Lutzomyia verrucarum*, dines on human blood and, in so doing, can inject bacteria into the bloodstream. The sandfly is found only in certain areas of the Peruvian Andes; other, as-yet-unidentified vectors are suspected in Ecuador and Colombia.

Once in the bloodstream, the bacteria latch onto red blood cells (erythrocytes), burrow into the cells, and reproduce. In the process, up to 90% of the host's erythrocytes are destroyed, causing severe hemolytic anemia. The anemia is accompanied by high fever, muscle and joint pain, **delirium**, and possibly **coma**.

Two to eight weeks after the acute phase, an infected individual develops verruga peruana. However, individuals may exhibit the characteristic lesions without ever experiencing the acute phase. Left untreated, the lesions may last months or years. These lesions resemble blood-filled blisters, up to 1.6 in (4 cm) in diameter, and appear primarily on the head and limbs. They can be painful to the touch and may bleed or ulcerate.

### Diagnosis

Bartonellosis is identified by symptoms and the patient's history, such as recent travel in areas where bartonellosis occurs. Isolation of *B. bacilliformis* from the bloodstream or lesions can confirm the diagnosis.

### Treatment

**Antibiotics** are the mainstay of bartonellosis treatment. The bacteria are susceptible to several antibiotics, including chloramphenicol, **penicillins**, and **aminoglycosides**. Blood transfusions may be necessary to treat the anemia caused by bartonellosis.

### Prognosis

Antibiotics have dramatically decreased the fatality associated with bartonellosis. Prior to the development of antibiotics, the fever was fatal in 40% of cases. With antibiotic treatment, that rate has dropped to 8%. Fatalities can result from complications associated with severe anemia and secondary infections. Once the infection is halted, an individual can recover fully.

### Prevention

Avoiding sandfly **bites** is the primary means of prevention. Sandfly eradication programs have been helpful in decreasing the sandfly population, and insect repellent can be effective in preventing sandfly bites.

### Resources

#### BOOKS

Gorbach, Sherwood F., John S. Bartlett, and Neil R. Blacklow, eds. *Infectious Diseases*, 3rd ed. Philadelphia: W. B. Saunders Co., 2004.

Julia Barrett

## Basal cell carcinoma

### Definition

A basal cell carcinoma is a skin **cancer** that originates from basal keratinocytes in the top layer of the skin, the epidermis. Sometimes these tumors are called “rodent ulcers.”

### Demographics

Basal cell carcinomas are most common from middle age until old age. They are more frequent in men than women. These cancers seem to be associated with exposure to ultraviolet light; they tend to develop on sun-exposed areas and are more common in people living near the equator. Those who have lighter skin are more susceptible; fair-haired blonds are more likely to develop tumors than people with darker complexions. In the United States, Caucasians have a 23% to 39% chance of developing a basal cell carcinoma over a lifetime.

Weakened immunity may also play a role. Those who have had an organ transplanted or who have contracted acquired immune deficiency syndrome (**AIDS**) are more likely to develop one of these cancers.

Basal cell carcinomas are particularly common among individuals with a rare genetic disease called nevoid basal cell carcinoma syndrome (Gorlin's syndrome). Individuals with this disease can be born with basal cell carcinomas or begin to develop them in childhood. Some have few or no cancers; others have more than 250. These tumors seldom grow much before **puberty**, but during and after adolescence they can spread rapidly. Other symptoms include small pits in the palms and soles, cysts in the jaw, and other abnormalities in the bones.

### Description

Basal keratinocytes are unpigmented skin cells found deep in the epidermis, hair follicles, and sweat glands. When they become cancerous, these cells invade the dermis (the layer of skin just below the epidermis) and spread out into the normal skin. They become visible as a small growth or area of change in the skin's appearance. These tumors can appear anywhere on the body, but most become evident on the face and neck.

Most basal cell carcinomas are small tumors that can be cured with simple surgeries. They usually grow quite slowly. However, neglected or aggressive tumors can invade vast amounts of skin. These cancers can also spread along bones, cartilage, muscles, and, more rarely, nerves. Some tumors may eventually reach the eye or

brain or become large enough to significantly disfigure the face. These serious consequences are more likely if the tumor lies close to bone and cartilage—for instance, at the corner of the eye. Very few basal cell carcinomas spread to more distant organs; the incidence of metastatic basal cell carcinoma is less than 0.1%. Most that do are very large, deep cancers that have been visible for years.

### Causes and symptoms

Basal cell carcinomas are caused by genetic damage to a skin cell. Exposure to ultraviolet light and x rays, suppression of the immune system, and genetic factors seem to increase the risk that this will happen. Frequent or severe sunburns during childhood, frequent sunbathing or exposure through **tanning** beds, occupational exposure to sunlight due to outdoor employment (farming, construction, fishing), treatment of **acne** using x rays, or exposure to arsenic through drinking well water may all increase a person's risk of developing basal cell carcinoma.

Several types of basal cell carcinomas exist. Nodular basal cell carcinomas are the most common form. These tumors begin as a tiny red or clear bump on the skin. Over time, they develop into a growth with clear or white “pearly” raised edges and, often, a depressed area in the middle. A network of tiny blood vessels usually criss-crosses the surface, and the tumor may bleed repeatedly or crust over. Morpheaform (sclerosing, morpheic) basal cell carcinomas are more difficult to detect. These tumors are usually pale, firm, flat growths that can blend into the normal skin around them. Many look just like a scar. Superficial basal cell carcinomas are flat, red, scaly plaques that can look like **psoriasis** or **eczema**. Unlike other basal cell carcinomas, they are usually found on the arms, legs, and torso. Pigmented basal cell carcinomas are brown, black, or blue; they are usually of the nodular type and can look like a melanoma.

Some general characteristics of skin cancers include:

- irregular or ragged borders
- non-symmetrical shape
- a change in color
- a size greater than 0.2 inches (6 mm)

### Diagnosis

Basal cell carcinomas are usually diagnosed with a **skin biopsy** taken in the doctor's office. This is generally a brief and simple procedure. Biopsy may or may not require numbing of the skin with injection of local anesthetic. A shave biopsy removes a tiny bit of superficial tissue; a punch biopsy removes a slightly larger, deeper sample. The skin biopsy must be sent to

a trained pathologist to be analyzed. It may take up to a week for the biopsy results to come back. Sometimes the tumor is removed immediately after the biopsy, before the results are known.

### Clinical staging, treatments, and prognosis

Basal cell carcinomas rarely spread into the lymph nodes and internal organs. For this reason, doctors tend not to stage them. If staging is needed, the TNM (tumor, lymph node, and metastases) system is usually used. For basal cell carcinomas, this can be simplified into the following five categories:

- Stage 0: The cancer is very small and has not yet spread from the epidermis to the dermis.
- Stage 1: The cancer is less than 2 cm (0.8 inches) in diameter. No cancer cells can be found in lymph nodes or other internal organs.
- Stage 2: The cancer is more than 2 cm (0.8 inches) in diameter. No cancer cells can be found in lymph nodes or other internal organs.
- Stage 3: Cancer cells have been found either in nearby lymph nodes or in the bone, muscle, or cartilage beneath the skin (or in both locations).
- Stage 4: Cancer cells have been discovered in internal organs, most often the lungs or lymph nodes, that are distant from the skin. A stage four cancer can be any size.

### Treatment

#### *Treatment options for non-metastatic, non-staged tumors*

For most non-metastatic, non-staged cancers, there may be several treatment options. The recommended treatment depends on the size and type of tumor, its location, and cosmetic considerations. The cure rates for most of the following techniques are approximately 85% to 95%, but vary with tumor size and other factors. Moh's micrographic surgery has a five-year cure rate of 96%. Success rates for recurrent tumors are approximately 50% with most techniques and 90% with Moh's surgery.

In conventional surgery, the doctor numbs the area with an injection of local anesthetic, then cuts out the tumor and a small margin of normal skin around it. The wound is closed with a few stitches. One advantage to conventional surgery is that the wound usually heals quickly. Another benefit is that the complete cancer can be sent to a pathologist for evaluation. If the skin around the tumor is not completely free of cancer cells, the tumor can be treated again immediately.

Moh's micrographic surgery is a variation of conventional surgery. In this procedure, the surgeon examines each piece of skin under the microscope as it is removed. If any cancer cells remain, another slice is taken from that area and checked. These steps are repeated until the edges of the wound are clear of tumor cells, then the wound is closed. The advantage to this technique is that all of the visible cancer cells are removed but as much normal skin as possible is spared. Moh's surgery is often used for larger or higher risk tumors and when cosmetic considerations are important. The main disadvantage is that it takes much longer than conventional surgery and requires a specially trained surgeon.

A laser is sometimes used as a cutting instrument instead of a scalpel. Laser light can also destroy some cancer cells directly. A disadvantage to **laser surgery** is that the **wounds** from some lasers heal more slowly than cuts from a scalpel. The advantage is that bleeding is minimal.

In electrodesiccation and curettage, the physician scoops out the cancer cells with a spoon-shaped instrument called a curette. After most of the tumor is gone, the remaining cancerous tissue is destroyed with heat from an electrical current. The wound is left open to heal like an abrasion. It leaks fluid, crusts over, and heals during the next two to six weeks. This is a safe and easy method for removing many basal cell carcinomas. One disadvantage is that there is no skin sample to confirm that the tumor is completely gone. The electrical current used during this surgery can interfere with some **pacemakers** and larger tumors may heal with a noticeable scar.

In cryosurgery, liquid nitrogen is used to freeze the tumor and destroy it. This treatment is another type of blind destruction; there is no skin sample to make sure the cancer cells have all been killed. Patients report swelling and **pain** after cryosurgery, and a wound appears a few days later where the cells were destroyed. When the site heals, it has usually lost its normal pigment. There is a risk of nerve damage with this technique.

**Radiation therapy** is an uncommon treatment for basal cell carcinoma. One disadvantage is the inconvenience: multiple treatments, over a period of weeks, are necessary. Tumors that return after radiation also tend to grow more quickly than the original cancer. In addition, x rays may promote new skin cancers. Radiation therapy may be an option for patients who cannot undergo even minor surgery. It is also used occasionally as an adjunct to surgery. One advantage is that the cosmetic results can be very good.

## KEY TERMS

**Albinism**—A genetic disease characterized by the absence of the normal skin pigment, melanin.

**Biopsy**—A sample of an organ taken to look for abnormalities. Also, the technique used to take such samples.

**Dermis**—A layer of skin sandwiched between the epidermis and the fat under the skin. It contains the blood vessels, nerves, sweat glands, and hair follicles.

**Epidermis**—The thin layer of skin cells at the surface of the skin.

**Fluorouracil**—A cancer drug.

**Hair follicles**—The structures in the skin that make each hair.

**Imiquimod**—A drug, approved by the FDA to treat warts, that may destroy basal cell carcinomas by stimulating the immune system. Also known by its trade name Aldara.

**Interferon alpha**—A chemical made naturally by the immune system and also manufactured as a drug.

**Local anesthetic**—A liquid used to numb a small area of the skin.

**Lymph node**—A small structure located throughout the body (part of the lymphatic system) designed to

filter the flow of lymph, a usually clear fluid that originates from stem cells.

**Nonsteroidal anti-inflammatory drugs (NSAIDS)**—A class of drugs that suppresses inflammation. Includes a wide variety of drugs, such as aspirin.

**Oncologist**—A doctor who specializes in the treatment of cancer.

**Pathologist**—A doctor who specializes in examining cells and other parts of the body for abnormalities.

**Premalignant skin lesion**—An abnormal change in the skin that has a good chance of turning into skin cancer but is not yet cancerous.

**Selenium**—A mineral needed in extremely small quantities by the body. Large amounts can be very toxic.

**Squamous cell carcinoma**—A type of skin cancer.

**Sweat glands**—Tiny glands scattered throughout the skin that produce sweat.

**TNM system**—A commonly used staging system that examines the main tumor (T), the lymph nodes (N), and metastases (M).

**Xeroderma pigmentosum**—A genetic disease characterized by the inability to repair damaged DNA. Individuals with this disease develop an excessive number of skin cancers.

Occasionally a lotion containing fluorouracil is applied to the tumor. This drug cannot penetrate very far and cancer cells in the deeper parts of the tumor may not be destroyed. The main advantage to this treatment is its simplicity.

### *Treatment options for metastatic cancers*

Cancers that have spread to internal organs are treated with a combination of surgery, radiation, and **chemotherapy**.

### *Special concerns*

Because many basal cell carcinomas are found on the face and neck, cosmetic concerns are a priority for many patients. If there is a risk of noticeable scarring or damage, a patient may wish to ask about alternative types of removal or inquire about the services of a plastic surgeon.

After treatment, it is important to return to the doctor periodically to check for regrowth or new skin cancers. Approximately 36% of all patients find a new

basal cell or squamous cell carcinoma within the next five years. Having a basal cell carcinoma before the age of 60 may also increase the chance of developing other cancers in internal organs.

### **Prognosis**

The prognosis for small, uncomplicated basal cell carcinomas is very good. The vast majority of these tumors can be successfully removed. However, cancers that were not completely destroyed may regrow. If the edges of the removed skin contain cancer cells, the chance that the tumor will return within the next five years is about 40%. Regrowth is more likely with cancers larger than 0.8 inches (2 cm), those on the face (particularly around the nose, eye, and ear), and higher-risk types such as morpheaform tumors. Tumors can redevelop in the scar from the surgery, on the edges of the surgery site, or deep in the skin. These cancers may not look like the original tumor. Patients should be particularly watchful for minor changes in the appearance of the scar or sores that appear nearby.

Cancers that metastasize spread most often to the lymph nodes and lungs. The prognosis for metastatic cancers is poor, even with treatment. Survival after spread of the cancer to internal organs is eight months on the average and seldom more than a year and a half.

## Prevention

The risk factors for basal cell carcinoma include:

- ethnic background
- complexion
- geographic location
- increasing age
- exposure to x rays and ultraviolet light (both UVA and UVB)
- a history of premalignant skin lesions or skin cancer
- genetic disorders such as nevoid basal cell carcinoma syndrome, xeroderma pigmentosum, and albinism
- suppression of the immune system by AIDS or an organ transplant

Some important preventive steps include wearing protective clothing and hats in the sun, using a sunscreen, avoiding the sun between 10 a.m. and 4 p.m., and staying away from suntanning booths. Checking the skin for early signs of cancer also is critical.

Drugs related to vitamin A (including beta-carotene, retinol, and isotretinoin), vitamin E, **nonsteroidal anti-inflammatory drugs** (NSAIDS), and selenium have been suggested as possibly preventing basal cell carcinoma. A 2003 study reported that selenium is not effective in preventing basal cell carcinoma and may even increase risk of squamous cell carcinoma.

## Resources

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- "Skin Cancer: Basal and Squamous Cell." American Cancer Society. <http://www.cancer.org/cancer/skincancer-basalsquamouscell/index> (accessed November 19, 2010).

## ORGANIZATIONS

- Nevoid Basal Cell Carcinoma Syndrome Support Network,  
162 Clover Hill Street, Marlboro, MA, 01752, (800)  
815-4447, [souldansur@aol.com](mailto:souldansur@aol.com).  
Skin Cancer Foundation, 245 Fifth Ave., Suite 2402, New York,  
NY, 10016, (212) 725-5176, <http://www.skincancer.org>.

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Basal gastric secretion test see **Gastric acid determination**

## Battered child syndrome

### Definition

Battered child syndrome refers to injuries sustained by a child as a result of physical **abuse**, usually inflicted by an adult caregiver. Alternative terms include: shaken baby; **shaken baby syndrome**; **child abuse**; and non-accidental trauma (NAT).

### Description

Internal injuries, cuts, **burns**, **bruises**, and broken or fractured bones are all possible signs of battered child syndrome. Psychological damage to a child is also often the by-product of child abuse and can result in serious behavioral problems such as **substance abuse** or the physical abuse of others. According to the U.S. Department of Health and Human Services Administration for Children and Families, in 2008, 1,740 child fatalities resulted from child abuse. Of these, more than three-quarters of the children were under four years old, with the largest number of deaths occurring in infants under one year old. In addition, about 772,000 children were documented victims of nonfatal maltreatment, a term that includes neglect and psychological abuse, as well as physical and **sexual abuse**. About 80% of abused children were abused by a parent or a parent acting with another individual.

### Causes and symptoms

Battered child syndrome (BCS) is found at every level of society, although the incidence may be higher in low-income households where adult caregivers experience greater financial **stress** and social difficulties, have less education and understanding of child development, and may have less access to social services. In addition, children of parents who are substance abusers are more likely to experience abuse

## KEY TERMS

**Fontanel**—Soft spot on top of an infant's skull.

**Retinal hemorrhage**—Bleeding in the back of the eye.

than children living in households where there is no substance abuse. Many child abusers were also themselves abused as children.

The child batterer most often injures a child in the heat of anger. The incessant crying of an infant or child, refusal to follow directions, or the child creating a mess or breaking an object may trigger abuse. Symptoms may include a delayed visit to the emergency room with an injured child, an implausible explanation of the cause of a child's injuries, bruises that match the shape of a hand, fist or belt, cigarette burns, scald marks, bite marks, black eyes, unconsciousness, bruises around the neck, and a bulging fontanel in infants.

### Diagnosis

Battered child syndrome is most often diagnosed by an emergency room physicians, pediatricians, teachers, or social workers. **Physical examination** detects bruises, burns, swelling, or **retinal hemorrhage**. X rays, MRI, CT, or other imaging techniques may confirm bone **fractures** or internal soft tissue injuries. The presence of injuries at different stages of healing (i.e., having occurred at different times) is nearly always indicative of BCS. Establishing the diagnosis is often hindered by the caregiver's intentional concealment of the true origin of the child's injuries, as a result of fear, shame, avoidance, or denial mechanisms.

### Treatment

Medical treatment for battered child syndrome varies according to the type of injury incurred. Counseling and the implementation of an intervention plan for the child's parent(s) or guardian(s) is necessary. The child abuser may be incarcerated, and/or the abused child removed from the home to prevent further harm. Reporting child abuse to authorities is mandatory for doctors, teachers, and childcare workers in most states as a way to prevent continued abuse. Both physical and psychological therapy are often recommended as treatment for the abused child.

### Prognosis

The prognosis for battered child syndrome depends on the severity of injury, actions taken by the authorities

to ensure the future safety of the injured child, and the willingness of parents or guardians to seek counseling for themselves as well as for the child.

### Prevention

Recognizing the potential for child abuse in a situation, and the seeking or offering of intervention and counseling before battered child syndrome occurs is the best way to prevent it. Signs that a child may be at risk for physical abuse include parental alcohol or substance abuse, previous abuse of the child or the child's siblings, history of mental or psychological problems in parents, parents abused as children, absence of visible parental love or concern for the child, and the child's hygiene neglected.

### Resources

#### OTHER

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"Child Welfare Information Gateway." *United States Department of Health and Human Services*. December 1, 2008 [cited December 17, 2008]. <http://www.childwelfare.gov>

#### ORGANIZATIONS

Childhelp National Child Abuse Hotline, 15757 N. 78th St., Suite B., Scottsdale, AZ, 85260, (480) 922-8212, (480) 922-7061, (800) 422-4453, <http://www.childhelp.org>.

Prevent Child Abuse America, 228 South Wabash Avenue, 10th Floor, Chicago, IL, 60604, (312) 663-3520, (312) 939-8962, [mailbox@preventchildabuse.org](mailto:mailbox@preventchildabuse.org), <http://www.preventchildabuse.org>.

Rape, Abuse and Incest National Network (RAINN), 2000 L Street NW, Suite 406, Washington, DC, 20036, (202) 544-1034, (202) 544-3556, (800) 656-HOPE (4673), <http://www.rainn.org/get-help/national-sexual-assault-online-hotline>.

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Becker muscular dystrophy see **Muscular dystrophy**

Beclomethasone see **Corticosteroids**

## Bedbug infestation

### Definition

Bedbug infestation is the contamination of bedding, clothing, and household furnishings with the insect *Cimex lectularius* or *C. hemipterus*, commonly known as bedbugs.



**Magnified image of a bedbug, which can often be found clinging to mattresses.** (© Dennis Kunkel Microscopy, Inc./Visuals Unlimited/Corbis.)

## Demographics

Before 1950, bedbugs were common worldwide. The development of the pesticide DDT eliminated bedbugs from most developed countries. However, since DDT use has been banned because of its harmful effects on the environment, bedbugs have made a comeback. Bedbug infestation is relatively common in developed countries and very common in underdeveloped countries. They spread easily, often through international travelers and are difficult to exterminate. Bedbugs are equal opportunity pests, showing no preference in the age, gender, or race of their victims.

## Description

Bedbugs are small (5–8 mm long), oval, reddish-brown insects that feed on blood of birds and mammals. They are primarily nocturnal, feeding at night. During the day, they hide in mattress seams, cracks in bed frames or other furniture, behind loose wallpaper, and in bedding and clothing. Females lay large numbers of eggs that hatch in 4–5 days. Adults can live for months without feeding.

Bedbug **bites** are painless, but the bites cause an allergic reaction in most people resulting in an itchy, red

rash. Although bedbug bites are rarely medically dangerous, they can become infected through scratching.

### Risk factors

People often associate bedbugs with poor or dirty living conditions, but bedbugs can be found in pristine clean environments. In recent years, complaints about bedbugs in both budget and first-class hotels have increased.

The risk of exposure to bedbugs increases with certain activities including:

- international travel
- frequent overnight stays in hotels and motels
- living in refugee camps or homeless shelters
- living in apartment buildings (bedbugs are efficient crawlers and can move through cracks from apartment to apartment)
- living in military barracks or dormitories

## Causes and symptoms

The bite of a bedbug causes an allergic reaction in most people that can be difficult to differentiate from skin reactions caused by other bites or **allergies**. The rash caused by bedbugs is a red, itchy rash that is typically darker in the center of the bite. Often, but not always, bites form lines or groups of three, sometimes called “breakfast,” “lunch,” and “dinner.” Although bedbugs will bite any exposed skin, bites are most often found on the face, neck, arms, and hands.

The time it takes a bedbug rash to appear is variable, ranging from as long as 10 days to less than one minute. Generally, the more frequently a person is exposed to bedbugs, the shorter the time it takes for the rash to appear. In rare cases, some individuals can have an extreme, life-threatening allergic reaction to bedbug bites called **anaphylaxis** or anaphylactic shock.

Bedbugs can be infected with the **hepatitis B** virus and with the parasite that causes Chagas disease.

## Diagnosis

Medical diagnosis is not always necessary; the individual can make the diagnosis based on their past experience with bedbugs and recent history of travel or examination of their bedding for signs of infestation. When a medical diagnosis is sought, it is made based on the appearance of the rash along with a detailed history of recent travel and hotel stays. The doctor may also inquire about any drugs, herbs, or supplements being taken to help eliminate other possible causes of the rash. There are no tests to diagnose bedbug bites.

## KEY TERMS

**Anaphylaxis**—Also called anaphylactic shock; a severe allergic reaction characterized by airway constriction, tissue swelling, and lowered blood pressure.

**Chagas disease**—A parasitic disease that causes mild early swelling at the site of the infection, then

becomes asymptomatic for many years, but later may cause serious heart and digestive system problems. Parasites causing this disease are most common in rural Central and South America.

**Hepatitis B**—A disease that causes inflammation of the liver and serious liver damage.

### Treatment

#### *Treatment of the individual*

The symptoms and rash associated with bedbug bites go away on their own, usually within a week to 10 days. An over-the-counter skin cream containing hydrocortisone may be applied to reduce **itching**. An over-the-counter antihistamine containing diphenhydramine (e.g., Benadryl) may also help reduce itching. Parents of affected infants and children, or pregnant and **breast-feeding** women should consult an appropriate healthcare professional before using these medications.

#### *Treatment of the infested environment*

Ridding an infested environment of bedbugs is considerably more difficult than treatment of the individual. A professional exterminator experienced with bedbug elimination may be required. Because bedbugs can hide in small cracks in furniture, mattresses, and box springs, vacuuming will not remove all of them. Special mattress covers can be purchased to lock out bedbugs, but it may be more effective to purchase a new mattress and box springs. Bedbugs can live for 9–12 months without feeding.

Bedbugs can be killed by heat. Bedding and clothing should be washed in hot water and dried at very hot temperatures. The temperature must reach at least 120°F (49°C). Items that cannot be washed can be put in sealed plastic bags and placed in a car with the windows rolled up in the summer when the temperature will reach 120 degrees or more inside the car. Freezing is less effective. Items must be left at temperatures below 32°F (0°C) for several days to kill bedbugs.

Insecticides effective against bedbugs include permethrin and diethyltoluamide. Permethrin spray can be used on clothing. Diethyltoluamide in high concentrations can be toxic to infants and children. Consult a physician before using. A professional exterminator is the safest way to rid the environment of bedbugs.

Room foggers and sprays against mosquitoes and ticks are ineffective against bedbugs. Many treatments for

the elimination or prevention of bedbugs are sold over the Internet. These vary considerably in cost and effectiveness, so it is important to research products before buying.

### Prognosis

Almost everyone recovers from bedbug bites within two weeks. Complications may arise from scratching the bites so that they become infected. If infection occurs, then an antibiotic may be prescribed. Very rarely do bedbug bites transmit hepatitis B or Chagas disease to humans.

### Prevention

Prevention is difficult. Avoiding secondhand bed frames, mattresses, and beds is helpful. Birds and bats can carry bedbugs, so they should be eliminated from attics and eaves. Checking the seams of mattresses for dark specks of bedbug excrement in hotels is helpful but not foolproof.

### Resources

#### OTHER

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- Schwartz, Robert A. “Bedbug Bites.” eMedicine.com. March 24, 2010. <http://emedicine.medscape.com/article/1088931-overview> (accessed August 18, 2010).

### ORGANIZATIONS

- Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (404) 639-3534, (800) CDC-INFO (800-232-4636). TTY: (888) 232-6348inquiry@cdc.gov, <http://www.cdc.gov>.
- National Institute of Allergy and Infectious Diseases, Office of Communications and Government Relations, 6610 Rockledge Drive, MSC 6612, Bethesda, MD, 20892-

6612, (301) 496-5717, (866) 284-4107 or TDD: (800)877-8339 (for hearing impaired), (301) 402-3573, <http://www3.niaid.nih.gov>.

Tish Davidson, AM

## Bedsores

### Definition

Bedsores are also called decubitus ulcers, pressure ulcers, or pressure sores. These tender or inflamed patches develop when skin covering a weight-bearing part of the body is squeezed between bone and another body part, or a bed, chair, splint, or other hard object.

### Description

Each year, about one million people in the United States develop bedsores ranging from mild inflammation to deep **wounds** that involve muscle and bone. This often painful condition usually starts with shiny red skin that quickly blisters and deteriorates into open sores that can harbor life-threatening infection.

Bedsores are not cancerous or contagious. They are most likely to occur in people who must use wheelchairs or who are confined to bed, such as quadriplegics or long-term hospital patients.

Bedsores are most apt to develop on the:

- ankles
- back of the head
- heels
- hips



**Bedsores.** (Custom Medical Stock Photo, Inc. Reproduced by permission.)

- knees
- lower back
- shoulder blades
- spine

People over the age of 60 are more likely than younger people to develop bedsores. Risk is also increased by:

- atherosclerosis (hardening of arteries)
- diabetes or other conditions that make skin more susceptible to infection
- diminished sensation or lack of feeling
- heart problems
- incontinence (inability to control bladder or bowel movements)
- malnutrition
- obesity
- paralysis or immobility
- poor circulation
- prolonged bed rest, especially in unsanitary conditions or with wet or wrinkled sheets
- spinal cord injury

### Causes and symptoms

Bedsores most often develop when constant pressure pinches tiny blood vessels that deliver oxygen and nutrients to the skin. When skin is deprived of oxygen and nutrients for as little as an hour, areas of tissue can die and bedsores can form.

Slight rubbing or friction against the skin can cause minor pressure ulcers. They can also develop when a patient stretches or bends blood vessels by slipping into a different position in a bed or chair.

Urine, feces, or other moisture increases the risk of skin infection, and people who are unable to move or recognize internal cues to shift position have a greater than average risk of developing bedsores.

Other risk factors include:

- malnutrition
- anemia (lack of red blood cells)
- disuse atrophy (muscle loss or weakness from lack of use)
- infection

### Diagnosis

Bedsores usually follow six stages:

- redness of skin
- redness, swelling, and possible peeling of outer layer of skin

- dead skin, draining wound, and exposed layer of fat
- tissue death through skin and fat, to muscle
- inner fat and muscle death
- destruction of bone, bone infection, fracture, and blood infection

### Treatment

Prompt medical attention can prevent surface pressure sores from deepening into more serious infections. For mild bedsores, treatment involves relieving pressure, keeping the wound clean and moist, and keeping the area around the ulcer clean and dry. **Antiseptics**, harsh soaps, and other skin cleansers can damage new tissue, so a saline solution should be used to cleanse the wound whenever a fresh nonstick dressing is applied.

The patient's doctor may prescribe infection-fighting **antibiotics**, special **dressings** or drying agents, or lotions or ointments to be applied to the wound in a thin film three or four times a day. Warm whirlpool treatments are sometimes recommended for sores on the arm, hand, foot, or leg.

In a procedure called debriding, a scalpel may be used to remove dead tissue or other debris from the wound. Deep, ulcerated sores that don't respond to other therapy may require skin grafts or **plastic surgery**.

A doctor should be notified whenever a person:

- will be bedridden or immobilized for an extended time
- is very weak or unable to move
- develops bedsores

Immediate medical attention is required whenever:

- skin turns black or becomes inflamed, tender, swollen, or warm to the touch.
- the patient develops a fever during treatment.
- the sore contains pus or has a foul-smelling discharge.

With proper treatment, bedsores should begin to heal two to four weeks after treatment begins.

### Alternative treatment

Zinc and **vitamins A, C, E, and B complex** help skin repair injuries and stay healthy, but large doses of vitamins or **minerals** should never be used without a doctor's approval.

A poultice made of equal parts of powdered slippery elm (*Ulmus fulva*), marsh mallow (*Althaea officinalis*), and **echinacea** (*Echinacea spp.*) blended with a small amount of hot water can relieve minor inflammation. An infection-fighting rinse can be made by diluting two drops of essential tea tree oil (*Melaleuca spp.*) in eight

ounces of water. An herbal tea made from the calendula (*Calendula officinalis*) can act as an antiseptic and wound healing agent. Calendula cream can also be used.

Contrasting hot and cold local applications can increase circulation to the area and help flush out waste products, speeding the healing process. The temperatures should be extreme (hot hot and ice cold), yet tolerable to the skin. Hot compresses should be applied for three minutes, followed by 30 seconds of cold compress application, repeating the cycle three times. The cycle should always end with the cold compress.

### Prevention

It is usually possible to prevent bedsores from developing or worsening. The patient should be inspected regularly; should bathe or shower every day, using warm water and mild soap; and should avoid cold or dry air. A bedridden patient should be repositioned at least once every two hours while awake. A person who uses a wheelchair should shift his weight every 10 or 15 minutes, or be helped to reposition himself at least once an hour. It is important to lift, rather than drag, a person being repositioned. Bony parts of the body should not be massaged. Even slight friction can remove the top layer of skin and damage blood vessels beneath it.

If the patient is bedridden, sensitive body parts can be protected by:

- sheepskin pads
- special cushions placed on top of a mattress
- a water-filled mattress
- a variable-pressure mattress whose sections can be individually inflated or deflated to redistribute pressure.

Pillows or foam wedges can prevent a bedridden patient's ankles from irritating each other, and pillows placed under the legs from mid-calf to ankle can raise the heels off the bed. Raising the head of the bed slightly and briefly can provide relief, but raising the head of the bed more than 30 degrees can cause the patient to slide, thereby causing damage to skin and tiny blood vessels.

A person who uses a wheelchair should be encouraged to sit up as straight as possible. Pillows behind the head and between the legs can help prevent bedsores, as can a special cushion placed on the chair seat. Donut-shaped cushions should not be used because they restrict blood flow and cause tissues to swell.

### Prognosis

Bedsores can usually be cured, but about 60,000 deaths a year are attributed to complications caused

by bedsores. Bedsores can be slow to heal. Without proper treatment, they can lead to:

- gangrene (tissue death)
- osteomyelitis (infection of the bone beneath the bed sore)
- sepsis (tissue-destroying bacterial infection)
- other localized or systemic infections that slow the healing process, increase the cost of treatment, lengthen hospital or nursing home stays, or cause death

## ORGANIZATIONS

National Pressure Ulcer Advisory Panel, 1025 Thomas Jefferson St. NW, Suite 500 East, Washington, DC, 20007, (202) 521-6789, (202) 833-3636, npuap@npuap.org, <http://www.npuap.org>.

Wound, Ostomy and Continence Nurses Society, 15000 Commerce Parkway, Suite C, Mt. Laurel, NJ, 08054, (888) 224-WOCN (9626).

Maureen Haggerty

disorder. Only 5–10% of cases of bedwetting are caused by medical conditions. The number of children with nocturnal enuresis decreases sharply after five years of age. According to the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), about 10% of five-year-olds, 5% of 10-year-olds, and 1% of 18-year-olds experience episodes of bedwetting. Bedwetting at all ages is twice as common in boys as in girls; males make up 60% of bedwetters overall and make up more than 90% of those who wet the bed every night. Various studies place adult bedwetting rates somewhere between 0.5% and 2.3%.

Bedwetting is known to run in families. A family history of bedwetting is found in 50% of children with secondary nocturnal enuresis. One study reported bedwetting in 43% of children whose fathers had a childhood history of bedwetting; 44% of children of enuretic mothers; and 77% of children whose father and mother had histories of bedwetting.

Bedwetting has recently been linked to specific loci on four different chromosomes. A locus on chromosome 13 was identified in 1995 as associated with bedwetting. Since then, other genetic loci have been identified on chromosomes 8, 12, and 16. It should be noted that the genes in these loci do not govern bedwetting by itself; rather, they control such factors associated with bedwetting as the ability to wake up when the bladder feels full or the capacity of the bladder to hold urine.

## Description

One of the major tasks of toddlerhood is to learn how to achieve conscious control over the timing of urination. Most children do not become fully toilet trained until they are about two to four years old. Before then, the parts of the nervous system in charge of bladder control are not fully developed and functional. In general, boys take longer to learn to control their bladders than girls; most girls are dry at night by age six, but most boys do not achieve nighttime dryness until age seven. In addition, daytime bladder control is easier for a child than overnight bladder control. As of 2010, researchers do not yet fully understand why it is easier for young children to stay dry during the day than during sleep.

## Risk factors

There are only three known risk factors for bedwetting as of 2010:

- family history of bedwetting
- gender—boys are more likely to have problems with bedwetting than girls

## Demographics

Bedwetting is the single most common urologic complaint in children but is a developmental issue in most children rather than a psychological or medical

## KEY TERMS

**Antidiuretic hormone (ADH)**—A substance stored in the pituitary gland and released at night to diminish the formation of urine. It is also known as vasopressin.

**Behavior modification**—Therapy aimed at changing behavior by substituting problem behaviors with more useful activities.

**Continence**—The ability to control one's bladder and bowel functions.

**Culture test**—A laboratory test to grow samples of an infecting organism from discharge or samples of affected tissue.

**Diuretic**—A substance that stimulates the formation and excretion of urine.

**Incontinence**—Loss of bowel or bladder control.

**Nocturnal enuresis**—The medical term for bedwetting.

**Rapid eye movement sleep**—A stage of sleep during which dreams occur. This stage usually alternates with a heavier, more restful stage of sleep.

**Sitz bath**—A hydrotherapy treatment for soaking the pelvic or genital areas.

**Urethra**—The tube that drains urine from the bladder.

**Urologist**—A physician who specializes in treating problems of the urinary tract.

- Attention deficit hyperactivity disorder (ADHD)—bedwetting is more common in children diagnosed with ADHD

Race or ethnicity do not appear to be risk factors for bedwetting.

### Causes and symptoms

Bedwetting is in most cases due to the normal immaturity of the nervous system and the urinary system. For instance, up to age six, bedwetting is often due to nothing more than the bladder having a small capacity. In addition, the muscles that control the opening and closing of the urethra may not be sufficiently developed. Often it takes a while for a child to learn recognition of bladder fullness, waking up, and going to the toilet. Sometimes chronic **constipation** causes bedwetting because the fullness of the child's large intestine reduces bladder capacity. Still another factor may be insufficient production of antidiuretic hormone (ADH), a hormone stored in the pituitary gland and released at night to slow down urine production. In most cases, urinary capacity and control increase over time, and the bedwetting problem will eventually be outgrown.

One major cause of bedwetting is lack of sleep. If a child is not sleeping enough hours, then there will be less of the light, rapid eye movement (REM) sleep, and more periods of heavy, deep sleep. During the periods of deep sleep some children have difficulty becoming aware of the urge to urinate and awakening to go to the toilet.

Bedwetting may be a sign of allergic reactions, which end up irritating sphincter muscles around the urethra. This contributes to a loss of bladder control during sleep. Heavy **snoring**, mouth breathing, and night sweats may all be indications of the presence of **allergies**.

In some cases, bedwetting is an early symptom of diabetes. Other signs and symptoms of this metabolic disease may include passing large amounts of urine all at once, increased thirst, unusual tiredness, and weight loss in spite of a good appetite.

Bedwetting can sometimes be due to emotional and psychological **stress**, including such major life changes as moving, starting school, the birth of a sibling, or the parents' divorce. This stress usually leads to the type of bedwetting called secondary nocturnal enuresis (SNE), in which a previous level of accomplishment with bladder control is lost. In other words, a child who has been dry at night will suddenly start wetting the bed again. This may indicate an underlying problem such as constipation, diabetes, physical defects in the urinary tract, sacral nerve disorders, a pelvic growth, urinary stasis, infection, **kidney stones**, or kidney damage. Secondary enuresis also frequently occurs in children who are being physically or sexually abused. A pediatrician should be consulted if the condition persists.

About 5% of cases of bedwetting are caused by a serious underlying medical problem. If the following symptoms are present, a pediatrician or a pediatric urologist should be consulted:

- straining during urination
- a burning feeling or other discomfort during urination

- constant or recurrent dribbling of urine
- cloudy or pink urine
- bloodstains or other discharge on underpants or nightclothes
- an unpleasant urine odor
- onset of abdominal pain, backache, or fever
- constant thirst, especially at night
- sudden loss of bladder control previously mastered
- a child over the age of two who still shows no signs of being ready to learn bladder control

## Diagnosis

### Examination

When bedwetting in a child is resistant to home treatments or when more serious symptoms are present, a visit should be made to a healthcare provider. This is especially warranted if the child is older than six. A thorough history and physical exam should be taken along with a urine sample. Analysis and culture tests can be done on the urine to determine if an infection is present.

### Tests

Further evaluations may be made using ultrasound, an x ray of the kidney, or a consultation with a urologist. If the bedwetting appears to be connected with issues of stress or family problems, a mental health consultation may be recommended.

Bedwetting in adults is rare and should be promptly evaluated, as it is often a sign of a serious medical condition or disorder. Causes may include **bladder cancer**, obstructive **sleep apnea**, diabetes, disorders of the central nervous system, urinary tract enlargement, or stones in the urinary tract. Bedwetting in an adult male may be a symptom of prostate enlargement or **prostate cancer**. It is rare for **anxiety disorders** or other psychiatric disturbances to cause bedwetting in adults, but emotional stress has been known to cause occasional SNE in a small number of adults.

## Treatment

### Traditional

One option for treatment of bedwetting in children is simple watchful waiting. If the child does not seem to be emotionally upset by bedwetting episodes and there is no other major stress in the family, a reassuring talk with the pediatrician may be all that is needed. As children grow, their bladder capacity increases, the natural body signals to get up and urinate become more efficient, the production of ADH

increases, and the child learns to respond to the body's signal to wake up and go to the bathroom.

Another option is mechanical bedwetting alarms. These are devices that consist of a moisture-sensitive pad worn inside the child's pajamas, a wire connected to a battery-operated control mechanism, and an alarm that sounds when the pad detects wetness. Ideally, the child will be awakened by the alarm in time to get to the bathroom before all of the urine has been voided. If the child is a very heavy sleeper, a parent or older sibling may need to sleep in the child's bedroom in order to awaken him or her when the alarm sounds. Some researchers have found that alarms are more effective with older children than with younger ones.

Behavior modification therapy may also be tried. A widely used program for bedwetters involves reminding the child to urinate before going to bed, recording wet and dry nights, changing wet clothing and bedding, and discussing progress. Positive reinforcements, such as gold stars on a chart and other rewards, are given for nights that the child does not urinate in bed. The International Children's Continence Society recommends a behavioral modification approach to bedwetting as well as age-appropriate explanations for children about other types of treatment for bedwetting.

### Drugs

Medications may be useful in treating some cases of bedwetting, although doctors do not usually prescribe them for children younger than seven. The three drugs used most often are desmopressin (DDAVP), oxybutynin (Ditropan), and imipramine (Tofranil). Desmopressin, given as a pill or nasal spray, works by raising the levels of ADH in the body. Oxybutynin is a drug that works to relax the muscles in the bladder, preventing premature contractions. Imipramine is a tricyclic antidepressant that works on both the brain and the urinary bladder.

Medications are effective in about 70% of children with bedwetting problems. However, it is not unusual for children to relapse once the drugs are discontinued. In addition, all three drugs have side effects: desmopressin may cause seizures; oxybutynin may cause **dry mouth** and flushing; and imipramine can cause mood changes. Because an overdose of imipramine is potentially fatal in children, the antidepressant is usually prescribed only when other treatments fail.

### Alternative

**HANDS-ON THERAPIES.** **Acupressure**, **reflexology**, and **shiatsu** can be used to relax the child, counteract stress, and improve the actions of the nervous system.

**Hypnotherapy** can also be helpful in improving bedwetting. Among other things, the child will be given positive goal affirmations to say before going to bed. This should help make the urge to urinate during the night more conscious, and encourage the child to awaken and go to the toilet.

**HOMEOPATHY.** The best way to use homeopathy is to see a homeopath for individual prescribing. *Equisetum 6c* may be useful, especially if there are dreams or nightmares connected with the bedwetting. For bedwetting in very excitable, outgoing children, which occurs soon after falling asleep, *Causticum 6c* may be recommended. The remedies should be given once per day at bedtime for up to two weeks. A practitioner should be consulted for more specific remedies.

**HERBAL MEDICINE.** A strong tea can also be made using equal parts of horsetail, *Equisetum arvense*; **St. John's wort**; cornsilk, *Zea mays*; and lemon balm, *Melissa officinalis*. Two to three handfuls of the mixture should be placed in a quart or liter jar and then covered with boiling water. The tea should be allowed to steep overnight. The child should be given half a cup of the tea three times per day, with the last dose being given at least two hours before bedtime.

Nettles, *Urtica dioica*, can be made into a pleasant tea and consumed throughout the day as a tonic for the kidneys. The tea can be mixed with equal parts of fruit juice as a pleasant drink for the child.

**AROMATHERAPY.** **Aromatherapy** uses the essential oil of cypress, *Cupressus sempervirens* to treat chronic bedwetting. Several drops of cypress oil should be put in olive oil for massage. The oil should be rubbed onto the child's stomach right before bedtime.

### Home remedies

Sitting in a cool **sitz bath** (with only the child's pelvic area immersed) for about five minutes daily can tone up the urethral sphincter. The sitz bath can be set up by using a bathtub filled with 2–3 in (4.5–6.6 cm) of water; having the child sit in a large basin of water; or purchasing a sitz basin (available from drugstores and medical supply stores).

### Prognosis

Most children outgrow bedwetting at some point. Underlying disease conditions may have to be assessed and treated. The prognosis of bedwetting in adults depends on the underlying cause.

### Prevention

Episodes of bedwetting cannot always be prevented, but the following measures are recommended to reduce their frequency:

- Limit the child's fluid intake in the evening.
- Avoid foods or drinks containing caffeine, which is a diuretic. Caffeine is contained not only in tea and coffee, but also in energy drinks, cola, hot chocolate, and foods containing chocolate.
- Encourage the child to urinate regularly throughout the day as well as just before bedtime. A common suggestion is to ask the child to urinate every two hours during the day.
- Make sure that constipation is treated if the child has problems with it.

### Resources

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- Bennett, Howard J. *Waking Up Dry: A Guide to Help Children Overcome Bedwetting*. Elk Grove Village, IL: American Academy of Pediatrics, 2005.
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#### ORGANIZATIONS

- American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Avenue, N.W., Washington, DC, 20016-3007, (202) 966-7300 (202) 966-2891 <http://www.aacap.org>.
- American Academy of Pediatrics (AAP), 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007, (847) 434-4000 (847) 434-8000 <http://www.aap.org>.
- International Children's Continence Society (ICCS), c/o Trygve Neveus, Uppsala University Children's Hospital, Nephrology Unit, Uppsala, Sweden, 751 85 Uppsala, +46-18-6110000 +46-18-6115853 Trygve. Neveus@kbh.uu.se, <http://www.i-c-c-s.org>.
- National Association for Continence (NAFC), P.O. Box 1019, Charleston, SC, 29402, (843) 377-0900 (800) BLADDER (843) 377-0905 [memberservices@nafc.org](mailto:memberservices@nafc.org), <http://www.nafc.org>.
- National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), Building 31, Rm 9A06, 31 Center Drive, MSC 2560, Bethesda, MD, 20892-2560, (301) 496-3583 <http://www2.niddk.nih.gov>.

Patience Paradox  
Rebecca J. Frey, PhD

Beef tapeworm infection see **Tapeworm diseases**

Behavior therapy see **Cognitive-behavioral therapy**

## Behcet's syndrome

#### Definition

A group of symptoms that affect a variety of body systems, including musculoskeletal, gastrointestinal, and

## KEY TERMS

**Remission**—When active symptoms of a chronic disease are absent.

**Uveitis**—Inflammation of the area of the eye around the pupil.

the central nervous system. These symptoms include ulceration of the mouth or the genital area, **skin lesions**, and inflammation of the uvea (an area around the pupil of the eye).

#### Description

Behcet's syndrome is a chronic disease that involves multiple body systems. The disease is named for a Turkish dermatologist, Hulusi Behcet, who first reported a patient with recurrent mouth and genital ulcers along with **uveitis** in 1937. The disease occurs worldwide, but is most prevalent in Japan, the Middle East, and in the Mediterranean region. There is a wider prevalence among males than females in a ratio of two to one.

#### Causes and symptoms

The cause of Behcet's syndrome is unknown. Symptoms include recurring ulcers in the mouth or the genital area, skin lesions, arthritis that affects mainly the knees and ankles, **pain** and irritation in the eyes, and **fever**. The mouth and genital ulcers tend to occur in multiples and can be quite painful. In the mouth, these ulcers are generally found on the tongue, gums, and the inside of the lips or jaws. In the genital area, the ulcers usually occur on the penis and scrotum in males and on the vulva of women. The eye inflammation can lead to blindness.

#### Diagnosis

Because Behcet's syndrome is a multisystem disease, it is difficult to diagnose. International criteria have been proposed to assist in classifying this disease. There is no one diagnostic feature of this disease, so diagnosis depends on grouping together enough symptoms in order to identify the disease. Symptoms of Behcet's syndrome also occur in other diseases, so it is often necessary to rule out the other diseases before a definitive diagnosis can be reached.

#### Treatment

Some of the current drugs used to treat Behcet's syndrome include **corticosteroids**, cyclosporine,

azathioprine, chlorambucil, interferon alpha, thalidomide, levamisole, and pulse cyclophosphamide.

## Prognosis

The prognosis for Behcet's syndrome is generally poor. There has been a documented case of Behcet's lasting for 17 years. Although the disease is considered painful but not fatal, when the central nervous system is involved there is usually severe disability and **death** often occurs. The condition is usually chronic, although there can be remissions during the course of the disease. There is no predictable method to determine which patients will progress into the more serious symptoms, and which might move into remission.

## Prevention

There is no known prevention for Behcet's syndrome.

## Resources

### BOOKS

Firestein, Gary S., et al. *Kelley's Textbook of Rheumatology*. Philadelphia: Saunders/Elsevier, 2009.

McPhee, Stephen, and Maxine Papadakis. *Current Medical Diagnosis and Treatment*, 2010, 49th ed. New York: McGraw-Hill Medical, 2009.

### ORGANIZATIONS

American Behcet's Disease Association, PO Box 869, Smithtown, NY, 11787-0869, (631) 656-0537, (480) 247-5377, (800) 723-423-4238, <http://www.behcets.com>.  
Behcet's Organization Worldwide, Head Office. P.O. Box 27, Watchet, United Kingdom, Somerset TA23 OYJ, <http://www.behcets.org>.

National Eye Institute, 2020 Vision Place, Bethesda, MD, (301) 496-5248, <http://www.nei.nih.gov/>.

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, <http://www.rarediseases.org>.

Kim A. Sharp, M.Ln.

## Bejel

### Definition

Bejel, also known as endemic **syphilis**, is a chronic but curable disease, seen mostly in children in arid regions. Unlike the better-known venereal syphilis, endemic syphilis is not a sexually transmitted disease.

### Description

Bejel has many other names depending on the locality: siti, dichuchwa, njovera, belesh, and skerljevo

are some of the names. It is most commonly found in the Middle East (Syria, Saudi Arabia, Iraq), Africa, central Asia, and Australia. Bejel is related to **yaws** and **pinta**, but has different symptoms.

## Causes and symptoms

*Treponema pallidum*, the bacteria that causes bejel, is very closely related to the one that causes the sexually transmitted form of syphilis, but transmission is very different. In bejel, transmission is by direct contact, with broken skin or contaminated hands, or indirectly by sharing drinking vessels and eating utensils. *T. pallidum* is passed on mostly between children living in poverty in very unsanitary environments and with poor hygiene.

The skin, bones, and mucous membranes are affected by bejel. Patches and ulcerated sores are common in the mouth, throat, and nasal passages. Gummy lesions may form, even breaking through the palate. Other findings may include a region of swollen lymph nodes and deep bone **pain** in the legs. Eventually, bones may become deformed.

## Diagnosis

*T. pallidum* can be detected by microscopic study of samples taken from the sores or lymph fluid. However, since antibody tests don't distinguish between the types of syphilis, specific diagnosis of the type of syphilis depends on the patient's history, symptoms, and environment.

## Treatment

Large doses of benzathine penicillin G given by injection into the muscle can cure this disease in any stage, although it may take longer and require additional doses in later stages. If penicillin cannot be given, the alternative is tetracycline. Since tetracycline can permanently discolor new teeth still forming, it is usually not prescribed for children unless no viable alternative is available.

## Prognosis

Bejel is completely curable with antibiotic treatment.

## Prevention

The World Health Organization (WHO) has worked with many countries to prevent this and other diseases, and the number of cases has been reduced somewhat. Widespread use of penicillin has been responsible for reducing the number of existing cases, but the only way to eliminate bejel is by improving living and sanitation conditions.

## KEY TERMS

**Endemic disease**—An infectious disease that occurs frequently in a specific geographical locale. The disease often occurs in cycles. Influenza is an example of an endemic disease.

**Lymph**—This is a clear, colorless fluid found in lymph vessels and nodes. The lymph nodes contain organisms that destroy bacteria and

other disease causing organisms (also called pathogens).

**Syphilis**—This disease occurs in two forms. One is a sexually transmitted disease caused by a bacteria. The second form is not sexually transmitted, but passed on by direct contact with the patient or through use of shared food dishes and utensils.

## Resources

### BOOKS

Fauci, Anthony S., et al., eds. *Harrison's Principles of Internal Medicine*. 17th ed. New York: McGraw-Hill Professional, 2008.

Jill S. Lasker

**Benazepril see Angiotensin-converting enzyme inhibitors**

can cause Bence Jones proteins in the urine. These diseases include: **Waldenström's macroglobulinemia**, some lymphomas and leukemias, osteogenic sarcoma, cryoglobulinemia, malignant B-cell disease, **amyloidosis**, light chain disease, and cancer that has spread to bone.

## Description

Urine is the best specimen in which to look for Bence Jones proteins. Proteins are usually too large to move through a healthy kidney, from the blood into the urine. Bence Jones proteins are an exception. They are small enough to move quickly and easily through the kidney into the urine.

A routine **urinalysis** will not detect Bence Jones proteins. There are several methods used by laboratories to detect and measure these proteins. The classic Bence Jones reaction involves heating urine to 140 °F (60°C). At this temperature, the Bence Jones proteins will clump. The clumping disappears if the urine is further heated to boiling and reappears when the urine is cooled. Other clumping procedures using salts, acids, and other chemicals are also used to detect these proteins. These types of test will reveal whether or not Bence Jones proteins are present, but not how much is present.

A more complex procedure is done to measure the exact amount of Bence Jones proteins. This procedure—immunoelectrophoresis—is usually done on urine that has been collected for 24 hours.

The test is covered by insurance when medically necessary. Results are usually available within several days.

## Preparation

Urine is usually collected throughout a 24-hour time period. A person is given a large container in which to collect the urine. The urine should be

## Bence Jones protein test

### Definition

Bence Jones proteins are small proteins (light chains of immunoglobulin) found in the urine. Testing for these proteins is done to diagnose and monitor **multiple myeloma** and other similar diseases.

### Purpose

Bence Jones proteins are considered the first tumor marker. A tumor marker is a substance, made by the body, that is linked to a certain **cancer**, or malignancy. Bence Jones proteins are made by plasma cells, a type of white blood cell. The presence of these proteins in a person's urine is associated with a malignancy of plasma cells.

Multiple myeloma, a tumor of plasma cells, is the disease most often linked with Bence Jones proteins. The amount of Bence Jones proteins in the urine indicates how much tumor is present. Physicians use Bence Jones proteins testing to diagnose the disease as well as to check how well the disease is responding to treatment.

Other diseases involving cancerous or excessive growth of plasma cells or cells similar to plasma cells

## KEY TERMS

**Bence Jones protein**—Small protein, composed of a light chain of immunoglobulin, made by plasma cells.

**Multiple myeloma**—A tumor of the plasma cells.

**Plasma cells**—A type of white blood cell.

refrigerated until it is brought to the laboratory or physician's office.

### Normal results

Bence Jones proteins normally are not present in the urine.

### Abnormal results

Bence Jones proteins are present in 50–80% of people with multiple myeloma. People with other malignancies also can have a positive Bence Jones protein test, but less frequently.

Certain nonmalignant diseases, such as **rheumatoid arthritis**, **systemic lupus erythematosus**, and chronic renal insufficiency, can have Bence Jones proteins in the urine. High doses of penicillin or **aspirin** before collecting the urine can give a false positive result.

### Resources

#### BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Nancy J. Nordenson

## Bender-Gestalt test

### Definition

The Bender Visual Motor Gestalt test (or Bender-Gestalt test) is a psychological assessment used to evaluate visual-motor functioning, visual-perceptual skills, neurological impairment, and emotional disturbances in children and adults ages three and older.

### Purpose

The Bender-Gestalt is used to evaluate visual-motor maturity and to screen children for developmental delays. The test is also used to assess brain

damage and neurological deficits. Individuals who have suffered a traumatic brain injury may be given the Bender-Gestalt as part of a battery of neuropsychological measures, or tests.

The Bender-Gestalt is sometimes used in conjunction with other personality tests to determine the presence of emotional and psychiatric disturbances such as **schizophrenia**.

### Precautions

Psychometric testing requires a clinically trained examiner. The Bender Visual Motor Gestalt Test should be administered and interpreted by a trained psychologist or psychiatrist. The Bender-Gestalt should always be employed as only one element of a complete battery of psychological or developmental tests, and should never be used alone as the sole basis for a diagnosis.

### Description

The original Bender Visual Motor Gestalt test was developed in 1938 by psychiatrist Lauretta Bender. There are several different versions of the Bender-Gestalt available today (i.e., the Bender-Gestalt test; Modified Version of the Bender-Gestalt test for Preschool and Primary School Children; the Hutt Adaptation of the Bender-Gestalt test; the Bender Visual Motor Gestalt test for Children; the Bender-Gestalt test for Young Children; the Watkins Bender-Gestalt Scoring System; the Canter Background Interference Procedure for the Bender-Gestalt test). All use the same basic test materials, but vary in their scoring and interpretation methods.

The standard Bender Visual Motor Gestalt test consists of nine figures, each on its own  $3 \times 5$  card. An examiner presents each figure to the test subject one at a time and asks the subject to copy it onto a single piece of blank paper. The only instruction given to the subject is that he or she should make the best reproduction of the figure possible. The test is not timed, although standard administration time is typically 10–20 minutes. After testing is complete, the results are scored based on accuracy and organization. Interpretation depends on the form of the test in use. Common features considered in evaluating the drawings are rotation, distortion, symmetry, and perseveration. As an example, a patient with frontal lobe injury may reproduce the same pattern over and over (perseveration).

The Bender-Gestalt can also be administered in a group setting. In group testing, the figures are shown to test subjects with a slide projector, in a test booklet, or on larger versions of the individual test cards. Both the individual and group-administered Bender-Gestalt

## KEY TERMS

**Neuropsychological test**—A test or assessment given to diagnose a brain disorder or disease.

**Perseveration**—The persistence of a repetitive response after the cause of the response has been removed, or the response continues to different stimuli.

**Visual-motor skills**—Hand-eye coordination; in the Bender-Gestalt test, visual-motor skills are measured by the subject's ability to accurately perceive and then reproduce figures.

**Visual-perceptual skills**—The capacity of the mind and the eye to "see" something as it objectively exists.

evaluation may take place in either an outpatient or hospital setting. Patients should check with their insurance plans to determine if these or other mental health services are covered.

### Normal results

Children normally improve in this test as they age, but, because of the complexity of the scoring process, results for the Bender-Gestalt should only be interpreted by a clinically trained psychologist or psychiatrist.

### ORGANIZATIONS

American Psychological Association (APA), 750 First St. NE, Washington, DC, 20002-4242, (202) 336-5500, (800) 374-2721, <http://www.apa.org/>.

ERIC Clearinghouse on Assessment and Evaluation, 1131 Shriver Laboratory (Bldg 075), University of Maryland, College Park, MD, 20742, (800) 464-3742, [feedback3@ericae.net](mailto:feedback3@ericae.net), <http://www.ericae.net>.

Paula Anne Ford-Martin

Bends see **Decompression sickness**

Benign prostatic hyperplasia see **Enlarged prostate**

Benign prostatic hypertrophy see **Enlarged prostate**

Benzocaine see **Antiseptics**

### Purpose

Benzodiazepines are a class of **antianxiety drugs**. While anxiety is a normal response to stressful situations, some people have unusually high levels of anxiety that can interfere with everyday life. For these people, benzodiazepines can help bring their feelings under control. The medicine can also relieve troubling symptoms of anxiety, such as pounding heartbeat, breathing problems, irritability, **nausea**, and faintness.

Physicians may sometimes prescribe these drugs for other conditions, such as **muscle spasms**, **epilepsy** and other seizure disorders, **phobias**, **panic disorder**, withdrawal from alcohol, and sleeping problems. However, this medicine should not be used every day for sleep problems that last more than a few days. If used this way, the drug loses its effectiveness within a few weeks.

### Description

The family of antianxiety drugs known as benzodiazepines includes alprazolam (Xanax), chlordiazepoxide (Librium), diazepam (Valium), and lorazepam (Ativan). These medicines take effect fairly quickly, starting to work within an hour after they are taken. Benzodiazepines are available only with a physician's prescription and are available in tablet, capsule, liquid, or injectable forms.

### Recommended dosage

The recommended dosage depends on the type of benzodiazepine, its strength, and the condition for which it is being taken. Doses may be different for different people. Check with the physician who prescribed the drug or the pharmacist who filled the prescription for the correct dosage.

Always take benzodiazepines exactly as directed. Never take larger or more frequent doses, and do not take the drug for longer than directed. If the medicine does not seem to be working, check with the physician who prescribed it. *Do not increase the dose or stop*

## Benzodiazepines

### Definition

Benzodiazepines are medicines that help relieve nervousness, tension, and other symptoms by slowing the central nervous system.

## KEY TERMS

**Anxiety**—Worry or tension in response to real or imagined stress, danger, or dreaded situations. Physical reactions, such as fast pulse, sweating, trembling, fatigue, and weakness may accompany anxiety.

**Asthma**—A disease in which the air passages of the lungs become inflamed and narrowed.

**Bronchitis**—Inflammation of the air passages of the lungs.

**Central nervous system**—The brain and spinal cord.

**Chronic**—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

**Emphysema**—An irreversible lung disease in which breathing becomes increasingly difficult.

**Epilepsy**—A brain disorder with symptoms that include seizures.

**Glaucoma**—A condition in which pressure in the eye is abnormally high. If not treated, glaucoma may lead to blindness.

**Myasthenia gravis**—A chronic disease with symptoms that include muscle weakness and sometimes paralysis.

**Panic disorder**—A disorder in which people have sudden and intense attacks of anxiety in certain situations. Symptoms such as shortness of breath, sweating, dizziness, chest pain, and extreme fear often accompany the attacks.

**Phobia**—An intense, abnormal, or illogical fear of something specific, such as heights or open spaces.

**Porphyria**—A disorder in which porphyrins build up in the blood and urine.

**Porphyrin**—A type of pigment found in living things.

**Seizure**—A sudden attack, spasm, or convulsion.

**Sleep apnea**—A condition in which a person temporarily stops breathing during sleep.

**Withdrawal symptoms**—A group of physical or mental symptoms that may occur when a person suddenly stops using a drug to which he or she has become dependent.

*taking the medicine unless the physician says to do so.* Stopping the drug suddenly may cause withdrawal symptoms, especially if it has been taken in large doses or over a long period. People who are taking the medicine for seizure disorders may have seizures if they stop taking it suddenly. If it is necessary to stop taking the medicine, check with a physician for directions on how to stop. The physician may recommend tapering down gradually to reduce the chance of withdrawal symptoms or other problems.

### Precautions

Seeing a physician regularly while taking benzodiazepines is important, especially during the first few months of treatment. The physician will check to make sure the medicine is working as it should and will note unwanted side effects.

People who take benzodiazepines to relieve nervousness, tension, or symptoms of panic disorder should check with their physicians every two to three months to make sure they still need to keep taking the medicine.

Patients who are taking benzodiazepines for sleep problems should check with their physicians if they are not sleeping better within 7–10 days. Sleep problems

that last longer than this may be a sign of another medical problem.

People who take this medicine to help them sleep may have trouble sleeping when they stop taking the medicine. This effect should last only a few nights.

Some people, especially older people, feel drowsy, dizzy, lightheaded, or less alert when using benzodiazepines. The drugs may also cause clumsiness or unsteadiness. When the medicine is taken at bedtime, these effects may even occur the next morning. Anyone who takes these drugs should not drive, use machines or do anything else that might be dangerous until they have found out how the drugs affect them.

Benzodiazepines may also cause behavior changes in some people, similar to those seen in people who act differently when they drink alcohol. More extreme changes, such as confusion, agitation, and **hallucinations**, also are possible. Anyone who starts having strange or unusual thoughts or behavior while taking this medicine should get in touch with his or her physician.

Because benzodiazepines work on the central nervous system, they may add to the effects of alcohol and other drugs that slow down the central nervous system, such as **antihistamines**, cold medicine, allergy medicine, sleep aids, medicine for seizures, tranquilizers, some **pain**

relievers, and **muscle relaxants**. They may also add to the effects of anesthetics, including those used for dental procedures. These effects may last several days after treatment with benzodiazepines ends. *The combined effects of benzodiazepines and alcohol or other CNS depressants (drugs that slow the central nervous system) can be very dangerous, leading to unconsciousness or, rarely, even death.* Anyone taking benzodiazepines should not drink alcohol and should check with his or her physician before using any CNS depressants. *Taking an overdose of benzodiazepines can also cause unconsciousness and possibly death.* Anyone who shows signs of an overdose or of the effects of combining benzodiazepines with alcohol or other drugs should get immediate emergency help. Warning signs include slurred speech or confusion, severe drowsiness, staggering, and profound weakness.

Some benzodiazepines may change the results of certain medical tests. Before having medical tests, anyone taking this medicine should alert the health care professional in charge.

Children are generally more sensitive than adults to the effects of benzodiazepines. This sensitivity may increase the chance of side effects.

Older people are more sensitive than younger adults to the effects of this medicine and may be at greater risk for side effects. Older people who take these drugs to help them sleep may be drowsy during the day. Older people also increase their risk of falling and injuring themselves when they take these drugs.

### *Special conditions*

People with certain medical conditions or who are taking certain other medicines can have problems if they take benzodiazepines. Before taking these drugs, be sure to let the physician know about any of these conditions:

**ALLERGIES.** Anyone who has had unusual reactions to benzodiazepines or other mood-altering drugs in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

**PREGNANCY.** Some benzodiazepines increase the likelihood of **birth defects**. Using these medicines during **pregnancy** may also cause the baby to become dependent on them and to have withdrawal symptoms after birth. When taken late in pregnancy or around the time of labor and delivery, these drugs can cause other problems in the newborn baby, such as weakness, breathing problems, slow heartbeat, and body temperature problems.

**BREASTFEEDING.** Benzodiazepines may pass into breast milk and cause problems in babies whose mothers taken the medicine. These problems include drowsiness, breathing problems, and slow heartbeat. Women who are **breastfeeding** their babies should not use this medicine without checking with their physicians.

**OTHER MEDICAL CONDITIONS.** Before using benzodiazepines, people with any of these medical problems should make sure their physicians are aware of their conditions:

- current or past drug or alcohol abuse
- depression
- severe mental illness
- epilepsy or other seizure disorders
- swallowing problems
- chronic lung disease such as emphysema, asthma, or chronic bronchitis
- kidney disease
- liver disease
- brain disease
- glaucoma
- hyperactivity
- myasthenia gravis
- porphyria
- sleep apnea

**USE OF CERTAIN MEDICINES.** Taking benzodiazepines with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

### **Side effects**

The most common side effects are **dizziness**, light-headedness, drowsiness, clumsiness, unsteadiness, and slurred speech. These problems usually go away as the body adjusts to the drug and do not require medical treatment unless they persist or they interfere with normal activities.

More serious side effects are not common, but may occur. If any of the following side effects occur, check with the physician who prescribed the medicine as soon as possible:

- behavior changes
- memory problems
- difficulty concentrating
- confusion
- depression
- seizures (convulsions)
- hallucinations
- sleep problems

- increased nervousness, excitability, or irritability
- involuntary movements of the body, including the eyes
- low blood pressure
- unusual weakness or tiredness
- skin rash or itching
- unusual bleeding or bruising
- yellow skin or eyes
- sore throat
- sores in the mouth or throat
- fever and chills

Patients who take benzodiazepines for a long time or at high doses may notice side effects for several weeks after they stop taking the drug. They should check with their physicians if these or other troublesome symptoms occur:

- irritability
- nervousness
- sleep problems

Other rare side effects may occur. Anyone who has unusual symptoms during or after treatment with benzodiazepines should get in touch with his or her physician.

## Interactions

Benzodiazepines may interact with a variety of other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes benzodiazepines should let the physician know all other medicines he or she is taking. Among the drugs that may interact with benzodiazepines are:

- Central nervous system (CNS) depressants such as medicine for allergies, colds, hay fever, and asthma; sedatives; tranquilizers; prescription pain medicine; muscle relaxants; medicine for seizures; sleep aids; barbiturates; and anesthetics.

Medicines other than those listed above may interact with benzodiazepines. Be sure to check with a physician or pharmacist before combining benzodiazepines with any other prescription or nonprescription (over-the-counter) medicine.

## Resources

### OTHER

“Medicines.” MedlinePlus. <http://www.nlm.nih.gov/medlineplus/medicines.html> (accessed November 24, 2010)

Nancy Ross-Flanigan

Benzoyl peroxide see **Antiacne drugs**

Benztropine see **Antiparkinson drugs**

## Bereavement

### Definition

Bereavement refers to the period of mourning and grief following the **death** of a beloved person or animal. The English word *bereavement* comes from an ancient Germanic root word meaning “to rob” or “to seize by violence.” *Mourning* is the word that is used to describe the public rituals or symbols of bereavement, such as holding funeral services, wearing black clothing, closing a place of business temporarily, or lowering a flag to half mast. *Grief* refers to one’s personal experience of loss; it includes physical symptoms as well as emotional and spiritual reactions to the loss. While public expressions of mourning are usually time-limited, grief is a process that takes most people several months or years to work through.



**Students gathered around a memorial on a college campus, honoring and grieving slain students.** (Scott Olson/Getty Images News/Getty Images.)

## KEY TERMS

**Bibliotherapy**—The use of books (usually self-help or problem-solving works) to improve one's understanding of personal problems and/or to heal painful feelings.

**Biofield healing**—A general term for a group of alternative therapies based on the belief that the human body is surrounded by an energy field (or aura) that reflects the condition of the person's body and spirit. Rebalancing or repairing the energy field is thought to bring about healing in mind and body. Reiki, therapeutic touch, polarity balancing, Shen therapy, and certain forms of color therapy are considered forms of biofield healing.

**Complicated grief**—An abnormal response to bereavement that includes unrelieved yearning for the dead person, the complete loss of previous positive beliefs or worldviews, and a general inability to function.

**Disenfranchised grief**—Grief that cannot be openly expressed because the death or other loss cannot be publicly acknowledged.

**Euthanasia**—The act of putting a person or animal to death painlessly or allowing them to die by withholding medical services, usually because of a painful and incurable disease.

**Mourning**—The public expression of bereavement; it may include funerals and other rituals, special clothing, and symbolic gestures.

**Regression**—A return to earlier, particularly infantile, patterns of thought and behavior.

**Thanatology**—The medical, psychological, or legal study of death and dying.

**Traumatic grief**—Grief resulting from the loss of a loved one in a traumatic situation (natural or transportation disaster, act of terrorism or mass murder, etc.).

### Description

Bereavement is a highly individual as well as a complex experience. It is increasingly recognized that no two people respond the same way to the losses associated with the death of a loved one. People's reactions to a death are influenced by such factors as ethnic or religious traditions; personal beliefs about life after death; the type of relationship ended by death (relative, friend, colleague, etc.); the cause of death; the person's age at death; whether the death was sudden or expected; and many others. In addition, the death of a loved one inevitably confronts adults (and older adolescents) with the fact that they too will die. As a result of this complexity, most doctors and other counselors advise people to trust their own feelings about bereavement and grieve in the way that seems most helpful to them.

It is also increasingly understood that people can experience bereavement with regard to other losses. Some examples of these so-called "silent losses" include miscarriages in early **pregnancy**, the death of a child in the womb shortly before birth, or the news that a loved one has **Alzheimer's disease** or another illness that slowly destroys their personality. In addition, many counselors recognize that bereavement has two dimensions, the actual loss and the symbolic losses. For example, a person whose teenage son or daughter is

killed in an accident suffers a series of symbolic losses—knowing that their child will never graduate from high school, get married, or have children—as well as the actual loss of the adolescent to death.

### Causes and symptoms

#### *Causes*

The immediate cause of bereavement is usually the death of a loved friend or relative. There are a number of situations, however, that can affect or prolong the grief process:

- The relationship with the dead person was a source of pain rather than love and support. Examples would include an abusive parent or spouse.
- The person died in military service or in a natural, transportation, or workplace disaster. Bereavement in these cases is often made more difficult by intrusive news reporters as well as anxiety over the loved one's possible physical or mental suffering prior to death.
- The person was murdered. Survivors of homicide victims often find the criminal justice system as well as the media frustrating and upsetting.
- The person is missing and presumed dead but their death has not been verified. As a result, friends and relatives may alternate between grief and hope that the person is still alive.

- The person committed suicide. Survivors may feel guilt over their inability to foresee or prevent the suicide, shame that the death was self-inflicted, or anger at the person who committed suicide.
- The relationship with the dead person cannot be openly acknowledged. This situation often leads to what is called disenfranchised grief. The most common instances are sexual relationships that have been kept secret for the sake of spouses or other family members.
- The loved one was an animal rather than a human being. Western societies are only beginning to accept that adults as well as children can grieve for a dead animal; many adults still feel that there is “something wrong” about grieving for their pet. The question of euthanasia may be an additional source of sorrow; even when the pet is terminally ill, many people are very uneasy about making the decision to end its life.

### *Symptoms*

Bereavement typically affects a person’s physical well-being as well as emotions. Common symptoms of grief include changes in appetite and weight, **fatigue**, **insomnia** and other sleep disturbances, loss of interest in sex, low energy levels, **nausea and vomiting**, chest or throat **pain**, and **headache**. People who have lost a loved one in traumatic circumstances may have symptoms of **post-traumatic stress disorder**, such as an exaggerated startle response, visual or auditory **hallucinations**, or high levels of muscular tension.

Doctors and other counselors have identified four stages or phases in uncomplicated bereavement:

- Shock, disbelief, feelings of numbness. This initial phase lasts about two weeks, during which the bereaved person finally accepts the reality of the loved one’s death.
- Suffering the pain of grief. This phase typically lasts for several months. Some people undergo a mild temporary depression about six months after the loved one’s death.
- Adjusting to life without the loved one. In this phase of bereavement, survivors may find themselves taking on the loved one’s roles and responsibilities as well as redefining their own identities.
- Moving forward with life, forming new relationships, and having positive expectations of the future. Most people reach this stage within one to two years after the loved one’s death.

**BEREAVEMENT IN CHILDREN.** Children do not experience bereavement in the same way as adolescents and adults. Preschool children usually do not understand death as final and irreversible, and may talk or act as if

the dead pet or family member will wake up or come back. Children between the ages of five and nine are better able to understand the finality of death, but they tend to assume it will not affect them or their family. They are likely to be shocked and severely upset by a death in their immediate family. In addition to the physical disturbances that bereaved adults often experience, children sometimes begin to act like infants again (wanting bottle feeding, using baby talk, etc.) This pattern of returning to behaviors characteristic of an earlier life stage is called regression.

**TRAUMATIC AND COMPLICATED GRIEF.** Since the early 1990s, thanatologists (doctors and other counselors who specialize in issues related to death and dying) have identified two types of grief that do not resolve normally with the passage of time. Traumatic grief is defined as grief resulting from a sudden traumatic event that involves violent suffering, mutilation, and/or multiple deaths; appears to be random or preventable; and often involves the survivor’s own brush with death. The symptoms of traumatic grief are similar to those of post-traumatic stress disorder (PTSD). Such events as the terrorist attacks of September 11, 2001; the East Asian tsunami of December 2004; and airplane crashes or other transportation disasters may produce traumatic grief in survivors.

In contrast to traumatic grief, complicated grief does not necessarily result from a specific type of event but rather refers to an abnormally intense and prolonged response to bereavement. While most people are able to move through a period of bereavement and recover a sense of purpose and meaning in life, people with complicated grief feel as if their entire worldview has been shattered. They cannot stop thinking of the dead person, long to be with him or her, and may feel that part of them died along with the loved one. They sometimes start acting like the deceased person, mimicking the symptoms of his or her illness, behaving in reckless ways, talking about “joining” the loved one, or refusing to accept the reality of the death. In general they are unable to function normally. Complicated grief should not be regarded as simply a subtype of clinical depression; the two conditions may coexist or overlap in some patients but are nonetheless distinct entities.

### *Diagnosis*

Bereavement is considered a normal response to a death or other loss. A doctor who suspects that a patient is suffering from traumatic or complicated grief, however, may use various psychological inventories or questionnaires to see whether the patient meets the criteria for PTSD, major depression, or **acute stress**

**disorder.** In addition, there are several specific questionnaires to help diagnose complicated grief.

## Treatment

Most people do not require formal treatment for bereavement. However, many people choose to participate in support groups for recently bereaved people or hospice follow-up programs for relatives of patients who died in that hospice. Bereavement support groups are particularly helpful in guiding members through such common but painful problems as disposing of the dead person's possessions, celebrating holidays without the loved one, coping with anniversaries, etc.

Traumatic grief is usually treated in the same way as post-traumatic stress, with temporary use of medications to control sleep disturbances and **anxiety** symptoms along with long-term **psychotherapy**. Those suffering from traumatic grief may also be referred to support groups of people dealing with the same type of sudden and violent loss. Complicated grief is usually managed with a combination of group and individual psychotherapy.

## Alternative treatment

Alternative therapies that have been reported to help with the sleep disturbances and other physical symptoms of bereavement include prayer and **meditation**; such movement therapies as **yoga** and **tai chi**; **therapeutic touch**, **Reiki**, and other forms of biofield healing; bibliotherapy and journaling; **music therapy**; **art therapy**; **hydrotherapy**; and **massage therapy**.

## Prognosis

Most people move through the stages of the normal grief process within several months to two years, depending on the length and closeness of the relationship. Traumatic grief and complicated grief, however, may take three years or longer to resolve, even with appropriate treatment.

## Prevention

Bereavement is considered a normal response to death and loss, which are universal human experiences. It should ordinarily be allowed to run its course; most counselors maintain that trying to stifle or cut short the grief process is more likely to cause emotional problems later on than to prevent them.

## Resources

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## ORGANIZATIONS

Alzheimer's Association, 225 N. Michigan Ave., Fl. 17, Chicago, IL, 60601-7633, (312) 335-8700, (866) 699-1246, (800) 272-3900, [info@alz.org](mailto:info@alz.org), <http://www.alz.org>.

American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Ave. NW, Washington, DC, 20013-3007, (202) 966-7300, (202) 966-2891, [communications@aacap.org](mailto:communications@aacap.org), <http://www.aacap.org/>.

American Veterinary Medical Association (AVMA), 1931 North Meacham Road, Suite 100, Schaumburg, IL, 60173-4360, (847) 925-1329, (800) 248-2862, <http://www.avma.org/>.

Dougy Center for Grieving Children and Families, PO Box 86852, Portland, OR, 97286, (503) 775-5683, (503) 777-3097, (866) 775-5683, <http://www.dougy.org>.

National Air Disaster Alliance/Foundation (NADA), 2020 Pennsylvania Avenue NW #315, Washington, DC, 20006-1846, (336) 643-1394, (888) 444-NADA (6232), <http://www.planesafe.org>.

National Hospice and Palliative Care Organization, 700 Diagonal Road, Suite 625, Alexandria, VA, 22314, (703) 837-1500, (703) 837-1233, <http://www.nhpco.org>.

National Institute of Mental Health (NIMH), 6001 Executive Boulevard, Bethesda, MD, 20892, (301) 443-4513, (301) 443-4279, (866) 615-6464, [nimhinfo@nih.gov](mailto:nimhinfo@nih.gov), <http://www.nimh.nih.gov>.

Tragedy Assistance Program for Survivors, Inc. (TAPS), National Headquarters, 1777 F Street NW, Suite 600, Washington, DC, 20006, (202) 588-TAPS (8277), (202) 509-8282, (800) 959-TAPS (8277), info@taps.org, http://www.taps.org.

Rebecca Frey, PhD

Berger's disease see **Idiopathic primary renal hematuric/proteinuric syndrome**

## Beriberi

### Definition

Beriberi is a disease caused by a deficiency of thiamine (vitamin B<sub>1</sub>) that affects many systems of the body, including the muscles, heart, nerves, and digestive system. Beriberi literally means "I can't, I can't" in Singhalese, which reflects the crippling effect it has on its victims. It is common in parts of southeast Asia, where white rice is the main food. In the United States, beriberi is primarily seen in people with chronic alcoholism.

### Description

Beriberi puzzled medical experts for years as it ravaged people of all ages in Asia. Doctors thought it was caused by something in food. Not until the early 1900s did scientists discover that rice bran, the outer covering that was removed to create the polished white rice preferred by Asians, actually contained something that prevented the disease. Thiamine was the first vitamin identified. In the 1920s, extracts of rice polishings were used to treat the disease.

In adults, there are different forms of beriberi, classified according to the body systems most affected. Dry beriberi involves the nervous system; wet beriberi affects the heart and circulation. Both types usually occur in the same patient, with one set of symptoms predominating.

A less common form of cardiovascular, or wet beriberi, is known as "shoshin." This condition involves a rapid appearance of symptoms and acute **heart failure**. It is highly fatal and is known to cause sudden **death** in young migrant laborers in Asia whose diet consists of white rice.

Cerebral beriberi, also known as Wernicke-Korsakoff syndrome, usually occurs in chronic alcoholics and affects the central nervous system (brain and

spinal cord). It can be caused by a situation that aggravates a chronic thiamine deficiency, like an alcoholic binge or severe **vomiting**.

Infantile beriberi is seen in breastfed infants of thiamine-deficient mothers, who live in developing nations.

Although severe beriberi is uncommon in the United States, less severe thiamine deficiencies do occur. About 25% of all alcoholics admitted to a hospital in the United States show some evidence of thiamine deficiency.

### Causes and symptoms

Thiamine is one of the B **vitamins** and plays an important role in energy metabolism and tissue building. It combines with phosphate to form the coenzyme *thiamine pyrophosphate (TPP)*, which is essential in reactions that produce energy from glucose or that convert glucose to fat for storage in the tissues. When there is not enough thiamine in the diet, these basic energy functions are disturbed, leading to problems throughout the body.

Special situations, such as an over active metabolism, prolonged **fever**, **pregnancy**, and **breastfeeding**, can increase the body's thiamine requirements and lead to symptoms of deficiency. Extended periods of **diarrhea** or chronic **liver disease** can result in the body's inability to maintain normal levels of many nutrients, including thiamine. Other persons at risk are patients with kidney failure on dialysis and those with severe digestive problems who are unable to absorb nutrients. Alcoholics are susceptible because they may substitute alcohol for food and their frequent intake of alcohol decreases the body's ability to absorb thiamine.

The following systems are most affected by beriberi:

- Gastrointestinal system. When the cells of the smooth muscles in the digestive system and glands do not get enough energy from glucose, they are unable to produce more glucose from the normal digestion of food. There is a loss of appetite, indigestion, severe constipation, and a lack of hydrochloric acid in the stomach.
- Nervous system. Glucose is essential for the central nervous system to function normally. Early deficiency symptoms are fatigue, irritability, and poor memory. If the deficiency continues, there is damage to the peripheral nerves that causes loss of sensation and muscle weakness, which is called peripheral neuropathy. The legs are most affected. The toes feel numb and the feet have a burning sensation; the leg

## KEY TERMS

**B vitamins**—This family of vitamins consists of thiamine ( $B_1$ ), riboflavin ( $B_2$ ), niacin ( $B_3$ ), pantothenic acid ( $B_5$ ), pyridoxine ( $B_6$ ), biotin, folic acid ( $B_9$ ), and cobalamin ( $B_{12}$ ). They are interdependent and involved in converting glucose to energy.

**Coenzyme**—A substance needed by enzymes to produce many of the reactions in energy and protein metabolism in the body.

**Edema**—An excess accumulation of fluid in the cells and tissues.

**Enzyme**—A protein that acts as a catalyst to produce chemical changes in other substances without being changed themselves.

**Metabolism**—All the physical and chemical changes that take place within an organism.

**Peripheral neuropathy**—A disease affecting the portion of the nervous system outside the brain and spinal chord. One or more nerves can be involved, causing sensory loss, muscle weakness and shrinkage, and decreased reflexes.

**Thiamine pyrophosphate (TPP)**—The coenzyme containing thiamine that is essential in converting glucose to energy.

muscles become sore and the calf muscles cramp. The individual walks unsteadily and has difficulty getting up from a squatting position. Eventually, the muscles shrink (atrophy) and there is a loss of reflexes in the knees and feet; the feet may hang limp (footdrop).

- **Cardiovascular system.** There is a rapid heartbeat and sweating. Eventually the heart muscle weakens. Because the smooth muscle in the blood vessels is affected, the arteries and veins relax, causing swelling, known as edema, in the legs.
- **Musculoskeletal system.** There is widespread muscle pain caused by the lack of TPP in the muscle tissue.

Infants who are breastfed by a thiamine-deficient mother usually develop symptoms of deficiency between the second and fourth month of life. They are pale, restless, unable to sleep, prone to diarrhea, and have muscle wasting and **edema** in their arms and legs. They have a characteristic, sometimes silent, cry and develop heart failure and nerve damage.

### Diagnosis

A **physical examination** will reveal many of the early symptoms of beriberi, such as **fatigue**, irritation, **nausea**, **constipation**, and poor memory, but the deficiency may be difficult to identify. Information about the individual's diet and general health is also needed.

There are many biochemical tests based on thiamine metabolism or the functions of TPP that can detect a thiamine deficiency. Levels of thiamine can be measured in the blood and urine and will be reduced if there is a deficiency. The urine can be collected for 24 hours to measure the level of thiamine excreted. Another reliable test measures the effect of TPP on

red blood cell activity since all forms of beriberi affect the metabolism of red blood cells.

An electroencephalogram (EEG), which measures electrical activity in the brain, may be done to rule out other causes of neurologic changes. Observing improvements in the patient after giving thiamine supplements will also confirm the diagnosis.

### Treatment

Treatment with thiamine reverses the deficiency in the body and relieves most of the symptoms. Severe thiamine deficiency is treated with high doses of thiamine given by injection into a muscle (intramuscular) or in a solution that goes into a vein (intravenously) for several days. Then smaller doses can be given either by injection or in pill form until the patient recovers. Usually there are other deficiencies in the B vitamins that will also need treatment.

The cardiovascular symptoms of wet beriberi can respond to treatment within a few hours if they are not too severe. Heart failure may require additional treatment with **diuretics** that help eliminate excess fluid and with heart-strengthening drugs like digitalis.

Recovery from **peripheral neuropathy** and other symptoms of dry beriberi may take longer and patients frequently become discouraged. They should stay active; **physical therapy** will also help in recovery.

Infantile beriberi is treated by giving thiamine to both the infant and the breast-feeding mother until levels are normal.

In Wernicke-Korsakoff syndrome, thiamine should be given intravenously or by injection at first because the intestinal absorption of thiamine is probably impaired

and the patient is very ill. Most of the symptoms will be relieved by treatment, though there may be residual **memory loss**.

Excess thiamine is excreted by the body in the urine, and negative reactions to too much thiamine are rare. Thiamine is unstable in alkali solutions, so it should not be taken with **antacids** or **barbiturates**.

### Alternative treatment

Alternative treatments for beriberi deal first with correcting the thiamine deficiency. As in conventional treatments, alternative treatments for beriberi stress a diet rich in foods that provide thiamine and other B vitamins, such as brown rice, whole grains, raw fruits and vegetables, legumes, seeds, nuts, and yogurt. Drinking more than one glass of liquid with a meal should be avoided, since this may wash out the vitamins before they can be absorbed by the body. Thiamine should be taken daily, with the dose depending on the severity of the disease. Additional supplements of B vitamins, a multivitamin and mineral complex, and Vitamin C are also recommended. Other alternative therapies may help relieve the person's symptoms after the thiamine deficiency is corrected.

### Prognosis

Beriberi is fatal if not treated and the longer the deficiency exists, the sicker the person becomes. Most of the symptoms can be reversed and full recovery is possible when thiamine levels are returned to normal and maintained with a balanced diet and vitamin supplements as needed.

### Prevention

A balanced diet containing all essential nutrients will prevent a thiamine deficiency and the development of beriberi. People who consume large quantities of junk food like soda, pretzels, chips, candy, and high carbohydrate foods made with unenriched flours may be deficient in thiamine and other vital nutrients. They may need to take vitamin supplements and should improve their **diets**.

### Dietary requirements

The body's requirements for thiamine are tied to carbohydrate metabolism and expressed in terms of total intake of calories. The current recommended dietary allowances (RDA) are 0.5 mg for every 1000 calories, with a minimum daily intake of 1 mg even for those who eat fewer than 2,000 calories in a day. The RDA for children and teenagers is the same as for adults: 1.4 mg daily for males over age eleven, and 1.1 mg for females.

During pregnancy, an increase to 1.5 mg daily is needed. Because of increased energy needs and the secretion of thiamine in breast milk, breast-feeding mothers need 1.5 mg every day. In infants, 0.4 mg is advised.

### Food sources

The best food sources of thiamine are lean pork, beef, liver, brewer's yeast, peas and beans, whole or enriched grains, and breads. The more refined the food, as in white rice, white breads, and some cereals, the lower the thiamine. Many food products are enriched with thiamine, along with riboflavin, niacin, and iron, to prevent dietary deficiency.

During the milling process, rice is polished and all the vitamins in the exterior coating of bran are lost. Boiling the rice before husking preserves the vitamins by distributing them throughout the kernel. Food enrichment programs have eliminated beriberi in Japan and the Phillipines.

Like all B vitamins, thiamine is water soluble, which means it is easily dissolved in water. It will leach out during cooking in water and is destroyed by high heat and overcooking.

### Resources

#### PERIODICALS

Ryan, Ruth, et al. "Beriberi Unexpected." *Psychosomatics*  
May–June 1997: 191-294.

Karen Ericson, RN

Berry aneurysm see **Cerebral aneurysm**

## Berylliosis

### Definition

Berylliosis is lung inflammation caused by inhaling dust or fumes that contain the metallic element beryllium. Found in rocks, coal, soil, and volcanic dust, beryllium is used in the aerospace industry and in many types of manufacturing. Berylliosis occurs in both acute and chronic forms. In some cases, appearance of the disease may be delayed as much as 20 years after exposure to beryllium.

### Description

In the 1930s, scientists discovered that beryllium could make fluorescent light bulbs last longer. During the following decade, the hard, grayish metal was

## KEY TERMS

**Beryllium**—A steel-grey, metallic mineral used in the aerospace and nuclear industries and in a variety of manufacturing processes.

**Chelation therapy**—A treatment using chelating agents, compounds that surround and bind to target substances allowing them to be excreted from the body.

**Corticosteroids**—A group of anti-inflammatory drugs.

identified as the cause of a potentially debilitating, sometimes deadly disease characterized by **shortness of breath** and inflammation, swelling, and scarring of the lungs.

The manufacture of fluorescent light bulbs is no longer a source of beryllium exposure, but serious health hazards are associated with any work environment or process in which beryllium fumes or particles become airborne. Working with pure beryllium, beryllium compounds (e.g., beryllium oxide), or beryllium alloys causes occupational exposure. So do jobs involving:

- electronics
- fiber optics
- manufacturing ceramics, bicycle frames, golf clubs, mirrors, and microwave ovens
- mining
- nuclear weapons and reactors
- reclaiming scrap metal
- space and atomic engineering
- dental and laboratory technology

Beryllium dust and fumes are classified as toxic air pollutants by the Environmental Protection Agency (EPA). It is estimated that 2–6% of workers exposed to these contaminants eventually develop berylliosis.

### Causes and symptoms

Coughing, shortness of breath, and weight loss that begin abruptly can be a symptom of acute berylliosis. This condition is caused by beryllium air pollution that inflames the lungs making them rigid; it can affect the eyes and skin as well. People who have acute berylliosis are usually very ill. Most recover, but some die of the disease.

Chronic berylliosis is an allergic reaction to long-term exposure to even low levels of beryllium dust or

fumes. A systemic disease that causes formation of abnormal lung tissue and enlargement of the lymph nodes, chronic berylliosis also may affect other parts of the body. The symptoms of chronic berylliosis are largely the same as those seen in acute berylliosis, but they develop more slowly.

### Diagnosis

Berylliosis is initially suspected if a patient with symptoms of the disease has a history of beryllium exposure. A **chest x ray** shows characteristic changes in the lungs. However, since these changes can resemble those caused by other lung diseases, further testing may be necessary.

The beryllium lymphocyte proliferation test (BeLPT), a blood test that can detect beryllium sensitivity (i.e., an allergic reaction to beryllium), is used to screen individuals at risk of developing berylliosis. When screening results reveal a high level of sensitivity, BeLPT is performed on cells washed from the lungs. This test is now considered the most definitive diagnostic test for berylliosis.

### Treatment

Individuals with beryllium sensitivity or early-stage berylliosis should be transferred from tasks that involve beryllium exposure and regularly examined to determine whether the disease has progressed.

Acute berylliosis is a serious disease that occasionally may be fatal. Ventilators can help patients with acute berylliosis breathe. Prompt corticosteroid therapy is required to lessen lung inflammation.

Chronic beryllium disease is incurable. Corticosteroid therapy is often prescribed, but it is not certain that **steroids** can alter the progression of the disease, and they have no effect on scarring of lung tissue. Cleansing the lungs of beryllium is a slow process, so long-term therapy may be required. **Chelation therapy** is currently under investigation as a treatment for the disease.

### Prognosis

Most patients with acute berylliosis recover fully 7–10 days after treatment begins, and the disease usually causes no after effects.

Patients whose lungs are severely damaged by chronic berylliosis may experience fatal **heart failure** because of the strain placed on the heart.

### Prevention

Eliminating exposure to beryllium is the surest way to prevent berylliosis. Screening workers who are exposed to beryllium fumes or dust or who develop an

allergic reaction to these substances is an effective way to control symptoms and prevent disease progression.

#### ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, (202) 758-3355, (202) 452-1805, (800) 548-8252, info@lungusa.org, http://www.lungusa.org/.

Beryllium Support Group, P.O. Box 2021, Broomfield, CO, 80038-2021, (303) 412-7065, http://www.chronicberylliumdisease.com/tools/tl\_support.htm.

National Center for Environmental Health, 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, http://www.cdc.gov/nceh.

Maureen Haggerty

Beryllium pneumonosis see **Berylliosis**

Beryllium poisoning see **Berylliosis**

Beta-adrenergic blockers see **Beta blockers**

Beta-thalassemia see **Thalassemia**

only to be partially reabsorbed back into the blood when it reaches the kidney's tubules. In glomerular kidney disease, the glomeruli can't filter it out of the blood, so levels increase in the blood and decrease in the urine. In tubular kidney disease, the tubules can't reabsorb it back into the blood, so urine levels rise and blood levels fall. After a kidney transplant, increased blood levels may be an early sign of rejection.

Increased urinary levels are found in people with kidney damage caused by high exposure to the heavy metals cadmium and mercury. Periodic testing of workers exposed to these metals helps to detect beginning kidney damage.

Beta<sub>2</sub>-microglobulin levels also rise during infection with some viruses, including cytomegalovirus and human **immunodeficiency** virus (HIV). Studies show that as HIV disease advances, beta<sub>2</sub>-microglobulin levels rise.

#### Description

Testing methods vary, but most involve adding the person's serum—the yellow, liquid part of blood—or urine to one or more substances that bind to beta<sub>2</sub>-microglobulin in the serum or urine. The amount of the substance(s) bound to beta<sub>2</sub>-microglobulin is measured and the original amount of beta<sub>2</sub>-microglobulin is determined.

The test is covered by insurance when medically necessary. Results are usually available the next day.

#### Preparation

The blood test requires 5 mL of blood. A health-care worker ties a tourniquet on the person's upper arm, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

Urine may be a single collection or collected throughout a 24-hour time period. The urine should be refrigerated until it is brought to the laboratory and must not become acidic.

#### Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs on the puncture site relieve discomfort.

## KEY TERMS

**Beta<sub>2</sub>-microglobulin**—A protein found on the surface of many cells, particularly white blood cells.

**Chronic lymphocytic leukemia**—A cancer of the blood cells characterized by large numbers of cancerous, mature white blood cells and enlarged lymph nodes.

**Glomerular kidney disease**—Disease of the kidney that affects the glomeruli, the part of the kidney that filters certain substances out of the blood.

**Multiple myeloma**—A malignancy (cancer) of a certain kind of white blood cell, called a plasma cell.

**Non-Hodgkin's lymphoma**—Cancer that originates in the lymphatic system and typically spreads throughout the body.

**Tubular kidney disease**—Disease of the kidney that affect the tubules, the part of the kidney that allows certain substances to be reabsorbed back into the blood.

### Normal results

- Serum: less than or equal to 2.7 g/mL
- Urine: less than 1 mg/24 hours or 0–160 g/L

### Abnormal results

The meaning of an abnormal result varies with the clinical condition of the person tested. In a person with multiple myeloma, a higher level means a poorer prognosis than a lower level. In a person with kidney disease, an increased blood level means the problem is tubular, not glomerular. In a kidney transplant patient, an increase may be a sign of rejection, toxic amounts of antirejection medication, or a viral infection. An increased level in a worker exposed to cadmium or mercury may signal beginning kidney damage, and in a person with HIV, advancing disease.

### Resources

#### BOOKS

Pagana, Kathleen Deska, and Timothy J. Pagana. *Mosby's Manual of Diagnostic and Laboratory Tests*. 4th ed. St. Louis: Mosby, 2009.

Nancy J. Nordenson

### Purpose

Beta blockers lower heart rate and reduce the force of heart contractions. Beta blockers are used to help treat the following conditions:

- congestive heart failure
- chest pain (angina)
- high blood pressure
- irregular heart beat (arrhythmia)
- maintaining normal heart rhythm after treating rhythm disturbance
- heart attack
- acute migraine headaches, and preventing future ones in some patients
- essential tremors
- some types of glaucoma
- performance anxiety (off-label)

### Description

Beta blockers are available as capsules, tablets, liquids, eye drops, and injections.

Examples of beta blockers include atenolol (Tenormin), metoprolol (Lopressor), nadolol (Corgard), propranolol (Inderal), and timolol (Blocadren).

### Recommended dosage

The recommended dose depends on the type and strength of drug used and the condition for which it is prescribed.

Beta blockers should be taken as directed and not stopped without consulting with a physician.

This medicine may take several weeks to noticeably lower blood pressure. It is important to take the medication exactly as directed.

## Beta blockers

### Definition

Beta blockers are medicines that reduce the body's response to **stress** hormones, including adrenalin.

Brand name (generic name)	Possible side effects
Betapace (sotalol)	Diarrhea, excessive tiredness, headache, muscle aches
Blocadren (timolol)	Coldness in hands and feet, dizziness, fatigue, headache, heartburn
Cartrol (carteolol)	Blurred vision, burning or stinging in eyes, sensitivity to light
Corgard (nadolol)	Excessive tiredness, lightheadedness
Inderal (propranolol)	Constipation, dizziness, fatigue, insomnia, upset stomach
Kerlone (betaxolol)	Diarrhea, heartburn, insomnia, joint pain, nausea, rash, strange dreams
Lopressor, Toprol XL (metoprolol)	Depression, dizziness, dry mouth, fatigue, nausea and vomiting, rash
Sectral (acebutolol)	Constipation, dizziness, fatigue, headache, muscle aches
Tenormin (atenolol)	Blurred vision, difficulty breathing, fainting, pallor, swelling of extremities, weight gain
Zebeta (bisoprolol)	Diarrhea, muscle aches, runny nose, vomiting
Ziac (bisoprolol/hydrochlorothiazide)	Cough, fatigue, headache, lightheadedness

(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

Physicians may recommend that patients check their pulse before and after taking this medicine. If the pulse rate becomes too slow, circulation problems may result.

## Precautions

Discontinuing beta blockers without medical advice may increase the risk of **heart attack**.

Beta blockers antagonize the effects of **bronchodilators** used to treat **asthma** and **emphysema** and may interfere with treating those conditions.

These drugs may mask the effects of low blood sugar, like rapid heart rate, in diabetic patients.

Anyone taking beta blockers should seek advice from a pharmacist or physician before taking other prescription or over-the-counter medicine.

Anyone taking beta blockers should inform their health care professionals before having surgical or dental procedures or receiving emergency treatment.

People may feel drowsy, dizzy, or lightheaded when they start taking these drugs. They should not drive or use dangerous machines until they find how the drugs affect them.

Beta blockers may increase sensitivity to cold, especially in older people or people who have poor circulation. Anyone who takes these medicines should dress warmly in cold weather.

People with chest **pain** on exertion may not experience the same kinds of pain while taking these medications. They should seek advice from their physicians regarding safe levels of physical activity while taking these drugs.

Older people may be unusually sensitive to the effects of beta blockers.

Before starting to take beta blockers, treating physicians need to know what other medications and medical conditions their patients have.

Beta blockers may affect the way patients respond to their **allergies**.

**DIABETES.** Beta blockers may make blood sugar levels rise and may hide some symptoms of low blood sugar. Diabetic patients should discuss these possible problems with their physicians.

**PREGNANCY.** Atenolol, and possibly other beta blockers, crosses the placenta; babies born of pregnant women taking these drugs may be briefly affected.

**BREASTFEEDING.** Some beta blockers pass into breast milk and may cause low blood pressure and low pulse rates in nursing babies whose mothers take the drugs. Women who need to take beta blockers and who want to breastfeed should seek medical advice.

**OTHER MEDICAL CONDITIONS.** Patients with asthma and/or emphysema may be adversely affected by beta blocker medications and should monitor themselves carefully.

Beta blockers may reduce symptoms, especially rapid pulse, of an overactive thyroid.

Liver and kidney diseases may increase or prolong the effects of these drugs.

Beta blockers may also make the following medical conditions worse:

- normally slow heartbeat (bradycardia)
- Myasthenia gravis (chronic disease causing muscle weakness and possibly paralysis)
- psoriasis (itchy, scaly, red patches of skin)
- depression

## Side effects

The most common side effects include:

- fatigue
- dizziness

- drowsiness
- lightheadedness
- decreased sexual desire
- cold hands
- trouble sleeping
- trouble breathing
- depression

## Interactions

Beta blockers may interact with a number of medicines. Reactions may be minor or severe and affect the risks or side effects of either drug. Patients should discuss drugs they take with health providers before starting to take beta blockers.

Possible interactions include:

- The effects of both beta blockers and calcium channel blockers (Cardizem and Calan) increase when they are taken together.
- Phenothiazines (Thorazine and Mellaril) and beta blockers have a probable delayed interaction that may increase the effects of either or both drugs. This is particularly dangerous in elderly people.
- Barbiturates may reduce the effectiveness of beta blockers.
- Cimetidine (Tagamet) may reduce the effectiveness of beta blockers.
- Benadryl increases the effects of these drugs on the heart.
- If orange juice is drunk at the same time that beta blockers are taken, their effects may be reduced.
- Hydralazine (Apresoline) and beta blockers interact to increase the effects of both drugs.
- Haloperidol (Haldol) and beta blockers interact to increase the effects of both drugs.
- NSAIDs, non-steroidal anti inflammatory drugs (ibuprofen, naproxen, indomethacin), may decrease the effectiveness of beta blockers.
- Penicillins (Ampicillin) may reduce the effects of beta blockers.
- Salicylates (aspirin) may reduce the effects of beta blockers.

## Resources

### BOOKS

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James Waun, MD, RPh

Betamethasone see **Corticosteroids**

Bile duct atresia see **Biliary atresia**

## Bile duct cancer

### Definition

Bile duct **cancer**, or cholangiocarcinoma, is a malignant tumor of the bile ducts within the liver (intrahepatic), or leading from the liver to the small intestine (extrahepatic). It is a rare tumor with poor outcome for most patients.

### Description

Bile is a substance manufactured by the liver that aids in the digestion of food. Bile ducts are channels that carry the bile from the liver to the small intestine. Like the tributaries of a river, the small bile ducts in the liver converge into two large bile ducts called the left and right hepatic ducts. These exit the liver and join to form the common hepatic duct. The gallbladder, which concentrates and stores the bile, empties into the common hepatic duct to form the common bile duct. Finally, this large duct connects to the small intestine where the bile can help digest food. Collectively, this network of bile ducts is called the biliary tract.

Bile duct cancer originates from the cells that line the inner surface of the bile ducts. A tumor may arise anywhere along the biliary tract, either within or outside of the liver. Bile duct tumors are typically slow-growing tumors that spread by local invasion of neighboring structures and by way of lymphatic channels.

Bile duct cancer is an uncommon malignancy. In the United States, approximately one case arises per 100,000 people per year, but it is more common in Southeast Asia. It occurs in men only slightly more often than in women and it is most commonly diagnosed in people in their 50s and 60s. In fact, about 65% of patients with bile duct cancer are over age 65.

### Causes and symptoms

A number of risk factors are associated with the development of bile duct cancer:

- Primary sclerosing cholangitis. This disease is characterized by extensive scarring of the biliary tract, sometimes associated with inflammatory bowel disease.
- Choledochal cysts. These are abnormal dilatations of the biliary tract that usually form during fetal development. There is evidence that these cysts may rarely arise during adulthood.
- Hepatolithiasis. This is the condition of stone formation within the liver (not including gallbladder stones).

- Liver flukes. Parasitic infection with certain worms is thought to be at least partially responsible for the higher prevalence of bile duct cancer in Southeast Asia.
- Thorotrast. This is a chemical that was previously injected intravenously during certain types of x rays. It is not in use anymore. Exposure to Thorotrast has been implicated in the development of cancer of the liver as well as the bile ducts.

### Symptoms

**Jaundice** is the first symptom in 90% of patients. This occurs when the bile duct tumor causes an obstruction in the normal flow of bile from the liver to the small intestine. Bilirubin, a component of bile, builds up within the liver and is absorbed into the bloodstream in excess amounts. This can be detected in a blood test, but it can also manifest as yellowish discoloring of the skin and eyes. The bilirubin in the bloodstream also makes the urine appear dark. Additionally, the patient may experience generalized **itching** due to the deposition of bile components in the skin. Normally, a portion of the bile is excreted in stool; bile actually gives stool its brown color. But when the biliary tract is obstructed by tumor, the stools may appear pale.

Abdominal **pain**, **fatigue**, weight loss, and poor appetite are less common symptoms. Occasionally, if obstruction of the biliary tract causes the gallbladder to swell enormously yet without causing pain, the physician may be able to feel the gallbladder during a **physical examination**. Sometimes the biliary tract can become infected, but this is normally a rare consequence of invasive tests. Infection causes **fever**, chills, and pain in the right upper portion of the abdomen.

### Diagnosis

Certain laboratory tests of the blood may aid in the diagnosis. The most important one is the test for elevated bilirubin levels in the bloodstream. Levels of alkaline phosphatase and CA 19-9 may also be elevated.

When symptoms, physical signs, and blood tests point toward an abnormality of the biliary tract, the next step involves radiographic exams. Ultrasound, computed tomography (CT scan), and **magnetic resonance imaging** (MRI) are noninvasive and rapid. In recent years, MRI has become the favored imaging choice for initial diagnosis of cholangiocarcinoma when the exam is available and affordable or covered by insurance. These tests can often detect the actual tumor as well as dilatation of the obstructed biliary tract. If these tests indicate the presence of a tumor, cholangiography is required. This procedure involves injecting dye into the biliary tract to obtain anatomic images of the bile ducts and

the tumor. The specialist that performs this test can also insert small tubes, or stents, into a partially obstructed portion of the bile duct to prevent further obstruction by growth of the tumor. This is vitally important since it may be the only intervention that is possible in certain patients. Cholangiography is an invasive test that carries a small risk of infection of the biliary tract. The objective of these radiological tests is to determine the size and location of the tumor, as well as the extent of spread to nearby structures.

The treatment of bile duct tumors is usually not affected by the specific type of cancer cells that comprise the tumor. For this reason, some physicians forego biopsy of the tumor.

### Treatment

The treatment is with surgical resection (removal) of the tumor and all involved structures. Unfortunately, sometimes the cancer has already spread too far when the diagnosis is made. Thus, in the treatment of bile duct cancer, the first question to answer is if the tumor may be safely resected by surgery with reasonable benefit to the patient. If the cancer involves certain blood vessels or has spread widely throughout the liver, resection may not be possible. Sometimes further invasive testing is required.

**Angiography** can determine if the blood vessels are involved. **Laparoscopy** is a surgical procedure that allows the surgeon to directly assess the tumor and nearby lymph nodes without making a large incision in the abdomen. Only about 45% of bile duct cancers are ultimately resectable.

If the tumor is resectable, and the patient is healthy enough to tolerate the operation, the specific type of surgery performed depends on the location of the tumor. For tumors within the liver or high up in the biliary tract, resection of part of the liver may be required. Tumors in the middle portion of the biliary tract can be removed alone. Tumors of the lower end of the biliary tract may require extensive resection of part of the pancreas, small intestine, and stomach to ensure complete resection.

Unfortunately, sometimes the cancer appears resectable by all the radiological and invasive tests, but is found to be unresectable during surgery. In this scenario, a bypass operation can relieve the biliary tract obstruction, but does not remove the tumor itself. This does not produce a cure but it can offer a better quality of life for the patient.

### Prognosis

Prognosis depends on the stage and resectability of the tumor. If the patient cannot undergo surgical

resection, the survival rate is commonly less than one year. If the tumor is resected, the survival rate improves, with 20% of these patients surviving past five years.

### Clinical trials

Studies of new treatments in patients are known as clinical trials. These trials seek to compare the standard method of care with a new method, or the trials may be trying to establish whether one treatment is more beneficial for certain patients than others. Sometimes, a new treatment that is not being offered on a wide scale may be available to patients participating in clinical trials, but participating in the trials may involve some risk. To learn more about clinical trials, patients can call the National Cancer Institute (NCI) at 1-800-4-CANCER or visit the NCI website for patients at [www.cancertrials.nci.nih.gov](http://www.cancertrials.nci.nih.gov).

### Prevention

Other than the avoidance of infections caused by liver flukes, there are no known preventions for this cancer.

### Resources

#### BOOKS

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Sabiston, David C., et al. *Sabiston Textbook of Surgery: The Biological Basis of Modern Surgical Practice*. Philadelphia: Saunders/Elsevier, 2008.

#### PERIODICALS

"COX-2 Promoter Enhances the Efficacy of Cholangiosarcoma Gene Therapy." *Cancer Weekly* (May 20, 2003): 167.  
Khan, S.A., et al. "Guidelines for the Diagnosis and Treatment of Cholangiosarcoma: Consensus Document." *Gut* (November 2002): vi1–9.

#### ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, <http://www.cancer.org>.  
American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, (212) 483-8179, <http://www.liverfoundation.org/>.  
National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), [cancergovstaff@mail.nih.gov](mailto:cancergovstaff@mail.nih.gov), <http://www.cancer.gov>.

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Teresa G. Odle

Bile duct infection see **Cholangitis**

Bile flow obstruction see **Cholestasis**

Bilharziasis see **Schistosomiasis**

## Biliary atresia

### Definition

Biliary atresia is the failure of a fetus to develop an adequate pathway for bile to drain from the liver to the intestine.

### Description

Biliary atresia is the most common lethal **liver disease** in children, occurring once every 10,000–15,000 live births. Half of all liver transplants are done for this reason.

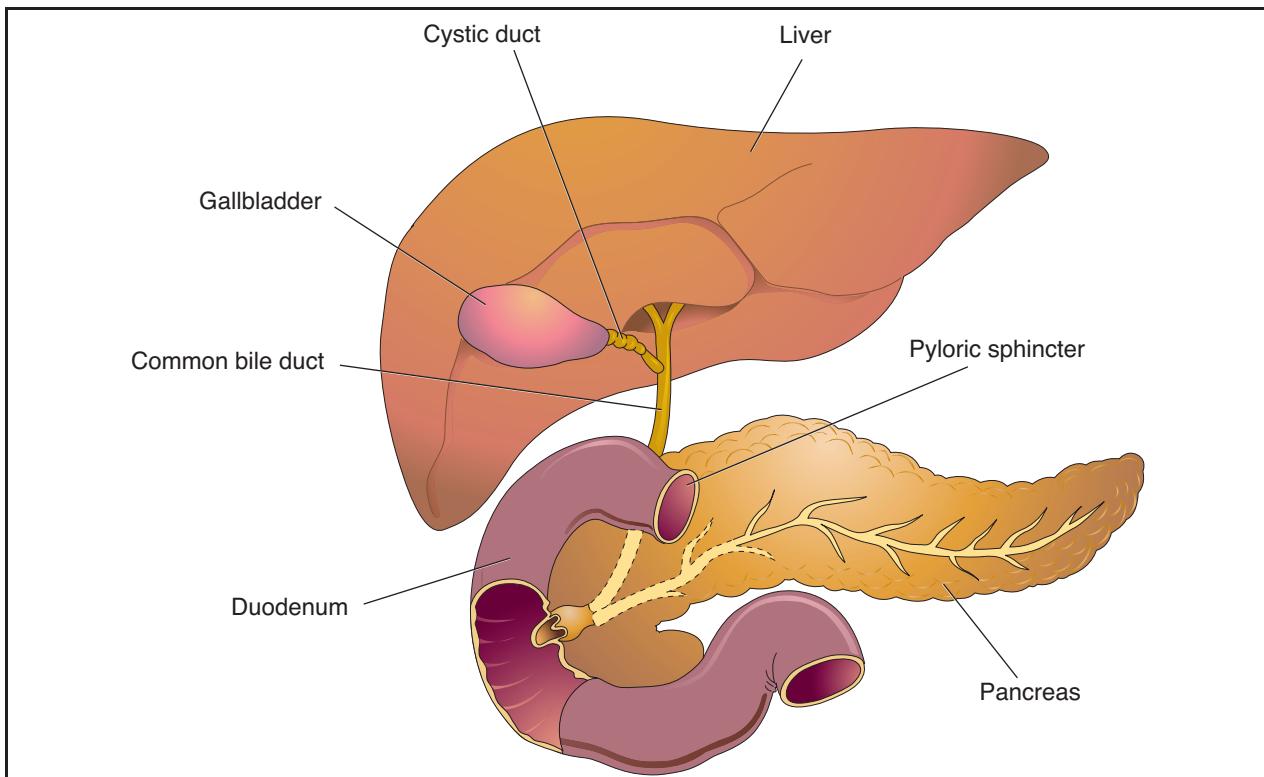
The normal anatomy of the bile system begins within the liver, where thousands of tiny bile ducts collect bile from liver cells. These ducts merge into larger and larger channels, like streams flowing into rivers, until they all pour into a single duct that empties into the duodenum (first part of the small intestine). Between the liver and the duodenum this duct has a side channel connected to the gall bladder. The gall bladder stores bile and concentrates it, removing much of its water content. Then, when a meal hits the stomach, the gall bladder contracts and empties its contents.

Bile is a mixture of waste chemicals that the liver removes from the circulation and excretes through the biliary system into the intestine. On its way out, bile assists in the digestion of certain nutrients. If bile cannot get out because the channels are absent or blocked, it backs up into the liver and eventually into the rest of the body. The major pigment in bile is a chemical called bilirubin, which is yellow. Bilirubin is a breakdown product of hemoglobin (the red chemical in blood that carries oxygen). If the body accumulates an excess of bilirubin, it turns yellow (jaundiced). Bile also turns the stool brown. Without it, stools are the color of clay.

### Causes and symptoms

It is possible that a viral infection is responsible for this disease, but evidence is not yet convincing. The cause remains unknown.

The affected infant will appear normal at birth and during the newborn period. After two weeks the normal **jaundice** of the newborn will not disappear, and the stools will probably be clay colored. At this point, the condition will come to the attention of a physician. If not, the child's abdomen will begin to swell, and the infant will get progressively more ill.



**Biliary atresia** is a congenital condition in which the pathway for bile to drain from the liver to the intestine is undeveloped. It is the most common lethal liver disease in children. (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

Nearly all untreated children will die of liver failure within two years.

### Diagnosis

The persistence of jaundice beyond the second week in a newborn with clay-colored stools is a sure sign of obstruction to the flow of bile. An immediate evaluation that includes blood tests and imaging of the biliary system will confirm the diagnosis.

### Treatment

Surgery is the only treatment. Somehow the surgeon must create an adequate pathway for bile to escape the liver into the intestine. The altered anatomy of the biliary system is different in every case, calling upon the surgeon's skill and experience to select and execute the most effective among several options. If the obstruction is only between the gall bladder and the intestine, it is possible to attach a piece of intestine directly to the gall bladder. More likely, the upper biliary system will also be inadequate, and the surgeon will attach a piece of intestine directly to the liver—the Kasai procedure. In its wisdom, the body will discover that the tiny bile ducts in

that part of the liver are discharging their bile directly into the intestine. Bile will begin to flow in that direction, and the channels will gradually enlarge. Survival rates for the Kasai procedure are commonly 50% at five years and 15% at 10 years. Persistent disease in the liver gradually destroys the organ.

### Prognosis

Before liver transplants became available, even prompt and effective surgery did not cure the whole problem. Biliary drainage can usually be established, but the patients still have a defective biliary system that develops progressive disease and commonly leads to an early **death**. Transplantation now achieves up to 90% one-year survival rates and promises to prevent the chronic disease that used to accompany earlier procedures.

### Prevention

The specific cause of this birth defect is unknown, so all that women can do is to practice the many general preventive measures, even before they conceive.

## Resources

### BOOKS

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J. Ricker Polsdorfer, MD

Biliary duct cancer see **Gallbladder cancer**

Biliary tract cancer see **Bile duct cancer**

Bilirubin test see **Liver function tests**

## Binge eating

### Definition

Binge eating is an abnormal pattern and loss of control in which an individual eats a significant amount of food in a limited time. The timeframe for a binge is usually 1–2 hours. A binge eater differs from a bulimic, in that they do not purge after such an episode.

### Demographics

Estimates of the number of Americans who have binge-eating disorder range from less than 1% to 4%, with 2% being the most commonly cited figure. Although women with binge-eating disorder outnumber men three to two, binge eating is the most common male eating disorder. The disorder affects blacks and whites equally; little research has been done on other racial or ethnic groups. Unlike the **eating disorders anorexia nervosa** or **bulimia nervosa** that start in the teenage or young adult years, binge-eating disorder is more likely to occur in middle-aged adults between the ages of 46 and 55. Although binge eaters may be of normal weight, binge eating is a common disorder among people who are obese. Some estimates suggest that up to half the obese people in formal weight loss programs have problems with binge eating.

### Description

Everyone eats too much occasionally, but people who are binge eaters have an abnormal eating pattern that occurs frequently. Many eating disorder specialists define binge-eating disorder as binge-eating behavior that occurs at least twice a week for three months and has a negative effect on the individual's relationships and daily activities.

The eating disorders anorexia nervosa and bulimia nervosa are considered psychiatric disorders and have

formal diagnostic criteria that are defined in the *Diagnostic and Statistical Manual for Mental Disorders Fourth Edition, Text Revision (DSM-IV-TR)* published by the American Psychiatric Association (APA). Binge eating is an acknowledged problem, but it has not risen to the level of a separate psychiatric disorder as defined by the APA. The *DSM-IV-TR* classifies binge eating under the diagnosis of eating disorders not otherwise specified. Binge-eating disorder is, however, under consideration as a separate diagnostic category, pending further study. Some experts believe binge eating is a subtype of bulimia, an eating disorder characterized by episodes of binge eating followed by purging the body of calories. Other experts believe that binge eating should be classified as an obesity-related behavior. Although the way a healthcare professional views binge eating does not change the behavior, it may influence the type of therapy recommended and affect the degree to which treatment is covered by health insurance providers.

Binge eaters exhibit many of the following behaviors:

- They eat abnormally large amounts of food at one sitting, often consuming 3,000–10,000 calories in a short period.
- They gobble their food, eating much faster than normal.
- During a binge, they feel out of control and unable to stop eating, even though they may want to.
- Despite feeling full or even painfully uncomfortable, they continue to eat.
- Binge eaters tend to diet constantly but never lose weight.
- Then often eat alone and hide empty food containers to disguise from others how much they eat.
- They are ashamed and embarrassed about their bingeing.
- Food hoarding is common.
- After a binge, they feel guilty, upset, disgusted, and/or depressed about how much they have eaten.
- They vow to themselves never to binge again but cannot keep this promise.
- People who binge eat are far more likely to describe themselves as experiencing personal problems and work difficulties and to be hypersensitive to the thoughts and opinions of others.

Binge-eating disorder is different from bulimia. The two disorders are similar in their bingeing behavior, but people with bulimia follow a binge by purging the body of calories. They do this by some combination of self-induced **vomiting**; laxative, diuretic, or enema **abuse**; **fasting**; and compulsive exercising

## KEY TERMS

**Anorexia nervosa**—An eating disorder that involves self-imposed starvation.

**Electrolyte**—Ions in the body that participate in metabolic reactions. The major human electrolytes are sodium ( $\text{Na}^+$ ), potassium ( $\text{K}^+$ ), calcium ( $\text{Ca}^{2+}$ ), magnesium ( $\text{Mg}^{2+}$ ), chloride ( $\text{Cl}^-$ ), phosphate ( $\text{HPO}_4^{2-}$ ), bicarbonate ( $\text{HCO}_3^-$ ), and sulfate ( $\text{SO}_4^{2-}$ ).

**Neurotransmitter**—One of a group of chemicals secreted by a nerve cell (neuron) to carry a chemical message to another nerve cell, often as a way of transmitting a nerve impulse. Examples of neurotransmitters include acetylcholine, dopamine, serotonin, and norepinephrine.

**Selective serotonin reuptake inhibitors (SSRIs)**—A class of antidepressants that work by blocking the reabsorption of serotonin in brain cells, raising the level of the chemical in the brain. SSRIs include Prozac, Zoloft, Luvox, and Paxil.

**Serotonin**—5-Hydroxytryptamine; a substance that occurs throughout the body with numerous effects including neurotransmission. Inadequate amounts of serotonin are implicated in some forms of depression and obsessive-compulsive disorder.

**Triglycerides**—A type of fat found in the blood. High levels of triglycerides can increase the risk of coronary artery disease.

beyond reasonable levels. People with binge-eating disorder do nothing to purge the body of the extra calories they have eaten, although they often try to diet between binges. Many people who are bulimic also have anorexic behaviors. There is no overlap between binge-eating disorder and anorexia. Most people who have binge-eating disorder are obese, but not all obese people have binge-eating behaviors.

### Risk factors

People at higher risk of developing binge-eating disorder share certain characteristics. These include:

- Frequent dieting. People who go on rigorous diets or who frequently gain and lose large amounts of weight (weight cycling) are more likely to become binge eaters.
- Impulsiveness. Binge eaters, like bulimics, have problems with impulse control.
- Low self-worth and negative self-talk. This occurs almost universally among people with all types of eating disorders.
- Difficulty managing anger and appropriately expressing feelings.
- Preoccupation with body image and weight.
- History of sexual abuse. Some, but by no means all, people with binge eating disorder report being sexually abused as children. This is an area of ongoing research.
- Depression. It is not clear whether depression causes binge eating or if binge eating causes depression, but the two are often found together.

### Causes and symptoms

Binge eating is a relatively new area of research. Like all eating disorders, binge eating appears to have multiple causes. Some people seem to be genetically predisposed to become binge eaters. Researchers think this may be related to abnormalities in neurotransmitters in the brain that help to regulate appetite. Research continues actively in this area.

For many binge eaters, **stress** is the factor that triggers a binge. Stress can be caused by very restrictive dieting, but it is often caused by social and cultural factors, such as family conflict, job-related stress, dysfunctional relationships, and the repeated message from the media that a thin body is favorable.

Symptoms of binge eating may be difficult to detect. Binge eating is different from continuously snacking. Binge eaters are often secretive about food and their bingeing is often done in private. **Obesity** and obesity-related diseases such as **hypertension** (high blood pressure), type 2 diabetes, and joint **pain** are signs that binge-eating disorder could be present, but not all obese people are binge eaters. Behaviors such as secretive eating, constant dieting without losing weight, obsessive concern about weight, depression, **anxiety**, and **substance abuse** are all clues, but none of these signs are definitive. The individual may complain about symptoms related to obesity, such as **fatigue** and **shortness of breath**, or mention unsuccessful dieting, but again, these signs are not definitive.

### Diagnosis

Binge-eating disorder is often diagnosed and treated by a psychiatrist and/or a psychologist.

Diagnosis can be difficult. Binge eaters often go out of their way to hide how much they eat. They may, for example, buy snack food at the grocery store and eat it in the car before they go home, or they may buy food in secret and hoard it, so that people close to them will not know they are bingeing. Normally healthcare professionals begin diagnosis with a family and personal history. However, people with binge-eating disorder often lie about their eating habits.

### Tests

A physician will begin with a **physical examination** and usually order standard laboratory tests such as a **complete blood count** (CBC), **urinalysis**, and blood tests to check the level of cholesterol, **triglycerides**, and electrolytes. Additional tests, such as a thyroid function test, may be ordered to rule out other disorders. If the individual is obese, tests may be done check for obesity-related diseases such as diabetes, cardiovascular disease, and **sleep apnea**.

Several different personality and behavioral inventories, such as the **Minnesota Multiphasic Personality Inventory** (MMPI), may be administered as part of the assessment process. One of several clinical inventories, or scales, may also be used to assess depressive symptoms, including the Hamilton Depression Scale (HAM-D) or Beck Depression Inventory (BDI). These tests are usually administered in an office setting.

### Treatment

#### *Traditional treatment*

The medical community does not completely agree on the best treatment for binge eating. Medical specialists are more likely first to treat weight control issues with drugs, diet, and **nutrition** counseling in order to reduce the health risks of obesity-related diseases. Although there are no drugs specifically approved by the United States Food and Drug Administration for treating binge-eating disorder, the FDA has approved **selective serotonin reuptake inhibitors** (SSRIs) such as fluoxetine (Prozac) and sertraline (Zoloft) for the treatment of bulimia. Bulimia also involves binge-eating behavior. These medications increase serotonin levels in the brain and are thought to affect the body's sense of fullness. They are used whether or not the patient shows signs of depression. SSRIs are often prescribed for people with binge-eating disorder. Appetitive suppressants are also sometimes prescribed to help control binge eating. Treatment is most successful when **group therapy** occurs in conjunction with **psychotherapy**.

### *Psychotherapy*

Psychologists are more likely to approach the problem of binge eating by using therapy that helps the individual change his or her behavior and by treating emotional and psychological problems that cause it. For them, treating obesity is secondary to treating the behavior and the thought patterns that cause it. Psychologists tend to think that once the individual understands and can control bingeing behavior, obesity will be easier to treat.

Some types of psychotherapy that have been successful in treating people with binge-eating disorder are:

- Cognitive behavior therapy (CBT) is designed to confront and then change the individual's thoughts and feelings about his or her body and behaviors toward food, but it does not address why those thoughts or feelings exist. Strategies to maintain self-control may be explored. This therapy is relatively short term.
- Interpersonal therapy is short-term therapy that helps the individual identify specific issues and problems in relationships. The individual may be asked to look at his or her family and personal history to try to recognize problem areas and to work toward resolving them.
- Dialectical behavior therapy consists of structured private and group sessions in which the therapist and patient(s) work at reducing behaviors that interfere with quality of life, finding alternate solutions to current problem situations, and learning to regulate emotions.
- Family therapy is helpful in treating children who are binge eaters. It teaches strategies to reduce conflict, disorder, and stress that may be factors in triggering binge eating.
- Some people with binge-eating disorder find self-help groups and structured weight-loss programs useful, while others do not.

#### *Nutrition and dietetic counseling*

People with binge-eating disorder understand that their eating pattern is abnormal and unhealthy. Nutrition counseling and meal planning can help bring weight under control, but they do not address the inability to control the impulse to binge. Nutrition counseling needs to be part of a broader treatment program that includes psychotherapy and possibly drug therapy.

#### *Alternative and complementary therapy*

Alternative treatment may focus on curbing the depression that is common in individuals who binge

eat. Herbal remedies that may ease the symptoms of depression include damiana (*Turnera diffusa*), **ginseng** (*Panax ginseng*), kola (*Cola nitida*), lady's slipper (*Cypripedium calceolus*), lavender (*Lavandula angustifolia*), lime blossom (*Tilia x vulgaris*), oats (*Avena sativa*), rosemary (*Rosmarinus officinalis*), skullcap (*Scutellaria laterifolia*), **St. John's wort** (*Hypericum perforatum*), valerian (*Valeriana officinalis*), and vervain (*Verbena officinalis*).

Binge-eating episodes that appear to be triggered by stress may be reduced by educating the individual in relaxation exercises and techniques, including aromatherapy, breathing exercises, **biofeedback**, **music therapy**, **yoga**, and massage. Herbs known as adaptogens may also be prescribed by an herbalist or holistic health-care professional. These herbs are thought to promote adaptability to stress, and include Siberian ginseng (*Eleutherococcus senticosus*), ginseng (*Panax ginseng*), wild yam (*Dioscorea villosa*), borage (*Borago officinalis*), licorice (*Glycyrrhiza glabra*), chamomile (*Chamaemelum nobile*), and nettles (*Urtica dioica*). Tonics of skullcap (*Scutellaria laterifolia*), and oats (*Avena sativa*), may also be recommended to ease anxiety.

## Prognosis

There is no clear prognosis for binge-eating disorder. Since stress often triggers bingeing, relapses are apt to occur in response to stressful life events. Some individuals find that simply seeking help improves their control over binge eating. For example, some studies have found that receiving a placebo is as effective as receiving medication. This is one reason why some parts of the medical community refuse to accept binge eating as a genuine disorder. Many studies are underway to test different approaches to treating binge eating. Individuals interested in participating in a clinical trial at no cost can find a list of studies currently enrolling volunteers at <http://www.clinicaltrials.gov>.

## Prevention

Since binge eating is difficult to detect, it is also difficult to prevent. Some prevention strategies are:

- Parents should not obsess about their weight, appearance, or diet in front of their children.
- Do not tease people about their body shapes or compare them to others.
- Make it clear that family members are loved and accepted as they are.
- Try to eat meals with others whenever possible; avoid eating alone.
- Avoid using food for comfort in times of stress.
- Monitor negative self-talk; practice positive self-talk.
- Spend time doing something enjoyable every day.

- Become aware of the situations that trigger a binge and look for ways to avoid or defuse them. Do not go on extreme diets.
- Be alert to signs of low self-worth, anxiety, depression, and drug or alcohol abuse and seek help as soon as these signs appear.

## Resources

### BOOKS

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- Mayo Clinic. "Binge Eating Disorder." Mayo Clinic Research and Education Foundation, February 28, 2008 [June 2, 2009] <http://www.mayoclinic.com/health/binge-eating-disorder/DS00608>
- Medline Plus. "Eating Disorders." U. S. National Library of Medicine, May 15, 2009 [June 2, 2009] <http://www.nlm.nih.gov/medlineplus/eatingdisorders.html>

### ORGANIZATIONS

- American Psychological Association, 750 First Street, NE, Washington, DC, 20002-4242, (202) 336-5500; TDD/TTY: (202) 336-6123, (800) 374-2721, [apa@psych.org](mailto:apa@psych.org), <http://www.apa.org>.
- National Association of Anorexia Nervosa and Related Eating Disorders (ANAD), P.O. Box 7, Highland Park, IL, 60035, (847) 831-3438, (847) 433-3996, <http://www.anad.org>.
- National Eating Disorders Association, 603 Stewart Street, Suite 803, Seattle, WA, 98101, (206) 382-3587 Help and Referral Line: (800) 931-2237, (206) 829-8501 [info@nationaleatingdisorders.org](mailto:info@nationaleatingdisorders.org), <http://www.nationaleatingdisorders.org>.

Tish Davidson, A.M.

## Biofeedback

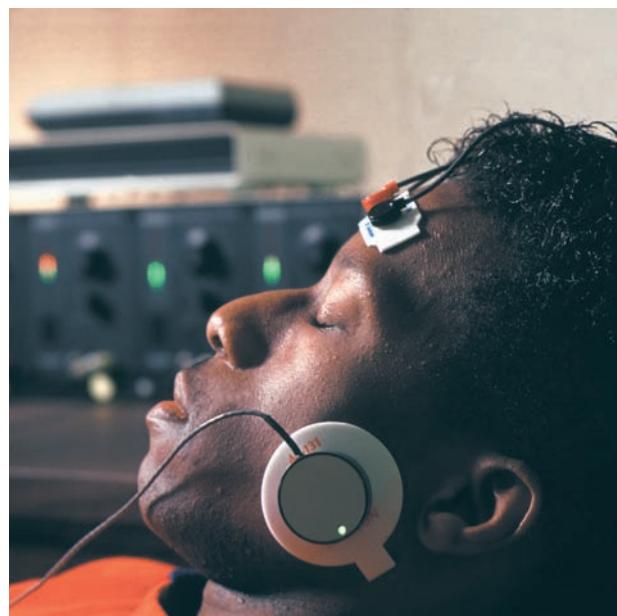
### Definition

Biofeedback, or applied psychophysiological feedback, is a patient-guided treatment that teaches an individual to control muscle tension, **pain**, body temperature, brain waves, and other bodily functions and processes through relaxation, visualization, and other cognitive control techniques. The name biofeedback refers to the biological signals that are fed back, or returned, to the patient in order for the patient to develop techniques of manipulating them.

### Purpose

Biofeedback has been used to successfully treat a number of disorders and their symptoms, including temporomandibular joint disorder (TMJ), chronic pain, **irritable bowel syndrome** (IBS), Raynaud's syndrome, **epilepsy**, attention-deficit hyperactivity disorder (**ADHD**), migraine headaches, **anxiety**, depression, traumatic brain injury, and **sleep disorders**.

Illnesses that may be triggered at least in part by **stress** are also targeted by biofeedback therapy. Certain types of headaches, high blood pressure, **bruxism** (teeth grinding), **post-traumatic stress disorder**, **eating disorders**, **substance abuse**, and some **anxiety disorders** may be treated successfully by teaching patients the ability to relax and release both muscle and mental tension. Biofeedback is often just one part



**A patient undergoing biofeedback therapy.** (Photo Researchers, Inc.)

of a comprehensive treatment program for some of these disorders.

NASA has used biofeedback techniques to treat astronauts who suffer from severe space sickness, during which the autonomic nervous system is disrupted. Scientists at the University of Tennessee have adapted these techniques to treat individuals suffering from severe **nausea and vomiting** that is also rooted in autonomic nervous system dysfunction.

Recent research also indicates that biofeedback may be a useful tool in helping patients with **urinary incontinence** regain bladder control. Individuals learning pelvic-floor muscle strengthening exercises can gain better control over these muscles by using biofeedback. Sensors are placed on the muscles to train the patient where they are and when proper contractions are taking place.

### Description

#### Origins

In 1961, Neal Miller, an experimental psychologist, suggested that autonomic nervous system responses (for instance, heart rate, blood pressure, gastrointestinal activity, regional blood flow) could be under voluntary control. As a result of his experiments, he showed that such autonomic processes were controllable. This work led to the creation of biofeedback therapy. Willer's work was expanded by other researchers. Thereafter, research performed in the 1970s by UCLA researcher Dr. Barry Sterman established that both cats and monkeys could be trained to control their brain wave patterns. Sterman then used his research techniques on human patients with epilepsy, where he was able to reduce seizures by 60% with the use of biofeedback techniques. Throughout the 1970s, other researchers published reports of their use of biofeedback in the treatment of cardiac **arrhythmias**, headaches, Raynaud's syndrome, and excess stomach acid, and as a tool for teaching deep relaxation. Since the early work of Miller and Sterman, biofeedback has developed into a frontline behavioral treatment for an even wider range of disorders and symptoms.

During biofeedback, special sensors are placed on the body. These sensors measure the bodily function that is causing the patient problem symptoms, such as heart rate, blood pressure, muscle tension (EMG or electromyographic feedback), brain waves (EEG or electroencephalographic feedback), respiration, and body temperature (thermal feedback), and translates the information into a visual and/or audible readout, such as a paper tracing, a light display, or a series of beeps.

While the patient views the instantaneous feedback from the biofeedback monitors, he or she begins to recognize what thoughts, fears, and mental images influence his or her physical reactions. By monitoring this relationship between mind and body, the patient can then use these same thoughts and mental images as subtle cues, as these act as reminders to become deeply relaxed, instead of anxious. These reminders also work to manipulate heartbeat, brain wave patterns, body temperature, and other bodily functions. This is achieved through relaxation exercises, mental imagery, and other cognitive therapy techniques.

As the biofeedback response takes place, patients can actually see or hear the results of their efforts instantly through the sensor readout on the biofeedback equipment. Once these techniques are learned and the patient is able to recognize the state of relaxation or visualization necessary to alleviate symptoms, the biofeedback equipment itself is no longer needed. The patient then has a powerful, portable, and self-administered treatment tool to deal with problem symptoms.

Biofeedback that specializes in reading and altering brain waves is sometimes called *neurofeedback*. The brain produces four distinct types of brain waves—delta, theta, alpha, and beta—that all operate at a different frequency. Delta, the slowest frequency wave, is the brain wave pattern associated with sleep. Beta waves, which occur in a normal, waking state, can range from 12–35 Hz. Problems begin to develop when beta wave averages fall in the low end (underarousal) or the high end (overarousal) of that spectrum. Underarousal might be present in conditions such as depression or attention-deficit disorder, and overarousal may be indicative of an anxiety disorder, obsessive-compulsive disorder, or excessive stress. Beta wave neurofeedback focuses on normalizing that beta wave pattern to an optimum value of around 14 Hz. A second type of neurofeedback, alpha-theta, focuses on developing the more relaxing alpha (8–13 Hz) and theta waves (4–9 Hz) that are usually associated with deep, meditative states, and has been used with some success in substance abuse treatment.

Through brain wave manipulation, neurofeedback can be useful in treating a variety of disorders that are suspected or proven to impact brain wave patterns, such as epilepsy, attention-deficit disorder, migraine headaches, anxiety, depression, traumatic brain injury, and sleep disorders. The equipment used for neurofeedback usually uses a monitor as an output device. The monitor displays specific patterns that the patient attempts to change by producing the appropriate type of brain wave. Or, the monitor may reward the patient for producing the appropriate brain wave by producing

a positive reinforcer, or reward. For example, children may be rewarded with a series of successful moves in a displayed video game.

Depending on the type of biofeedback, individuals may need up to 30 sessions with a trained professional to learn the techniques required to control their symptoms on a long-term basis. Therapists usually recommend that their patients practice both biofeedback and relaxation techniques on their own at home.

## Preparations

Before initiating biofeedback treatment, the therapist and patient will have an initial consultation to record the patient's medical history and treatment background and discuss goals for therapy.

Before a neurofeedback session, an EEG is taken from the patient to determine his or her baseline brain-wave pattern.

Biofeedback typically is performed in a quiet and relaxed atmosphere with comfortable seating for the patient. Depending on the type and goals of biofeedback being performed, one or more sensors will be attached to the patient's body with conductive gel and/or adhesives. These may include:

- Electromyographic (EMG) sensors. EMG sensors measure electrical activity in the muscles, specifically muscle tension. In treating TMJ or bruxism, these sensors would be placed along the muscles of the jaw. Chronic pain might be treated by monitoring electrical energy in other muscle groups.
- Galvanic skin response (GSR) sensors. These are electrodes placed on the fingers that monitor perspiration, or sweat gland, activity.
- Temperature sensors. Temperature, or thermal, sensors measure body temperature and changes in blood flow.
- Electroencephalography (EEG) sensors. These electrodes are applied to the scalp to measure the electrical activity of the brain, or brain waves.
- Heart rate sensors. A pulse monitor placed on the finger tip can monitor pulse rate.
- Respiratory sensors. Respiratory sensors monitor oxygen intake and carbon dioxide output.

## Precautions

Individuals who use a pacemaker or other implantable electrical devices should inform their biofeedback therapist before starting treatments, as certain types of biofeedback sensors have the potential to interfere with these devices.

Biofeedback may not be suitable for some patients. Patients must be willing to take a very active role in the treatment process. And because biofeedback focuses strictly on behavioral change, those patients who wish to gain insight into their symptoms by examining their past might be better served by psychodynamic therapy.

Biofeedback may also be inappropriate for cognitively impaired individuals, such as those patients with organic brain disease or a traumatic brain injury, depending on their levels of functioning.

Patients with specific pain symptoms of unknown origin should undergo a thorough medical examination before starting biofeedback treatments to rule out any serious underlying disease. Once a diagnosis has been made, biofeedback can be used concurrently with conventional treatment.

Biofeedback may only be one component of a comprehensive treatment plan. For illnesses and symptoms that are manifested from an organic disease process, such as **cancer** or diabetes, biofeedback should be an adjunct to (complementary to), and not a replacement for, conventional medical treatment.

### Side effects

There are no known side effects to properly administered biofeedback or neurofeedback sessions.

### Research and general acceptance

Preliminary research indicates that neurofeedback may be a promising new tool in the treatment of **schizophrenia**. Researchers reported that schizophrenic patients had used neurofeedback to simulate brain wave patterns that antipsychotic medications produce in the brain. Further research is needed to determine what impact this may have on treatment for schizophrenia.

The use of biofeedback techniques to treat an array of disorders has been extensively described in the medical literature. Controlled studies for some applications are limited, such as for the treatment of menopausal symptoms and premenstrual disorder (PMS). There is also some debate over the effectiveness of biofeedback in ADHD treatment, and the lack of controlled studies on that application. While many therapists, counselors, and mental health professionals have reported great success with treating their ADHD patients with neurofeedback techniques, some critics attribute this positive therapeutic impact to a placebo effect.

There may also be some debate among mental health professionals as to whether biofeedback should be considered a first line treatment for some mental

illnesses, and to what degree other treatments, such as medication, should be employed as an adjunct therapy.

### Resources

#### BOOKS

Field, Tiffany. *Complementary and Alternative Therapies Research*. Washington, DC: American Psychological Association, 2009.

#### ORGANIZATIONS

Association for Applied Psychophysiology and Biofeedback, 10200 W. 44th Avenue, Suite 304, Wheat Ridge, CO, 80033, (303) 422-8436, (800) 477-8892, [aapb@resourcecenter.com](mailto:aapb@resourcecenter.com), <http://www.aapb.org>.

Biofeedback Certification Institute of America, 10200 W. 44th Avenue, Suite 310, Wheat Ridge, CO, 80033-2840, (303) 420-2902, (303) 422-8894, (866) 908-8713, [info@bcia.org](mailto:info@bcia.org), <http://www.bcia.org/>.

Paula Anne Ford-Martin

**Biopsy** see **Bone biopsy; Bone marrow aspiration and biopsy; Brain biopsy; Breast biopsy; Cervical conization; CT-guided biopsy; Endometrial biopsy; Joint biopsy; Kidney biopsy; Liver biopsy; Lung biopsy; Lymph node biopsy; Myocardial biopsy; Pleural biopsy; Prostate biopsy; Skin biopsy; Small intestine biopsy; Thyroid biopsy**

## Bipolar disorder

### Definition

Bipolar disorder, formerly known as manic depression, is a psychiatric disorder characterized by severe and unusual changes in energy level, mood, and interactions with others. The mood swings associated with bipolar disorder are unpredictable and range from **mania** (elevated or irritable mood) to depression (a mood characterized by loss of interest and sadness). Bipolar disorder causes significant impairment in social, occupational, and general functioning.

### Demographics

According to the National Institutes of Mental Health (NIMH), in 2008 the lifetime prevalence rate of bipolar disorder in the United States was 1–1.6%. Other statistics suggest that 1.0% of the population has bipolar disorder type I, and 1.1% of the population has bipolar disorder type II. About another 2.4–4.7% of

the population has subthreshold bipolar disorder, meaning that they show characteristics of the disorder that do not rise to the level of formal diagnosis. Internationally the lifetime prevalence of reported bipolar disorder ranges from 0.3–1.5%.

No racial differences in distribution exist. While bipolar type I occurs equally in both sexes, bipolar II and rapid-cycling bipolar disorder are more common in females than in males. The average age of onset of bipolar disorder is 25; however, about 1% of adolescents and between 0.2% and 0.4% of children have been diagnosed with the bipolar disorder. Controversy exists about diagnosing the disorder in these groups. Because of the complexity of the disorder, a correct diagnosis can be delayed, and between 20% and 30% of adults with bipolar disorder report having undiagnosed symptoms in childhood or adolescence.

## Description

Bipolar disorder is characterized by alternating manic episodes in which the individual feels abnormally euphoric, optimistic, and energetic, and depressive periods in which the individual feels sad, hopeless, guilty, and sometimes suicidal. Manic or depressive periods may last for days, weeks, or months and run the spectrum from mild to severe. These episodes may be separated by periods of emotional stability in which the individual functions normally.

Bipolar I disorder is characterized by at least one manic episode without a major depressive episode. Manic episodes are the “high” of the manic-depressive cycle. A person experiencing a manic episode often has feelings of self-importance, elation, talkativeness, increased sociability, and a desire to embark on goal-oriented activities, coupled with the characteristics of irritability, impatience, impulsiveness, hyperactivity, and a decreased need for sleep. Usually this manic period is followed by a period of severe depression, although a few individuals may not experience a major depressive episode. Mixed states, where both manic or hypomanic symptoms and depressive symptoms occur at the same time, also may occur (e.g., racing thoughts of mania with the listlessness of depression). Also, dysphoric mania is common particularly in adolescents. This is mania characterized by anger and irritability.

Bipolar II disorder is characterized by major depressive episodes alternating with episodes of hypomania, a milder form of mania. A bipolar depressive episode may be difficult to distinguish from a unipolar major depressive episode. Patients with bipolar depression tend to have extremely low energy, slowed mental and physical processes, and more profound

**fatigue** (for example, hypersomnia, a sleep disorder marked by a need for excessive sleep or sleepiness when awake) than people with unipolar depression.

Cyclothymia refers to the cycling of hypomanic episodes with less severe depression that does not reach major depressive proportions. Some people with cyclothymia develop bipolar I or II disorder later in life.

A phenomenon known as rapid cycling occurs in up to 20% of bipolar individuals. In rapid cycling, at least four manic and depressive mood swings must occur within 12 months. In some cases of ultra-rapid cycling, the individual may bounce between manic and depressive states several times within a 24-hour period. This condition is very hard to distinguish from mixed states.

## Risk factors

According to the Mayo Clinic, 60% of bipolar cases have a family history of the disease. The Child and Adolescent Bipolar Foundation (CABF) reports that the risk for a child of one bipolar parent to develop the disorder is 15%–30%. If both parents have bipolar disorder, the risk for each child increases to 50%–75%. The risk in siblings and fraternal twins is 15%–25%. The risk in identical twins, who share the same genes, is approximately 70%. Research in identical twins indicates that both genes and other factors play a role in developing bipolar disorder.

Women who have given birth may also be at increased risk of developing subsequent episodes in the immediate period after giving birth.

## Causes and symptoms

### Possible causes

Although the source of bipolar disorder has not been clearly identified, a number of genetic and environmental factors appear to be involved in triggering episodes. Bipolar disorder has an inherited component. As noted above, children who have at least one parent with bipolar disorder are more likely to develop the disorder. They are also more likely to be diagnosed with other psychiatric disorders such as attention deficit/hyperactivity disorder (**ADHD**). Several studies have uncovered possible genetic connections to the predisposition for bipolar disorder. A large study done in Sweden reported in 2009 that **schizophrenia** and bipolar disorder appeared to share similar genetic causes.

No specific gene mutations have been identified that consistently show up in bipolar patients. However, there appears to be a potential genetic correlation between bipolar disorder and mutations in specific regions of chromosomes 13, 18, and 21. The building blocks of

genes, called nucleotides, are normally arranged in a specific order and quantity. If these nucleotides are repeated in a redundant fashion, a genetic abnormality often results. Some evidence exists for an abnormal type of nucleotide sequence (CAG/CTG repeats) on chromosome 18 in patients with bipolar II disorder. However, not all bipolar patients have this mutation, and the presence of this sequence does not worsen the disorder or change the age of onset.

People with bipolar disorder tend to have other psychiatric disorders. **Oppositional defiant disorder** (ODD) and **ADHD** are among the most common. Over half of patients diagnosed with bipolar disorder have a history of **substance abuse**. A high rate of association exists between **cocaine** abuse and bipolar disorder. The emotional and physical highs and lows of cocaine use correspond to the manic depression cycle of the bipolar patient, making the disorder difficult to diagnoses.

For some bipolar patients, manic and depressive episodes coincide with seasonal changes. Depressive episodes are typical during winter and fall, and manic episodes are more probable in the spring and summer months.

Brain imaging studies suggest that there are physical changes in the brains of people with bipolar disorder. It is hypothesized that dopamine and other neurotransmitters involved in mood may be involved. The possible role of hormonal imbalances in bipolar disorder is another area of investigation. Further research is needed to determine which genes are involved in bipolar disorder. It is likely that both genetic and environmental factors contribute to the disease.

### Symptoms

Bipolar disorder causes recurrent dramatic mood swings that range from a manic high to a depressive low. There are often periods of normal mood in between episodes of mania and depression. Severe changes in energy and behavior accompany the swings in mood.

Manic episode symptoms include:

- increased energy, activity, and restlessness
- excessively high, euphoric mood
- extreme irritability and reactivity
- racing thoughts and fast speech that jump from one topic to another, known as flight of ideas
- distractibility due to unimportant events and the inability to concentrate
- reduced perceived need for sleep

- unrealistic beliefs in one's abilities, powers, or importance
- poor judgment and impulsive behaviors
- increased sexual drive
- provocative, intrusive, or aggressive behavior
- denial that anything is wrong

Depressive episode symptoms include:

- persistent sad, anxious, or empty mood
- feelings of irritability, hopelessness, or negative mood
- feelings of guilt, worthlessness, or helplessness
- inability to take pleasure in activities
- fatigue
- inability to concentrate
- extreme sleep patterns
- extreme appetite changes that result in weight change
- chronic pain or physical discomfort in the absence of physical illness or injury
- thoughts of or attempts at suicide

Some people with bipolar II disorder have depressive episodes concurrent with mood reactivity (mood improves with positive event), and can switch from depression to hypomania. Hypomania is characterized by a mild or moderate level of mania. Because hypomania is less severe, it may be associated with increased functioning and enhanced productivity. However, hypomania is not a normal state of mind. Without proper treatment, hypomania may eventually progress into severe mania or switch into depression. Severe episodes of mania or depression may also include symptoms of **psychosis**. Psychotic symptoms include visual or auditory **hallucinations** and **delusions** (illogical, false, but strongly held beliefs). Psychotic symptoms in bipolar disorder tend to reflect the current extreme mood episode. During mania, psychotic delusions may include grandiosity, such as believing one has special powers of flight or extreme financial wealth or power. During depressive episodes, delusions may include paranoid fears of being poisoned or the belief that one has committed a terrible crime. Because of these psychotic symptoms, bipolar disorder is sometimes mistaken for schizophrenia.

Some people with bipolar disorder present with a mixed state of symptoms. A mixed bipolar state is characterized by symptoms of agitation, sleeplessness, appetite changes, psychosis, and suicidal tendencies. A depressed and hopeless mood may occur in conjunction with extreme energy. Signs of bipolar disorder may also be demonstrated outside of mental illness symptoms in behaviors such as alcohol or drug abuse, poor work performance, strained interpersonal

## KEY TERMS

**Cyclothymia**—A milder form of bipolar disorder characterized by alternating hypomania and less severe depressive episodes.

**Dopamine**—A neurotransmitter and the precursor of norepinephrine.

**Neuroprotective**—Conveying some form of protection to the nervous system from injury.

**Neurotransmitter**—One of a group of chemicals secreted by a nerve cell (neuron) to carry a chemical message to another nerve cell, often as a way of transmitting a nerve impulse. Examples of neurotransmitters include acetylcholine, dopamine, serotonin, and norepinephrine.

**Nucleotides**—Building blocks of genes, which are arranged in specific order and quantity.

**Off-label use**—Drugs in the United States are approved by the Food and Drug Administration

(FDA) for specific uses, periods of time, or dosages based on the results of clinical trials. However, it is legal for physicians to administer these drugs for other “off label” or non-approved uses. It is not legal for pharmaceutical companies to advertise drugs for off-label uses.

**Rapid cycling**—Four or more manic, hypomanic, mixed, or depressive episodes within a 12-month period.

**Schizophrenia**—A severe mental disorder in which a person loses touch with reality and may have illogical thoughts, delusions, hallucinations, behavioral problems and other disturbances.

**Selective serotonin reuptake inhibitors (SSRIs)**—A class of antidepressants that work by blocking the reabsorption of serotonin in brain cells, raising the level of the chemical in the brain. SSRIs include Prozac, Zoloft, Luvox, and Paxil.

relationships, or excessive promiscuity. Symptoms of bipolar disorder with postpartum onset usually occur within four weeks after **childbirth**. Bipolar disorder with a seasonal pattern displays symptoms related to seasonal change and latitude. The prevalence of the season-specific bipolar symptoms increases with higher latitudes and winter months.

Bipolar symptoms often present differently in children and adolescents. Manic episodes in these age groups are typically characterized by more psychotic features than in adults, which may lead to a misdiagnosis of schizophrenia. Children and adolescents also tend toward irritability and aggressiveness instead of elation. Further, symptoms tend to be chronic (ongoing), rather than acute (episodic). Bipolar children are easily distracted, impulsive, and hyperactive, which can lead to a misdiagnosis of ADHD. Furthermore, their aggression often leads to violence, which may be misdiagnosed as a **conduct disorder**. Complicating the picture is that ADHD and conduct disorders are often present concurrently in children with bipolar disorder.

### Diagnosis

Bipolar disorder usually is diagnosed and treated by a psychiatrist and/or a psychologist with medical assistance. In addition to an interview, several clinical inventories or scales may be used to assess the patient’s mental status and determine the presence of bipolar

symptoms. These include the Millon Clinical Multiaxial Inventory III (MCMI-III), **Minnesota Multiphasic Personality Inventory II (MMPI-2)**, the Internal State Scale (ISS), the Self-Report Manic Inventory (SRMI), and the Young Mania Rating Scale (YMRS). The tests are verbal and/or written and are administered in both hospital and outpatient settings. Laboratory tests for drug and alcohol may be done to rule out other causes of the behavior.

Psychologists and psychiatrists typically use the criteria listed in the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition Text Revision (DSM-IV-TR)* published by the American Psychiatric Association to definitively diagnose bipolar disorder. The *DSM-IV-TR* describes a manic episode as an abnormally elevated or irritable mood lasting a period of at least one week that is distinguished by at least three of the mania symptoms: inflated self-esteem, decreased need for sleep, talkativeness, racing thoughts, distractibility, increase in goal-directed activity, or excessive involvement in pleasurable activities that have a high potential for painful consequences. If the mood of the patient is irritable and not elevated, four of the symptoms are required.

Although some clinicians find the criteria too rigid, a hypomanic diagnosis requires a duration of at least four days with at least three of the symptoms indicated for manic episodes (four if mood is irritable and not elevated). The *DSM-IV-TR* notes that unlike

manic episodes, hypomanic episodes do not cause a marked impairment in social or occupational functioning, do not require hospitalization, and do not have psychotic features. In addition, because hypomanic episodes are characterized by high energy and goal-directed activities, often result in a positive outcome, and are perceived in a positive manner by the patient (e.g., as a time of heightened creativity or work output), bipolar II disorder can go undiagnosed.

Substance abuse, thyroid disease, and use of prescription or over-the-counter medication can mask or mimic the presence of bipolar disorder. In cases of substance abuse, the patient must undergo a period of **detoxification** and abstinence before a mood disorder is diagnosed and treatment begins.

## Treatment

### Drugs

Medication is the most effective treatment for bipolar disorder. A combination of mood stabilizing agents with antidepressants, antipsychotics, and anti-convulsants may be used for long-term regulation of manic and depressive episodes. In the acute phase, the choice of medication for bipolar disorder is dependent on the stage or type of current episode. Many drugs are used to treat an acute manic episode, primarily the antipsychotics and **benzodiazepines** (e.g., lorazepam, clonazepam). In the presence of psychotic symptoms, atypical antipsychotics may be used to treat psychotic symptoms and acute mania, and may contribute to mood stabilization. For depressive episodes, antidepressants may be used. Medications may be added temporarily, to treat episodes of mania or depression that break through despite mood-stabilizer treatment.

Mood stabilizing drugs dampen the extremes of manic and depressive episodes. Lithium (Cibalith-S, Eskalith, Lithane, Lithobid, Lithonate, Lithotabs) was the first mood stabilizer approved by the United States Food and Drug Administration (FDA) for the treatment of mania and the prevention of both manic and depressive episodes. Lithium is a first-line medication used in the long-term preventative treatment of extreme mood episodes in bipolar disorder. It has been demonstrated to play a neuroprotective role in brain function. Because lithium takes up to ten days to reach a therapeutic level in the bloodstream, it sometimes is prescribed in conjunction with neuroleptics and/or benzodiazepines to provide more immediate relief of a manic episode. Lithium also has been shown to be effective in regulating bipolar depression, but it is not recommended for mixed mania. Lithium may not be an effective long-term treatment option for rapid cyclers,

who typically develop a tolerance for it or may not respond to it. Possible side effects of the drug include weight gain, thirst, **nausea**, and hand **tremors**. Prolonged lithium use also may cause **hyperthyroidism** (a disorder in which the thyroid is overactive, which may cause heart **palpitations**, nervousness, the presence of **goiter**, sweating, and a wide array of other symptoms) and abnormalities in liver function.

In addition to lithium, the following drugs are commonly used to treat bipolar disorders:

- Carbamazepine (Tegretol, Atretol) is an anticonvulsant drug often prescribed in conjunction with other mood stabilizing agents. The drug may be used to treat bipolar patients who have not responded well to lithium therapy. Blurred vision and abnormal eye movement are two possible side effects of carbamazepine therapy.
- Valproate (divalproex sodium, or Depakote; valproic acid, or Depakene) is one of the few drugs available that has been proven effective in treating rapid cycling bipolar and mixed states patients. Valproate is prescribed alone or in combination with carbamazepine and/or lithium. Stomach cramps, indigestion, diarrhea, hair loss, appetite loss, nausea, and unusual weight loss or gain are some of the common side effects of valproate.
- Risperidone (Risperdal) may be used for short-term (usually no more than 3 weeks) treatment of acute mania associated with bipolar disorder. It may be given in conjunction with lithium or valproate. Side effects include weight gain, sedation, and abnormally low blood pressure upon rising from lying down (orthostatic hypotension).
- Quetiapine (Seroquel) is a newer antipsychotic that acts on neurotransmitters in the brain. It appears to have fewer side effects than some of the older antipsychotics.
- Olanzapine (Zyprexa, Zydis) may be used to treat acute manic episodes in individuals with bipolar I. Its mechanism of action is not clear. Side effects include orthostatic hypotension (low blood pressure when rising to a standing position).
- Symbyax, a combination of olanzapine and fluoxetine, was approved by the FDA in 2004 as the first drug to specifically treat bipolar disorder.

Because antidepressants may stimulate manic episodes in some bipolar patients, their use in bipolar disorder, once common, is now controversial. They are typically used as short-term treatment. Antidepressants are not specifically approved for treating depression associated with bipolar disorder but may be prescribed off-label. **Selective serotonin reuptake inhibitors**

(SSRIs) or, less often, **monoamine oxidase inhibitors** (MAO inhibitors) may be prescribed for episodes of bipolar depression. **Tricyclic antidepressants** used to treat unipolar depression may trigger rapid cycling in bipolar patients and are, therefore, not a preferred treatment option for bipolar depression. Antidepressants commonly prescribed for bipolar disorder include:

- SSRIs such as fluoxetine (Prozac), sertraline (Zoloft), and paroxetine (Paxil) regulate depression by regulating levels of serotonin, a neurotransmitter. Anxiety, diarrhea, drowsiness, headache, sweating, nausea, sexual problems, and insomnia are all possible side effects of SSRIs.
- MAOIs such as tranylcypromine (Parnate) and phenelzine (Nardil) block the action of monoamine oxidase (MAO), an enzyme in the central nervous system. Patients taking MAOIs must cut foods high in tyramine (found in aged cheeses and meats) out of their diet to avoid hypotensive side effects.
- Bupropion (Wellbutrin) is a heterocyclic antidepressant. The exact neurochemical mechanism of the drug is not known, but it has been effective in regulating bipolar depression in some patients. Side effects of bupropion include agitation, anxiety, confusion, tremor, dry mouth, fast or irregular heartbeat, headache, and insomnia.

Other drugs may be used in conjunction with a long-term pharmaceutical treatment plan.

- Long-acting benzodiazepines such as clonazepam (Klonopin) and alprazolam (Xanax) may be used for rapid treatment of manic symptoms to calm and sedate patients until mania or hypomania have waned and mood-stabilizing agents can take effect. Sedation is a common effect, and clumsiness, light-headedness, and slurred speech are other possible side effects of benzodiazepines.
- Neuroleptics such as chlorpromazine (Thorazine) and haloperidol (Haldol) also may be used to control mania while a mood stabilizer such as lithium or valproate takes effect. Because neuroleptic side effects can be severe (difficulty in speaking or swallowing, paralysis of the eyes, loss of balance control, muscle spasms, severe restlessness, stiffness of arms and legs, tremors in fingers and hands, twisting movements of body, and weakness of arms and legs), benzodiazepines are generally preferred over neuroleptics.
- Clozapine (Clozaril) is an atypical antipsychotic medication used to control manic episodes in patients who have not responded to typical mood stabilizing agents. The drug has also been a useful prophylactic, or preventative treatment, in some bipolar patients. Common side effects of clozapine include tachycardia (rapid

heart rate), hypotension, constipation, and weight gain. Agranulocytosis, a potentially serious but reversible condition in which the white blood cells that typically fight infection in the body are destroyed, is a possible side effect of clozapine. Patients treated with the drug should undergo weekly blood tests to monitor white blood cell counts.

### *Electroconvulsive therapy*

**Electroconvulsive therapy** (ECT) has been successful in treating both unipolar and bipolar depression and mania. However, ECT usually is employed after all pharmaceutical treatment options have been explored in patients with severe depression and suicidal thoughts. ECT is given under anesthesia and patients are given a muscle relaxant medication to prevent convulsions. The treatment consists of a series of electrical pulses that move into the brain through electrodes on the patient's head. Although the exact mechanisms behind the success of ECT therapy are not known, it is believed that this electrical current alters the electrochemical processes of the brain, consequently relieving depression. Headaches, muscle soreness, nausea, and confusion are possible side effects immediately following an ECT procedure. Temporary **memory loss** has also been reported in ECT patients. In bipolar patients, ECT is often used in conjunction with drug therapy.

### *Psychosocial interventions*

Psychosocial interventions include both patient education and **psychotherapy**. It is important for patients to receive social support and illness management skills. Family and friends must be aware of the high rates of social dysfunction and marital discord. Involvement in national support groups is advisable (i.e., National Depressive and Manic-Depressive Association).

Psychoeducation usually focuses on all of the following:

- assessment of what parameters will have an impact on the outcome of patient's disease
- implementing the boundaries and requirements of treatment
- implementation of a personal cost-benefit analysis concerning specific treatment directions
- implementing a follow-up program
- implementing future directions, which may include adjustment or change interventions

**Genetic counseling** should be included in family education programs since the predisposition for this

disorder has been genetically proven to increase among first-degree relatives.

### **Alternative and complementary treatment**

Alternative treatments for bipolar disorder generally are complementary treatments to conventional therapies. General recommendations for controlling bipolar symptoms include maintaining a calm environment, avoiding overstimulation, getting plenty of rest, regular **exercise**, and eating a healthy diet.

Chinese herbs may help to soften mood swings. **Traditional Chinese medicine** (TCM) remedies are prescribed based on the patient's overall constitution and the presentation of symptoms. These remedies can help to stabilize moods, not just treat swings in mood. A TCM practitioner might recommend a mixture called the Iron Filings Combination, which includes the Chinese herbs asparagus, ophiopogon, fritillaria, arisaema, orange peel, polygala, acorus, forsythia, hoelen, fu-shen, scrophularia, uncaria stem, salvia, and iron filings, to treat certain types of mania in the bipolar patient. There are other formulas for depression. A trained practitioner should guide all of these remedies.

**Acupuncture** can be used for treatment to help maintain a more even temperament.

**Biofeedback** is effective in helping some patients control symptoms such as irritability, poor self-control, racing thoughts, and sleep problems.

A diet low in vanadium, a mineral found in meats and other foods, and high in vitamin C may be helpful in reducing depression.

Individuals using herbal remedies in addition to traditional pharmaceuticals should tell their physician, as some herbal remedies interact with conventional drugs, either heightening or depressing their effect. Recommended herbal remedies to ease depressive episodes may include damania (*Turnera diffusa*), **ginseng** (*Panax ginseng*), kola (*Cola nitida*), lady's slipper (*Cypripedium calceolus*), lavender (*Lavandula angustifolia*), lime blossom (*Tilia x vulgaris*), oats (*Avena sativa*), rosemary (*Rosmarinus officinalis*), skullcap (*Scutellaria laterifolia*), **St. John's wort** (*Hypericum perforatum*), valerian (*Valeriana officinalis*), and vervain (*Verbena officinalis*).

### **Prognosis**

While most patients will show some positive response to treatment, response varies widely, from full recovery to a complete lack of response to all drug and/or ECT therapy. Drug therapies frequently need adjustment to achieve the maximum benefit for

the patient. Bipolar disorder is a chronic, recurrent illness in over 90% of people with the disorder. The disorder requires lifelong observation and treatment after diagnosis. According to the World Health Organization, bipolar disorder is the sixth leading cause of disability worldwide.

**Suicide** is the major complication of bipolar disorder, and is related to the duration of the depressive episode. Between 25% and 50% of individuals with bipolar disorder attempt suicide, and 11% complete the suicide attempt. The longer the depressive episode lasts, the higher the risk of suicidal tendencies. Alcoholics and patients with other chronic medical diseases are particularly prone to planning and implementing a suicide attempt.

The four main groups that are likely to carry out a suicide attempt include the following:

- Individuals who are overwhelmed by life problems. Suicide attempts in this group tend to be related to aggression and impulsive behaviors, not significant depressive episodes.
- Individuals who are attempting to control others.
- Individuals who are chronically ill with another medical disease.
- Individuals with other severe types of psychotic illness, delusions, and paranoia.

### **Prevention**

The ongoing medical management of bipolar disorder is critical to preventing relapse, or recurrence, of manic episodes. Even in carefully controlled treatment programs, bipolar patients may experience recurring episodes of the disorder. Patient education in the form of psychotherapy or self-help groups is crucial for training bipolar patients to recognize signs of mania and depression and to take an active part in their treatment program.

### **Resources**

#### **BOOKS**

Mondimore, Francis M. *Bipolar Disorder: A Guide for Patients and Families*. 2nd ed. Baltimore: Johns Hopkins University Press, 2006.

#### **OTHER**

"Bipolar Disorder." *MedlinePlus*. January 19, 2009 [cited January 28, 2009]. <http://www.nlm.nih.gov/medlineplus/bipolardisorder.html>

"Bipolar Disorder." *National Institute of Mental Health*. April 2, 2008 [cited January 28, 2009]. <http://www.nimh.nih.gov/health/topics/bipolar-disorder/index.shtml>

## ORGANIZATIONS

American Academy of Child and Adolescent Psychiatry (AACAP), 3615 Wisconsin Ave. NW, Washington, DC, 20013-3007, (202) 966-7300, (202) 966-2891, communications@aacap.org, http://www.aacap.org/.  
 American Psychiatric Association (APA), 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209, (888) 357-7924, apa@psych.org, http://www.psych.org.  
 Depression and Bipolar Support Alliance, 730 N. Franklin Street, Suite 501, Chicago, IL, 60654-7225, (312) 642-7243, (800) 826-3632, info@dbsalliance.org, http://www.dbsalliance.org.  
 Mental Health America, 2000 N. Beauregard Street, 6th Floor, Alexandria, VA, 22311, (703) 684-7722, (703) 684-5968, (800) 969-6642, infoctr@mentalhealthamerica.net, http://www.mentalhealthamerica.net.  
 National Institute of Mental Health, 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD, 20892-9663, (301) 443-4513, TTY (301) 443-8431, (866) 615-6464, TTY (866) 415-8051, (301) 443-4279, http://www.nimh.nih.gov.

Maria Basile, Ph.D.  
 Tish Davidson, A.M.

Bird flu see **Avian flu**

Birth control see **Diaphragm (birth control); Condom; Contraception**

Birth control pills see **Oral contraceptives**



**Congenital absence of three fingers.** Deformities such as this are usually caused by damage to the developing fetus *in utero*. (Dr. P. Marazzi/Photo Researchers, Inc.)

two or more defects tend to appear together but do not share the same cause, they are called associations.

## Causes and symptoms

The specific cause of many congenital abnormalities is unknown, but several factors associated with **pregnancy** and delivery can increase the risk of birth defects.

### Teratogens

Any substance that can cause abnormal development of the egg in the mother's womb is called a teratogen. In the first two months after conception, the developing organism is called an embryo; developmental stages from two months to birth are called fetal. Growth is rapid, and each body organ has a critical period in which it is especially sensitive to outside influences. About 7% of all congenital defects are caused by exposure to teratogens.

**DRUGS.** Only a few drugs are known to cause birth defects, but all have the potential to cause harm. For example, in 2003, a study found that use of topical (local) **corticosteroids** in the first trimester of pregnancy may be associated with **cleft lip**. Thalidomide is known to cause defects of the arms and legs; several other types also cause problems, such as:

<b>Prevalence of common birth defects</b>	
Type of defect	Number of infants affected worldwide
Congenital heart defects	1 in 100–200
Down syndrome	1 in 800
Neural tube defects (e.g., spina bifida, anencephaly)	1 in 1,000
Orofacial clefts (e.g., cleft lip, cleft palate)	1 in 700–1,000

SOURCE: Centers for Disease Control and Prevention, "Birth Defects: Frequently Asked Questions." Available online at: <http://www.cdc.gov/ncbddd/bd/faq1.htm> (accessed September 23, 2010).

(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

- Alcohol. Drinking large amounts of alcohol while pregnant causes a cluster of defects called fetal alcohol syndrome, which includes mental retardation, heart problems, and growth deficiency. Binge drinking early in pregnancy is dangerous even if the woman quits drinking later.
- Antibiotics. Certain antibiotics are known teratogens. Tetracycline affects bone growth and discolors the teeth. Drugs used to treat tuberculosis can lead to hearing problems and damage to a nerve in the head (cranial damage).
- Anticonvulsants. Drugs given to prevent seizures can cause serious problems in the developing fetus, including mental retardation and slow growth. Studies in the United Kingdom and Australia have tracked the percentage of birth defects caused by certain antiepileptic drugs.
- Antipsychotic and antianxiety agents. Several drugs given for anxiety and mental illness are known to cause specific defects.
- Antineoplastic agents. Drugs given to treat cancer can cause major congenital malformations, especially central nervous system defects. They also may be harmful to the health care worker who is giving them while pregnant.
- Hormones. Male hormones may cause masculinization of a female fetus. A synthetic estrogen (DES) given in the 1940s and 1950s caused an increased risk of cancer in the adult female children of the mothers who received the drug.
- Recreational drugs. Drugs such as LSD have been associated with arm and leg abnormalities and central nervous system problems in infants. Crack cocaine also has been associated with birth defects.

Since drug abusers tend to use many drugs and have poor nutrition and prenatal care, it is hard to determine the effects of individual drugs.

**CHEMICALS.** Environmental chemicals such as fungicides, food additives, and pollutants are suspected of causing birth defects, though this is difficult to prove.

**RADIATION.** Exposure of the mother to high levels of radiation can cause small skull size (microcephaly), blindness, **spina bifida**, and **cleft palate**. How severe the defect is depends on the duration and timing of the exposure.

**INFECTIONS.** Three viruses are known to harm a developing baby: **rubella**, cytomegalovirus (CMV), and herpes simplex. *Toxoplasma gondii*, a parasite that can be contracted from undercooked meat, from dirt, or from handling the feces of infected cats, causes serious problems. Untreated **syphilis** in the mother also is harmful.

### Genetic factors

A gene is a tiny, invisible unit containing information (DNA) that guides how the body forms and functions. Each individual inherits tens of thousands of genes from each parent, arranged on 46 chromosomes. Genes control all aspects of the body, how it works, and all its unique characteristics, including eye color and body size. Genes are influenced by chemicals and radiation, but sometimes changes in the genes are unexplained accidents. Each child gets half of its genes from each parent. In each pair of genes one will take precedence (dominant) over the other (recessive) in determining each trait, or characteristic. Birth defects caused by dominant inheritance include a form of dwarfism called **achondroplasia**; high cholesterol; Huntington's disease, a progressive nervous system disorder; **Marfan syndrome**, which affects connective tissue; some forms of glaucoma, and **polydactyly** (extra fingers or toes).

If both parents carry the same recessive gene, they have a one-in-four chance that the child will inherit the disease. Recessive diseases are severe and may lead to an early **death**. They include sickle cell anemia, a blood disorder that commonly affects persons of African descent, and **Tay-Sachs disease**, which causes **mental retardation** in people of eastern European Jewish heritage. Two recessive disorders more common in Caucasians are **cystic fibrosis**, a lung and digestive disorder, and **phenylketonuria** (PKU), a metabolic disorder. If only one parent passes along the genes for the disorder, the normal gene received from the other parent will prevent the disease, but the child will be a carrier. Having the gene is not harmful

to the carrier, but there is the 25% chance of the genetic disease showing up in the child of two carriers.

Some disorders are linked to the sex-determining chromosomes passed along by parents. **Hemophilia**, a condition that prevents blood from clotting, and Duchenne **muscular dystrophy**, which causes muscle weakness, are carried on the X chromosome. Genetic defects also can take place when the egg or sperm are forming if the mother or father passes along some faulty gene material. This is more common in older mothers. The most common defect of this kind is **Down syndrome**, a pattern of mental retardation and physical abnormalities, often including heart defects, caused by inheriting three copies of a chromosome rather than the normal pair.

A less understood cause of birth defects results from the interaction of genes from one or both parents plus environmental influences. These defects are thought to include:

- Cleft lip and palate, which are malformations of the mouth.
- Clubfoot, ankle or foot deformities.
- Spina bifida, an open spine caused when the tube that forms the brain and spinal chord does not close properly.
- Water on the brain (hydrocephalus), which causes brain damage.
- Diabetes mellitus, an abnormality in sugar metabolism that appears later in life.
- Heart defects.
- Some forms of cancer.

A serious illness in the mother, such as an underactive thyroid, or **diabetes mellitus**, in which her body cannot process sugar, also can cause birth defects in the child. In fact, in 2003, it was shown that babies of diabetic mothers are five times as likely to have structural heart defects as other babies. An abnormal amount of amniotic fluid may indicate or cause birth defects. Amniotic fluid is the liquid that surrounds and protects the unborn child in the uterus. Too little of this fluid can interfere with lung or limb development. Too much amniotic fluid can accumulate if the fetus has a disorder that interferes with swallowing. In 2003, a study linked the mother's weight to risk of birth defects. Obese women were about three times more likely to have an infant with spina bifida or omphalocele (protrusion of part of the intestine through the abdominal wall) than women of average weight. Women who were overweight or classified as obese also were twice as likely to have an infant with a heart defect or multiple birth defects than women classified as average weight.

## Diagnosis

If there is a family history of birth defects or if the mother is over 35 years old, then screening tests can be done during pregnancy to gain information about the health of the baby.

- Alpha-fetoprotein test. This is a simple blood test that measures the level of a substance called alpha-fetoprotein that is associated with some major birth defects. An abnormally high or low level may indicate the need for further testing.
- Ultrasound. The use of sound waves to examine the shape, function, and age of the fetus is a common procedure. It also can detect many malformations, such as spina bifida, limb defects, and heart and kidney problems. In 2003, researchers in England announced a new combination of blood tests and ultrasound to detect Down syndrome sooner and more accurately than with the usual blood screenings done at 20 weeks of pregnancy.
- Amniocentesis. This test usually is done between the 13th and 15th weeks of pregnancy. A small sample of amniotic fluid is withdrawn through a thin needle inserted into the mother's abdomen. Chromosomal analysis can rule out Down syndrome and other genetic conditions.
- Chorionic villus sampling (CVS). This test can be done as early as the ninth week of pregnancy to identify chromosome disorders and some genetic conditions. A thin needle is inserted through the abdomen or a slim tube is inserted through the vagina that takes a tiny tissue sample for testing.

If a birth defect is suspected after a baby is born, then confirmation of the diagnosis is very important. The patient's medical records and medical history may hold essential information. A careful **physical examination** and laboratory tests should be done. Special diagnostic tests also can provide genetic information in some cases. The March of Dimes, a nonprofit organization, recommends that every baby born in the United States receives, at minimum, screening for the same core group of birth defects including phenylketonuria, **congenital adrenal hyperplasia**, congenital hypothyroidism, biotinidase deficiency, and others. The goal of the recommendations is to unify screening procedures across the United States.

## Treatment

Treatment depends on the type of birth defect and how serious it is. When an abnormality has been identified before birth, delivery can be planned at a health care facility that is prepared to offer any special care

needed. Some abnormalities can be corrected with surgery. Experimental procedures have been used successfully in correcting some defects, like excessive fluid in the brain (**hydrocephalus**), even before the baby is born. Early reports have shown success with fetal surgery on spina bifida patients. By operating on these fetuses while still in the womb, surgeons have prevented the need for shunts and improved outcomes at birth for many newborns. However, long-term studies still are needed. Patients with complicated conditions usually need the help of experienced medical and educational specialists with an understanding of the disorder.

## Prognosis

The prognosis for a disorder varies with the specific condition.

## Prevention

Pregnant women should eat a nutritious diet. Taking **folic acid** supplements before and during pregnancy reduces the risk of having a baby with serious problems of the brain or spinal chord (neural tube defects). It is important to avoid any teratogen that can harm the developing baby, including alcohol and drugs. When there is a family history of congenital defects in either parent, **genetic counseling** and testing can help parents plan for future children. Often, counselors can determine the risk of a genetic condition occurring and the availability of tests for it. Talking to a genetic counselor after a child is born with a defect can provide parents with information about medical management and available community resources.

## Resources

### PERIODICALS

- “Babies of Diabetic Mothers Have Fivefold Increase in Structural Heart Defects.” *Diabetes Week* (October 6, 2003): 8.
- Bauer, Jeff. “Researchers Link Mom’s Weight to Baby’s Risk of Birth Defects.” *RN* (August 2003): 97–102.
- “Fetal Alcohol Syndrome Is Still a Threat, Says Publication.” *Science Letter* (September 28, 2004): 448.
- “Fetal Diagnostic Test Combo Shows Promise.” *Health & Medicine Week* (October 27, 2003): 224.
- “Fetal Surgery for Spina Bifida Shows Benefits in Leg Function, Fewer Shunts.” *Health & Medicine Week* (October 20, 2003): 608.
- “March of Dimes Pushes Newborn Screening.” *Diagnostics & Imaging Week* (July 31, 2003): 10–11.
- “Studies Reveal Risk of Birth Defects from AEDs.” *Pharma Marketletter* (September 13, 2004).
- “Topical Corticosteroids Use During Pregnancy May Associate With Cleft Lip.” *Biotech Week* (September 24, 2003): 190.

## OTHER

March of Dimes. *Public Health Education Information Sheets*.

## ORGANIZATIONS

March of Dimes Birth Defects Foundation, 1275 Mamaroneck Ave., White Plains, NY, 10605, (914) 997-4488, <http://www.modimes.org>.

Karen Ericson, RN  
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## Birthmarks

### Definition

Birthmarks, including angiomas and vascular malformations, are benign (noncancerous) skin growths composed of rapidly growing or poorly formed blood vessels or lymph vessels. Found at birth (congenital) or developing later in life (acquired) anywhere on the body, they range from faint spots to dark swellings covering wide areas.

### Description

Skin angiomas, also called vascular (pertaining to vessel) nevi (marks), are composed of blood vessels (hemangiomas) or lymph vessels (lymphangiomas), that lie beneath the skin’s surface. Hemangiomas, composed of clusters of cells that line the capillaries, the body’s smallest blood vessels, are found on the face and neck (60%), trunk (25%), or the arms and legs (15%). Congenital hemangiomas, 90% of which appear at birth or within the first month of life, grow quickly, and disappear over time. They are found in 1–10% of



**A fading capillary hemangioma on the nose of a child.** (Custom Medical Stock Photo, Inc. Reproduced by permission.)

full-term infants, and 25% of premature infants. About 65% are capillary hemangiomas (strawberry marks), 15% are cavernous (deep) hemangiomas, and the rest are mixtures. Hemangiomas are three times more common in girls. Usually, only one hemangioma is found; in 20% two are found, while fewer than 5% of affected infants have three or more. Lymphangiomas are skin bumps caused by enlarged lymph vessels anywhere on the body.

Vascular malformations are poorly formed blood or lymph vessels that appear at birth or later in life. One type, the salmon patch (nevus simplex), a pink mark composed of dilated capillaries, is found on the back of the neck (also called a stork bite) in 40% of newborns, and on the forehead and eyelids (also called an angel's kiss) in 20%. Stork bites are found in 70% of white and 60% of black newborns.

Found in fewer than 1% of newborns, port-wine stains (nevus flammeus), are vascular malformations composed of dilated capillaries in the upper and lower layers of the skin of the face, neck, arms, and legs. Often permanent, these flat pink-to-red marks develop into dark purple bumpy areas in later life; 85% appear on only one side of the body.

Acquired hemangiomas include spider angiomas (nevus araneus), commonly known as spider veins, and cherry angiomas (senile angiomas or Campbell de Morgan spots). Found around the eyes, cheekbones, arms, and legs, spider angiomas are red marks formed from dilated blood vessels. They occur during **pregnancy** in 70% of white women and 10% of black women, in alcoholics and **liver disease** patients, and in 50% of children. Cherry angiomas, dilated capillaries found mainly on the trunk, appear in the 30s, and multiply with **aging**.

## Causes and symptoms

There are no known causes for congenital skin angiomas; they may be related to an inherited weakness of vessel walls. Exposure to estrogen causes spider angiomas in pregnant women or those taking **oral contraceptives**. Spider angiomas tend to run in families, and may be associated with liver disease, sun exposure, and trauma.

### Hemangiomas

Hemangiomas first appear as single or multiple, white or pale pink marks, ranging from 2–20 cm (average 2–5 cm) in size. Some are symptomless while others cause **pain** or bleeding, or interfere with normal functioning when they are numerous, enlarged, infected, or ulcerated. Vision is affected by large marks on the

eyelids. Spider and cherry angiomas are unsightly but symptomless.

Each type of hemangioma has a characteristic appearance:

- Capillary hemangiomas (strawberry marks). These round, raised marks are bright red and bumpy like a strawberry, and become white or gray when fading.
- Cavernous hemangiomas. These slightly raised, dome-shaped, blue or purple swellings are sometimes associated with lymphangiomas or involve the soft tissues, bone, or digestive tract.
- Spider angiomas. These are symptomless, reddish blue marks formed from blood-filled capillaries radiating around a central arteriole (small artery) in the shape of a spider web.
- Cherry angiomas. These harmless, dilated capillaries appear as tiny, bright red-to-violet colored bumps.
- Lymphangiomas. These dilated lymph vessels form light pink or yellow cysts (fluid-filled sacs) or swellings.

## Vascular malformations

These are faint, flat, pink stains that grow as the child grows into larger dark red or purple marks. Some are symptomless but others bleed if enlarged or injured. Disfiguring port-wine stains can cause emotional and social problems. About 5% of port-wine stains on the forehead and eyelids increase eye pressure due to involvement of the eye and surrounding nerves. Abnormalities of the spinal cord, soft tissues, or bone may be associated with severe port-wine stains.

Each type has a characteristic appearance:

- Salmon patches. These symptomless, light red-to-pink marks usually fade with time.
- Port-wine stains. These flat, pink marks progress to raised, dark red-to-purple grape-like lumps distorting the facial features, arms, or legs.

## Diagnosis

Patients are treated by pediatricians (doctors who specialize in the care of children), dermatologists (skin disease specialists), plastic surgeons (doctors who specialize in correcting abnormalities of the appearance), and ophthalmologists (eye disease specialists).

Angiomas and vascular malformations are not difficult to diagnose. The doctor takes a complete medical history and performs a **physical examination** including inspection and palpation of the marks. The skin is examined for discoloration, scarring, bleeding, infection, or ulceration. The type, location, size, number, and severity of the marks are recorded. The

doctor may empty the mark of blood by gentle pressure. Biopsies or specialized x rays or scans of the abnormal vessels and their surrounding areas may be performed. Patients with port-wine stains near the eye may require **skull x rays**, **computed tomography scans**, and vision and central nervous system tests. Most insurance plans pay for diagnosis and treatment of these conditions.

## Treatment

Treatment choices for skin angiomas and vascular malformations depend on their type, location, and severity, and whether they cause symptoms, pain, or disfigurement.

### *Watchful waiting*

No treatment is given, but the mark is regularly examined. This continues until the mark disappears, or requires treatment. This approach is particularly appropriate for the treatment of hemangiomas, which often do not require treatment, since they eventually shrink by themselves.

## Drugs

**CORTICOSTEROIDS.** Daily doses of the anti-inflammatory drugs prednisone or prednisolone are given for up to 2 months with gradual reduction of the dose. The marks begin to subside within 7–10 days, but may take up to 2 months to fully disappear. If no response is seen in 2 weeks, the drug is discontinued. Treatment may be repeated. Side effects include growth retardation, increased blood pressure and blood sugar, **cataracts**, glandular disorders, and infection. The **corticosteroids** triamcinolone acetate and betamethasone **sodium phosphate** or acetate are injected directly into the marks with a response usually achieved within a week; additional injections are given in 4–6 weeks. Side effects include tissue damage at the injection site.

**INTERFERON ALPHA-2A.** This drug reduces cell growth, and is used for vascular marks that affect vision and that are unresponsive to corticosteroids. Given in daily injections under the skin, a response rate of 50% is achieved after about 7 months. Side effects include **fever**, chills, muscle and joint pain, vision disorders, low white and red blood cell counts, **fatigue**, elevated liver enzymes, **nausea**, blood clotting problems, and nerve damage.

**ANTIBIOTICS.** Oral or topical (applied to the skin) **antibiotics** are prescribed for infected marks.

## Surgery

**LASER SURGERY.** Lasers create intense heat that destroys abnormal blood vessels beneath the skin, without damaging normal skin. Two types of lasers are used: the flashlamp-pulsed dye laser (FPDL) and the neodymium:YAG (Nd:YAG) laser. The FPDL, used mainly for strawberry marks and port-wine stains, penetrates to a depth of 1.8 mm and causes little scarring, while the Nd:YAG laser penetrates to a depth of 6 mm, and is used to treat deep hemangiomas. **Laser surgery** is not usually painful, but can be uncomfortable. Anesthetic cream is used for FPDL treatment. Treatment with the Nd:YAG laser requires local or **general anesthesia**. Children are usually sedated or anesthetized. Healing occurs within 2 weeks. Side effects include bruising, skin discoloration, swelling, crusting, and minor bleeding.

**SURGICAL EXCISION.** Under local or general anesthesia, the skin is cut with a surgical instrument, and vascular marks or their **scars** are removed. The cut is repaired with stitches or skin clips.

**CRYOSURGERY.** Vascular marks are frozen with an extremely cold substance sprayed onto the skin. **Wounds** heal with minimal scarring.

**ELECTRODESICTION.** Affected vessels are destroyed with the current from an electric needle.

## *Other treatments*

These include:

- **Sclerotherapy.** Injection of a special solution causes blood clotting and shrinkage with little scarring. Side effects include stinging, swelling, bruising, scarring, muscle cramping, and allergic reactions. This treatment is used most commonly for spider angiomas.
- **Embolization.** Material injected into the vessel blocks blood flow, which helps control blood loss during surgery or reduces the size of inoperable growths. A serious side effect, stroke, can occur if a major blood vessel becomes blocked.
- **Make-up.** Special brands are designed to cover birthmarks (Covermark or Dermablend).
- **Cleaning and compression.** Bleeding marks are cleaned with soap and water or hydrogen peroxide, and compressed with a sterile bandage for 5–10 minutes.

## *Alternative treatment*

Alternative treatments for strengthening weak blood vessels include eating high-fiber foods and foods containing bioflavonoids, including citrus fruit, blueberries, and cherries; supplementing the diet with vitamin C; and taking the herbs ginkgo (*Ginkgo biloba*) and bilberry (*Vaccinium myrtillus*.)

## Prognosis

The various types of birthmarks have different prognoses:

- Capillary hemangiomas. Fewer than 10% require treatment. Without treatment, 50% disappear by age 5, 70% by age 7, and 90% by age 9. No skin changes are found in half while others have some discoloration, scarring, or wrinkling. Thirty to 90% respond to oral corticosteroids, and 45% respond to injected corticosteroids; 50% respond to interferon Alpha-2a. About 60% improve after laser surgery.
- Cavernous hemangiomas. Some do not disappear and some are complicated by ulceration or infection. About 75% respond to Nd:YAG laser surgery but have scarring. Severe marks respond to oral corticosteroids, but some require excision.
- Spider angiomas. These fade following childbirth and in children, but may recur. About 90% respond to sclerotherapy, electrodesiccation, or laser therapy.
- Cherry angiomas. These are easily removed by electrodesiccation.
- Lymphangiomas. These require surgery.
- Salmon patches. Eyelid marks disappear by 6–12 months of age, and forehead marks fade by age 6; however, 50% of stork bites on the neck persist into adulthood.
- Port-wine stains. Some flat birthmarks are easily covered with make-up. Treatment during infancy or childhood improves results. About 95% of the stains respond to FPDL surgery with minimal scarring; 25% will completely and 70% will partially disappear. For unknown reasons, 5% show no improvement.

## Prevention

Congenital hemangiomas or vascular malformations cannot be prevented, but spider angiomas may be prevented by **exercise**, weight control, and a high-fiber diet, as well as avoidance of sun exposure, alcohol drinking, or wearing tight hosiery.

## ORGANIZATIONS

American Academy of Dermatology, PO Box 4014, Schaumburg, IL, 60168-4014, (847) 240-1859, (866) 503-SKIN (7546), <http://www.aad.org>.

American Academy of Pediatrics (AAP), 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, (847) 424-8000, [kidsdocs@aap.org](mailto:kidsdocs@aap.org), <http://www.aap.org>.

Congenital Nevus Support Group, P.O. Box 305, West Salem, OH, 44287, (419) 853-4525, [info@nevusnetwork.org](mailto:info@nevusnetwork.org), <http://www.nevusnetwork.org/>.

Vascular Birthmarks Foundation, PO Box 106, Latham, NY, 12110, (877) VBF-4646, [hbvf@aol.com](mailto:hbvf@aol.com), <http://www.birthmark.org>.

Mercedes McLaughlin

Bismuth subsalicylate see **Antidiarrheal drugs**

## Bites and stings

### Definition

Bites and stings are puncture injuries inflicted by an animal that penetrate the skin.

### Demographics

The majority of animal bites in the United States come from dogs and cats. Many animal bites are never reported and never become infected. The Centers for Disease Control and Prevention (CDC) estimates that between three and six million animal bites occur annually in the United States. Dog bites account for 80%–90% of animal bites. In 2008 in the United States, about 885,000 dog bites required medical attention and 31,000 required **reconstructive surgery**. Cats account for only 5%–15% of animal bites, but 6% of cat bites require hospitalization compared to 1% of dog bites. The remainder of bites in the United States are caused mainly by small rodents (e.g., rabbits, rats and mice, ferrets).

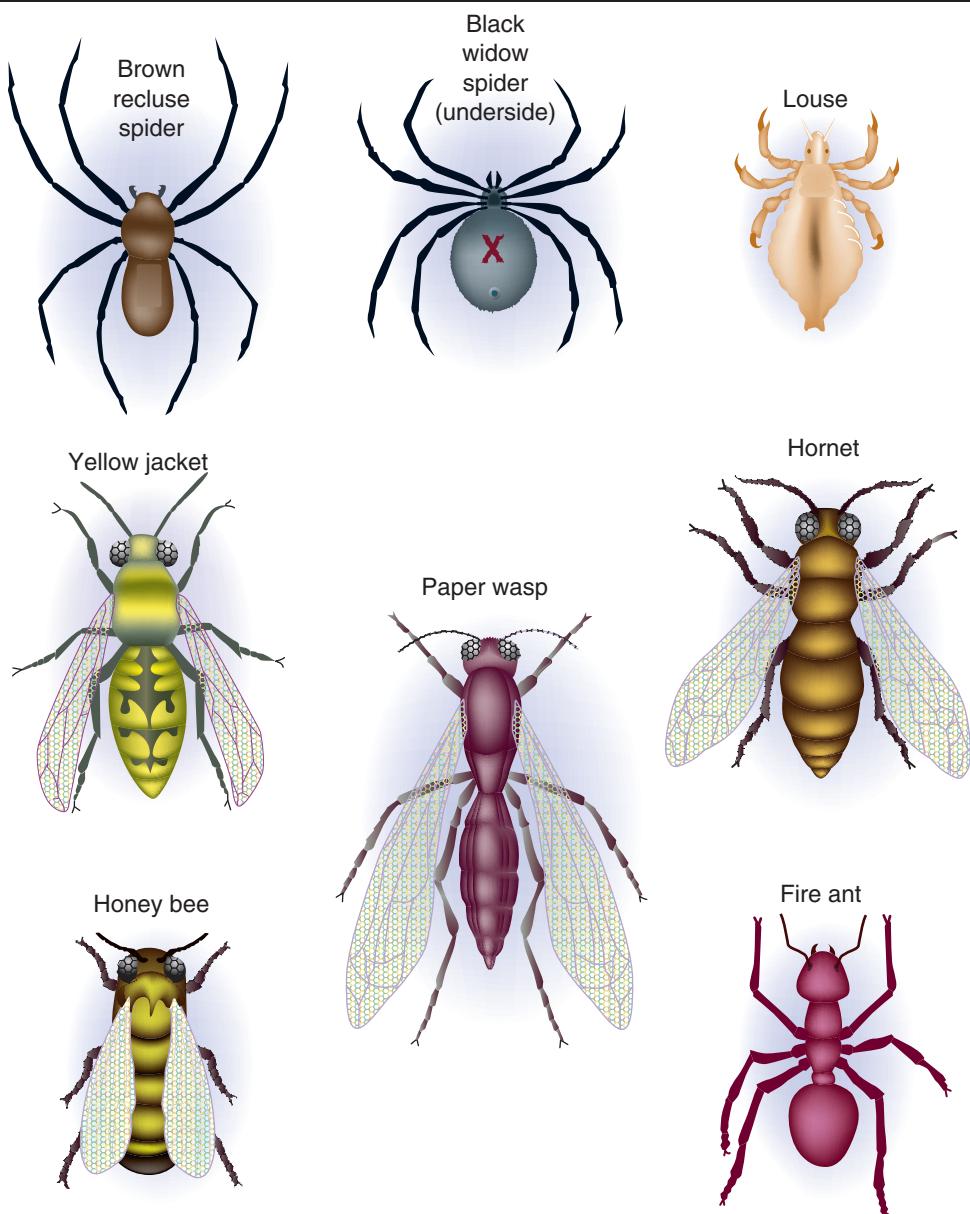
Women are bitten by cats three times more often than men, while men are bitten by dogs three times more often than women. Children ages 5–9 have the highest incidence of animal bites. Animal bites account for about 1% of all emergency room visits. Dog bites kill between 10 and 20 people (most often children) annually in the United States.

### Description

Humans can be injured by the bites or stings of many kinds of animals, including mammals such as dogs, cats, and fellow humans; arthropods such as spiders, bees, and wasps; snakes; and marine animals such as jellyfish and stingrays.

### Mammals

**DOGS.** In the United States, where the dog population exceeds 75 million, dogs surpass all other mammals in the number of bites inflicted on humans; however, most dog-bite injuries are minor. Studies



**Types of spiders and insects that bite and sting.** (Illustration by Argosy, Inc. Reproduced by permission of Gale, a part of Cengage Learning.)

show that most dog bites are from pets or other dogs known to the bitten person. Nearly all of the injuries had by people seeking treatment in emergency rooms are of low severity, and most people are treated and released without being admitted to the hospital or sent to another facility. Many of the bites resulted from people attempting to break up fights between animals.

**CATS.** Although cats are found in nearly one-third of U.S. households, cat bites are far less common than dog bites. The tissue damage caused by cat bites is

usually limited, but cat bites carry a high risk of infection. Whereas the infection rate for dog bite injuries is 15–20%, the infection rate for cat bites is 30–40%.

**HUMANS.** Bites from mammals other than dogs and cats are uncommon, with one exception—human bites. There are at least 70,000 human bites each year in the United States. Because the human mouth contains a multitude of potentially harmful microorganisms, human bites are more infectious than those of most other animals.



**A close-up view of lacerations on the shin of an adult woman inflicted by a Rottweiler dog.** (Custom Medical Stock Photo, Inc. Reproduced by permission.)

### Arthropods

Arthropods are invertebrates belonging to the phylum Arthropoda, which includes insects, arachnids, crustaceans, and other subgroups. There are more than 700,000 species in all. The list of arthropods that bite or sting humans is extensive and includes lice, bedbugs, fleas, mosquitoes, black flies, ants, chiggers, ticks, centipedes, scorpions, and other species. Spiders, bees, and wasps are the three kinds of arthropod that most often bite people.

**SPIDERS.** In the United States, only two kinds of venomous spider are truly dangerous: widow spiders and brown (violin or fiddle) spiders. The black widow, which is found in every state except Alaska, is probably the most notorious widow spider. It prefers dark, dry places such as barns, garages, and outhouses, and also lives under rocks and logs. Disturbing a female black widow or its web may provoke a bite. Brown spiders also prefer sheltered places, including clothing, and may bite if disturbed.

**BEEs AND WASPS.** Bees and wasps will sting to defend their nests or if they are disturbed. Species common to the United States include honeybees, bumblebees, yellow jackets, bald-faced hornets, brown hornets, and paper wasps. Of note are also Africanized bee species, also called “killer bees,” that have been found in the United States since 1990. More than 50 Americans die each year after being stung by a bee, wasp, or ant. Almost all of those deaths are the result of allergic reactions, and not of exposure to the venom itself.

### Snakes

There are 20 species of venomous snakes in the United States. These snakes are found in every state except Maine, Alaska, and Hawaii. Each year about

8,000 Americans receive a snakebite; only four or five die, mostly from rattlesnake bites.

The venomous snakes of the United States are divided into two families, the Crotalidae (pit vipers) and the Elapidae. Pit vipers, named after the small heat-sensing pit that lies between each eye and nostril, are responsible for about 99% of the venomous snakebites experienced by Americans. Rattlesnakes, copperheads, and cottonmouths (also called water moccasons) are pit vipers. This family of snakes delivers its venom through two long, hinged fangs in the upper jaw. Some pit vipers carry potent venom that can threaten the brain and spinal cord. The venom of others, such as the copperheads, is less harmful.

The Elapidae family includes two kinds of venomous coral snakes indigenous to the southern and western states. Because coral snakes are bashful creatures that come out only at night, they almost never bite humans, and are responsible for approximately 25 bites a year in the United States. Coral snakes have short fangs and a small mouth, which lowers the risk of a bite actually forcing venom into a person’s body. However, their venom is quite poisonous.

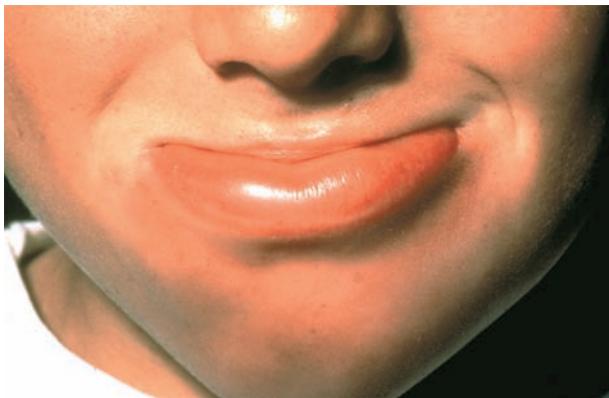
### Marine animals

Several varieties of marine animal may bite or sting. Jellyfish and stingrays are two kinds that pose a threat to people who live or vacation in coastal communities.

### Causes and symptoms

#### Dogs

A typical dog bite results in a laceration, tear, puncture, or crush injury. Bites from large, powerful dogs may cause **fractures** and dangerous internal injuries. Dogs trained to attack may bite repeatedly during a single episode. Infected bites usually cause **pain**, **cellulitis** (inflammation of the connective tissues), and a pus-filled discharge at the wound site within 8–24 hours. Many infections are confined to the wound site, but some of the microorganisms in the mouths of dogs can cause systemic and possibly life-threatening infections. Examples are **bacteremia** and meningitis—especially severe in people diagnosed with acquired **immunodeficiency syndrome (AIDS)** or other health conditions that increase their susceptibility to infection. **Rabies** is rare among pet dogs in the United States, most of which have been vaccinated against the disease. **Tetanus** is also rare but can be transmitted by a dog bite if the victim is not immunized.



An insect bite caused this person's lower lip to swell. (Custom Medical Stock Photo, Inc. Reproduced by permission.)

### Cats

The mouths of cats and dogs contain many of the same microorganisms. Cat scratches and bites are also capable of transmitting the *Bartonella henselae* bacterium, which can lead to **cat-scratch disease**, an unpleasant but usually not life-threatening illness.

Cat bites are mostly found on the arms and hands. Sharp cat teeth typically leave behind a deep puncture wound that can reach muscles, tendons, and bones, which are vulnerable to infection because of their comparatively poor blood supply. This is why cat bites are much more likely to become infected than dog bites. Also, people are less inclined to view cat bites as dangerous and requiring immediate attention; the risk that infection has set in by the time a medical professional is consulted is thus greater.

### Humans

Human bites result from fights, sexual activity, medical and dental treatment, and seizures. Bites raise the possibility of spousal or **child abuse**. Children often bite other children, but those bites are hardly ever severe. Human bites are capable of transmitting a wide range of dangerous diseases, including **hepatitis B**, **syphilis**, and **tuberculosis**.

Human bites fall into two categories: occlusional (true) bites and clenched-fist injuries. Occlusional bites present a lower risk of infection. Clenched-fist injuries, which are very infectious and can permanently damage the hand, usually result from a fist hitting teeth during a fight. People often wait before seeking treatment for a clenched-fist injury, with the result that about half of such injuries are infected by the time they are seen by a medical professional.

### Spiders

As a rule, people rarely see a black widow bite, nor do they feel the bite as it occurs. The first (and possibly only) evidence that a person has been bitten may be a mild swelling of the injured area and two red puncture marks. Within a short time, some victims begin to experience severe **muscle cramps** and rigidity of the abdominal muscles. Other possible symptoms include excessive sweating, **nausea**, **vomiting**, headaches, and vertigo, as well as breathing, vision, and speech problems.

A brown spider's bite can lead to necrotic arachnidism, in which the tissue in an area of up to several inches around the bite becomes necrotic (dies), producing an open sore that can take months or years to disappear. In most cases, the bite simply produces a hard, painful, itchy, and discolored area that heals without treatment in 2–3 days. The bite may be accompanied by a **fever**, chills, **edema** (an accumulation of excess tissue fluid), **nausea and vomiting**, **dizziness**, muscle and joint pain, and a rash.

### Bees and wasps

The familiar symptoms of bee and wasp stings include pain, redness, swelling, and itchiness in the area of the sting. Multiple stings can have much more severe consequences, such as **anaphylaxis**, a life-threatening allergic reaction that occurs in hypersensitive persons.

### Snakes

Venomous pit viper bites usually begin to swell within 10 minutes and sometimes are painful. Other symptoms include skin blisters and discoloration, weakness, sweating, nausea, faintness, dizziness, bruising, and tender lymph nodes. Severe **poisoning** can lead to **tingling** in the scalp, fingers, and toes; muscle contractions; an elevated heart rate; rapid breathing; large drops in body temperature and blood pressure; **vomiting** of blood; and **coma**.

Many pit viper and coral snake bites (20–60%) fail to poison (envenomate) their victim, or introduce only a small amount of venom into the victim's body. The **wounds**, however, can still become infected by the harmful microorganisms that snakes carry in their mouths.

Coral snake bites are painful but may be hard to see. One to seven hours after the bite, a bitten person begins to experience the effects of the venom, which include tingling at the wound site, weakness, nausea, vomiting, excessive salivation, and irrational behavior. Major nerves of the body can become paralyzed for 6–14 days, causing double vision, difficulty swallowing and speaking, **respiratory failure**, and other

## KEY TERMS

**Anaphylaxis**—Also called anaphylactic shock; a severe allergic reaction characterized by airway constriction, tissue swelling, and lowered blood pressure.

**Debridement**—Removal of dead and damaged tissue.

**Hepatitis**—A disease that causes inflammation of the liver and serious liver damage.

problems. Six to eight weeks may be needed before normal muscular strength is regained.

### *Jellyfish*

Jellyfish venom is delivered by barbs called nematocysts, which are located on the creature's tentacles and penetrate the skin of people who brush up against them. Instantly, painful and itchy red lesions usually result. The pain can continue up to 48 hours. Severe cases may lead to skin necrosis, **muscle spasms and cramps**, vomiting, nausea, **diarrhea**, headaches, excessive sweating, and other symptoms. In rare instances, cardiorespiratory failure may occur.

### *Stingrays*

Tail spines are the delivery mechanism for stingray venom. Deep puncture wounds result that can cause an infection if pieces of spine become embedded in the wound. A typical stingray injury scenario involves a person who inadvertently steps on a resting stingray and is lashed in the ankle by its tail. Stingray venom produces immediate, excruciating pain that lasts several hours. Sometimes the victim has a severe reaction, including vomiting, diarrhea, hemorrhage (bleeding), a drop in blood pressure, and cardiac arrhythmia (disordered heart beat).

## Diagnosis

### *Dogs*

Gathering information on the circumstances of a dog attack is a crucial part of treatment. Medical professionals need to know when the attack occurred (the chances of infection increase dramatically if the wound has been left untreated more than eight hours) and what led to the attack (unprovoked attacks are more likely to be associated with rabies). A person's general health must also be assessed, including the tetanus immunization history (if any), as well as information concerning possible **allergies** to medication and pre-existing health problems that may increase the risk of infection.

A **physical examination** requires careful scrutiny of the wound, with special attention to possible bone, joint, ligament, muscle, tendon, nerve, or blood vessel damage caused by deep punctures or severe crush injuries. Serious hand injuries should be evaluated by a specialized surgeon. Laboratory tests for identifying the microorganisms in bite wounds are performed if infection is present. X rays and other diagnostic procedures may be necessary.

### *Cats*

The diagnostic procedures used for dog bites also apply to cat bites.

### *Humans*

Testing the blood of a person who has been bitten for immunity to hepatitis B and other diseases is always necessary after a human bite. Ideally, the biter should be tested for the presence of transmissible disease. Clenched-fist injuries often require evaluation by a hand surgeon or orthopedist. Because many people deny having been in a fight, medical professionals usually consider lacerations over the fourth and fifth knuckles—the typical result of a clenched-fist injury—to be evidence of a bite wound. Medical professionals also look for indications of spousal or child **abuse** when evaluating human bites.

### *Spiders*

Because bites from widow spiders and brown spiders require different treatments, capturing and identifying the spider helps to establish diagnosis.

### *Snakes*

Diagnosis relies on a physical examination of the victim, information about the circumstances of the bite, and a look at the snake itself (if it can safely be killed and brought in for identification). Blood tests and **urinalysis** supply important data on the victim's condition. Chest x rays and **electrocardiography** (a procedure for measuring heart activity) may also be necessary.

## Treatment

### Dogs

Minor dog bites can be treated at home. The American Academy of Family Physicians recommends gently washing the wound with soap and water and then applying pressure to the injured area with a clean towel to stop the bleeding. The next step is to apply antibiotic ointment and a sterile bandage to the wound. To reduce swelling and fend off infection, ice should be applied and the injured area kept elevated above the level of the heart. The wound should be cleaned and covered with ointment twice a day until it heals.

Any dog bite that does not stop bleeding after 15 minutes of pressure must be seen by a medical professional. The same is true for bites that are deep or gaping; bites to the head, hands, or feet; and bites that may have broken a bone, damaged nerves, or caused a major injury of another kind. Bite victims must watch for infection. A fever is one sign of infection, as are redness, swelling, warmth, increased tenderness, and pus at the wound site. People who are diabetic, who have AIDS or **cancer**, individuals who have not had a tetanus shot in five years, and anyone else who has a medical problem that can increase susceptibility to infection should seek medical treatment no matter how minor the bite appears.

Medical treatment of dog bites involves washing (irrigating) the wound with an anti-infective solution. Removal of dead and damaged tissue (debridement) under local, regional, or general anesthetic may be required after the wound has been washed, and any person whose tetanus shots are not up to date should receive a booster injection. Some wounds are left open and allowed to heal on their own, while others require stitches (stitching may be delayed a few days if infection is a concern). Many emergency departments prescribe **antibiotics** for all people with dog bites, but some researchers suggest that antibiotics usually are unnecessary and should be limited to those whose injuries or other health problems make them likely candidates for infection. A follow-up visit after one or two days is generally required for anyone who has received bite treatment.

### Cats

Because of the high risk of infection, people who are bitten by a cat should always see a doctor. Cat scratches do not require professional medical treatment unless the wound appears infected or the scratched person has a weakened immune system.

Medical treatment for cat bites generally follows the procedures used for dog bites. Experts advise that

cat-bite wounds should be left open to prevent infection. Persons who have been bitten by cats usually receive antibiotics as a preventive measure.

### Humans

Human bites should always be examined by a doctor. Such bites are normally treated with antibiotics and left open because of the high risk of infection. Routine use of antibiotics for human bites may not be necessary, as physicians try to minimize overuse of antibiotics. Superficial wounds in low-risk areas may no longer need antibiotic treatment, but more serious human bites to high-risk areas such as the hands should be treated with antibiotics to prevent serious infection. A person who has been bitten may require immunization against hepatitis B and other diseases. Persons who are being treated for a clenched-fist injury require a daily follow-up examination for 3–5 days.

### Spiders

No spider bite should be ignored. The antidote for severe widow spider bites is a substance called antivenin, which contains antibodies taken from the blood serum of horses injected with spider venom. Doctors exercise caution in using antivenin because it can trigger anaphylactic shock, a potentially deadly allergic reaction, and **serum sickness**, an inflammatory response that can give rise to joint pain, a fever, **rashes**, and other unpleasant, though rarely serious, consequences.

An antivenin for brown spider bites exists as well, but it is in limited distribution. The drug dapsone, used to treat **leprosy**, can sometimes stop the tissue **death** associated with a brown spider bite. Necrotic areas may need **debridement** and skin grafts. Pain medications, **antihistamines**, antibiotics, and tetanus shots are a few of the other treatments that are sometimes necessary after a bite from a brown spider or widow spider.

### Bees and wasps

Most stings can be treated at home. A stinger that is stuck in the skin can be scraped off with a blade, fingernail, credit card, or piece of paper (using tweezers may push more venom out of the venom sac and into the wound). The area should be cleaned and covered with an ice pack. **Aspirin** and other pain medications, oral antihistamines, and calamine lotion are good for treating minor symptoms. Putting meat tenderizer on the wound has no effect.

People who have been stung and experience an allergic reaction, or who are at risk due to their medical history, require immediate medical attention. The

danger signs, which usually begin 10 minutes after an individual is stung (although possibly not for several hours), include nausea, faintness, chest pain, abdominal cramps, diarrhea, and difficulty swallowing or breathing.

### ***Snakes***

Although most snakes are not venomous, any snakebite should immediately be examined at a hospital. While waiting for emergency help to arrive, the victim should wash the wound site with soap and water, and then keep the injured area still and at a level lower than the heart. Ice should never be used on the wound site nor should attempts be made to suck out the venom. Making a cut at the wound site is also dangerous. It is important to stay calm and wait for emergency medical aid if it can arrive quickly. Otherwise, the victim should proceed directly to a hospital.

When the victim arrives at a hospital, the medical staff must determine whether the bite was inflicted by a venomous snake and, if so, whether envenomation occurred and how much venom the person has received. Patients may develop low blood pressure, abnormal blood clotting, or severe pain, all of which require aggressive treatment. Fortunately, the effects of some snakebites can be counteracted with antivenin. Minor rattlesnake envenomations can be successfully treated without antivenin, as can copperhead and water moccasin bites. Coral snake envenomations and the more dangerous rattlesnake envenomations require antivenin, sometimes in large amounts. Other treatment measures include antibiotics to prevent infection and a tetanus booster injection.

### ***Jellyfish***

Vinegar and other acidic substances are used to neutralize jellyfish nematocysts still clinging to the skin, which are then scraped off. Anesthetic ointments, antihistamine creams, and steroid lotions applied to the skin are sometimes beneficial. Other measures may be necessary to counter the many harmful effects of jellyfish stings, which, if severe, require emergency medical care.

### ***Stingrays***

Stingray wounds should be washed with saltwater and then soaked in very hot water for 30–90 minutes to neutralize the venom. Afterwards, the wound should be examined by a doctor to ensure that no pieces of spine remain.

## **Alternative treatment**

### ***Arthropods***

Several alternative self-care approaches are used to treat minor bee, wasp, and other arthropod stings, including **aromatherapy**, **Ayurvedic medicine**, **flower remedies**, herbs, homeopathy, and nutritional therapy.

### **Prognosis**

#### ***Mammals***

Prompt treatment and recognizing that even apparently minor bites can have serious consequences are the keys to a good outcome after a mammal bite. Infected bites can be fatal if neglected. Surgery and hospitalization may be needed for severe bites.

#### ***Spiders***

Even without treatment, adults usually recover from black widow bites after 2–3 days. Those most at risk of dying are very young children, the elderly, and people with high blood pressure. In the case of brown spider bites, the risk of death is greatest for children, although rare.

#### ***Bees and wasps***

The pain and other symptoms of a bee or wasp sting normally fade away after a few hours. People who are allergic to such stings can experience severe and occasionally fatal anaphylaxis.

### ***Snakes***

A snakebite victim's chances of survival are excellent if medical aid is obtained in time. Some bites result in **amputation**, permanent deformity, or loss of function in the injured area.

### ***Stingrays***

Stingray venom rarely leads to death in humans.

## **Prevention**

### ***Dogs***

The risk of a dog bite injury can be reduced by avoiding sick or stray dogs, staying away from dog-fights (people often get bitten when they try to separate the animals), and not behaving in ways that might provoke or upset dogs, such as wrestling with them or bothering them while they are sleeping, eating, or looking after their puppies. Special precautions need to be taken around infants and young children, who must never be left alone with a dog. Pit bulls,

Rottweilers, and German shepherds are responsible for nearly half of all fatal dog attacks in the United States and are potentially dangerous pets in households where children live or visit. For all breeds of dog, obedience training and spaying or neutering lessen the chances of aggressive behavior.

### Cats

Prevention involves warning children to stay away from strange cats and to avoid rough play and other behavior that can anger cats and cause them to bite.

### Spiders

Common-sense precautions include clearing webs out of garages, outhouses, and other places favored by venomous spiders; keeping one's hands away from places where spiders may be lurking; and checking clothing, shoes, and sleeping areas when camping or vacationing.

### Bees and wasps

When possible, it is advised to avoid the nests of bees and wasps and to not eat sweet food or wear bright clothing, perfumes, or cosmetics that attract bees and wasps.

Emergency medical kits containing self-administrable epinephrine (Epi-pen) to counter anaphylactic shock are available for people allergic to bee or wasp stings and should be carried by them at all times. People who suspect they are allergic should consult an allergist about shots that can reduce reactions to bee and wasp venom.

### Snakes

Snakes should not be kept as pets. Measures such as mowing the lawn, keeping hedges trimmed, and removing brush from the yard discourages snakes from living close to human dwellings. Tongs should be used to move brush, lumber, and firewood, to avoid exposing one's hands to snakes that might be lying underneath. Similarly, golfers should never use their hands to retrieve golf balls from a water hole, since snakes can be hiding in the rocks and weeds. Caution is also necessary when walking through weedy or grassy areas. Children should be prevented from playing in weedy, vacant lots and other places where snakes may live. Leather boots and long pants offer hikers and campers some protection from bites. Approaching a snake, even a dead one, can be dangerous, for the venom of recently killed snakes may still be active.

### Jellyfish

Prevention of jellyfish stings includes obeying posted warning signs at the beach. Jellyfish tentacles may be transparent and up to 120 ft (36.5 m) long; therefore, great caution must be exercised whenever a jellyfish is sighted nearby. An over-the-counter cream tested at the Stanford University in 2004 was shown to prevent jellyfish stings.

### Stingrays

Shuffling while walking through shallow areas that may be inhabited by stingrays will disturb the water, causing the animal to move before it can be stepped on.

### Resources

#### OTHER

Garth, Alisha P., and M. Stuart Harris. "Animal Bites." June 25, 2009. <http://emedicine.medscape.com/article/768875-overview> (accessed September 18, 2010). "What You Should Know about Animal Bites." Louisiana State University School of Veterinary Medicine. 2009. [http://www.vetmed.lsu.edu/animal\\_bites.htm](http://www.vetmed.lsu.edu/animal_bites.htm) (accessed September 18, 2010).

#### ORGANIZATIONS

American Academy of Family Physicians, P.O. Box 11210, Shawnee Mission, KS, 66207, (913)906-6000 (800) 274-2237 (913) 906-6075 <http://familydoctor.org>. American Veterinary Medical Association (AVMA), 1931 North Meacham Road, Suite 100, Schaumburg, IL, 60173, (800) 248-2862, (847) 925-1329, [avmainfo@avma.org](mailto:avmainfo@avma.org), <http://www.avma.org>. Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (404) 639-3534, 800-CDC-INFO (800-232-4636), TTY: (888) 232-6348, [inquiry@cdc.gov](mailto:inquiry@cdc.gov), <http://www.cdc.gov>. World Health Organization, Avenue Appia 20, 1211 Geneva 27, Switzerland, +22 41 791 21 11, +22 41 791 31 11, [info@who.int](mailto:info@who.int), <http://www.who.int>.

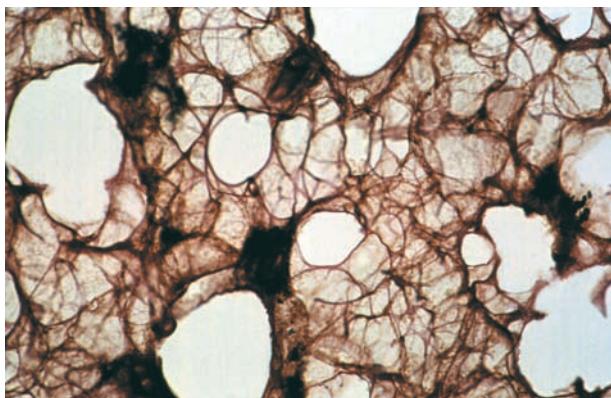
L. Fleming Fallon, Jr., MD, PhD  
Tish Davidson, AM

Black death see **Plague**

## Black lung disease

### Definition

Black lung disease is the common name for coal workers' pneumoconiosis (CWP) or anthracosis, a lung disease of older workers in the coal industry caused



**A light micrograph of a human lung containing particles of inspired coal dust (anthracosis). The black masses shown are groups of coal dust particles.** (Astrid & Hanns-Frieder Michler/Photo Researchers, Inc.)

by inhalation, over many years, of small amounts of coal dust.

## Description

The risk of having black lung disease is directly related to the amount of dust inhaled over the years; the disease typically affects workers over age 50. Its common name comes from the fact that the inhalation of heavy deposits of coal dust makes miners lungs look black instead of a healthy pink. Although people who live in cities often have some black deposits in their lungs from polluted air, coal miners have much more extensive deposits.

In the years since the federal government has regulated dust levels in coal mines, the number of cases of black lung disease has fallen sharply. Since the Federal Coal Mine Health and Safety Act of 1969, average dust levels have fallen from 8.0 mg per cubic meter to the current standard of 2.0 mg per cubic meter. The 1969 law also set up a black lung disability benefits program to compensate coal miners who have been disabled by on-the-job dust exposure.

Despite the technology available to control the hazard, however, miners still run the risk of developing this lung disease. The risk is much lower today, however; fewer than 10% of coal miners have any x ray evidence of coal dust deposits. When there is such evidence, it often shows up as only small black spots less than 0.4 in. (1 cm) in diameter, and may have been caused by **smoking** rather than coal dust. This condition is called "simple CWP" and does not lead to symptoms or disability.

## Causes and symptoms

Since the particles of fine coal dust, which a miner breathes when he is in the mines, cannot be destroyed within the lungs or removed from them, they build up. Eventually, this build up causes thickening and scarring, making the lungs less efficient in supplying oxygen to the blood.

The primary symptom of the disease is **shortness of breath**, which gradually gets worse as the disease progresses. In severe cases, the patient may develop **cor pulmonale**, an enlargement and strain of the right side of the heart caused by chronic lung disease. This may eventually cause right-sided **heart failure**.

Some patients develop **emphysema** (a disease in which the tiny air sacs in the lungs become damaged, leading to shortness of breath, and respiratory and heart failure) as a complication of black lung disease. Others develop a severe type of black lung disease called progressive massive fibrosis, in which damage continues in the upper parts of the lungs even after exposure to the dust has ended. Scientists aren't sure what causes this serious complication. Some think that it may be due to the breathing of a mixture of coal and silica dust that is found in certain mines. Silica is far more likely to lead to scarring than coal dust alone.

## Diagnosis

Black lung disease can be diagnosed by checking a patient's history for exposure to coal dust, followed by a chest x ray to discover if the characteristic spots in the lungs caused by coal dust are present. A pulmonary function test may aid in diagnosis.

X rays can detect black lung disease before it causes any symptoms. If exposure to the dust is stopped at that point, progression of the disease may be prevented.

## Treatment

There is no treatment or cure for this condition, although it is possible to treat complications such as lung infections and cor pulmonale. Further exposure to coal dust must be stopped.

## Prognosis

Those miners with simple CWP can lead a normal life. However, patients who develop black lung disease at an early age, or who have progressive massive fibrosis, have a higher risk of premature **death**.

## Prevention

The only way to prevent black lung disease is to avoid long-term exposure to coal dust. Coal mines may help prevent the condition by lowering coal dust levels and providing protective clothes to coal miners.

A light micrograph of a human lung containing particles of inspired coal dust (anthracosis). The black masses shown are groups of coal dust particles.

## ORGANIZATIONS

Mine Safety and Health Administration, 4015 Wilson Blvd, Arlington, VA, 22203, (877) 778-6055, MSHAhelpdesk@ dol.gov, <http://www.msha.gov>.

Carol A. Turkington

**Bladder calculi** see **Bladder stones**

## Bladder cancer

### Definition

Bladder **cancer** is a disease in which the cells lining the urinary bladder lose the ability to regulate their growth and start dividing uncontrollably. This abnormal growth results in a mass of cells that form a tumor. The most common type of bladder cancer diagnosed in the United States is urothelial bladder cancer, which in the past was classified as transitional cell carcinoma of the bladder.

### Demographics

Bladder cancer is the fourth most commonly diagnosed cancer in men and the tenth most common cancer diagnosed in women in the United States. In 2009, the American Cancer Society (ACS) estimated that approximately 70,980 new cases of bladder cancer would be diagnosed (about 52,810 men and 18,170 women), causing approximately 14,330 deaths. The mortality rate for bladder cancer has declined since the 1990s. Greater than 90% of cases are diagnosed in individuals 55 years of age and older.

The rates for bladder cancer in men of African descent and Hispanic men are similar and are approximately one-half of the rate among white non-Hispanic men. The lowest rate of bladder cancer occurs in the Asian population. Among women, the highest rates also occur in white non-Hispanic females and are approximately twice the rate for Hispanics. Women of African descent have higher rates of bladder cancer

than Hispanic women. Although blacks are diagnosed with bladder cancer less frequently than whites, their cancers are often diagnosed in later stages resulting in a poorer overall prognosis.

Approximately 75% of patients are diagnosed with bladder cancer that is confined to the bladder. Only 3% are diagnosed with bladder cancer that has spread to distant sites in the body at the time of diagnosis.

### Description

The urinary bladder is a hollow muscular organ that stores urine from the kidneys until it is excreted out of the body. Two tubes called the ureters bring the urine from the kidneys to the bladder. The urethra carries the urine from the bladder to the outside of the body.

Bladder cancer has a very high rate of recurrence. Even after superficial tumors are completely removed, there is a 75% chance new tumors will develop in other areas of the bladder. Hence, patients need frequent and thorough follow-up care.

### Risk factors

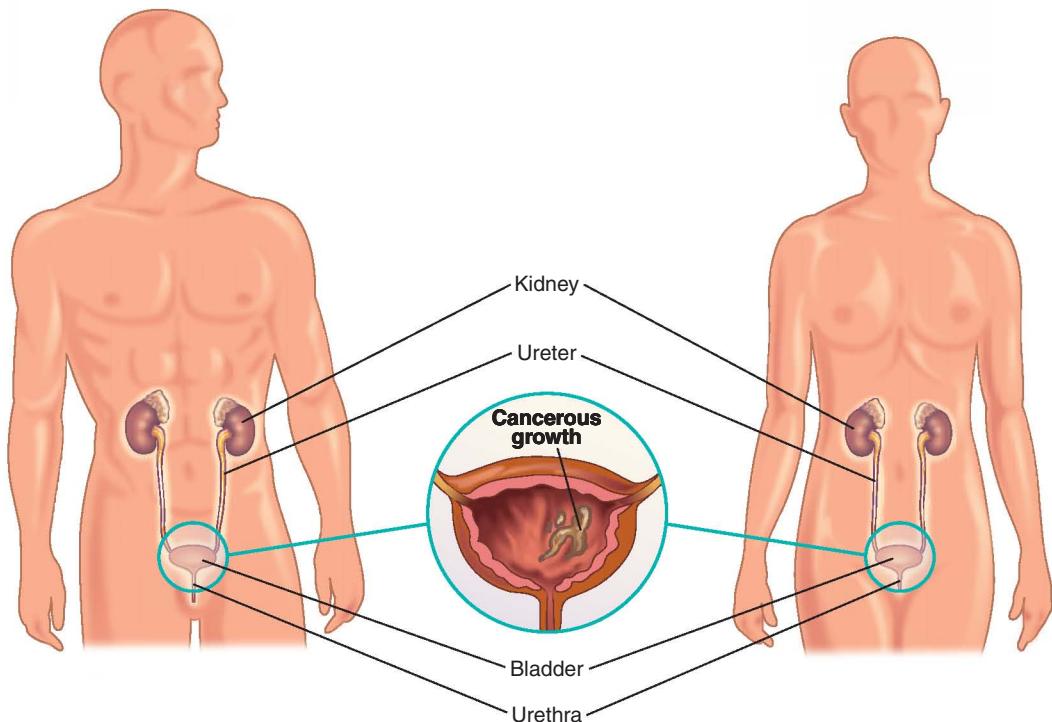
**Smoking** is considered the greatest risk factor for this type of cancer and by some estimates accounts for about 50% of all bladder cancers. Workers who are exposed to certain chemicals used in the dye industry and in the rubber, leather, textile, and paint industries are believed to be at a higher risk for bladder cancer. The disease also is three times more common in men than in women; Caucasians also are at an increased risk. The risk of bladder cancer increases with age. Most cases are found in people who are 50–70 years old.

Frequent urinary infections, kidney and **bladder stones**, and other conditions that cause long-term irritation to the bladder may increase the risk of getting bladder cancer. For example, individuals with spinal cord injuries requiring in-dwelling urinary catheters have a 16 to 20 times increased risk of developing bladder cancer. A past history of tumors in the bladder also could increase one's risk of getting other tumors.

Patients who have been previously treated with the cancer **chemotherapy** drug cyclophosphamide are at increased risk as are those who have been previously treated with radiation to the pelvis.

Several genetic mutations are associated with bladder cancer. Although heredity is not typically linked

## Bladder cancer



**The urinary systems of a man and a woman, illustrating bladder cancer on the inner lining of the bladder.** (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

with the development of this type of cancer, familial clusters of bladder cancer have been identified.

### Causes and symptoms

The exact cause of bladder cancer is not known, but smokers are twice as likely as nonsmokers to get the disease.

One of the first warning signals of bladder cancer is blood in the urine, which is reported by 80% of patients. This change in the urine is not typically associated with any **pain**. Sometimes, there is enough blood to change the color of the urine to a yellow-red or a dark red. At other times, the color of the urine appears normal but chemical testing of the urine reveals the presence of blood cells. A change in bladder habits such as painful urination, increased frequency of urination and a feeling of needing to urinate but not being able to do so are some of the signs of possible bladder cancer. All of these symptoms may be caused by conditions other than cancer, but it is important to

see a doctor and have the symptoms evaluated. When detected early and treated appropriately, patients have a very good chance of being cured completely.

Symptoms associated with advanced bladder cancer may include flank, back, and/or pelvic pain and **edema** in the lower extremities.

### Diagnosis

#### Examination

If a doctor has any reason to suspect bladder cancer, several tests can help find out if the disease is present. As a first step, a complete medical history will be taken to check for any risk factors. A thorough **physical examination** will be conducted to assess all the signs and symptoms.

#### Tests

Laboratory testing of a urine sample helps to rule out the presence of a bacterial infection. In a urine

## KEY TERMS

**Cystectomy**—Surgical removal of the bladder.

**Cystoscopy**—A diagnostic procedure that uses a cystoscope to look inside the bladder and to collect samples of urine and tissue.

**Immunotherapy**—A form of treatment that targets specific cells in the body's immune system to disrupt the growth of a cancer.

**Urostomy**—A surgical opening (a stoma) created to divert urine to the outside of the body for collection once the bladder has been removed.

cytology test, the urine is examined under a microscope to look for any abnormal or cancerous cells.

### Procedures

A catheter (tube) is sometimes advanced into the bladder through the urethra, and a salt solution is passed through it to wash the bladder. The solution is collected and examined under a microscope to check for the presence of cancerous cells.

Another procedure, known as the intravenous pyelogram (IVP), is an x-ray examination that is done after a dye is injected into the bloodstream through a vein in the arm. The dye travels through the bloodstream and then reaches the kidneys to be excreted. It clearly outlines the kidneys, ureters, bladder, and urethra. Multiple x rays are taken to detect any abnormality in the lining of these organs. In addition to the IVP, a renal ultrasound may be used in the diagnosis of bladder cancer.

A procedure known as a **cystoscopy** may be used to view the inside of the bladder. A thin, hollow, lighted tube is introduced into the bladder through the urethra. If any suspicious looking masses are seen, a small piece of the tissue can be removed from it using a pair of biopsy forceps. The tissue is then examined microscopically to verify if cancer is present, and if so, to identify the type of cancer.

If cancer is detected and there is evidence to indicate that it has metastasized (spread) to distant sites in the body, imaging tests such as chest x rays, **computed tomography scans** (CT), and **magnetic resonance imaging** (MRI) may be done to determine which organs are affected. Bladder cancer generally tends to spread to the lungs, liver, and bone.

## Treatment

Treatment for bladder cancer depends on the stage of the tumor; specifically, whether the tumor has invaded the muscle wall of the bladder. The patient's medical history, overall health status, and personal preferences are taken into account when deciding on an appropriate treatment plan.

### Traditional

**Cystectomy**, surgical removal of the bladder, may be used to treat cases of non-invasive and muscle-wall invasive cancers. In non-muscle invasive disease cystectomy may be performed if the tumor is an aggressive type that tends to recur despite treatment with BCG. A 90% survival rate can be attained in this group of patients if the cystectomy is done prior to progression of the tumor to the muscle wall. The 5-year survival rate after cystectomy drops by 30–40% once the muscle wall has been invaded by tumor. Surgery may also be recommended for patients with large superficial tumors that cannot be surgically removed, those with prostatic urethral involvement, and for patients who did not respond to BCG therapy.

In patients with muscle-invasive disease, surgery is done to remove the bladder, prostate, and pelvic lymph nodes in men. In women, the bladder, urethra, uterus, ovaries, anterior vaginal wall, and pelvic lymph nodes may be removed.

If the entire urinary bladder is removed, an alternate place must be created for the urine to be stored before it is excreted out of the body. To do this, a piece of intestine is converted into a small bag and attached to the ureters. This is then connected to an opening (stoma) that is made in the abdominal wall. The procedure is called a urostomy or a urinary diversion. In some urostomy procedures, the urine from the intestinal sac is routed into a bag that is placed over the stoma in the abdominal wall. The bag is hidden by the clothing and has to be emptied occasionally by the patient. In a different procedure, the urine is collected in the intestinal sac, but there is no bag on the outside of the abdomen. The intestinal sac has to be emptied by the patient, by placing a drainage tube through the stoma.

External beam **radiation therapy** as a primary therapy is not as effective as cystectomy in the treatment of bladder cancer. For disease confined to the bladder, the 5-year survival rate after cystectomy is 90% compared to a 5-year survival rate of 20–40% for patients treated with external beam radiation.

## Drugs

Modalities used to treat non-muscle invasive bladder cancer include instilling Bacillus Calmette-Guerin (BCG) immunotherapy directly into the bladder and/or instilling chemotherapy agents such as Thioguanine, mitomycin-C, doxorubicin, and/or epirubicin directly into the bladder. Recommendations for the treatment of muscle-invasive bladder cancer include administration of adjuvant and neoadjuvant chemotherapy. Common chemotherapy agents used are methotrexate, vinblastine, doxorubicin, and cisplatin (MVAC regimen). Metastatic bladder cancer can also be treated with the MVAC chemotherapy regimen. A newer regimen that uses the chemotherapy drugs gemcitabine and cisplatin (GC) has proved to be just as effective as the MVAC regimen in the treatment of metastatic bladder cancer and is now considered a first-line treatment option.

## Prognosis

When detected in early stages, the prognosis for those with bladder cancer is excellent. At least 90% of people diagnosed with non-muscle invasive bladder cancer survive five years or more after initial diagnosis. However, if the disease has spread to the nearby tissues, the survival rate drops. Once the cancer has metastasized to distant organs such as the lung and liver, only 5% of patients survive two years or more. As newer treatment methods are developed, some prognoses improve.

Non-muscle invasive bladder cancers have a high rate of recurrence and progression. Careful follow-up and surveillance is of critical importance and includes cystoscopy and bladder wash cytology every three months for two years, then every six months for two years, followed by a minimum of once yearly.

## Prevention

Since the exact causes of bladder cancer are not known, there is no certain way to prevent it. Avoiding risk factors whenever possible is the best alternative.

Since smoking doubles one's risk of getting bladder cancer, avoiding tobacco may prevent at least half the deaths that result from bladder cancer. Taking appropriate safety precautions when working with organic cancer-causing chemicals is another way of preventing the disease.

If a person has had a history of bladder cancer, or has been exposed to cancer-causing chemicals, he or she is considered to be at an increased risk of getting bladder cancer. Similarly, **kidney stones**, frequent urinary infections, and other conditions that cause long-

term irritation to the bladder also increase the chance of getting the disease.

## Resources

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### ORGANIZATIONS

American Cancer Society, 250 Williams Street, Suite 400, Atlanta, GA, 30303, (800) 227-2345, <http://www.cancer.org>.

American Urological Association Foundation, 1000 Corporate Boulevard, Linthium, MD, 21090, (800) 828-7866, (410) 689-3700.

Cancer Research Institute, One Exchange Plaza 55 Broadway, Suite 1802, New York, NY, 10006, (800) 992-2623, <http://www.cancerresearch.org>.

National Cancer Institute, NCI Office of Communications and Education, Public Inquiries Office, 6116 Executive Boulevard, Suite 300, Bethesda, MD, 20892-8322, (800) 422-6237, <http://www.cancer.gov>.

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**Bladder removal** see **Cystectomy**

**Bladder resection** see **Transurethral bladder resection**

## Bladder stones

### Definition

Bladder stones are crystalline masses that form from the **minerals** and proteins that naturally occur in urine. These types of stones are much less common than **kidney stones**.

## Description

Bladder stones can form anywhere in the urinary tract before depositing in the bladder. They begin as tiny granules about the size of a grain of sand, but they can grow to more than an inch in diameter. These stones can block the flow of urine causing **pain** and difficulty with urination. They can also scratch the bladder wall, which may lead to bleeding or infection.

## Causes and symptoms

While the exact causes of the formation of bladder stones are not completely understood, bladder stones usually occur because of **urinary tract infection** (UTI), obstruction of the urinary tract, enlargement of the prostate gland in men, or the presence of foreign bodies in the urinary tract. Diet and the amount of fluid intake also appear to be important factors in the development of bladder stones.

Ninety-five percent of all bladder stones occur in men, most of whom have an **enlarged prostate** gland or a UTI. These stones are rarely seen in children or in African Americans. People with **gout** may develop bladder stones composed almost entirely of uric acid.

The symptoms of bladder stones may become evident when the wall of the bladder is scratched or when the urinary tract becomes obstructed by the stone. These symptoms include:

- abnormally dark colored urine
- blood in the urine
- difficulty urinating
- frequent urge to urinate
- lower abdominal pain
- pain or discomfort in the penis

Some people with bladder stones also may experience an inability to control urination (**urinary incontinence**).

## Diagnosis

The diagnosis of bladder stones is usually made after a **physical examination**, which may include a **rectal examination** to check for enlargement of the prostate gland. Urine tests are then used to determine if there is blood or indications of an UTI in the urine. If bladder stones are suspected, bladder or pelvic x rays may be ordered. Stones that are large enough to cause problems with urinary function are almost always detectable by x ray.

## Treatment

Many bladder stones can be passed out of the body in the urine. People with small bladder stones will be asked to increase their fluid intakes to at least six to eight eight-ounce glasses of water per day to increase urinary output. If the stones do not pass after two weeks, or if the patient's symptoms become worse, further medical treatment may be required.

A large bladder stone, or small stone that the patient cannot pass in the urine, may be broken up into smaller stones using ultrasound (shock waves). These smaller stones may then pass in the urine. Stones that cannot be broken into pieces by these methods, or that the patient cannot pass, may have to be surgically removed.

## Alternative treatment

Traditional herbal remedies for bladder stones include celery seed and horsetail. Also, because incomplete bladder emptying may cause bladder stones, many patients may benefit from methods and remedies aimed at improving overall bladder function. These include Kegel exercises, which are used to strengthen the muscles involved in urination; herbal supplements (cornsilk, hydrangea, juniper berries, parsley, and uva ursi) used to increase urine flow and flush out sediment from the bladder; and the consumption of cranberry juice and/or fresh, unsweetened lemon juice. Cranberry juice helps to control urinary tract infection and contains a chemical that coats the walls of the bladder, making them more resistant to infection. Lemon juice helps to flush out the urinary system.

## Prognosis

Most bladder stones can be, and are, passed out of the body in the urine without any permanent damage to the bladder or the rest of the urinary tract. However, most bladder stones arise from an underlying medical condition. Therefore, if this medical condition is not corrected approximately half of all patients will experience a recurrence of bladder stones within five years.

## Prevention

Bladder stones may, in some cases, be prevented by the patient receiving prompt medical treatment for an enlarged prostate gland or UTI. The consumption of at least six to eight eight-ounce glasses of water per day and/or the regular consumption of cranberry juice may help to prevent recurrences of bladder stones.

## Resources

### OTHER

“Bladder Stones.” MedlinePlus. <http://www.nlm.nih.gov/medlineplus/ency/article/001275.htm> (accessed November 22, 2010).

### ORGANIZATIONS

American Urological Association Foundation, 1000 Corporate Blvd., Linthicum, MD, 21090, (410) 689-3700, (410) 689-3800, (866) 746-4282, [auafoundation@auafoundation.org](mailto:auafoundation@auafoundation.org), <http://www.urologyhealth.org/>.

Paul A. Johnson, Ed.M.

## Bladder training

### Definition

Bladder training is a behavioral modification treatment technique for **urinary incontinence** that involves placing a patient on a toileting schedule. The time interval between urination is gradually increased in order to train the patient to remain continent.

### Purpose

Bladder training is used to treat urinary urge incontinence. Urge incontinence occurs when an individual feels a sudden need to urinate and cannot control the urge to do so and, as a consequence, involuntarily loses urine before making it to the toilet.

### Precautions

Incontinence may be controlled through a number of invasive and non-invasive treatment options, including Kegel exercises, **biofeedback**, bladder training, medication, insertable incontinence devices, and surgery. Each patient should undergo a full diagnostic work-up to determine the type and cause of the incontinence in order to determine the best course of treatment.

### Description

Bladder training may be prescribed and implemented by a general physician, urologist, or urogynecologist. A urination schedule is created for the patient. The schedule typically starts out with fairly short intervals between bathroom breaks (e.g., an hour). As soon as the patient is able to consistently remain continent for several days at a certain toileting time interval, the time span is increased. Bladder training continues until the patient regularly achieves continence at a time interval he/she feels comfortable with.

## Preparation

A complete evaluation to determine the cause of urinary incontinence is critical to proper treatment. A thorough medical history and **physical examination** should be performed on patients considering bladder training. Diagnostic testing may include x rays, ultrasound, urine tests, and a physical examination of the pelvis. It may include a series of exams called urodynamic testing that measure bladder pressure and capacity and the urinary flow. The patient may also be asked to keep a diary of their urination output and frequency and episodes of incontinence over a period of several days or a week.

## Risks

Bladder training may not be successful in all patients with urge incontinence. Patients who demonstrate a strong desire to control their continence and are committed to sticking with a training program tend to have the most success with bladder training.

### Normal results

Patients who undergo successful bladder training gain complete or improved control over their urination. In some cases, additional alternate treatment such as biofeedback or pelvic muscle exercises may be recommended to supplement the progress made with bladder training.

### ORGANIZATIONS

American Urological Association Foundation, 1000 Corporate Blvd., Linthicum, MD, 21090, (410) 689-3700, (410) 689-3800, (866) 746-4282, [auafoundation@auafoundation.org](mailto:auafoundation@auafoundation.org), <http://www.urologyhealth.org/>.  
National Association for Continence, P.O. Box 1019, Charleston, SC, 29402-1019, (843) 377-0900, (843) 377-0905, (800) 252-3337, [memberservices@nafc.org](mailto:memberservices@nafc.org), <http://www.nafc.org>.

Paula Anne Ford-Martin

*Blastomyces dermatitidis* see **Blastomycosis**

## Blastomycosis

### Definition

Blastomycosis is an infection caused by inhaling microscopic particles (spores) produced by the fungus *Blastomyces dermatitidis*. Blastomycosis may be limited to the lungs or also involve the skin and bones. In its



**Blastomycosis is usually attributed to contact with yeast-like fungi.** (Custom Medical Stock Photo, Inc. Reproduced by permission.)

most severe form, the infection can spread throughout the body and involve many organ systems (systemic).

## Description

Blastomycosis is a fungal infection caused by *Blastomyces dermatitidis*. Although primarily an airborne disease, farmers and gardeners may become infected from contact with spores in the soil through cuts and scrapes. The fungus that causes the disease is found in moist soil and wood in the southeastern United States, the Mississippi River valley, southern Canada, and Central America. Blastomycosis is also called Gilchrist's disease, Chicago disease, or North American blastomycosis. Another South and Central American disease, paracoccidioidomycosis, is sometimes called **South American blastomycosis**, but despite the similar name, this disease is substantially different from North American blastomycosis. Canine blastomycosis, a common dog disease, is caused by the same fungus that infects humans. However, people do not get this disease from their dogs except only very rarely through dog bites.

Blastomycosis is a rare disease infecting only about 4 in every 100,000 people. It is at least six times more common in men than in women and tends to more often infect children and individuals in the 30–50-year-old age group. People who have **diabetes mellitus** or who are taking drugs that suppress the immune system (immunocompromised) are more likely to develop blastomycosis. Although people with **AIDS** can get blastomycosis because of their weakened immune system, blastomycosis has not been one of the more common fungal infections associated with AIDS.

## Causes and symptoms

Once inhaled, the spores of *B. dermatitidis* can lodge in the lungs and cause a localized inflammation.

This is known as primary pulmonary blastomycosis. The disease does not spread from one person to another. In the early stages, symptoms may include a dry **cough**, **fever**, heavy sweating, **fatigue**, and a general feeling of ill health. In approximately 25% of blastomycosis cases, only the lungs are affected. As the disease progresses, small lesions form in the lungs causing the air sacs deep within the lungs (alveoli) to break down and form small cavities.

In another 35%, the disease involves both the lungs and the skin. Bumps develop on the skin, gradually becoming small, white, crusted blisters filled with pus. The blisters break open, creating abscesses that do not heal. Approximately 19% of infected people have skin sores without infection in the lungs.

The remaining approximately 20% of the infected population has blastomycosis that has spread or disseminated to other systems of the body. Symptoms may include **pain** and lesions on one or more bones, the male genitalia, and/or parts of the central nervous system. The liver, spleen, lymph nodes, heart, adrenal glands, and digestive system may also be infected.

## Diagnosis

A positive diagnosis of blastomycosis is made when the fungus *B. dermatitidis* is identified by direct microscopic examination of body fluids such as sputum and prostate fluid or in tissue samples (biopsies) from the lung or skin. Another way to diagnose blastomycosis is to culture and isolate the fungus from a sample of sputum. Chest x rays are used to assess lung damage, but alone cannot lead to a definitive diagnosis of blastomycosis because any damage caused by other diseases, such as by **pneumonia** or **tuberculosis**, may appear on the x ray. Because its symptoms vary widely, blastomycosis is often misdiagnosed.

## Treatment

Blastomycosis must be treated or it will gradually lead to **death**. Treatment with the fungicidal drug ketoconazole (Nizoral) taken orally is effective in about 75% of patients. Amphotericin B (Fungizone) given intravenously is also very effective, but it has more toxic side effects than ketoconazole. Treatment with amphotericin B usually requires hospitalization, and the patient may also receive other drugs to minimize its side effects.

## Alternative treatment

Alternative treatment for fungal infections focuses on creating an internal environment where the fungus cannot survive. This is accomplished by eating a diet low

in dairy products; sugars, including honey and fruit juice; and foods like beer that contain yeast. This is complemented by a diet consisting, in large part, of uncooked and unprocessed foods. Supplements of vitamins C, E, A-plus, and B complex may also be useful. *Lactobacillus acidophilus* and *Bifidobacterium* will replenish the good bacteria in the intestines. Some anti-fungal herbs, like garlic (*Allium sativum*), can be consumed in relatively large doses and for an extended period of time in order to increase effectiveness. A variety of antifungal herbs such as myrrh (*Commiphora molmol*), tea tree oil (*Melaleuca* spp.), citrus seed extract, pau d'arco tea (*Tabebuia impetiginosa*), and garlic may also be applied directly to the infected skin.

### Prognosis

Left untreated, blastomycosis gradually leads to death. When treated, however, patients begin to improve within one week and, with intensive treatment, may be cured within several weeks. The highest rate of recovery is among patients who only have **skin lesions**. People with the disseminated form of the disease are least likely to be cured and most likely to suffer a relapse.

### Prevention

Because the fungus that causes blastomycosis is airborne and microscopic, the only form of prevention is to avoid visiting areas where it is found in the soil. For many people this is impractical. Since the disease is rare, people who maintain general good health do not need to worry much about infection.

### ORGANIZATIONS

National Organization for Rare Disorders, P.O. Box 8923, New Fairfield, CT, 06812-8923, (800) 999-6673, <http://www.rarediseases.org>.

Tish Davidson, A.M.

Bleeding disorders see **Coagulation disorders**

## Bleeding time

### Definition

Bleeding time is a crude test of hemostasis (the arrest or stopping of bleeding). It indicates how well platelets interact with blood vessel walls to form **blood clots**.

### Purpose

Bleeding time is used most often to detect qualitative defects of platelets, such as Von Willebrand's disease. The test helps identify people who have defects in their platelet function. This is the ability of blood to clot following a wound or trauma. Normally, platelets interact with the walls of blood vessels to cause a blood clot. There are many factors in the clotting mechanism, and they are initiated by platelets. The bleeding time test is usually used on patients who have a history of prolonged bleeding after cuts, or who have a family history of bleeding disorders. Also, the bleeding time test is sometimes performed as a preoperative test to determine a patient's likely bleeding response during and after surgery. However, in patients with no history of bleeding problems, or who are not taking anti-inflammatory drugs, the bleeding time test is not usually necessary.

### Precautions

Before administering the test, patients should be questioned about what medications they may be taking. Some medications will adversely affect the results of the bleeding time test. These medications include anticoagulants, **diuretics**, **anticancer drugs**, **sulfonamides**, thiazide, **aspirin** and aspirin-containing preparations, and **nonsteroidal anti-inflammatory drugs**. The test may also be affected by anemia (a deficiency in red blood cells). Since the taking of aspirin or related drugs are the most common cause of prolonged bleeding time, no aspirin should be taken two weeks prior to the test.

### Description

There are four methods to perform the bleeding test. The Ivy method is the traditional format for this test. In the Ivy method, a blood pressure cuff is placed on the upper arm and inflated to 40 mM Hg. A lancet or scalpel blade is used to make a stab wound on the underside of the forearm. An automatic, spring-loaded blade device is most commonly used to make a standard-sized cut. The area stabbed is selected so that no superficial or visible veins are cut. These veins, because of their size, may have longer bleeding times, especially in people with bleeding defects. The time from when the stab wound is made until all bleeding has stopped is measured and is called the bleeding time. Every 30 seconds, filter paper or a paper towel is used to draw off the blood. The test is finished when bleeding has stopped completely.

The three other methods of performing the bleeding test are the template, modified template, and Duke methods. The template and modified template methods

are variations of the Ivy method. A blood pressure cuff is used and the skin on the forearm prepared as in the Ivy method. A template is placed over the area to be stabbed and two incisions are made in the forearm using the template as a location guide. The main difference between the template and the modified method is the length of the cut made.

For the Duke method, a nick is made in an ear lobe or a fingertip is pricked to cause bleeding. As in the Ivy method, the test is timed from the start of bleeding until bleeding is completely stopped. The disadvantage to the Duke method is that the pressure on the blood veins in the stab area is not constant and the results achieved are less reliable. The advantage to the Duke method is that no scar remains after the test. The other methods may result in a tiny, hairline scar where the wound was made. However, this is largely a cosmetic concern.

## Preparation

There is no special preparation required of the patient for this test. The area to be stabbed should be wiped clean with an alcohol pad. The alcohol should be left on the skin long enough for it to kill bacteria at the wound site. The alcohol must be removed before stabbing the arm because alcohol will adversely affect the tests results by inhibiting clotting.

## Aftercare

If a prolonged bleeding time is caused by unknown factors or diseases, further testing is required to identify the exact cause of the bleeding problem.

## Normal results

A normal bleeding time for the Ivy method is less than five minutes from the time of the stab until all bleeding from the wound stops. Some texts extend the normal range to eight minutes. Normal values for the template method range up to eight minutes, while for the modified template methods, up to 10 minutes is considered normal. Normal for the Duke method is three minutes.

## Abnormal results

A bleeding time that is longer than normal is an abnormal result. The test should be stopped if the patient hasn't stopped bleeding by 20–30 minutes. Bleeding time is longer when the normal function of platelets is impaired, or there is a lower-than-normal number of platelets in the blood.

A longer-than-normal bleeding time can indicate that one of several defects in hemostasis is present, including severe **thrombocytopenia**, platelet

dysfunction, vascular defects, Von Willebrand's disease, or other abnormalities.

## Resources

### BOOKS

McPherson, Richard A., Matthew R. Pincus, and John Bernard Henry. *Henry's Clinical Diagnosis and Management by Laboratory Methods*. Philadelphia: Saunders/Elsevier, 2007.

John T. Lohr, PhD

## Bleeding varices

### Definition

Bleeding varices are bleeding, dilated (swollen) veins in the esophagus (gullet), or the upper part of the stomach, caused by **liver disease**.

### Description

Engorged veins are called varices (plural of varix). Varices may occur in the lining of the esophagus (the tube that connects the mouth to the stomach) or in the upper part of the stomach. Such varices are called esophageal varices. These varices are fragile and can bleed easily because veins are not designed to handle high internal pressures.

### Causes and symptoms

Liver disease often causes an increase in the blood pressure in the main veins that carry blood from the stomach and intestines to the liver (portal veins). As the pressure in the portal veins increases, the veins of the stomach and esophagus swell, until they eventually become varices. Bleeding varices are a life-threatening complication of this increase in blood pressure (portal **hypertension**). The most common cause of bleeding varices is **cirrhosis** of the liver caused by chronic alcohol abuse or hepatitis. Bleeding varices occur in approximately one in every 10,000 people.

Symptoms of bleeding varices include:

- vomiting blood, sometimes in massive amounts
- black, tarry stools
- decreased urine output
- excessive thirst
- nausea
- vomiting

If bleeding from the varices is severe, a patient may go into **shock** from the loss of blood, characterized by pallor, a rapid and weak pulse, rapid and shallow respiration, and lowered systemic blood pressure.

## Diagnosis

Bleeding varices may be suspected in a patient who has any of the above-mentioned symptoms, and who has either been diagnosed with cirrhosis of the liver or who has a history of prolonged alcohol abuse. The definitive diagnosis is established via a specialized type of **endoscopy**, namely, **esophagogastroduodenoscopy** (EGD), a procedure that involves the visual examination of the lining of the esophagus, stomach, and upper duodenum with a flexible fiberoptic endoscope.

## Treatment

The objective during treatment of bleeding varices is to stop and/or prevent bleeding and to restore/maintain normal blood circulation throughout the body. Patients with severe bleeding should be treated in intensive care since uncontrolled bleeding can lead to **death**.

Initial treatment of bleeding varices begins with standard resuscitation, including intravenous fluids and blood transfusions as needed. Definitive treatment is usually endoscopic, with the endoscope used to locate the sites of the bleeding. An instrument, inserted along with the endoscope, is used either to inject these sites with a clotting agent or to tie off the bleeding sites with tiny rubber bands.

Repeated endoscopic treatments (usually four to six) are generally required to eliminate the varices and to prevent the recurrence of bleeding. These endoscopic techniques are successful in about 90 percent of cases.

Patients who cannot be treated endoscopically may be considered for an alternative procedure called TIPS (transjugular intrahepatic portosystemic shunt). This procedure involves placing a hollow metal tube (shunt) in the liver connecting the portal veins with the hepatic veins (veins that leave the liver and drain to the heart). This shunt lowers the pressure in the portal veins and prevents bleeding and portal hypertension. The TIPS procedure is performed by a radiologist and has become an accepted method for reducing portal vein pressure since 1992. Although the procedure continues to evolve, TIPS can routinely be created in more than 93% of patients.

Medications aimed at controlling bleeding may also be prescribed. These include propantheline, vasopressin, octreotide acetate, and isosorbide mononitrate.

## Alternative treatment

Some alternative treatments are aimed at preventing the cirrhosis of the liver that often causes bleeding varices, and most are effective. However, once a patient has reached the bleeding varice stage, standard

intervention to stop the bleeding is required or the patient may die.

## Prognosis

Bleeding varices represent one of the most feared complications of portal hypertension. They contribute to the estimated 32,000 deaths per year attributed to cirrhosis. Half or more of patients who survive episodes of bleeding varices are at risk of renewed esophageal bleeding during the first one to two years. The risk of recurrence can be lowered by endoscopic and drug treatment. Prognosis is usually more related to the underlying liver disease. Approximately 30 to 50 percent of people with bleeding varices will die from this condition within the six weeks of the first bleeding episode.

## Prevention

The best way to possibly prevent the development or recurrence of bleeding varices is to eliminate the risk factors for cirrhosis of the liver. The most common cause of cirrhosis is prolonged alcohol abuse, and alcohol consumption must be completely eliminated. People with **hepatitis B** or **hepatitis C** also have an increased risk of developing cirrhosis of the liver. **Vaccination** against hepatitis B and avoidance of intravenous drug usage reduce the risk of contracting hepatitis.

## Resources

### BOOKS

Worman, Howard J. *The Liver Disorders and Hepatitis Sourcebook*. New York: McGraw-Hill, 2006.

### PERIODICALS

Hegab, Ahmed M., and Velimir A. Luketic. "Bleeding esophageal varices: How to treat this dreaded complication of portal hypertension." *Postgraduate Medicine* 109 (February 2001): 75-89.

### OTHER

Goff, John. "Portal hypertensive bleeding." May 12, 2001. [http://www.nysge.org/PostGrad1999/Goff\\_VaricealBleeding.htm](http://www.nysge.org/PostGrad1999/Goff_VaricealBleeding.htm).

### ORGANIZATIONS

American Liver Foundation, 75 Maiden Lane, Suite 603, New York, NY, 10038, (212) 668-1000, (212) 483-8179, <http://www.liverfoundation.org/>.

Paul A. Johnson, Ed.M.

Blepharitis see **Eyelid disorders**

# Blepharoplasty

## Definition

Blepharoplasty is a cosmetic surgical procedure that removes fat deposits, excess tissue, or muscle from the eyelids to improve the appearance of the eyes.

## Purpose

The primary use of blepharoplasty is for improving the cosmetic appearance of the eyes. In some older patients, however, sagging and excess skin surrounding the eyes can be so extensive that it limits the range of vision. In those cases, blepharoplasty serves a more functional purpose.

## Precautions

Before performing blepharoplasty, the surgeon will assess whether the patient is a good candidate for the treatment. A good medical history is important. The surgeon will want to know about any history of thyroid disease, **hypertension**, or eye problems, which may increase the risk of complications.

## Description

Blepharoplasty can be performed on the upper or lower eyelid; it can involve the removal of excess skin and fat deposits and the tightening of selected muscles surrounding the eyelids. The goal is to provide a more youthful appearance.

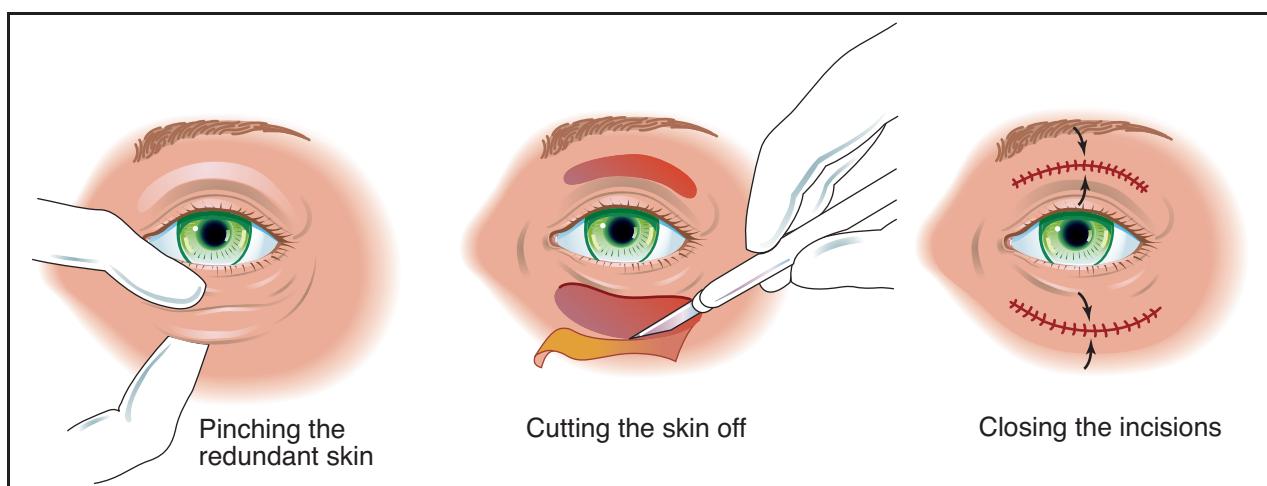
The surgeon will begin by deciding whether excess skin, fat deposits, or muscle looseness are at fault. While the patient is sitting upright, the surgeon will mark on the skin where incisions will be made. Care will be taken to hide the incision lines in the natural skin folds above and below the eye. The patient then receives injections of a local anesthetic to numb the **pain**. Many surgeons also give the patient a sedative intravenously during the procedure.

After a small, crescent-shaped section of eyelid skin is removed, the surgeon will work to tease out small pockets of fat that have collected in the lids. If muscle looseness is also a problem, the surgeon may trim tissue or add a stitch to pull it tighter. Then the incision is closed with stitches.

In some patients, fat deposits in the lower eyelid may be the only or primary problem. Such patients may be good candidates for transconjunctival blepharoplasty. In this procedure the surgeon makes no incision on the surface of the eyelid, but instead enters from behind to tease out the fat deposits from a small incision. The advantage of this procedure is that there is no visible scar.

## Preparation

Prior to surgery, patients meet with their surgeon to discuss the procedure, clarify the results that can be achieved, and discuss the potential problems that might occur. Having realistic expectations is important in any cosmetic procedure. Patients will learn, for example, that although blepharoplasty can improve the



**Blepharoplasty is one of the most common cosmetic surgical procedures. The illustration above depicts a procedure to eliminate dermochalasia, or baggy skin around the eyes.** (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

appearance of the eyelid, other procedures, such as a chemical peel, will be necessary to reduce the appearance of wrinkles around the eye. Some surgeons prescribe vitamin C and vitamin K for 10 days prior to surgery in the belief that this helps the healing process. Patients are also told to stop **smoking** in the weeks before and after the procedure, and to refrain from alcohol and **aspirin**.

### Aftercare

An antibiotic ointment is applied to the line of stitches for several days after surgery. Patients also take an antibiotic several times a day to prevent infection. Ice-cold compresses are applied to the eyes continuously for the first day following surgery, and several times a day for the next week or so, to reduce swelling. Some swelling and discoloration around the eyes is expected with the procedure. Patients should avoid aspirin or alcoholic beverages for one week and should limit their activities, including bending, straining, and lifting. The stitches are removed a few days after surgery. Patients can generally return to their usual activities within a week to 10 days.

### Risks

As with any surgical procedure, blepharoplasty can lead to infection and scarring. Good care of the wound following surgery can minimize these risks. In cases where too much skin is removed from the eyelids, the patient may have difficulty closing his eyes. Dry eye syndrome may develop, requiring the use of artificial tears to lubricate the eye. In a rare complication, called retrobulbar hematoma, a pocket of blood forms behind the eyeball.

### Normal results

Most patients can expect good results from blepharoplasty, with the removal of excess eyelid skin and fat producing a more youthful appearance. Some swelling and discoloration is expected immediately following the procedure, but this clears in time. Small **scars** will be left where the surgeon has made incisions, but these generally lighten in appearance over several months, and, if placed correctly, will not be readily noticeable.

### Abnormal results

As noted, if too much excess skin is removed from the upper eyelid, the patient may be unable to close his eyes completely; another surgery to correct the defect may be required. Similarly, too much skin can be

removed from the lower eyelid, allowing too much of the white of the eye (the sclera) to show. In extreme cases, the lower lid may be pulled down too far, revealing the underlying tissue. Called an ectropion, this too may require a second, corrective surgery. The eye's ability to make tears may also be compromised, leading to dry eye syndrome. Dry eye syndrome is potentially dangerous; in rare cases it leads to damage to the cornea of the eye and vision loss.

### ORGANIZATIONS

American Society for Dermatologic Surgery, 5550 Meadowbrook Dr., Suite 120, Rolling Meadows, IL, 60008, (847) 956-0900, (847) 956-0999, <http://www.asds.net/>.

American Society of Plastic Surgeons, 444 E. Algonquin Rd, Arlington Heights, IL, 60005, (847) 228-9900, <http://www.plasticsurgery.org/>.

Richard H. Camer

Blindness see **Visual impairment**

## Blood-viscosity reducing drugs

### Definition

Blood-viscosity reducing drugs thin blood, making it less sticky and improving blood flow.

### Purpose

By improving blood flow, these drugs help relieve cramps in arms, hands, and legs caused by narrowed arteries that reduce circulation and oxygen supply. Cramps caused by periodic spasms in small arteries are called **intermittent claudication**.

These drugs are sometimes used for off-label purposes like treating **stroke**; nerve, circulation and **impotence** problems caused by diabetes; **gangrene**; **septic shock**; complications of **sickle cell disease**; and leg ulcers.

### Description

Pentoxifylline (Trental, Pentoxyline) is the main blood-viscosity reducing drug. It is available only by prescription. This drug comes in extended-release tablet form.

Dried Ginkgo biloba extract reduces blood viscosity. It is available without prescription, but there are special precautions that need to be observed when using herbal medications.

## Recommended dosage

The usual dosage of Trental and Pentoxil for adults is 400 mg, two to three times a day, with meals. Safety of this drug has not been established in children.

## Precautions

This medicine may relieve cramps caused by poor circulation, but is not a substitute for specific treatments for underlying conditions.

This medicine may take several weeks to produce noticeable results. Be sure to keep taking it as directed, even if it doesn't seem to be helping.

**Smoking** may worsen the conditions for which the medicine is prescribed.

Older people may be especially sensitive to the effects of this medicine, which may increase the chance of side effects.

## Side effects

The most common adverse effects from this drug are **nausea and vomiting**. Other, rare side effects include allergic reactions like skin rash, swelling around the lips and mouth, and headaches.

## Interactions

This drug may increase the effects of theophylline (Theo-Dur).

James Waun, MD, RPh

# Blood clots

## Definition

A blood clot is a thickened mass in the blood formed by tiny substances called platelets. Clots form to stop bleeding, such as at the site of a cut. Clots should not form when blood is moving through the body; when clots form inside blood vessels or when blood has a tendency to clot too much, serious health problems can occur.

## Demographics

The formation of a clot in a blood vessel may result in **thrombophlebitis**. The term refers to swelling of one or more veins caused by a blood clot. Although some clots occur in the arms or small, surface blood vessels,

most occur in the lower legs. When the blood clot occurs in a deep vein, it is called **deep vein thrombosis**, or DVT.

As many as 350,000 to 600,000 venous blood clots per year occur in the United States. The danger of DVT comes when pieces of the clot, known as emboli or an embolus, break off and travel through the bloodstream to the lungs. About 1 in 3 blood clots to the lungs (**pulmonary embolism**) are fatal.

## Description

As soon as a blood vessel wall is damaged—by a cut or similar trauma—a series of reactions normally takes place to activate platelets to stop the bleeding. Platelets are the tiny particles in the blood released into the bone marrow that gather together and form a barrier to further bleeding. Several proteins in the body are involved in the platelets clotting process. Chief among these proteins are collagen, thrombin, and von Willebrand factor. Collagen and thrombin help platelets stick together. As platelets gather at the site of injury, they change in shape from round to spiny, releasing proteins and other substances that help catch more platelets and clotting proteins. This enlarges the plug that becomes a blood clot. Formation of blood clots also is called “coagulation.”

The series of reactions that cause proteins and platelets to create blood clots also are balanced by other reactions that stop the clotting process and dissolve clots after the blood vessel has healed. If this control system fails, minor blood vessel injuries can trigger clotting throughout the body. The tendency to clot too much is called “hypercoagulation.” Anytime clots form inside blood vessels, they can lead to serious complications.

A blood clot that blocks an artery to the brain can cause a **stroke**. If the clot blocks blood flow to the lungs, pulmonary **embolism** can occur. A blood clot that blocks a coronary artery can cause a **heart attack**. Certain people are at higher risk for blood clots than others; surgery, some injuries, **childbirth** and lying or sitting still for extended periods of time put people at higher risk, as do inherited disorders. Once a person has a blood clot, he or she may have to take blood-thinning drugs to prevent clots from recurring. Men and women are at similar risk for blood clots. A recent study in Austria found that men run a higher risk of recurring blood clots than women, though the reason is unknown.

## Causes and symptoms

Many causes can lead to blood clots, some genetic and some environmental. An environmental cause of

DVT is prolonged inactivity. For instance, having to sit in a car or airplane for a long period of time decreases blood flow in the lower legs. Recent studies have shown that 1% of air travelers develop blood clots, usually on long flights of five hours or more. However, one study in 2004 found that air travelers developed clots on flights as short as three hours, though they often dissolved naturally and did not lead to complications. Other environmental causes of blood clots include use of **hormone replacement therapy** to ease menopausal symptoms, **oral contraceptives** for birth control, **pregnancy** (and a childbirth within the past six weeks), recent surgery or procedures involving use of a central **venous access** catheter, and **cancer**. **Smoking** also is an important and preventable environmental risk for blood clots.

Some people are born with a higher risk for blood clots. **Hypercoagulation disorders** are genetic conditions. Usually the body doesn't produce enough of the proteins involved in the clotting process, so they cannot do their job to stop the clotting; in other cases, there is an extra protein that causes too much clotting.

There may be no symptoms of blood clots until they grow so large that they block the flow of blood through the vein. Then, symptoms may develop suddenly around the area and include:

- Pain or tenderness in the affected area.
- Warmth or redness of the skin in the affected area.
- Sudden swelling in the affected limb.

Additional symptoms may indicate serious complications of blood clots such as pulmonary embolism, stroke, and heart attack. If vein swelling or **pain** are accompanied by high **fever** or **shortness of breath**, rapid pulse, or chest pain, or other symptoms that may indicate stroke, heart attack, or pulmonary embolism, it is advised to go to an emergency room immediately.

## Diagnosis

A physician will diagnose blood clots based on patient history and one of several diagnostic imaging exams. The patient's history will help determine possible risk factors that may lead to suspected blood clots. In addition to family history or known genetic disorders, the patient may mention an environmental factor such as recent air travel or use of high-risk medications.

To help get a picture of suspected clots inside the blood vessels, usually the first test of choice is an ultrasound. Doppler or duplex ultrasound uses sound waves that travel through tissue and reflect back to

create images. A computer transforms the sound waves into moving images on the screen that may show the clot, as well as blood flow near the clot and any abnormalities. Ultrasound does not use x rays and is a noninvasive method. Computed tomography (CT) scans also might be used to image the blood vessels. CT scans are similar to x rays, except the images are much like cross-section slices with greater detail that can be computerized and even viewed three-dimensionally. A special dye called a contrast agent may be injected before the exam to help highlight the veins. Magnetic resonance **angiography** uses **magnetic resonance imaging** (MRI) to image the blood vessels. It also may involve injection of a contrast dye. **Venography** is less commonly used, and involves injecting a contrast and using x rays to image the veins.

## Treatment

Medicines can help thin blood, making it less likely to clot. The two most common blood thinners are heparin and warfarin. Heparin works right away, keeping blood clots from growing. It usually is injected. In recent years, more physicians have been prescribing low-molecular weight heparin, purified versions of the drug that can be given with less monitoring. Warfarin (coumadin) often is used for long-term treatment of blood clots and is taken orally. Patients must work closely with their physicians to constantly monitor its effects and adjust dose if necessary. Too little warfarin can lead to clotting, but too much can thin the blood so much that causing life-threatening bleeding can occur. The same can be true of low-molecular weight heparin when used on a long-term, at-home basis.

Other treatments for blood clots include injecting clot-busting drugs directly into the clot through a catheter, or in rare instances, installation of a filter to block a clot from lodging in the lungs. Sometimes, surgery also is needed to remove a clot blocking a pelvic or abdominal vein or one that is chronic and disabling. A cardiovascular surgeon or interventional radiologist may perform balloon **angioplasty** or insert a stent to open a narrowed or damaged vessel. In an emergency situation, a drug called tissue plasminogen activator, or tPA, may be given to immediately dissolve a life-threatening blood clot to the brain or heart. In 2004, the U.S. Food and Drug Administration (FDA) approved a new, small, corklike device (called a Merci Retriever) that can be used to remove blood clots from the brains of patients who cannot receive clot-busting drugs. More recently, the FDA approved a suction device that works in much the same way, called the Penumbra device.

## KEY TERMS

**Coronary arteries**—The main arteries that provide blood to the heart. The coronary arteries surround the heart like a crown, coming out of the aorta, arching down over the top of the heart, and dividing into various branches. These are the arteries in which heart disease occurs.

**Coronary artery disease**—Also called atherosclerosis, it is a buildup of fatty matter and debris in the coronary artery wall that causes narrowing of the artery.

**Embolus**—An embolus is a clot that has formed in a blood vessel somewhere in the body, often in the heart. It can break away from the wall of the vessel where it was formed, travel through the circulatory system, and become wedged in the brain, causing an embolic stroke. Ischemic strokes also can be caused by the formation of a blood clot in one of the cerebral arteries (arteries supplying blood to the brain). If the clot grows large enough it will block blood flow.

**Ischemia**—Ischemia (is-KEY-me-a) is the term used to describe the loss of oxygen and nutrients when there is inadequate blood flow. If ischemia is left untreated, it can lead to infarction (in-FARK-shun), or cell death and tissue death in the surrounding area.

### Alternative treatment

Garlic is thought to lower blood clotting potential. Less evidence suggests onions and cayenne pepper may help keep blood thin. New research from Australia adds tomato juice to the list of potential blood thinners. Subjects who drank a glass of tomato juice a day reduced their risk for DVT, stroke, and cardiovascular disease. Research has shown that a natural soy and pine product called pinokinase has been effective in controlling DVT in air travelers. Patients seeking alternative treatments for blood clots should work with certified practitioners and should inform their allopathic provider about their alternative care.

### Prognosis

If detected and controlled with medications, blood clots can be safely managed. However, if the clots become dislodged and travel to an artery, they can cause nearly instant **death**. For instance, more than 600,000 people have a pulmonary embolism each year and more than 10% of them die from the

embolism, most within 30 to 60 minutes after symptoms start.

### Prevention

Clots may be avoided by not smoking, and by not using medications that add to the risk. Clotting can be prevented by following physician recommendations concerning medications. Sometimes, physicians will prescribe special support stockings that prevent swelling and reduce chances of DVT. When taking an air flight of six hours or longer, drinking plenty of fluids to avoid **dehydration**, avoiding tight clothing around the waist, and stretching calves every hour can help prevent DVT. It is advised that those on long flights get up and move about once an hour during the flight. If not possible, moving the legs regularly while seated by flexing the ankles, then pressing the feet against the seat in the row ahead or on the floor can help stretch the calves. A physician may advise those at high risk of DVT wear support stockings during the flight or take low-molecular weight heparin two to four hours before departure.

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- Avoid Deep Vein Thrombosis: Keep the Blood Flowing.*  
 MedicineNet Web site, 2010. <http://www.medicinenet.com/script/main/art.asp?articlekey=40582>.

### ORGANIZATIONS

- American Heart Association, 7272 Greenville Ave., Dallas, TX, 75231, (301) 223-2307, (800) 242-8721, <http://www.americanheart.org>.  
 Centers for Disease Control and Prevention (CDC), Division for Heart Disease and Stroke Prevention, 4770 Buford Hwy NE, Atlanta, GA, 30341-3717, <http://www.cdc.gov/cholesterol/faqs.htm>.  
 National Blood Clot Alliance, 120 White Plains Road, Suite 100, Tarrytown, NY, 10591, <http://www.stoptheclot.org/contact.htm>.  
 National Heart, Lung, and Blood Institute, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (204) 629-3246, [nhlbiinfo@nhlbi.nih.gov](mailto:nhlbiinfo@nhlbi.nih.gov), <http://www.nhlbi.nih.gov>.

Teresa G. Odle

Blood crossmatching see **Blood typing and crossmatching**

## Blood culture

### Definition

A blood culture is done when a person has symptoms of a blood infection, also called **bacteremia**. Blood is drawn from the person one or more times and is tested in a laboratory to find and identify any microorganism present and growing in the blood. If a microorganism is found, more testing is done to determine the **antibiotics** that will be effective in treating the infection.

### Purpose

Bacteremia is a serious clinical condition and can lead to **death**. To give the best chance for effective treatment and survival, a blood culture is done as soon as an infection is suspected.

Symptoms of bacteremia are **fever**, chills, mental confusion, **anxiety**, rapid heartbeat, hyperventilation, blood clotting problems, and **shock**. These symptoms are especially significant in a person who already has another illness or infection, is hospitalized, or has trouble fighting infections because of a weak immune system. Often, the blood infection results from an infection somewhere else in the body that has now spread.

Additionally, blood cultures are done to find the causes of other infections. These include bacterial **pneumonia** (an infection of the lung) and infectious **endocarditis** (an infection of the inner layer of the heart). Both of these infections leak bacteria into the blood.

After a blood infection has been diagnosed, confirmed by culture, and treated, an additional blood culture may be done to make sure the infection is gone.

### Description

#### Culture strategies

There are many variables involved in performing a blood culture. Before the person's blood is drawn, the physician must make several decisions based on a knowledge of infections and the person's clinical condition and medical history.

Several groups of microorganisms, including bacteria, viruses, mold, and yeast, can cause blood infections. The bacteria group can be further broken down into aerobes and anaerobes. Most aerobes do not need oxygen to live. They can grow with oxygen (aerobic microbes) or without oxygen (anaerobic microbes).

Based on the clinical condition of the patient, the physician determines what group of microorganisms is likely to be causing the infection and then orders one or more specific types of blood culture, including aerobic, anaerobic, viral, or fungal (for yeasts and molds). Each specific type of culture is handled differently by the laboratory. Most blood cultures test for both aerobic and anaerobic microbes. Fungal, viral, and mycobacterial blood cultures can also be done, but are less common.

The physician must also decide how many blood cultures should be done. One culture is rarely enough, but two to three are usually adequate. Four cultures are occasionally required. Some factors influencing this decision are the specific microorganisms the physician expects to find based on the person's symptoms or previous culture results, and whether or not the person has had recent antibiotic therapy.

The time at which the cultures are to be drawn is another decision made by the physician. During most blood infections (called intermittent bacteremia) microorganisms enter the blood at various time intervals. Blood drawn randomly may miss the microorganisms. Since microorganisms enter the blood 30–90 minutes before the person's fever spikes, collecting the culture just after the fever spike offers the best likelihood of finding the microorganism. The second and third cultures may be collected at the same time, but from different places on the person, or spaced at 30-minute or one-hour intervals, as the physician chooses. During continuous bacteremia, such as infective endocarditis, microorganisms are always in the blood and the timing of culture collection is less important. Blood cultures should always be collected before antibiotic treatment has begun.

#### Laboratory analysis

Bacteria are the most common microorganisms found in blood infections. Laboratory analysis of a bacterial blood culture differs slightly from that of a fungal culture and significantly from that of a viral culture.

Blood is drawn from a person and put directly into a blood culture bottle containing a nutritional broth. After the laboratory receives the blood culture bottle, several processes must be completed:

- provide an environment for the bacteria to grow
- detect the growth when it occurs
- identify the bacteria that grow
- test the bacteria against certain antibiotics to determine which antibiotic will be effective

There are several types of systems, both manual and automated, available to laboratories to carry out these processes.

The broth in the blood culture bottle is the first step in creating an environment in which bacteria will grow. It contains all the nutrients that bacteria need to grow. If the physician expects anaerobic bacteria to grow, oxygen will be kept out of the blood culture bottle; if aerobes are expected, oxygen will be allowed in the bottle.

The bottles are placed in an incubator and kept at body temperature. They are watched daily for signs of growth, including cloudiness or a color change in the broth, gas bubbles, or clumps of bacteria. When there is evidence of growth, the laboratory does a gram stain and a subculture. To do the gram stain, a drop of blood is removed from the bottle and placed on a microscope slide. The blood is allowed to dry and then is stained with purple and red stains and examined under the microscope. If bacteria are seen, the color of stain they picked up (purple or red), their shape (such as round or rectangular), and their size provide valuable clues as to what type of microorganism they are and what antibiotics might work best. To do the subculture, a drop of blood is placed on a culture plate, spread over the surface, and placed in an incubator.

If there is no immediate visible evidence of growth in the bottles, the laboratory looks for bacteria by doing gram stains and subcultures. These steps are repeated daily for the first several days and periodically after that.

When bacteria grows, the laboratory identifies it using biochemical tests and the gram stain. Sensitivity testing, also called antibiotic susceptibility testing, is also done. The bacteria are tested against many different antibiotics to see which antibiotics can effectively kill it.

All information is passed on to the physician as soon as it is known. An early report, known as a preliminary report, is usually available after one day. This report will tell if any bacteria have been found yet, and if so, the results of the gram stain. The next preliminary report may include a description of the bacteria growing on the subculture. The laboratory notifies the physician immediately when an organism is found and as soon as sensitivity tests are complete. Sensitivity tests may be complete before the bacteria is completely identified. The final report may not be available for five to seven days. If bacteria was found, the report will include its complete identification and a list of the antibiotics to which the bacteria is sensitive.

One automated system is considered one of the most important recent technical advances in blood cultures. It is called continuous-monitoring blood

culture systems (CMCCS). The instruments automatically monitor the bottles containing the patient blood for evidence of microorganisms, usually every 10 minutes. Many data points are collected daily for each bottle, and fed into a computer for analysis. Sophisticated mathematical calculations can determine when microorganisms have grown. This, combined with more frequent blood tests, make it possible to detect microbial growth earlier. In addition, all CMBCS instruments have the detection system, incubator, and agitation unit in one unit.

## Preparation

Ten mL (milliliters) of blood is usually needed for each blood culture bottle. First a healthcare worker locates a vein in the inner elbow region. The area of skin where the blood will be drawn must be disinfected to prevent any microorganisms on a person's skin from entering the blood culture bottle and contaminating it. The area is disinfected by wiping the area with alcohol in a circular fashion, starting with tiny circles at the spot where the needle will puncture the skin and enlarging the size of the circles while wiping away from the puncture site. The same pattern of wiping is repeated using an iodine or iodophor solution. The top of the bottle is disinfected using alcohol. After the person's skin has been disinfected, the healthcare worker draws the blood and about 10 mL of blood is injected into each blood culture bottle. The type of bottles used will vary based on whether the physician is looking for bacteria (aerobes or anaerobes), yeast, mold, or viruses.

## Aftercare

Discomfort or bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops reduces bruising. Warm packs relieve discomfort.

## Normal results

Normal results will be negative. A single negative culture does not rule out a blood infection. False negatives can occur if the person was started on antibiotics before the blood was drawn, the environment for growth was not right, the timing was off, or for some unknown reason the microorganism just didn't grow. Three negative cultures may be enough to rule out bacteremia in the case of endocarditis.

## Abnormal results

The physician's skill in interpreting the culture results and assessing the person's clinical condition is

essential in distinguishing a blood culture that is positive because of a true infection from a culture that is positive because it became contaminated. In true bacteremia, the patient's clinical condition should be consistent with a blood infection caused by the microorganism that was found. The microorganism is usually found in more than one culture, grows soon after the bottles are incubated, and is often the cause of an infection somewhere else in the person's body.

When the culture is positive because of contamination, the patient's clinical condition usually is not consistent with an infection from the identified microorganism. In addition, the microorganism is often one commonly found on skin, rarely causes infection, is found in only one bottle, and may appear after several days of incubation. More than one microorganism often grow in contaminated cultures.

#### ORGANIZATIONS

American Society of Microbiology, 1752 N Street N.W., Washington, DC, 20036-2904, (202) 737-3600, <http://www.asm.org/>.

Nancy J. Nordenson

## Blood donation and registry

### Definition

Blood donation refers to the process of collecting, testing, preparing, and storing blood and blood components. Donors are most commonly unpaid volunteers, but they may also be paid by commercial enterprises. Blood registry refers to the collection and sharing of data about donated blood and ineligible donors.

### Purpose

The purpose of the blood collection and distribution system is to help ensure an adequate supply of blood for accident victims, people needing surgery, and people suffering from certain diseases, as well as for medical research.

Sometimes, donors give blood specifically to benefit a particular person. People preparing for elective surgery may donate their own blood to be held and then returned to them during surgery. This is known as autologous blood donation. Directed donor blood has been donated by someone known to the intended recipient, such as a family member or friend.

Each year, more than four million Americans receive blood transfusions involving more than 26

million units of blood (one unit equals 450 milliliters, or about one pint), or an average of about 32,000 units per day. All of that blood must be collected, tested, prepared, stored, and delivered to the appropriate sites. Roughly eight million people in the United States donate blood each year; about half of the total amount needed is provided by the 36 regional blood centers of the American Red Cross.

Whole blood and the various blood components have many uses. Red blood cells, which carry oxygen, are used to treat anemia. Platelets, which play a role in controlling bleeding, are commonly used in the treatment of leukemia and other cancers. Fresh frozen plasma is also used to control bleeding in people deficient in certain clotting factors. Cryoprecipitated AHF, made from fresh frozen plasma, contains a few specific clotting factors.

### Precautions

To ensure the safety of the blood supply, a multi-tiered process of donor screening and deferral is employed. This involves donor education, taking a detailed health history of each prospective donor, and giving potential donors a simple **physical examination** (which includes taking a few drops of blood to test for anemia). At any point in the process, a potential donor may be "deferred," or judged ineligible to donate blood. This deferral may be temporary or permanent, depending on the reason. Potential donors are also encouraged to "self-defer," or voluntarily decline to donate, rather than put future blood recipients at risk.

All donated blood is extensively tested before being used. The first step is determining the blood type, which indicates who can receive the blood. Receiving the wrong type of blood can cause **death**. Blood is also screened for any antibodies that could cause complications for recipients. In addition, blood is tested to screen out donors infected with the following diseases: **Hepatitis B** surface antigen ADD, hepatitis B core antibody, **hepatitis C** virus antibody, HIV-1 and HIV-2 antibody, HIV p24 antigen, HTLV-I and HTLV-II antibodies, and **syphilis**. Nucleic Acid Amplification testing is also performed, and other tests may be done if a doctor requests them.

In order to detect the greatest possible number of infections, these screening tests are extremely sensitive. For this reason, however, donors sometimes receive false positive test results. In these cases, more specific confirmatory tests are performed, to help rule out false positive results. Blood found to be abnormal is discarded, and all items coming into direct contact with donors are used only once and then discarded. Donors of infected blood are entered into the Donor Deferral

Register, a confidential national data base used to prevent deferred people from donating blood.

In general, blood donors must be at least 17 years old (some states allow younger people to donate blood with their parents' consent), must weigh at least 110 pounds (50 kg), and must be in good health.

Many factors can temporarily or permanently disqualify potential donors. Most of them have to do with experiences that put them at risk of infection or having spent time in certain specified areas. Among these factors are having had a tattoo, having had sex with people in high-risk groups, having had certain diseases, and having been raped.

## Description

There are eight different blood types in all—four ABO groups, each of which may be either Rh positive or Rh negative. These types, and their approximate distribution in the U.S. population, are as follows: O+ (38%), O- (7%), A+ (34%), A- (6%), B+ (9%), B- (2%), AB+ (3%), AB- (1%). In an emergency, anyone can safely receive type O red blood cells, and people with this blood type are known as "universal donors." People with type AB blood, known as "universal recipients," can receive any type of red blood cells and can give plasma to all blood types.

Blood donations can be made in community blood centers, at hospitals, or in bloodmobiles, which visit schools, churches and workplaces. The actual process of donating whole blood takes about 20 minutes. A sterile needle is inserted into a vein in the donor's arm. The blood flows through plastic tubing into a blood bag. Donors may be asked to clench their fist to encourage blood to flow. Usually, one unit of blood is collected. Afterward, donors are escorted to an observation area, given light refreshments, and allowed to rest.

Plasma, the liquid portion of the blood in which red blood cells, platelets, and other elements are suspended, is also collected, often by commercial enterprises that sell it to companies manufacturing clotting factors and other blood products. This is done using a process known as apheresis, in which whole blood is collected, the desired blood component is removed, and the remainder is returned to the donor. Collecting plasma generally takes one to two hours. Apheresis may also be used to collect other blood components, such as platelets and granulocytes.

## Preparation

Once whole blood has been collected, it is sent to a lab for testing and processing. Most donated blood is

separated into its constituent components, such as red blood cells, platelets, and cryoprecipitate. This enables more than one person to benefit from the same unit of donated blood.

Different blood components vary in how long they can be stored. Red blood cells can be refrigerated for up to 42 days or frozen for as long as 10 years. Platelets, stored at room temperature, may be kept for up to five days. Fresh frozen plasma and cryoprecipitated AHF can be kept for up to one year.

## Aftercare

It generally takes about 24 hours for the donor's body to replenish the lost fluid. Replacing the lost red blood cells, however, may take as much as two months. Whole blood donors must wait a minimum of eight weeks before donating again. Some states place further limits on the frequency and/or total number of times an individual may donate blood within a 12-month period.

## Risks

Thanks to the use of a multi-tiered screening system and advances in the effectiveness of screening tests, the transmission of infectious diseases via **transfusion** has been significantly diminished. Nonetheless, there is still a minuscule risk that blood recipients could contract HIV, Hepatitis C, or other infections via transfusion. Other diseases that could conceivably be contracted in this way, or that are of particular concern to blood-collection agencies, include **babesiosis**, Chagas disease, HTLV-I and -II, **Creutzfeldt-Jakob disease**, cytomegalovirus, **Lyme disease**, **malaria**, and new variant Creutzfeldt-Jakob disease.

Autologous blood donors run a tiny risk of having the wrong blood returned to them due to clerical error. There is also a faint possibility of bacterial contamination of the autologous blood.

## Normal results

For most donors, the process is quick and painless and they leave feeling fine. They may also find satisfaction in knowing that they have contributed to the nation's blood supply and may even have helped save lives.

## Abnormal results

Most blood donors suffer no significant aftereffects. Occasionally, however, donors feel faint or dizzy, nauseous, and/or have **pain**, redness, or a bruise where the blood was taken. More serious complications, which rarely occur, include **fainting**, **muscle spasms**, and nerve damage.

## ORGANIZATIONS

American Association of Blood Banks, 8101 Glenbrook Road, Bethesda, MD, 20814-2749, (301) 907-6977, (301) 907-6895, <http://www.aabb.org>.  
American Red Cross, 2025 E Street NW, Washington, DC, 20006, (202) 303-5000, (800) 733-2767, <http://www.redcross.org>.

Peter Gregutt

Blood fluke infection see **Schistosomiasis**

## Blood gas analysis

### Definition

Blood gas analysis, also called arterial blood gas (ABG) analysis, is a test that measures the amounts of oxygen and carbon dioxide in the blood, as well as the acidity (pH) of the blood.

### Purpose

An ABG analysis evaluates how effectively the lungs are delivering oxygen to the blood and how efficiently they are eliminating carbon dioxide from it. The test also indicates how well the lungs and kidneys are interacting to maintain normal blood pH (acid-base balance). Blood gas studies are usually done to assess respiratory disease and other conditions that may affect the lungs, and to manage patients receiving **oxygen therapy** (respiratory therapy). In addition, the acid-base component of the test provides information on kidney function.

### Description

Blood gas analysis is performed on blood from an artery. It measures the partial pressures of oxygen and carbon dioxide in the blood, as well as oxygen content, oxygen saturation, bicarbonate content, and blood pH.

Oxygen in the lungs is carried to the tissues through the bloodstream, but only a small amount of this oxygen can actually dissolve in arterial blood. How much dissolves depends on the partial pressure of the oxygen (the pressure that the gas exerts on the walls of the arteries). Therefore, testing the partial pressure of oxygen is actually measuring how much oxygen the lungs are delivering to the blood. Carbon dioxide is released into the blood as a by-product of cell metabolism. The partial carbon dioxide pressure



**A blood gas analyzer from Corning Corporation.** (Hank Morgan/Photo Researchers, Inc.)

indicates how well the lungs are eliminating this carbon dioxide.

The remainder of oxygen that is not dissolved in the blood combines with hemoglobin, a protein-iron compound found in the red blood cells. The oxygen content measurement in an ABG analysis indicates how much oxygen is combined with the hemoglobin. A related value is the oxygen saturation, which compares the amount of oxygen actually combined with hemoglobin to the total amount of oxygen that the hemoglobin is capable of combining with.

Carbon dioxide dissolves more readily in the blood than oxygen does, primarily forming bicarbonate and smaller amounts of carbonic acid. When present in normal amounts, the ratio of carbonic acid to bicarbonate creates an acid-base balance in the blood, helping to keep the pH at a level where the body's cellular functions are most efficient. The lungs

## KEY TERMS

**Acid-base balance**—The condition that exists when the body's carbonic acid-bicarbonate buffer system is in equilibrium, helping to maintain the blood pH at a normal level of 7.35–7.45.

**Hemoglobin**—A protein-iron compound in red blood cells that functions primarily in carrying oxygen from the lungs to the tissues of the body.

**pH**—A measure of the acidity of a solution. Normal blood pH ranges from 7.35–7.45.

and kidneys both participate in maintaining the carbonic acid-bicarbonate balance. The lungs control the carbonic acid level and the kidneys regulate the bicarbonate. If either organ is not functioning properly, an acid-base imbalance can result. Determination of bicarbonate and pH levels, then, aids in diagnosing the cause of abnormal blood gas values.

### The procedure

The blood sample is obtained by arterial puncture (usually in the wrist, although it could be in the groin or arm) or from an arterial line already in place. If a puncture is needed, the skin over the artery is cleaned with an antiseptic. A technician then collects the blood with a small sterile needle attached to a disposable syringe. The patient may feel a brief throbbing or cramping at the site of the puncture. After the blood is drawn, the sample must be transported to the laboratory as soon as possible for analysis.

### Preparation

There are no special preparations. Patients have no restrictions on drinking or eating before the test. If the patient is receiving oxygen, the oxygen concentration must remain the same for 20 minutes before the test; if the test is to be taken without oxygen, the gas must be turned off for 20 minutes before the test is taken. The patient should breathe normally during the test.

### Aftercare

After the blood has been taken, the technician or the patient applies pressure to the puncture site for 10–15 minutes to stop the bleeding, and then places a dressing over the puncture. The patient should rest quietly while applying the pressure to the puncture site. Health care workers will observe the patient for signs of bleeding or circulation problems

### Risks

Risks are very low when the test is done correctly. Risks include bleeding or bruising at the site, or delayed bleeding from the site. Very rarely, there may be a problem with circulation in the puncture area.

### Normal results

Normal blood gas values are as follows:

- partial pressure of oxygen ( $\text{PaO}_2$ ): 75–100 mm Hg
- partial pressure of carbon dioxide ( $\text{PaCO}_2$ ): 35–45 mm Hg
- oxygen content ( $\text{O}_2\text{CT}$ ): 15–23%
- oxygen saturation ( $\text{SaO}_2$ ): 94–100%
- bicarbonate ( $\text{HCO}_3$ ): 22–26 mEq/liter
- pH: 7.35–7.45

### Abnormal results

Values that differ from those listed above may indicate respiratory, metabolic, or **kidney disease**. These results also may be abnormal if the patient has experienced trauma that may affect breathing (especially head and neck injuries). Disorders, such as anemia, that affect the oxygen-carrying capacity of blood, can produce an abnormally low oxygen content value.

### Resources

#### BOOKS

Lynn, Pamela Barbara. *Taylor's Handbook of Clinical Nursing Skills*. Philadelphia, PA; London: Lippincott Williams & Wilkins, 2010.

Carol A. Turkington

Blood poisoning see **Acute lymphangitis**

Blood registry see **Blood donation and registry**

Blood removal see **Phlebotomy**

## Blood sugar tests

### Definition

Blood sugar tests include several different tests that measure the amount of sugar (glucose) in a person's blood. These tests are performed either on an empty stomach, or after consuming a meal or pre-measured glucose drink. Blood sugar tests are done primarily to diagnose and evaluate a person with **diabetes mellitus**.

## Purpose

The body uses sugar, also called glucose, to supply the energy it needs to function. People get sugar from their diet and from their body tissues. Insulin is made by the pancreas and affects the outer membrane of cells, making it easy for glucose to move from the blood into the cells. When insulin is active, blood glucose levels fall. Sugar from body tissues is stored in the form of glycogen. When glycogen is active, blood glucose levels rise.

After a meal, blood glucose levels rise sharply. The pancreas responds by releasing enough insulin to take care of all the newly added sugar found in the body. The insulin moves the sugar out of the blood and into the cells. Only then does the blood sugar start to level off and begin to fall. A person with diabetes mellitus either does not make enough insulin, or makes insulin that does not work properly. The result is blood sugar that remains high, a condition called hyperglycemia.

Diabetes must be diagnosed as early as possible. If left untreated, it can damage or cause failure of the eyes, kidneys, nerves, heart, blood vessels, and other body organs. **Hypoglycemia**, or low blood sugar, also may be discovered through blood sugar testing. Hypoglycemia is caused by various hormone disorders and **liver disease**, as well as by too much insulin.

## Description

There are a variety of ways to measure a person's blood sugar.

### *Whole blood glucose test*

Whole blood glucose testing can be performed by a person in his or her home, and kits are available for this purpose. The person pricks his or her finger (a finger stick) with a sterile sharp blade from the kit. A single drop of blood is placed on a strip in a portable instrument called a glucometer. The glucometer quickly determines the blood sugar and shows the results on a small screen in usually a few seconds.

New technologies for monitoring glucose levels will help diabetics better control their glucose levels. These tests are particularly important for children and adolescents. In mid-2002, the U.S. Food and Drug Administration (FDA) approved a new home test for use by children and adolescents (it had already been approved for adults) called the Cygnus GlucoWatch biographer that helped better detect hypoglycemia. Studies show that more frequent checks are better; new monitors such as this allow for simpler frequent testing. Continuous monitoring was in development in early 2004, as a company called TheraSense Inc.

received preapproval from the FDA for clinical trials on its home continuous glucose monitor. The monitor was designed to provide users with real-time glucose data, alarms for hypoglycemia and hyperglycemia and to show trends in their blood sugar levels.

### *Fasting plasma glucose test*

The **fasting** plasma glucose test is done on an empty stomach. For the eight hours before the test, the person must fast (nothing to eat or drink, except water). The person's blood is drawn from a vein by a health care worker. The blood sample is collected into a tube containing an anticoagulant. Anticoagulants stop the blood from clotting. In the laboratory, the tube of blood spins at high speed within a machine called a centrifuge. The blood cells sink to the bottom and the liquid stays on the top. This straw-colored liquid on the top is the plasma. To measure the glucose, a person's plasma is combined with other substances. From the resulting reaction, the amount of glucose in the plasma is determined.

### *Oral glucose tolerance test*

The oral glucose tolerance test is conducted to see how well the body handles a standard amount of glucose. This test measures the amount of glucose in a person's plasma before and two hours after drinking a large premeasured beverage containing glucose. The person must eat a consistent diet, containing at least 5.25 oz. (150g) of carbohydrates each day, for three days before this test. For eight hours before the test, the person must fast. A health care provider draws the first sample of blood at the end of the fast to determine the glucose level at the start of the test. The health care provider then gives the person a beverage containing 2.6 oz. (75g) of glucose. Two hours later, the person's blood is drawn again. These blood samples are centrifuged and processed in the laboratory. A doctor can then compare the before and after glucose levels to see how well the patient's body processed the sugar.

### *Two-hour postprandial blood glucose test*

The two-hour postprandial blood glucose test measures the amount of glucose in plasma after a person eats a specific meal containing a certain amount of sugar. Although the meal follows a predetermined menu, it is difficult to control many factors associated with this testing method.

Blood sugar tests can be used in a variety of situations including:

- Testing people suspected for diabetes. The American Diabetic Association (ADA) recommends that either a fasting plasma glucose test or an oral glucose

tolerance test be used to diagnose diabetes. If the person already has symptoms of diabetes, a blood glucose test without fasting (called a casual plasma glucose test) may be done. If the test result is abnormal, it must be confirmed with another test performed on another day. The two tests can be different or they can be the same, but they must be done on different days. If the second test also is abnormal, the person has diabetes. A two-hour post-prandial test is not recommended by the ADA as a test to use for the diagnosis of diabetes. A doctor may order this test, and follow it with the oral glucose tolerance test or the fasting plasma glucose test if the results are abnormal.

- Testing pregnant women. Diabetes that occurs during pregnancy (gestational diabetes) is dangerous for both the mother and the baby. Women who may be at risk are screened when they are 24–28 weeks pregnant. A woman is considered at risk if she is older than 25 years, is not at her normal body weight, has a parent or sibling with diabetes, or if she is in an ethnic group that has a high rate of diabetes (Hispanics, Native Americans, Asians, African Americans). The blood sugar test to screen for gestational diabetes is a variation of the oral glucose tolerance test. Fasting is not required. If the result is abnormal, a more complete test is done on another day.
- Testing healthy people. Healthy people without symptoms of diabetes should be screened for diabetes when they are 45 years old and again every three years. Either the fasting plasma glucose or oral glucose tolerance test is used for screening. People in high risk groups should be tested before the age of 45 and tested more frequently.
- Testing of people already diagnosed with diabetes. The ADA recommends that a person with diabetes keep the amount of glucose in the blood at a normal level as much as possible. This can be done by the diabetic person testing his or her own blood at home one or more times a day.

## Preparation

Each blood sugar test that uses plasma requires a 5 mL blood sample. A healthcare worker ties a tight band (tourniquet) on the person's upper arm, locates a vein in the inner elbow region, and inserts a needle into the vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

When fasting is required, the person should have nothing to eat or drink (except water) for eight hours before the test and until the test or series of tests is completed. The person should not smoke before or

during the testing period because this can temporarily increase the amount of glucose in the blood. Other factors that can cause inaccurate results are a change in diet before the test, illness or surgery two weeks before the test, certain drugs, and extended bed rest. The doctor may tell a person on insulin or taking pills for diabetes to stop the medication until after the test.

## Aftercare

After the test or series of tests is completed (and with the approval of his or her doctor), the person should eat, drink, and take any medications that were stopped for the test.

The patient may feel discomfort when blood is drawn from a vein. Bruising may occur at the puncture site or the person may feel dizzy or faint. Pressure to the puncture site until the bleeding stops will reduce bruising. Warm packs to the puncture site will relieve discomfort.

## Risks

If the person experiences weakness, **fainting**, sweating, or any other unusual reaction while fasting or during the test, he or she should immediately tell the person giving the test.

## Normal results

Normal results are:

- fasting plasma glucose test less than 120 mg/dL
- oral glucose tolerance test, 2 hours less than 140 mg/dL

For the diabetic person, the ADA recommends an ongoing blood sugar goal of less than or equal to 120 mg/dL.

## Abnormal results

These abnormal results indicate diabetes and must be confirmed with repeat testing:

- fasting plasma glucose test less than or equal to 126 mg/dL
- oral glucose tolerance test, 2 hours less than or equal to 200 mg/dL
- casual plasma glucose test (nonfasting, with symptoms) less than or equal to 200 mg/dL
- gestational oral glucose tolerance test, 1 hour less than or equal to 140 mg/dL

Brain damage can occur from glucose levels below 40 mg/dL and **coma** from levels above 470 mg/dL.

A condition known as prediabetes or impaired glucose tolerance, which may lead to type 2 diabetes, usually is indicated with a reading of 100 mg/dL.

Other hormone disorders can cause both hyperglycemia and hypoglycemia. Abnormal results must be interpreted by a doctor who is aware of the person's medical condition and medical history.

## Resources

### PERIODICALS

- "New Guidelines Set Lower Threshold for Precursor to Diabetes." *RN* (January 2004): 17.
- Plotnick, Leslie P. "The Next Step in Blood Glucose Monitoring?" *Pediatrics* (April 2003): 885.
- "Premarket Approval Application Filed for Continuous Glucose Monitor." *Medical Letter on the CDC & FDA* (January 4, 2004): 26.

### ORGANIZATIONS

- American Diabetes Association, 1701 North Beauregard Street, Alexandria, VA, 22311, (800) 342-2383, Ask ADA@diabetes.org, <http://www.diabetes.org/>.
- Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, cdcinfo@cdc.gov, <http://www.cdc.gov>.
- National Diabetes Information Clearinghouse (NDIC), 1 Information Way, Bethesda, MD, 20892-3560, (703) 738-4929, (800) 860-8747, ndic@info.niddk.nih.gov, <http://diabetes.niddk.nih.gov/>.

Nancy J. Nordenson  
Teresa G. Odle

Blood thinners see **Anticoagulant and antiplatelet drugs**

Blood transfusion see **Transfusion**

## Blood typing and crossmatching

### Definition

Blood typing is a laboratory test done to determine a person's blood type. If the person needs a blood **transfusion**, another test called crossmatching is done after the blood is typed to find blood from a donor that the person's body will accept.

### Purpose

Blood typing and crossmatching are most commonly done to make certain that a person who needs a transfusion will receive blood that matches (is compatible with) his own. People must receive blood of the same blood type; otherwise, a serious, even fatal, transfusion reaction can occur.

### Prevalence of blood types in the United States, by ethnicity

O positive is the most common blood type in the United States. The prevalence of different blood types in the U.S. population is as follows:

	Caucasian	African American	Hispanic	Asian
A+	33.0%	24.0%	29.0%	27.0%
A-	7.0%	2.0%	2.0%	0.5%
B+	9.0%	18.0%	9.0%	25.0%
B-	2.0%	1.0%	1.0%	0.4%
AB+	3.0%	4.0%	2.0%	7.0%
AB-	1.0%	0.3%	0.2%	0.1%
O+	<b>37.0%</b>	<b>47.0%</b>	<b>53.0%</b>	<b>39.0%</b>
O-	8.0%	4.0%	4.0%	1.0%

SOURCE: The American Red Cross, "Learn about Blood: Blood Types." Available online at: <http://www.redcrossblood.org/learn-about-blood/blood-types> (accessed August 12, 2010).

(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

Parents who are expecting a baby have their blood typed to diagnose and prevent hemolytic disease of the newborn (HDN), a type of anemia also known as **erythroblastosis fetalis**. Babies who have a blood type different from their mothers are at risk for developing this disease. The disease is serious with certain blood type differences, but is milder with others.

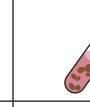
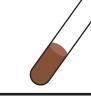
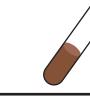
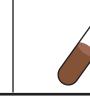
A child inherits factors or genes from each parent that determine his blood type. This fact makes blood typing useful in paternity testing. To determine whether or not the alleged father could be the true father, the blood types of the child, mother, and alleged father are compared.

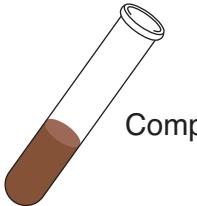
Legal investigations may require typing of blood or other body fluids, such as semen or saliva, to identify persons involved in crimes or other legal matters.

### Description

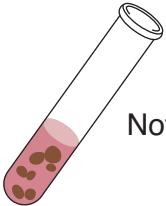
Blood typing and crossmatching tests are performed in a blood bank laboratory by technologists trained in blood bank and transfusion services. The tests are done on blood after it has separated into cells and serum (serum is the yellow liquid left after the blood clots.) Costs for both tests are covered by insurance when the tests are determined to be medically necessary.

Blood bank laboratories are usually located in facilities, such as those operated by the American Red Cross, that collect, process, and supply blood that is donated, as well as in facilities, such as most hospitals, that prepare blood for transfusion. These laboratories are regulated by the United States Food and Drug

Recipient's blood			Reactions with donor's red blood cells			
ABO antigens	ABO antibodies	ABO blood type	Donor type O cells	Donor type A cells	Donor type B cells	Donor type AB cells
None	Anti-A Anti-B	O				
A	Anti-B	A				
B	Anti-A	B				
A & B	None	AB				



Compatible



Not compatible

**Blood typing** is a laboratory test done to discover a person's blood type. If the person needs a blood transfusion, cross-matching is done following blood typing to locate donor blood that the person's body will accept. (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

Administration (FDA) and are often inspected and accredited by a professional association such as the American Association of Blood Banks (AABB).

Blood typing and crossmatching tests are based on the reaction between antigens and antibodies. An antigen can be anything that causes the body to launch an attack, known as an immune response, against it. The attack begins when the body builds a special protein, called an antibody, that is uniquely designed to attack and make ineffective (neutralize) the specific antigen that caused the attack. A person's body normally doesn't make antibodies against its own antigens, only against antigens that are foreign to it.

A person's body contains many antigens. The antigens found on the surface of red blood cells are important because they determine a person's blood type. When red blood cells having a certain blood type antigen are mixed with serum containing antibodies against that antigen, the antibodies attack and stick to the

antigen. In a test tube, this reaction is observed as the formation of clumps of cells (clumping).

When blood is typed, a person's cells and serum are mixed in a test tube with commercially-prepared serum and cells. Clumping tells which antigens or antibodies are present and reveals the person's blood type. When blood is crossmatched, patient serum is mixed with cells from donated blood that might be used for transfusion. Clumping or lack of clumping in the test tube tells whether or not the blood is compatible.

Although there are over 600 known red blood cell antigens, organized into 22 blood group systems, routine blood typing and crossmatching is usually concerned with only two systems: the ABO and Rh blood group systems.

### Blood typing

**ABO BLOOD GROUP SYSTEM.** In 1901, Karl Landsteiner, an Austrian pathologist, randomly combined

## KEY TERMS

**ABO blood type**—Blood type based on the presence or absence of the A and B antigens on the red blood cells.

**Antibody**—A special protein made by the body as a defense against foreign material that enters the body. It is uniquely designed to attack and neutralize the specific antigen that triggered the immune response.

**Antigen**—Anything that causes the body to launch an immune response against that antigen through the production of antibodies.

**Blood bank**—A laboratory that specializes in blood typing, antibody identification, and transfusion services.

**Blood type**—Blood categories based on the presence or absence of certain antigens on the red blood cells.

**Crossmatch**—A laboratory test done to confirm that blood from a donor and blood from the recipient are compatible.

**Gene**—A piece of DNA, located on a chromosome, that determines how traits such as blood type are inherited and expressed.

**Immune response**—The body's attack against an antigen that it considers foreign to itself. The attack begins with the production of antibodies against the antigen.

**Rh blood type**—Blood type based on the presence or absence of the D antigen on the red blood cells.

**Transfusion**—The therapeutic introduction of blood or a blood component into a patient's bloodstream.

the serum and red blood cells of his colleagues. From the reactions he observed in test tubes, he discovered the ABO blood group system. This discovery earned him the 1930 Nobel Prize in Medicine.

A person's ABO blood type—A, B, AB, or O—is based on the presence or absence of the A and B antigens on his red blood cells. The A blood type has only the A antigen and the B blood type has only the B antigen. The AB blood type has both A and B antigens, and the O blood type has neither A nor B antigens.

By the time a person is six months old, he naturally will have developed antibodies against the antigens his red blood cells lack. That is, a person with A blood type will have anti-B antibodies, and a person with B blood type will have anti-A antibodies. A person with AB blood type will have neither antibody, but a person with O blood type will have both anti-A and anti-B antibodies. Although the distribution of each of the four ABO blood types varies among racial groups, O is the most common and AB is the least common.

ABO typing is the first test done on blood when it is tested for transfusion. A person must receive ABO-matched blood. ABO incompatibilities are the major cause of fatal transfusion reactions. ABO antigens are also found on most body organs, so ABO compatibility is also important for organ transplants.

An ABO incompatibility between a pregnant woman and her baby is a minor cause of HDN and usually causes no problem for the baby. The structure of ABO antibodies makes it unlikely they will cross the placenta to attack the baby's red blood cells.

Paternity testing compares the ABO blood types of the child, mother, and alleged father. The alleged father can't be the true father if the child's blood type requires a gene that neither he nor the mother have. For example, a child with blood type B whose mother has blood type O, requires a father with either AB or B blood type; a man with blood type O cannot be the true father.

In some people, ABO antigens can be found in body fluids other than blood, such as saliva and semen. ABO typing of these fluids provides clues in legal investigations.

**RH BLOOD GROUP SYSTEM.** The Rh, or Rhesus, system was first detected in 1940 by Landsteiner and his colleague Alexander Wiener when they injected blood from rhesus monkeys into guinea pigs and rabbits. More than 50 antigens have since been discovered belonging to this system, making it the most complex red blood cell antigen system.

In routine blood typing and crossmatching tests, only one of these 50 antigens, the D antigen, also known as the Rh factor or Rh<sub>o</sub>[D], is tested for. If the D antigen is present, that person is Rh-positive; if the D antigen is absent, that person is Rh-negative.

Other important antigens in the Rh system are C, c, E, and e. These antigens are not usually tested for in routine blood typing tests. However, testing for the presence of these antigens is useful in paternity testing, and when a technologist tries to identify unexpected Rh antibodies or find matching blood for a person with antibodies to one or more of these antigens.

Unlike the ABO system, antibodies to Rh antigens don't develop naturally. They develop only as an immune response after a transfusion or during **pregnancy**.

The incidence of the Rh blood types varies between racial groups, but not as widely as the ABO blood types: 85% of whites and 90% of blacks are Rh-positive; 15% of whites and 10% of blacks are Rh-negative.

In transfusions, the Rh system is next in importance after the ABO system. Most Rh-negative people who receive Rh-positive blood will develop anti-D antibodies. A later transfusion of Rh-positive blood could result in a severe or fatal transfusion reaction.

Rh incompatibility is the most common and severe cause of HDN. This incompatibility can happen when an Rh-negative woman and an Rh-positive man produce an Rh-positive baby. Cells from the baby can cross the placenta and enter the mother's bloodstream, causing the mother to make anti-D antibodies. Unlike ABO antibodies, the structure of anti-D antibodies makes it likely that they will cross the placenta and enter the baby's bloodstream. There, they can destroy the baby's red blood cells, causing severe or fatal anemia.

The first step in preventing HDN is to find out the Rh types of the expectant parents. If the mother is Rh-negative and the father is Rh-positive, the baby is at risk for developing HDN. The next step is to test the mother's serum to make sure she doesn't already have anti-D antibodies from a previous pregnancy or transfusion. This procedure is similar to blood typing. Finally, the Rh-negative mother is given an injection of Rh Immunoglobulin (RhIg) at 28 weeks of gestation and again after delivery, if the baby is Rh positive. The RhIg attaches to any Rh-positive cells from the baby in the mother's bloodstream, preventing them from triggering anti-D antibody production in the mother. An Rh-negative woman should also receive RhIg following a **miscarriage**, abortion, or **ectopic pregnancy**.

**OTHER BLOOD GROUP SYSTEMS.** Several other blood group systems may be involved in HDN and transfusion reactions, although they are much less frequent than ABO and Rh. They are the Duffy, Kell, Kidd, MNS, and P systems. Tests for antigens from these systems are not included in routine blood typing, but they are commonly used in paternity testing.

Like Rh antibodies, antibodies in these systems do not develop naturally, but as an immune response after transfusion or during pregnancy. An antibody screening test is done before a crossmatch to check for unexpected antibodies to antigens in these systems. A person's serum is mixed in a test tube with commercially-prepared cells containing antigens

from these systems. If clumping occurs, the antibody is identified.

### Crossmatching

Crossmatching is the final step in pretransfusion testing. It is commonly referred to as compatibility testing, or "Type and Cross."

Before blood from a donor and the recipient are crossmatched, both are ABO and Rh typed. In addition, antibody screening is done to look for antibodies to certain Rh, Duffy, MNS, Kell, Kidd, and P system antigens. If an antibody to one of these antigens is found, only blood without that antigen will be compatible in a crossmatch. This sequence must be repeated before each transfusion a person receives.

To begin the crossmatch, blood from a donor with the same ABO and Rh type as the recipient is selected. In a test tube, serum from the patient is mixed with red blood cells from the donor. If clumping occurs, the blood is not compatible; if clumping does not occur, the blood is compatible. If an unexpected antibody is found in either the patient or the donor, the blood bank does further testing to make sure the blood is compatible.

In an emergency, when there is not enough time for blood typing and crossmatching, O red blood cells may be given, preferably Rh-negative. O blood type is called the universal donor because it has no ABO antigens for a patient's antibodies to attack. In contrast, AB blood type is called the universal recipient because it has no ABO antibodies to attack the antigens on transfused red blood cells. If there is time for blood typing, red blood cells of the recipient type (type specific cells) are given. In either case, the crossmatch is continued, even though the transfusion has begun.

### Preparation

To collect the 10 mL blood needed for these tests, a healthcare worker ties a tourniquet above the patient's elbow, locates a vein in the inner elbow region, and inserts a needle into that vein. Vacuum action draws the blood through the needle into an attached tube. Collection of the sample takes only a few minutes.

Blood typing and crossmatching must be done three days or less before a transfusion. A person doesn't need to change diet, medications, or activities before these tests. He should tell his healthcare provider if, during the last three months, he has received a blood transfusion or a plasma substitute, or has had a radiology procedure using intravenous contrast

media. These can give false clumping reactions in both typing and crossmatching tests.

### Aftercare

The possible side effects of any blood collection are discomfort or bruising at the site where the needle punctured the skin, as well as **dizziness** or **fainting**. Bruising is reduced if pressure is applied with a finger to the puncture site until the bleeding stops. Discomfort is treated with warm packs to the puncture site.

### Risks

There are no risks from the blood collection or test procedures. Blood transfusions always have the risk of an unexpected transfusion reaction. A nurse watches a patient for signs of a reaction during the entire transfusion.

### Normal results

There is no normal blood type. The desired result of a crossmatch is that compatible donor blood is found. Compatibility testing procedures are designed to provide the safest blood product possible for the recipient, but a compatible crossmatch is no guarantee that an unexpected adverse reaction will not appear during the transfusion.

### Abnormal results

Except in an emergency, a person cannot receive a transfusion without a compatible crossmatch result.

### ORGANIZATIONS

American Association of Blood Banks, 8101 Glenbrook Road, Bethesda, MD, 20814-2749, (301) 907-6977, (301) 907-6895, <http://www.aabb.org>.

Nancy J. Nordenson

## Blood urea nitrogen test

### Definition

The blood urea nitrogen (BUN) test measures the level of urea nitrogen in a sample of the patient's blood. Urea is a substance that is formed in the liver when the body breaks down protein. Urea then circulates in the blood in the form of urea nitrogen. In healthy people, most urea nitrogen is filtered out by the kidneys and leaves the body in the urine. If the patient's kidneys are not functioning properly or if the body is using large amounts of protein, the BUN level

### KEY TERMS

**Urea**—A compound containing nitrogen that occurs in the urine and other body fluids as a result of protein metabolism.

will rise. If the patient has severe **liver disease**, the BUN will drop.

### Purpose

The BUN level may be checked in order to assess or monitor:

- the presence or progression of kidney or liver disease
- blockage of urine flow
- mental confusion (patients with kidney failure are sometimes disoriented and confused)
- abnormal loss of water from the body (dehydration)
- recovery from severe burns (the body uses larger than normal amounts of protein following serious burns)

### Description

The BUN test is performed on a sample of the patient's blood, withdrawn from a vein into a vacuum tube. The procedure, which is called a venipuncture, takes about five minutes.

### Preparation

The doctor should check to make sure that the patient is not taking any medications that can affect BUN results. These drugs include the **antibiotics** chloramphenicol, streptomycin, amphotericin B, methicillin, gentamicin, tobramycin, and kanamycin, as well as **diuretics** and **corticosteroids**.

The patient should be advised not to eat large amounts of meat the day before the test.

### Aftercare

Aftercare consists of routine care of the area around the venipuncture.

### Risks

The primary risk is the possibility of a bruise or swelling in the area of the venipuncture. The patient can apply moist warm compresses.

## Normal results

Normal BUN levels are 5–18 mg/dL for children, 7–18 mg/dL for adults, and 8–20 mg/dL in the elderly.

## Abnormal results

### *Abnormally low BUN*

Low levels of BUN may indicate **overhydration**, **malnutrition**, **celiac disease** (a disease characterized by the inability to tolerate foods containing wheat protein [gluten]), liver damage or disease, or use of corticosteroids. Low BUN may also occur in early **pregnancy**.

### *Abnormally high BUN*

High levels of BUN may indicate **kidney disease** or failure; blockage of the urinary tract by a kidney stone or tumor; a **heart attack** or congestive **heart failure**; **dehydration**; **fever**; **shock**; or bleeding in the digestive tract. High BUN levels can sometimes occur during late pregnancy or result from eating large amounts of protein-rich foods. A BUN level higher than 100 mg/dL points to severe kidney damage.

## Resources

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Blood vessel scan see **Doppler ultrasonography**

some doctors think that it is underdiagnosed because it coexists so often with depression and other disorders. Estimates suggest that between 2% and 7% of people who have **cosmetic surgery** have the disorder. Reported rates of BDD among dermatology patients range between 6% and 15%. In addition, individuals are often ashamed of grooming rituals and other behaviors associated with BDD, and may avoid telling their doctor about them.

The usual age of onset of BDD is late childhood or early adolescence; the average age of individuals diagnosed with the disorder is 17, although the disorder may develop in older individuals who become preoccupied with the physical effects of **aging**. The disorder affects men and women equally, but there are no reliable data regarding racial or ethnic differences in the incidence of the disorder. BDD has a high rate of comorbidity, which means that people diagnosed with the disorder are highly likely to also be diagnosed with another psychiatric disorder, most commonly major depression, social phobia, or **obsessive-compulsive disorder** (OCD). About half of all men (but not women) diagnosed with BDD also have a **substance abuse** disorder. About 29% of individuals with BDD eventually try to commit **suicide**.

## Description

The earliest known case of BDD in the medical literature was reported by an Italian physician named Enrique Morselli in 1886, but the disorder was not defined as a formal diagnostic category in the United States until 1987. The World Health Organization (WHO) did not add BDD to the International Classification of Diseases (ICD) until 1992. The word *dysmorphic* comes from two Greek words that mean “bad” or “ugly” and “shape” or “form.” BDD was previously known as dysmorphophobia.

BDD is characterized by an unusual degree of worry or concern about a specific part of the face or body rather than concern about the general size or shape of the body. It is distinguished from **anorexia nervosa** and **bulimia nervosa** in that individuals with **eating disorders** are preoccupied with their overall weight and body shape. As many as 50% of individuals diagnosed with BDD undergo **plastic surgery** to correct their perceived physical defects.

The diagnostic criteria specify that the condition must be sufficiently severe to cause a decline in the individual's social, occupational, or educational functioning. The most common cause of this decline is the time lost in obsessing about the “defect.” One study found that 68% of individuals in a sample of adolescents diagnosed with

## Body dysmorphic disorder

### Definition

Body dysmorphic disorder (BDD) is defined by the American Psychiatric Association in the *Diagnostic and Statistical Manual of Mental Disorders, 4th Edition, Text Revision (DSM-IV-TR)* as a condition marked by excessive preoccupation with an imaginary or minor defect in a facial feature or localized part of the body.

### Demographics

BDD is thought to affect 1–2% of the general population in the United States and Canada, although

## KEY TERMS

**Body image**—A term that refers to a person's inner picture of his or her outward appearance. It has two components: perceptions of the appearance of one's body, and emotional responses to those perceptions.

**Delusion**—A false belief that is resistant to reason or contrary to fact. Common delusions include delusions of persecution, delusions about one's importance (sometimes called delusions of grandeur), or delusions of being controlled by others. In BDD, the delusion is related to the individual's perception of his or her body.

**Displacement**—A psychological process in which repressed feelings of discontent are expressed outwardly as the concern or preoccupation with an issue or problem that the individual considers more acceptable. In some BDD individuals, obsession about the body includes displaced feelings, often related to a history of childhood abuse.

**Muscle dysmorphia**—A subtype of BDD, described as excessive preoccupation with muscularity and body building to the point of interference with social, educational, or occupational functioning.

**Neurotransmitter**—One of a group of chemicals secreted by a nerve cell (neuron) to carry a chemical message to another nerve cell, often as a way of transmitting a nerve impulse. Examples of neurotransmitters include acetylcholine, dopamine, serotonin, and norepinephrine.

**Obsessive-compulsive disorder (OCD)**—An anxiety disorder in which a person cannot prevent himself

from dwelling on unwanted thoughts, acting on urges, or performing repetitive rituals, such as washing his hands or checking to make sure he turned off the lights.

**Off-label use**—Drugs in the United States are approved by the Food and Drug Administration (FDA) for specific uses over periods of time or in dosages based on the results of clinical trials. However, it is legal for physicians to administer these drugs for other "off-label" or non-approved uses. It is not legal for pharmaceutical companies to advertise drugs for off-label uses.

**Selective serotonin reuptake inhibitors (SSRIs)**—A class of antidepressants that work by blocking the reabsorption of serotonin in brain cells, raising the level of the chemical in the brain. SSRIs include Prozac, Zoloft, Luvox, and Paxil.

**Serotonin**—A chemical produced by the brain that functions as a neurotransmitter. Low serotonin levels are associated with mood disorders, particularly depression and obsessive-compulsive disorder. Medications known as selective serotonin reuptake inhibitors (SSRIs) are used to treat BDD and other disorders characterized by depressed mood.

**Somatoform disorders**—A group of psychiatric disorders in the DSM-IV-TR classification that are characterized by external physical symptoms or complaints. BDD is classified as a somatoform disorder.

BDD spent three or more hours every day thinking about the body part or facial feature of concern. BDD is part of the larger category of **somatoform disorders**, which are disorders characterized by physical complaints that appear to be medical in origin but that cannot be explained in terms of a physical disease, the results of substance **abuse**, or by another mental disorder.

Some psychiatrists have suggested that there is a subtype of BDD, known as muscle dysmorphia. Muscle dysmorphia is marked by excessive concern with one's muscularity and/or fitness. Persons with muscle dysmorphia spend unusual amounts of time working out in gyms or exercising rather than dieting obsessively or seeking plastic surgery.

BDD and muscle dysmorphia can both be described as disorders resulting from the individual's distorted body image. Body image refers to a person's

mental picture of his or her outward appearance, including size, shape, and form. It has two major components: how the person perceives his or her physical appearance and how he or she feels about his or her body. Significant distortions in self-perception can lead to intense dissatisfaction with one's body and dysfunctional behaviors aimed at improving one's appearance. Some individuals with BDD are aware that their concerns are excessive, but others do not have this degree of insight; about 50% of individuals diagnosed with BDD also meet the criteria for a delusional disorder.

### Causes and symptoms

The causes of BDD are not clearly understood; however, they are thought to involve neurobiological and psychosocial factors.

### **Neurobiological causes**

Research indicates that individuals diagnosed with BDD have serotonin levels that are lower than normal. Serotonin is a neurotransmitter and low levels also are associated with depression and other **mood disorders**. Research released in 2010 also suggests a strong relationship between BDD and OCD in that both disorders show somewhat similar defects in memory processing. Furthermore, studies indicate that people who have a family member with BDD are more likely to develop the disorder, suggesting there is an inherited component to the disorder.

### **Psychosocial causes**

Another factor in the development of BDD is one's experience with body image messages. Impressionable children and adolescents absorb the message from advertising and mass media that anything short of physical perfection is unacceptable. They may then develop distorted perceptions of their own faces and bodies.

A young person's family of origin also has a powerful influence on his or her vulnerability to BDD. Children whose parents are themselves obsessed with appearance, dieting, and/or bodybuilding, or who are highly critical of their children's looks, are at greater risk of developing BDD.

An additional factor in some young people is a history of childhood trauma or abuse. Buried feelings about the abuse or traumatic incident may emerge in the form of obsession about a part of the face or body. This "reassignment" of emotions from the unacknowledged true cause to another issue is called displacement. For example, an adolescent who frequently felt overwhelmed in childhood by physically abusive parents may develop a preoccupation at the high school level with muscular strength and power.

### **Symptoms**

The central symptom of BDD is excessive concern with a specific facial feature or body part. Research indicates that the features most likely to be the focus of the individual's attention are (in order of frequency): complexion flaws (**acne**, blemishes, **scars**, wrinkles), hair (on the head or the body, too much or too little), and facial features (size, shape, or lack of symmetry). The individual's concerns may, however, involve other body parts, and may shift over time from one feature to another. Women often become obsessed with their breasts or legs.

Other symptoms of body dysmorphic disorder include:

- Ritualistic behavior. Ritualistic behavior refers to actions that the individual performs to manage anxiety and that take up excessive amounts of his or her time. Individuals are typically upset if someone or something interferes with or interrupts their ritual. Ritualistic behaviors in BDD may include exercise or makeup routines, assuming specific poses or postures in front of a mirror, etc. In this way, BDD appears to be related to OCD.
- Camouflaging the "problem" feature or body part with makeup, hats, or clothing. Camouflaging appears to be the single most common symptom among individuals with BDD. It is reported by 94% of individuals with BDD.
- Abnormal behavior around mirrors, car bumpers, large windows, or similar reflecting surfaces. A majority of individuals diagnosed with BDD frequently check their appearance in mirrors or spend long periods doing so. A minority, however, react in the opposite fashion and avoid mirrors whenever possible.
- Frequent requests for reassurance from others about their appearance.
- Frequently comparing one's appearance to others.
- Avoiding activities outside the home, including school and social events.

### **Diagnosis**

Physicians in family practice often make the diagnosis of BDD in children or adolescents because they are more likely to have developed long-term relationships of trust with young people. At the adult level, it is often specialists in dermatology, **cosmetic dentistry**, or plastic surgery who may suspect that the individual suffers from BDD because of frequent requests for repeated or unnecessary procedures.

The diagnosis is made on the basis of the individual's history together with the physician's observations of the individual's overall mood and conversation patterns. People with BDD often come across to others as generally anxious and worried. In addition, the individual's dress or clothing styles may suggest a diagnosis of BDD. It is not unusual, however, for individuals with BDD to take offense if their primary care doctor suggests referral to a psychiatrist.

Diagnosis begins with a complete **physical examination**. A **complete blood count** (CBC), substance abuse screen, and measurement of thyroid hormone may be ordered to rule out other conditions. A mental status evaluation is made, and some physicians use a self-report questionnaire, such as the Multidimensional Body-Self Relations Questionnaire (MBSRQ) or the short form of

the Situational Inventory of Body-Image Dysphoria (SIBID), to evaluate individuals during an office visit.

### Treatment

The standard course of treatment for body dysmorphic disorder is a combination of medications and **psychotherapy**. Surgical, dental, or dermatologic treatments have been found to be ineffective.

#### Drugs

The medications most frequently prescribed for individuals with BDD are the **selective serotonin reuptake inhibitors** (SSRIs), most commonly fluoxetine (Prozac) or sertraline (Zoloft). Other SSRIs that have been used with this group of individuals include fluvoxamine (Luvox) and paroxetine (Paxil). These drugs are not approved by the United States Food and Drug Administration (FDA) for use in treating BDD (i.e., this is an off-label use). Individuals with BDD require higher dosages of SSRI medications than patients who are being treated for depression with these drugs; however, treatment of BDD with SSRIs results in a relatively high rate of positive responses.

#### Psychotherapy

The most effective approach to psychotherapy with BDD individuals is cognitive-behavioral restructuring. Since the disorder is related to **delusions** about one's appearance, cognitive-oriented therapy that challenges inaccurate self-perceptions is more effective than purely supportive approaches. Thought-stopping and relaxation techniques also work well with BDD individuals when they are combined with cognitive restructuring.

Some doctors recommend couples therapy or **family therapy** in order to involve the individual's parents, spouse, or partner in his or her treatment. This approach may be particularly helpful if family members are critical of the individual's looks or are reinforcing his or her unrealistic body image.

#### Alternative treatment

Although no alternative or complementary form of treatment has been recommended specifically for BDD, such herbal remedies for depression as **St. John's wort** have been reported as helping some BDD individuals. **Aromatherapy** appears to be a useful aid to relaxation techniques as well as a pleasurable physical experience for BDD individuals. **Yoga** has helped some persons with BDD acquire more realistic perceptions of their bodies and to replace obsessions about external appearance with new respect for their body's inner structure and functioning.

### Home remedies

Individuals with BDD may find the following actions helpful in reducing symptoms of BDD when used in conjunction with medication and psychotherapy:

- Exercising regularly
- Avoiding recreational drugs and alcohol
- Writing about emotions in a journal
- Joining a support group for people with BDD
- Practicing stress control techniques
- Learning what situations are personal triggers for body image anxiety

### Prognosis

BDD is a chronic disease with few symptom-free intervals, although the intensity of symptoms may have periods of improvement and periods of worsening. The disorder requires ongoing treatment. Just over half of patients with BDD who have improved relapse within 6 months of discontinuing treatment.

### Prevention

Given the pervasive influence of the mass media in contemporary Western societies, the best preventive strategy involves challenging the media's unrealistic portrayal of "attractive" people. Parents, teachers, primary health care professionals, and other adults who work with young people can point out and discuss the pitfalls of trying to look "perfect." However, given the apparent biochemical component to BDD, this is of limited preventative value. Parents and other adults who work with young people can educate themselves about BDD and its symptoms and pay attention to any warning signs in children's dress or behavior so that treatment can be begun as early as possible.

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## ORGANIZATIONS

- American Academy of Child and Adolescent Psychiatry, 3615 Wisconsin Avenue, NW, Washington, DC, 20016-3007, (202) 966-7300, (202) 966-2891, <http://www.aacap.org>.
- American Psychiatric Association, 1000 Wilson Boulevard, Suite 1825, Arlington, VA, 22209-3901, (703) 907-7300, [apa@psych.org](mailto:apa@psych.org), <http://www.psych.org>.
- Mental Health America, 2000 North Beauregard Street, 6th Floor, Alexandria, VA, 22311, (703) 684-7722, (800) 969-6642, TTY (800) 433-5959, (703) 684-5968, <http://www.nmha.org>.
- National Institute of Mental Health, 6001 Executive Boulevard, Room 8184, MSC 9663, Bethesda, MD, 20892-9663, (301) 443-4513, TTY (301) 443-8431, (866) 615-6464, TTY (866) 415-8051, (301) 443-4279, [nimhinfo@nih.gov](mailto:nimhinfo@nih.gov), <http://www.nih.nih.gov>.

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## Body image

### Definition

Body image is a person's mental opinion or description of his or her own physical appearance. It also involves the reactions of others toward that person's physical body based on what is perceived by that person. The concept of body image slowly develops over time, generally beginning in infancy. Perception of body image among people can widely range from very negative to very positive. Depending on age and other factors, the degree of concern with body image can also widely vary among an individual.

A person who has a poor body image perceives their body as unattractive to others, while someone with a good body image views their body as being attractive to others. Body image is studied within the area of **psychoanalysis**, which is a psychological theory that involves mental functions of humans both consciously and unconsciously.

Generally, within psychoanalytic study, body image is not related to any objective measure (based on facts) but is subjective (based on opinions and

feelings) in nature. Consequently, one's opinion of their own body image may or may not parallel how others judge that person's body image. For instance, people judging a person may view that person as attractive, whereas that person may judge themselves as having an unattractive body image.

Body image involves the perception of one's own body, based chiefly on comparison to socially constructed standards or ideals. Humans have the unique ability to form abstract conceptions about themselves. This can cause conflict when a person places unrealistic demands on him- or herself, especially on his or her own body. As the advertising and film industries bombard the industrialized world with images of idealized beauty, more and more adolescents are forming negative body images and engaging in self-destructive behaviors to fit an unrealistic ideal.

Body image, especially with young people going through **puberty** (a stage of physical and mental development that allows for sexual reproduction), can become a problem especially when: parents are overly concerned with their children's weights and appearances; parents, especially mothers, are very self-aware with their own weights and appearance; other children use excess pressure on their peers (fellow children) to look or act a particular way; and mass media advertisements and other such means that idealize a certain body type. Body image is also closely associated with self-esteem, which is defined as the amount of value and worthiness a person inwardly feels.

Older children and young adults are more concerned about how other people view them than other age groups, and so are much more sensitive in regards to body image and vulnerable to external pressures. This can affect their self-esteem as their bodies go through dramatic changes from adolescence to adulthood (puberty). Boys may be overly concerned with height when seeing girls of their same age growing faster. Girls may feel sensitive about their height, weight, or other noticeable changes happening within their body.

Statistically, according to the National Eating Disorders Association, 91% of young college women report having been on at least one diet. Seventy percent of young college men report being unhappy with their body image—with 32% of all college men stating that they have been on one or more **diets**. Other studies show similar percentages in older children and young adults, which help to support the contention that young people are very concerned with body image—a body image where the ideal is to be very slim.

### School-age children

Children begin to recognize themselves in mirrors in meaningful ways at about 18 months and begin perceiving themselves as physical beings in toddlerhood. School-age children are aware of how their bodies look, although relatively few focus an inappropriate amount of attention on them. Ideally, children learn that their physical appearance is in many ways beyond their control and learn to accept their bodies without judgment. However, children living in the industrialized world are immersed in a culture that creates standards of idealized beauty and then connects those standards to personal worth. Consequently, school-age children can become convinced that they are only worthwhile if they live up to an idealized standard of physical appearance.

Even without the pernicious effects of the media, children face prejudices based on their appearances. Children spend much of their early lives in schools, which are highly social and competitive, with notoriously rigid social hierarchies that are often based on physical appearance. Studies have found that teachers are also drawn to the most attractive children, which can further compound a child's poor body image. In a school-age child, a poor body image usually results in social withdrawal and poor self-esteem.

### Adolescence

As puberty nears, children become increasingly focused on the appearance of their bodies. An adolescent may mature more quickly or slowly than his or her peers or in a way that is unattractive or makes the adolescent stand out in the crowd. Any deviation from the ideal can result in a negative body image, and adolescents may diet, **exercise**, or use **steroids**, stimulants, or **laxatives** to counter their own negative self-concept and achieve the body image they desire. In the mid-2000s, teenage girls are increasingly having **plastic surgery** (with parental permission) to "correct" what they perceive as flaws in their appearance.

Distorted body images in adolescence can lead to a number of disorders, such as **anorexia nervosa**, bulimia, or **body dysmorphic disorder**, a severe, clinically recognized illusory body image. The behaviors that accompany these psychiatric disorders create physical disorders that can be life-threatening. Body image disorders are often accompanied by additional psychological problems, such as depression or **anxiety** and thoughts of **suicide**. Eventually body image becomes an all-consuming preoccupation.

### Purpose

Scientists have found that body image is first formed as an infant during contact, or lack of contact, with people such as parents and family members. Physical contact in the form of hugs, kisses, and other forms of affection can help develop an early positive body image. Lack of such contact can have the opposite effect, forming an early negative body image.

The purpose of body image is generally used as a way for individuals to compare themselves against a model (ideal) image and for people to compare others through physical traits and characteristics. It is usually measured against an ideal body shape with respect to various physical characterizations such as facial features and overall body weight of the human body, including fatness and muscle mass.

Within the field of psychoanalysis, a person's body image is often measured by asking a person to rate parts of his/her current body (such as face, stomach, and buttocks) with respect to a series of pictures representing an ideal body image. The difference in the rating between a person's current body image and a perceived idea body image is generally considered the amount a person is dissatisfied with their body.

### Description

Concern with body image is generally more important with women than it is with men. Women usually are more critical of their overall body and individual parts of their body than are men. However, the gap between the two genders has been narrowing over recent years as men become more concerned with their body image.

A perception of a poor body image often relates with a feeling of being overweight, especially with women. Men, on the other hand, desire more muscle mass when considering their body image. Their feeling to be more masculine parallels this desire to add additional muscle mass and to produce more definition in their current muscles.

Generally, a poor body image can lead to constant and fad dieting, **obesity**, and eating disorders, along with low self-esteem, depression, anxiety, and overall emotional distress. However, for the most part, people with good exercise habits, positive personal and sexual experiences, and excellent emotional and mental states have better and more accurate perceptions of their body image than people without those characteristics and experiences. These people also have fewer problems associated with a poor body image.

## Precautions

Exaggerated and distorted concerns with body image have been linked in medical studies with decreases in self-esteem and increases in dieting and eating disorders, including anorexia nervosa, **binge eating** disorder, and bulimia. Bulimia is an eating disorder marked by episodes of binge eating followed by one or more behaviors to control weight, most commonly self-induced **vomiting**, laxative **abuse**, **fasting**, or excessive exercise. The disorder is rare in children under age 14. It is estimated to occur in between 1% and 3% of high school- and college-aged women in the United States.

People with extreme body image problems may have body dysmorphic disorder (BDD), which involves a distorted body image without any eating disorders. Body dysmorphic disorder was formally recognized as a psychiatric disorder in 1997, although its symptoms have been described in patients for more than 100 years. The disorder involves obsession and complete preoccupation with an imagined or mild physical flaw. It is known to occur in 1–2% of Americans, but is thought to be underdiagnosed because it often occurs in conjunction with other psychiatric disorders such as major depression and **obsessive-compulsive disorder**. Excessive preoccupation with body image and an exaggerated obsession on positive body image has also been associated with the personality disorder narcissism (self-admiration, or an overestimation about one's appearance).

## Interactions

Body image can be affected by outside influences. Media sources, such as television, the Internet, and magazines, often portray people closer to the commonly accepted ideal body type than the average body image in order to sell their products and services. Consequently, people—especially older children and young adults—are overly influenced and swayed by such depictions of body image. For instance, according to the Association of Body Image and Disordered Eating (ABIDE), the average U.S. citizen was exposed to about 5,000 advertising messages each and every day. Studies of network television commercials have shown that attractiveness is a desirable trait that advertisers regularly use to convince viewers to purchase their products.

Family life can also affect a person's perception of their body image. Parents that criticize their children, such as in the way they look, talk, or act, often may have a negative effect on the development of self-esteem in their offspring.

Young people may also be affected by the comments of classmates and peers when it comes to their body image. Teasing is often a method used by young people to convey negative comments and hurtful words. Racial, sexual, and other types of teasing can have a negative impact on body image and self-esteem. Children often try to pressure their peers to conform to what is currently popular in clothing styles, language, and other characteristics, all of which can potentially hurt one's perception of their body image.

## Complications

Without a healthy regard for one's self, people can often become very self-conscious of their body image. Feelings of depression, anxiety, and isolation may occur. With low self-esteem and body image problems, some people use alcohol or drugs to offset those negative feelings. Others turn away from their regular activities and their usual friends—becoming withdrawn and showing lack of interest in themselves and the world around them.

A person may recover from such feelings by attempting to accept things that cannot be changed and working on things that realistically could be improved. In some cases, outside help is needed in the form of a guidance counselor, parent, coach, religious leader, or someone else that is trusted and accepting of personal feelings. Crisis hotlines are also available to help with such problems.

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## ORGANIZATIONS

- Academy for Eating Disorders, 60 Revere Drive, Suite 500, Northbrook, IL, 60062-1577, (206) 382-3587, (800) 931-2237, <http://www.nationaleatingdisorders.org>.
- National Association of Anorexia Nervosa and Associated Disorders (ANAD), P.O. Box 7, Highland Park, IL, 60035, (847) 831-3438.
- National Eating Disorders Association, 603 Stewart Street, Suite 803, Seattle, WA, 98101, (206) 382-3587, (206) 829-8501, [info@NationalEatingDisorders.org](mailto:info@NationalEatingDisorders.org), <http://www.edap.org>.

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**Body lice see Lice infestation**



A close-up view of a carbuncle on person's back. (John Watney/Photo Researchers, Inc.)

## Description

Boils and carbuncles are firm reddish swellings about 0.2–0.4 in. (5–10 mm) across that are slightly raised above the skin surface. They are sore to the touch. A boil usually has a visible central core of pus; a carbuncle is larger and has several visible heads. Boils occur most commonly on the face, back of the neck, buttocks, upper legs and groin area, armpits, and upper torso. Carbuncles are less common than single boils; they are most likely to form at the back of the neck. Males are more likely to develop carbuncles.

Boils and carbuncles are common problems in the general population, particularly among adolescents and adults. People who are more likely to develop these skin infections include those with:

- diabetes, especially when treated by injected insulin
- alcoholism or drug abuse
- poor personal hygiene
- crowded living arrangements
- jobs or hobbies that expose them to greasy or oily substances, especially petroleum products
- allergies or immune system disorders, including HIV infection.
- family members with recurrent skin infections



Boils often occur from a bacterial infection in a hair follicle or skin gland. (Custom Medical Stock Photo, Inc. Reproduced by permission.)

## Causes and symptoms

Boils and carbuncles are caused by *Staphylococcus aureus*, a bacterium that causes an infection in an oil gland or hair follicle. Although the surface of human skin is usually resistant to bacterial infection, *S. aureus* can enter through a break in the skin surface—including breaks caused by needle punctures for insulin or drug injections. Hair follicles that are blocked by greasy creams, petroleum jelly, or similar

## KEY TERMS

**Abscess**—A localized collection of pus in the skin or other body tissue.

**Carbuncle**—A large, deep skin abscess formed by a group or cluster of boils.

**Follicle**—The small sac at the base of a hair shaft. The follicle lies below the skin surface.

**Furunculosis**—A condition in which the patient suffers from recurrent episodes of boils.

**Pustule**—A small raised pimple or blister-like swelling of the skin that contains pus.

products are more vulnerable to infection. Bacterial skin infections can be spread by shared cosmetics or washcloths, close human contact, or by contact with pus from a boil or carbuncle.

As the infection develops, an area of inflamed tissue gradually forms a pus-filled swelling or pimple that is painful to touch. As the boil matures, it forms a yellowish head or point. It may either continue to swell until the point bursts open and allows the pus to drain, or it may be gradually reabsorbed into the skin. It takes between one and two weeks for a boil to heal completely after it comes to a head and discharges pus. The bacteria that cause the boil can spread into other areas of the skin or even into the bloodstream if the skin around the boil is injured by squeezing. If the infection spreads, the patient will usually develop chills and **fever**, swollen lymph nodes (**lymphadenitis**), and red lines in the skin running outward from the boil.

Furunculosis is a word that is sometimes used to refer to recurrent boils. Many patients have repeated episodes of furunculosis that are difficult to treat because their nasal passages carry colonies of *S. aureus*. These bacterial colonies make it easy for the patient's skin to be reinfected. They are most likely to develop in patients with diabetes, HIV infection, or other immune system disorders.

Carbuncles are formed when the bacteria infect several hair follicles that are close together. Carbunculosis is a word that is sometimes used to refer to the development of carbuncles. The abscesses spread until they merge with each other to form a single large area of infected skin with several pus-filled heads. Patients with carbuncles may also have a low-grade fever or feel generally unwell.

## Diagnosis

The diagnosis of boils and carbuncles is usually made by the patient's primary care doctor on the basis

of visual examination of the skin. In some cases involving recurrent boils on the face, the doctor may need to consider **acne** as a possible diagnosis, but for the most part boils and carbuncles are not difficult to distinguish from other skin disorders.

## Treatment

### *Patient and family education*

Patient education is an important part of the treatment of boils and carbuncles. Patients need to be warned against picking at or squeezing boils because of the danger of spreading the infection into other parts of the skin or bloodstream. It is especially important to avoid squeezing boils around the mouth or nose because infections in these areas can be carried to the brain. Patients should also be advised about keeping the skin clean, washing their hands carefully before and after touching the boil or carbuncle, avoiding the use of greasy cosmetics or creams, and keeping their towels and washcloths separate from those of other family members. Some doctors may recommend an antiseptic soap or gel for washing the infected areas.

If the patient has had several episodes of furunculosis, the doctor may examine family members or close contacts to see if they are carriers of *S. aureus*. In many cases they also need treatment for boils or carbuncles. Skin infections and reinfections involving small groups or clusters of people are being reported more frequently in the United States.

## Medications

Boils are usually treated with application of antibiotic creams—usually clindamycin or polymyxin—following the application of hot compresses. The compresses help the infection to come to a head and drain.

Carbuncles and furunculosis are usually treated with oral **antibiotics** as well as antibiotic creams or ointments. The specific medications that are given are usually dicloxacillin (Dynapen) or cephalexin (Keflex). Erythromycin may be given to patients who are allergic to penicillin. The usual course of oral antibiotics is 5–10 days; however, patients with recurrent furunculosis may be given oral antibiotics for longer periods. Furunculosis is treated with a combination of dicloxacillin and rifampin (Rifadin).

Patients with bacterial colonies in their nasal passages are often given mupirocin (Bactroban) to apply directly to the lining of the nose.

## Surgical treatment

Boils and carbuncles that are very large, or that are not draining, may be opened with a sterile needle or surgical knife to allow the pus to drain. The doctor will usually give the patient a local anesthetic if a knife is used; surgical treatment of boils is painful and usually leaves noticeable **scars**.

## Alternative treatment

### Naturopathic therapy

Naturopathic practitioners usually recommend changes in the patient's diet as well as applying herbal poultices to the infected area. The addition of zinc supplements and vitamin A to the diet is reported to be effective in treating boils. The application of a paste or poultice containing goldenseal (*Hydrastis canadensis*) root is recommended by naturopaths on the grounds that goldenseal helps to kill bacteria and reduce inflammation.

### Homeopathy

Homeopaths maintain that taking the proper homeopathic medication in the first stages of a boil or carbuncle will bring about early resolution of the infection and prevent pus formation. The most likely choices are *Belladonna* or *Hepar sulphuris*. If the boil has already formed, *Mercurius vivus* or *Silica* may be recommended to bring the pus to a head.

### Western herbal therapies

A variety of herbal remedies can be applied topically to boils to fight infection. These include essential oils of bergamot (*Citrus bergamia*), chamomile (*Matricaria recutita*), lavender (*Lavandula officinalis*), and sage (*Salvia officinalis*), as well as tea tree oil (*Melaleuca spp.*). Herbalists also recommend washing the skin with a mixture of goldenseal and witch hazel. To fight the inflammation associated with boils, herbalists suggest marsh mallow (*Althaea officinalis*) ointment, tinctures (herbal solutions made with alcohol) of blue flag (*Iris versicolor*) or myrrh (*Commiphora molmol*), and slippery elm (*Ulmus fulva*) made into a poultice.

## Prognosis

The prognosis for most boils is excellent. Some patients, however, suffer from recurrent carbuncles or furunculosis. In addition, although the spread of infection from boils is relatively unusual, there have been deaths reported from brain infections caused by

squeezing boils on the upper lip or in the tissue folds at the base of the nose.

## Prevention

There are some precautions that people can take to minimize the risk of developing bacterial skin infections:

- cleanse skin properly with soap and water, and take showers rather than tub baths
- do not share washcloths, towels, or facial cosmetics with others
- cut down on greasy or fatty foods and snacks
- always wash hands before touching the face
- consider using antiseptic soaps and shower gels
- consult a doctor if furunculosis is a persistent problem—it may indicate an underlying disease such as diabetes

## Resources

### BOOKS

Wolff, Klauss, et al., eds. *Fitzpatrick's Dermatology in General Medicine*. 7th ed. New York: McGraw-Hill, 2008.

Rebecca J. Frey, PhD

## Bone biopsy

### Definition

Bone biopsy is the removal of a piece of bone for laboratory examination and analysis.

### Purpose

Bone biopsy is used to distinguish between malignant tumors and benign bone disease such as **osteoporosis** and **osteomyelitis**. This test may be ordered to determine why a patient's bones ache or feel sore, or when a mass or deformity is found on an x ray, CT scan, **bone scan**, or other diagnostic imaging procedure.

### Precautions

The patient's doctor and the surgeon who performs the bone biopsy must be told about any prescription and over-the-counter medications the patient is taking, and about **allergies** or reactions the patient has had to anesthetics or **pain** relievers. Special care must be taken with patients who have experienced bleeding problems.

## KEY TERMS

**Biopsy**—Removal and examination of tissue to determine if cancer is present.

**Osteomyelitis**—An infection of the bone that is usually treated with antibiotics but sometimes requires surgery.

**Osteoporosis**—Thinning and loss of bone tissue.

## Description

A bone biopsy involves using a special drill or other surgical instruments to remove bone from the patient's body. The procedure usually lasts about 30 minutes and may be performed in the hospital, a doctor's office, or a surgical center.

A drill biopsy is generally used to obtain a small specimen. After the skin covering the bone has been cleansed with an antiseptic and shaved, the patient is given a local anesthetic. The doctor will not begin the procedure until the anesthetic has numbed the area from which the bone is to be removed, but the patient may feel pressure or mild pain when the needle pierces the bone. The surgeon turns the needle in a half-circle to extract a sample from the core, or innermost part, of the bone. The sample is drawn into the hollow stem of the biopsy needle. The sample is then sent to a laboratory where it is examined under a microscope.

An open biopsy is used when a larger specimen is needed. After the area covering the bone has been cleansed with an antiseptic and shaved, the patient is administered a general anesthetic. After the anesthetic takes effect and the patient is unconscious, the surgeon makes an incision and removes a bone specimen. The specimen is sent to the laboratory for immediate analysis. Results of that analysis may indicate that additional surgery should be performed right away.

## Preparation

No special preparation is needed for a drill biopsy, but a patient must fast for at least 12 hours before an open biopsy.

Some patients who are taking anticoagulants, **aspirin** and/or other products containing salicylates, some herbs, and **nutritional supplements** may be asked by their health care provider to discontinue taking the

medications/products for a specified number of days prior to the procedure.

## Aftercare

Pain medication is prescribed after a biopsy, and vital signs are monitored until they return to normal. Most patients can go home in about an hour. If bone was removed from the spine, the patient may stay in the hospital overnight. Sutures may be necessary to close the biopsy site. The surgical site must be kept clean and dry for 48 hours, and the patient's doctor should be notified if any of these symptoms appear:

- fever
- headache
- pain on movement
- inflammation or pus near the biopsy site
- bleeding through the bandage at the biopsy site

Some patients may be prescribed a course of **antibiotics** after discharge from the health care facility. Antibiotics should be taken as prescribed and the entire course of antibiotic therapy should be completed by the patient.

## Risks

Risks include bone fracture, injury to nearby tissue, and infection. Bleeding is a rare complication. Factors that increase risk include:

- stress
- obesity
- poor nutrition
- chronic illness
- some medications
- mind-altering drugs

## Results

Normal bone is made up of collagen fibers and bone tissue.

### Abnormal results

Bone biopsy can reveal the presence of benign disease, infection, or malignant tumors that have spread to the bone from other parts of the body.

Results of this test are considered reliable, but may be affected by a failure to obtain an adequate specimen or delayed microscopic examination or laboratory analysis.

## ORGANIZATIONS

National Institute of Arthritis and Musculoskeletal and Skin Diseases Information Clearinghouse, National Institutes

of Health, 1 AMS Circle, Bethesda, MD, 20892-3675,  
(301) 495-4484 (877) 336-4267 <http://www.niams.nih.gov>.

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Bone break fever see **Dengue fever**

Bone cancer see **Sarcomas**

Bone densitometry see **Bone density test**



## Bone density test

### Definition

A bone density test, or bone density scan, is designed to check for **osteoporosis**, a disease that occurs when the bones become thin and weak. Osteoporosis occurs when the bones lose **calcium** and other **minerals** that keep them strong.

### Purpose

A bone density scan measures the strength of an individual's bones and determines the risk of fracture. An observation of any osteoporosis present can be made.

### Demographics

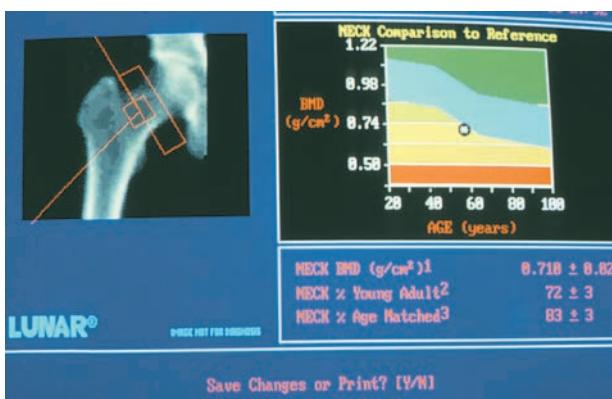
In 2008, the National Osteoporosis Foundation estimated that 10 million people in the United States over age 50 had osteoporosis, and another 34 million were at risk for developing the disease. Women are four to five times more likely than men to develop osteoporosis between ages 50 and 65. They have smaller, thinner

**Patient undergoing a bone density scan. (Photo Researchers, Inc.)**

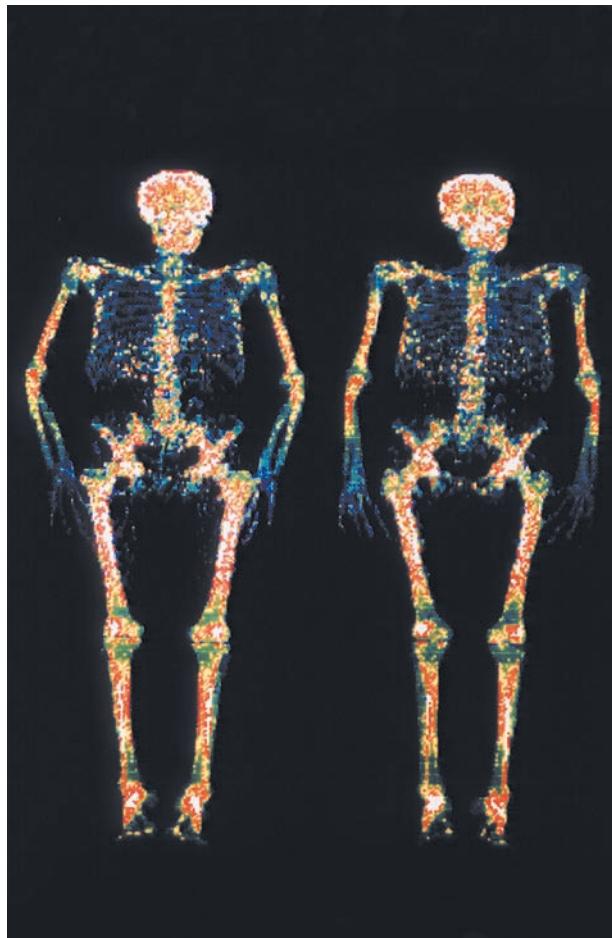
bones than men to begin with, and they lose bone mass more rapidly after **menopause** (usually around age 50) when they stop producing the female reproductive hormone estrogen, which has a bone-protecting effect. In the five to seven years following menopause, women can lose about 20% of their bone mass. By age 65, however, men and women lose bone mass at about the same rate. About half of all men and women over the age of 75 have osteoporosis. As an increasing number of men live to an older age, there is more awareness that osteoporosis is an important health issue for them as well as for women. Although people of any ethnic background can develop osteoporosis, it is especially common among white and Asian women over age 50.

### Description

Many people are not aware that they have osteoporosis until they fracture (break) a bone. Typically, this happens in a fall that would not have caused a fracture in a young adult. Osteoporosis is estimated to be responsible for 2 million **fractures** annually. The National Institutes of Health (NIH) estimates that after age 50, half of all women and one out of every eight men will experience an osteoporosis-related fracture. These fractures can occur in any bone, but the most common locations are the hip, spine, and wrist. Breaks in the hip and spine are of special concern because they require hospitalization and often surgery and commonly cause a decrease in mobility or a permanent disability. Hip fractures are a leading cause of nursing home admissions in the elderly. Only about 15% of people who fracture a hip are able to walk across a room unaided six months



**Computer read-out of a bone density scan. (Photo Researchers, Inc.)**



**A bone densitometry scan of identical twins. Their bone density is normal and identical to one another.** (Photo Researchers, Inc.)

later, and about one-fourth of people over age 50 who have a hip fracture die within one year.

Most bone density scans are done with a machine that uses a technology called Dual Energy X-ray Absorptiometry (DEXA). This machine takes a picture of the bones in the spine, hip, total body, and wrist and calculates the density of these bones. If a DEXA machine is not available, bone density scans can also be done with dual photon absorptiometry (measuring the spine, hip, and total body) and quantitative **computed tomography scans** (measuring the spine). Bone density scanners that use DEXA technology to just measure bone density in the wrist (called pDEXA scans) provide scans at some drugstores. These wrist scan tests are not as accurate as those that measure density in the total body, spine or hip.

Not all doctors routinely schedule this test. If the following factors apply to an individual, they may

## KEY TERMS

**Calcium**—A mineral that helps build bone. After menopause, when women start making less of the bone-protecting hormone estrogen, they may need to increase their intake of calcium.

**DEXA bone density scan**—A bone density scan that uses a rotating x-ray beam to measure the strength of an individual's bones and his or her fracture risk.

**Osteoporosis**—A condition found in older individuals in which bones decrease in density and become fragile and more likely to break. It can be caused by lack of vitamin D and/or calcium in the diet.

need a bone density scan and can discuss this with their doctor. Factors include if the individual:

- is at risk for osteoporosis
- is near menopause
- has broken a bone after a modest trauma
- has a family history of osteoporosis
- uses steroid or antiseizure medications
- has had a period of restricted mobility for more than six months

To take a DEXA bone density scan, the individual lies on a bed underneath the scanner, which has a curving plastic arm that emits x rays. These low-dose x rays form a fan beam that rotates around the body. During the test, the scanner moves to capture images of the individual's spine, hip, or entire body. A computer then compares the individual's bone strength and risk of fracture to that of other people in the United States of the same age and to young people at peak bone density. Bones reach peak density at about age 30 and then start to lose mass. The test takes about 20 minutes and is painless. Some insurance companies and Medicare cover the cost. pDEXA wrist bone scans in drugstores are available at little cost.

## Preparation

Minimal preparation is needed. The individual will be asked to undress and put on a hospital gown.

## Aftercare

No special aftercare is needed. The individual should be able to go home immediately without assistance after the test.

## Risks

The DEXA **bone scan** exposes the individual to only a small amount of radiation—about one-fiftieth that of a **chest x ray**, or about the amount a person is exposed to from taking a cross-country airplane flight.

## Normal results

The individual, when compared with people at “young normal bone density” (called the T-score), has the same (or higher) bone density as a healthy 30-year-old. T scores above 1 mean that an individual has a healthy bone mass. Scores from 0 to –1 mean that the individual has borderline bone mass and should repeat the test in two to five years.

## Abnormal results

The individual has two to four times the risk of a broken bone as other people in the United States at the same age and those at peak bone density. If an individual’s T score ranges from –1 to –2.5 they have low bone mass and are at risk for osteoporosis. A T score below –2.5 means osteoporosis is already evident. These individuals should have a repeat bone density scan every year or two.

## Resources

### OTHER

- Cole, Adam. “Bone Density Test Guidelines.” LiveStrong.com. January 4, 2010. <http://www.livestrong.com/article/26389-bone-density-test-guidelines>
- Cole, Adam. “How to Read Bone Density Test Results.” LiveStrong.com. January 8, 2010. <http://www.livestrong.com/article/23559-read-bone-density-test-results>

### ORGANIZATIONS

- Center, 2 AMS Circle, Bethesda, MD, 20892-3676, (202) 223-0344, TTY: (202) 466-4315, (800) 624-2663(BONE), (202) 293-235, NIAMSBoneInfo@mail.nih.gov, [www.niams.nih.gov/Health\\_Info/Bone](http://www.niams.nih.gov/Health_Info/Bone).
- National Osteoporosis Foundation, 1150 17th Street NW, Suite 850, Washington, DC, 20036, (202) 223-2226, (800) 231-4222, <http://www.nof.org>.

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## Bone disorder drugs

### Definition

Bone disorder drugs are medicines used to treat weakened, brittle bones.

## KEY TERMS

**Fracture**—A break or crack in a bone.

**Menopause**—The stage in a woman’s life when menstruation stops.

**Osteoporosis**—A condition commonly found with aging, inadequate exercise, chronic illness, or taking corticosteroids such as prednisone long term. People with osteoporosis have advanced bone loss and brittle bones that are more easily fractured.

## Purpose

These drugs are used to treat or prevent **osteoporosis** (brittle bones) in postmenopausal women and elderly men; to treat Paget’s disease, a painful, probably genetic condition associated with weak, deformed bones; and to treat both men and women who have osteoporosis from taking **corticosteroids** (prednisone) for prolonged periods of time.

Like other living tissues, bone is constantly being reabsorbed and replaced by new bone. There is normally a balance between newly forming and older bone. **Exercise** and adequate intake of **calcium** and Vitamin D are crucial in maintaining this balance. When bone is lost more rapidly than it is formed, the condition is initially called osteopenia. Osteoporosis is advanced bone loss.

## Description

Bone disorder drugs are available only with a physician’s prescription and come in tablet, nasal spray, and injectable forms.

Commonly used bone disorder drugs include bisphosphonates alendronate (Fosamax) and risedronate (Actonel); the hormone calcitonin (Miacalcin, Calcimar); and raloxifene (Evista).

## Recommended dosage

Doses depend on the dosage forms and conditions being treated. Consult the prescriber or pharmacist for details.

## Precautions

### *Aldendronate (Fosamax, Actonel)*

People with low blood levels of calcium should not take this medicine. When taking the drug, it is

important to have adequate amounts of calcium and Vitamin D in the diet or as dietary supplements.

People with **kidney disease** should have their renal function carefully monitored while taking this medicine.

This medicine may worsen digestive and swallowing problems. It is important to take the medicine with a full glass of water and not lie down for at least 45 minutes afterward. If digestive problems worsen, the medicine may need to be discontinued.

Some patients with **cancer** have developed necrosis (**death**) of bone, mostly in the jaw, after taking the drug. Regular dental exams are strongly recommended.

Some patients taking this drug experience severe bone, joint, and/or muscle **pain**.

### ***Calcitonin (Miacalcin)***

Skin tests for sensitivity are frequently used before beginning treatment with this medication.

When used as a nasal spray, this drug may cause irritation and/or small sores in the nose. If this happens, it may need to be temporarily discontinued.

The injectable form of this drug has caused serious allergic reactions in some people. The nasal spray is not known to cause such reactions.

### ***Raloxifene (Evista)***

This drug increases the risk for **blood clots** and emboli to the lungs and brain. The drug should not be used in women who have a history of heart disease or **stroke** and should be discontinued at least three days before surgery or prolonged bed rest.

This drug has not been proven either safe or effective for postmenopausal women.

### ***General precautions for bone disorder drugs***

To keep bones strong, the body needs calcium and vitamin D. Dairy products and fatty fish such as salmon, sardines, and tuna are good sources of both calcium and vitamin D. People who are taking bone disorder drugs who do not get enough of these nutrients in their **diets** may need to take **nutritional supplements**.

It is important to have lifelong habits of performing regular weight-bearing exercises, such as walking, to develop and maintain strong bones.

The use of tobacco and alcohol is not recommended for people with osteopenia or osteoporosis.

Very high blood levels of calcium may interfere with the actions of these drugs.

Anyone who has had unusual reactions to bone disorder drugs in the past should let his or her physician know before taking the drugs again. The physician also should be told about any **allergies** to foods, dyes, preservatives, or other substances.

Women who are pregnant, may become pregnant, or are **breastfeeding** should check with their physicians before using these drugs.

### **Side effects**

#### ***Aldendronate (Fosamax, Actonel)***

Common side effects include **constipation**, **diarrhea**, **indigestion**, **nausea**, and abdominal, bone, or muscle pain. If these symptoms do not go away, the drug may need to be discontinued.

#### ***Calcitonin (Miacalcin)***

The most common side effects of Miacalcin nasal spray are nasal dryness, redness, **itching**, sores, bleeding, and general discomfort. These problems should go away as the body adjusts to the medicine. But if they do not, or if they are very uncomfortable, check with a physician. Other side effects include skin rash, **headache**, **dizziness**, **fatigue**, and back and joint pain.

Injectable calcitonin may cause minor side effects such as nausea or **vomiting**; diarrhea; stomach pain; loss of appetite; flushing of the face, ears, hands, or feet; and discomfort or redness at the injection site.

Anyone who has a skin rash or **hives** after receiving a calcitonin injection should check with a physician.

#### ***Raloxifene (Evista)***

Common side effects include swelling of the feet or legs, hot flashes, leg cramps, **nausea and vomiting**, headache, and skin rash.

### **Interactions**

#### ***Aldendronate (Fosamax or Actonel)***

Taking **aspirin** with these drugs may increase the chance of upset stomach. **Acetaminophen** (Tylenol) or buffered aspirin may reduce that possibility.

All foods and beverages interfere with the absorption of these drugs.

#### ***Calcitonin (Miacalcin)***

Calcitonin may keep certain other drugs used to treat Paget's disease from working properly.

### Raloxifene (*Evista*)

Raloxifene may affect blood clotting. Patients who are taking warfarin (Coumadin) should check with their physicians before taking Evista.

### ORGANIZATIONS

Foundation for Osteoporosis Research & Education, 1814 Franklin Street, Suite 620, Oakland, CA, 94612, (510) 832-2663, (510) 208-7174, (888) 266-3015, info@fore.org, <http://www.fore.org>.

National Association for the Relief of Paget's Disease, 323 Manchester Road, Walkden, Worsley, Manchester, England, M28 3HH, 44 (161) 799-4646, director@paget.org.uk, <http://www.paget.org.uk>.

National Osteoporosis Foundation (NOF), 1150 17th Street NW, Suite 850, Washington, DC, 20036-4603, (202) 223-2226, (202) 223-2237, (800) 231-4222, <http://www.nof.org>.

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## Bone grafting

### Definition

Bone grafting is a surgical procedure by which new bone or a replacement material is placed into spaces between or around broken bone (**fractures**) or holes in bone (defects) to aid in healing.

### Purpose

Bone grafting is used to repair bone fractures that are extremely complex, pose a significant risk to the patient, or fail to heal properly. Bone graft is also used to help fusion between vertebrae, to correct deformities, or to provide structural support for fractures of the spine. In addition to **fracture repair**, bone graft is used to repair defects in bone caused by **birth defects**, traumatic injury, or surgery for bone **cancer**.

### Description

Bone is composed of a matrix mainly made up of a protein called collagen. It is strengthened by deposits of



**Surgeons harvesting a sample of material for bone grafting.** (Custom Medical Stock Photo, Inc. Reproduced by permission.)

## KEY TERMS

**Allograft**—Tissue for transplantation that is taken from another person.

**Autograft**—Tissue for transplantation that is taken from the patient.

**Hydroxyapatite**—A calcium phosphate complex that is the primary mineral component of bone.

**Osteoblasts**—Bone cells that build new bone tissue.

**Osteoclasts**—Bone cells that break down and remove bone tissue.

**Osteoconduction**—Provision of a scaffold for the growth of new bone.

**Osteocytes**—Bone cells that maintain bone tissue.

**Osteogenesis**—Growth of new bone.

**Osteoinduction**—Acceleration of new bone formation by chemical means.

calcium and phosphate salts, called hydroxyapatite. Within and around this matrix are located four types of bone cells. Osteoblasts produce the bone matrix. Osteocytes are mature osteoblasts that serve to maintain the bone. Osteoclasts break down and remove bone tissue. Bone lining cells cover bone surfaces. Together, these four types of cells are responsible for building the bone matrix, maintaining it, and remodeling the bone as needed.

There are three ways in which a bone graft can help repair a defect. The first is called osteogenesis, the formation of new bone by the cells contained within the graft. The second is osteoinduction, a chemical process in which molecules contained within the graft (bone morphogenetic proteins) convert the patient's cells into cells that are capable of forming bone. The third is osteoconduction, a physical effect by which the matrix of the graft forms a scaffold on which cells in the recipient are able to form new bone.

New bone for grafting can be obtained from other bones in the patient's own body (e.g., hip bones or ribs), called autograft, or from bone taken from other people that is frozen and stored in tissue banks, called allograft. A variety of natural and synthetic replacement materials are also used instead of bone, including collagen, the protein substance of the white fibers of the skin, bone, and connective tissues; polymers, such as silicone and some acrylics; hydroxyapatite; calcium sulfate; and ceramics. A new material, called resorbable polymeric grafts, is also being studied. These resorbable grafts provide a structure for new bone to grow on; the grafts then slowly dissolve, leaving only the new bone behind.

To place the graft, the surgeon makes an incision in the skin over the bone defect and shapes the bone graft or replacement material to fit into the defect. After the graft is placed into the defect, it is held in place with pins, plates, or screws. The incision is closed with stitches

and a splint or cast is used to prevent movement of the bones while healing.

The costs associated with a bone graft vary. These costs include: the surgeon's fee (variable); anesthesiologist's fees (averaging \$350 to \$400 per hour); hospital charges (averaging \$1,500 to \$1,800 per day, more for intensive care or private rooms); medication charges (\$200 to \$400); and additional charges, including an assisting surgeon, treatment of complications, diagnostic procedures (e.g., blood work or x rays), medical supplies, and equipment use. The cost for the graft itself can range from \$250 to \$900.

This procedure is covered by many third-party insurers; insurance coverage should be explored for each individual case.

### Aftercare

The time required for convalescence for fractures or spinal fusion may vary from one to 10 days, and vigorous **exercise** may be limited for up to three months.

Most bone grafts are successful in helping the bone defect to heal. The extent of recovery will depend on the size of the defect and the condition of the bone surrounding the graft at the time of surgery. Severe defects may take some time to heal and may require further attention after the initial graft. In one study of over 1,000 patients who received very large allografts after surgery for bone cancer, researchers found that approximately 85% of the patients were able to return to work or normal physical activities without using crutches. However, about 25% of these patients required a second operation, because the first did not heal properly. Less severe bone defects, though, should heal completely without serious complications.

### Risks

The risks for any surgical procedure requiring anesthesia include reactions to the medications and

breathing problems. The risks for any surgical procedure include bleeding and infection.

The drawbacks of autografts include: the additional surgical and anesthesia time (typically 30 minutes per procedure) to obtain, or harvest, the bone for grafting; added costs of the additional surgery; **pain** and infection that might occur at the site from which the graft is taken; and the relatively small amount of bone that is available for grafting.

The drawbacks of allografts include: variability between lots, since the bone is harvested from a variety of donors; the bone may take longer to incorporate with the host bone than an autograft would; the graft may be less effective than an autograft; and there is the possibility of transferring diseases to the patient. Other complications may result from the immune response mounted by the patient's immune system against the grafted bone tissue. With the use of anti-rejection agents (drugs to combat rejection of grafted bone tissue), immune rejection is less of a problem.

#### ORGANIZATIONS

American Association of Tissue Banks, 1320 Old Chain Bridge Road, Suite 450, McLean, VA, 22101, (703) 827-9582, (703) 356-2198, [aatb@aatb.org](mailto:aatb@aatb.org), <http://www.aatb.org>.

Lisa Christenson, PhD

## Bone growth stimulation

### Definition

Bone growth stimulation is the technique of promoting bone growth in difficult-to-heal **fractures** by applying a low electrical current or ultrasound to the fracture.

### Purpose

Bone growth stimulation is done when satisfactory healing is not occurring naturally or when the pace of healing is too slow. This condition is called fracture nonunion, and it occurs more frequently among adults than children, in people with severe or complex fractures, and in people who smoke.

The theory behind applying an electric current to fractures to stimulate healing is based on the fact that the concave side of the bone becomes negatively charged and the convex side is positively charged. It is believed that artificially encouraging this charging

## KEY TERMS

**Anode**—The positive electrode to which an electromagnetic current flows.

**Cathode**—The negative electrode from which an electromagnetic current flows.

with an electric current will speed healing. In 1996, the Food and Drug Administration (FDA) also approved the application of low-intensity ultrasound pulses as a treatment for fracture nonunion.

Ultrasound and electromagnetic stimulation are expensive and are used only when healing problems exist for a substantial length of time. Each method must be used for at least three to six months to be effective.

### Precautions

Bone growth stimulation cannot be used if the gap between the ends of the fracture is too large.

### Description

Electric stimulation can be applied either from the inside of the body (invasively) or from the outside the body (noninvasively). Ultrasound is a noninvasive procedure. The type of stimulation selected depends on the doctor's preference, the type and location of the fracture, and the patient's motivation to comply with the treatment schedule. Treatment can take anywhere from three to six months.

### Invasive stimulators

Invasive electric stimulators are either fully or partially implantable. The advantage of these devices is that they apply a direct electric current to the fracture 24 hours a day. The fully implantable stimulator requires little daily attention from the patient. Patients using a semi-implanted stimulator must regulate their own treatment schedule and have to care for the external power pack. The disadvantage of implantable and semi-implantable stimulators is that their implantation is a surgical procedure.

Fully implantable direct current stimulators are installed in a hospital under general or regional anesthesia. Both the stimulator and the power source are implanted. The surgeon makes an incision and places a spiral-shaped cathode inside the bone. A wire leads to the power source and a small anode. The power source

is a battery pack that is implanted in the nearby muscle. The body transmits electrical current to close the circuit. The incision is then closed. Once in place, the device provides continuous direct electric current for bone growth stimulation.

Partially implanted stimulators use cathode pins that are implanted at the edge of each bone that is fractured. Wires lead to the surface of the skin where a power source and the anode are located. Wires complete the circuit. The external portion of the device is held in place by a cast. This source of stimulation also runs continuously.

### **Noninvasive stimulators**

In the noninvasive stimulator, external electromagnetic coils are placed on either side of the fracture and are held in place by a strap or cuff. Locating the coils correctly is important, and their location relative to the fracture is usually confirmed by x rays.

The coils produce a pulsating electromagnetic field. It is up to the patient to maintain the prescribed treatment schedule. Effective treatment requires stimulation anywhere from three to ten hours each day in periods of no less than one hour.

Ultrasound stimulation is the most recent treatment for stimulating bone growth. A device that generates low intensity pulses of sound is applied to the skin over the fracture. The advantage of this technique is that it is noninvasive and the period of application of the sound pulses can be as short as 20–30 minutes each day. The results of this treatment have been studied less than the effect of electromagnetic stimulation.

### **Preparation**

Bone growth stimulation is done only when healing has failed to occur for many months. Before it is started, x rays are done of the fracture area. If the device is to be implanted, standard preoperative blood and urine tests are done. The patient may meet with an anesthesiologist to discuss any conditions that might affect the administration of anesthesia.

### **Aftercare**

If a noninvasive, pulsating, electromagnetic field device is used, the patient must not put any stress or weight on the fracture until it is healed, which is a matter of months in most cases. In all lower limb fractures, regardless of the stimulation method used, the patient can not bear weight on the limb with the fracture until healing is complete. This limits the patient's mobility for many months. Patients have

the responsibility of regularly making sure that the unit works and caring for external devices and the casts that hold them in place.

### **Risks**

Noninvasive devices have few risks associated with them. The main risk associated with implantable devices is the development of infection at the site of implantation.

### **Normal results**

Success in healing a fracture nonunion using bone growth stimulation depends on the type, location, and severity of the fracture and the age and general health of the patient.

### **Resources**

#### **OTHER**

"Physical Fields." American Academy of Orthopaedic Surgeons. <http://orthoinfo.aaos.org/topic.cfm?topic=A00279> (accessed November 23, 2010).

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Bone infection see **Osteomyelitis**

## **Bone marrow aspiration and biopsy**

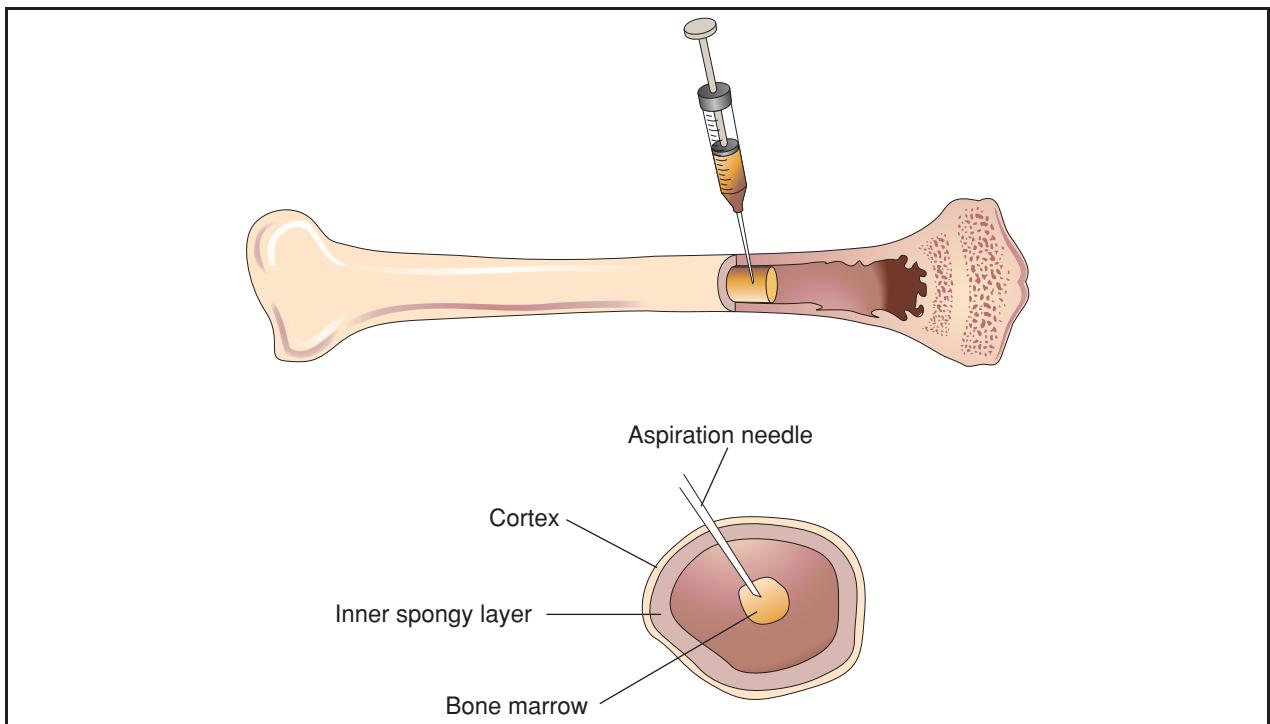
### **Definition**

Bone marrow aspiration, also called bone marrow sampling, is the removal by suction of the soft, spongy semisolid tissue (marrow) that fills the inside of the body's long and flat bones. Bone marrow biopsy, or needle core biopsy, is the removal of a small piece (about 0.75 x 0.06 in. [2 x 0.16 cm]) of intact bone marrow. The bone marrow is where blood cells are made.

### **Purpose**

Examination of the bone marrow may be the next step that follows an irregular clinical finding, such as an abnormal **complete blood count** (CBC), and/or an abnormal peripheral blood smear. It also may be performed following an abnormal bone image, such as the finding of a lesion on x rays.

A biopsy of bone marrow shows the intact tissue, so that the structure of the fat cells, lymphocytes, plasma cells, fibrous connective tissue cells, and other cells—and



In a bone marrow aspiration, a needle is inserted beneath the skin and rotated until it penetrates the cortex, or outer covering of the bone. A small amount of marrow is suctioned out of the bone by a syringe attached to the needle. (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

their relationships to each other—can be seen. A bone marrow biopsy is used to:

- diagnose and manage any form of leukemia or other myeloproliferative condition such as multiple myeloma
- rule out or confirm bone marrow infiltration by malignancies such as Hodgkin's disease, non-Hodgkin's lymphoma, and metastatic carcinoma
- monitor the effects of chemotherapy and the response or lack of response to treatment of blood disease
- evaluate the success of bone marrow transplantation
- diagnose certain genetic diseases (e.g., lipid storage disease)
- investigate pancytopenia (a decrease of all blood cells in peripheral blood), neutropenia (decreased phagocytic white blood cells), or thrombocytopenia (decreased platelets)
- diagnose an infection of unknown origin
- investigate rare anemias for which a cause cannot be found or which do not respond to treatment as anticipated
- diagnose some types of cancer, anemia, and other blood disorders

- identify the source of an unexplained fever (e.g., granulomatous lesions)
- diagnose fibrosis of bone marrow and myeloma when bone marrow aspiration has failed to provide an appropriate specimen

A combination of aspiration and biopsy procedures are commonly used to ensure the availability of the best possible bone marrow specimen. The aspirate is collected at the same time as the bone core biopsy by attaching a syringe to the bone marrow needle and withdrawing the sample before the cutting blades are inserted and the bone core is removed. The aspirate is the sample of choice for studying and classifying the nucleated blood cells of the bone marrow (e.g., determining the ratio of immature white blood cells to red blood cells, which is called the M:E ratio). The biopsy is the only sample that shows the blood-forming cells in relation to the structural and connective tissue elements (i.e., the microarchitecture) of the bone marrow. It provides the best sample for evaluating the cellularity of the bone marrow (the percentage of blood-forming tissue versus fat).

### Description

A physician requests or orders the procedure. A pathologist, hematologist, or oncologist with special

## KEY TERMS

**Antibodies**—Proteins that are produced normally by specialized white blood cells after stimulation by a foreign substance (antigen) and that act specifically against the antigen in an immune response.

**Aspiration**—A procedure to withdraw fluid and cells from the body.

**Connective tissue**—Cells such as fibroblasts, and material such as collagen and reticulin, that unite one part of the body with another.

**Fibrosis**—A condition characterized by the presence of scar tissue, or reticulin and collagen proliferation in tissues to the extent that it replaces normal tissues.

**Hematologist**—A specialist who treats diseases and disorders of the blood and blood-forming organs.

**Hematoma**—Blood that collects under the skin, forms a blood clot, and causes swelling.

**Hemorrhage**—Heavy bleeding.

**Immune system**—Mechanism that protects the body from foreign substances, foreign cells, and pathogens. The thymus, spleen, lymph nodes, white blood cells (including the B cells and T cells), and

antibodies are involved in the immune response, which aims to destroy these foreign bodies.

**Lymphocytes**—Type of white blood cells that are part of the immune system. The lymphocytes are composed of three main cell lines: B lymphocytes, T lymphocytes, and natural killer (NK) cells.

**Megakaryocyte**—A large bone marrow cell that is responsible for the production of platelets, which are active in blood clotting.

**Myeloma (multiple myeloma)**—A tumor of plasma cells that originates in bone marrow and usually spreads to more than one bone.

**Needle biopsy**—The procedure of using a large hollow needle to obtain a sample of intact tissue.

**Pathologist**—A medical doctor that specializes in identifying diseases by studying cells and tissues under a microscope.

**Plasma cells**—Cells in the blood and bone marrow that are formed from B lymphocytes and that produce antibodies.

**White blood cell (leukocyte; WBC)**—A blood cell that is responsible for fighting infection.

training in this procedure most often performs the aspirate and biopsy in a hospital or clinic. Bone marrow aspiration and biopsy are performed by a pathologist, hematologist, or oncologist with special training in this procedure. The procedure may be performed on an outpatient basis. In adults, the specimen is usually taken from the posterior superior iliac crest (top rear part of the hip). The sternum (breastbone) may be used for aspiration, but is less desirable because it carries the risk of cardiac puncture. Other sites that are rarely used are the anterior (front) superior iliac crest or a spinal column bone. When the patient is a child, the biopsy site is generally the anterior tibia, the larger of the two bones in the lower leg. A vertebra may also be used.

The skin covering the biopsy site is cleansed with an antiseptic, and the patient may be given a mild sedative. A local anesthetic such as lidocaine is administered, first under the skin with a fine needle and then around the bone at the intended puncture site with a somewhat larger-gauge needle. When the area is numb, a small incision is made in the skin and the biopsy needle is inserted. Pressure is applied to force the needle through the outer bone, and a decrease in resistance signals entry into the marrow cavity. The needle most often used for bone

marrow biopsy is a Jamshidi trephine needle or a Wester- man-Jensen trephine needle. A syringe is placed on the top of the needle and 1–2 mL of the bone marrow is aspirated into the syringe. In some instances, the marrow cannot be aspirated because it is fibrosed or packed with neoplastic cells. The syringe is removed, and the medical technologist uses this sample to prepare several smears containing small pieces of bone (spicules). Another syringe is fitted onto the needle hub and another sample of 3 mL is removed and transferred to a tube containing ethylenediaminetetraacetic acid (EDTA) for analysis by flow cytometry, cytogenetic testing, or other special laboratory procedures. Following aspiration, the cutting blades are inserted into the hollow of the needle until they protrude into the marrow. The needle is then forced over the tips of the cutting blades and the needle is rotated as it is withdrawn from the bone. This process captures the core sample inside the needle. A wire probe is inserted at the cutting end, and the bone marrow sample is pushed through the hub of the needle onto sterile gauze. The specimen is used to make several preparations on glass slides or cover glasses and is transferred to a fixative solution.

In the laboratory, the aspirate slides are stained with Wright stain or Wright-Giemsa stain. The biopsy

material is sectioned onto glass slides and stained with hematoxylin-eosin, Giemsa, and Prussian blue stains. Prussian blue stain is used to evaluate the amount of bone marrow iron, and the other stains are used to contrast cell structures under the microscope. In addition, special stains may be used that aid in the classification of malignant white blood cells.

The analysis of the bone marrow is done by a pathologist, and a written report is added to the patient's medical record. A histologic technician performs special stains for bone marrow. Clinical laboratory scientists/medical technologists perform smear reviews and analysis of bone marrow cells by flow cytometry. Cytogenetic technologists may perform chromosomal analysis of bone marrow white blood cells.

### **Preparation**

The physician should be informed of any medication the patient is using and of any heart surgery that the patient may have undergone.

Adults require no special preparation for this test. As for infants and children, they need physical and psychological preparation, depending on their age, previous medical experiences, and level of trust.

### **Infant preparation**

Before the test, parents should know that their child will probably cry and that restraints might be used. To provide comfort and to help their child through this procedure, parents commonly are asked to be present during the procedure. Crying is a normal infant response to an unfamiliar environment, strangers, restraints, and separation from the parent. Infants cry more for these reasons than because they hurt. An infant will be restrained by hand or with devices because they have not yet developed the physical control, coordination, and ability to follow commands as adults have. The restraints used thus aim to ensure the infant's safety.

### **Toddler preparation**

Parents should prepare a toddler for bone marrow aspiration directly before the procedure because toddlers have a very short attention span. Some general guidelines for parents include the following:

- Explain the procedure in a simple language, using concrete terms and avoiding abstract terminology.
- Make sure that the child understands where on the body the procedure will be performed and that it will be limited to that area.

- Allow the child to yell, cry, or express anything, especially pain, verbally.
- Describe how the test will feel.
- Stress the benefits of the procedure and anything that the child may find enjoyable afterwards, such as feeling better or going home.

### **Preschooler preparation**

Parents should prepare a preschooler for bone marrow aspiration directly before the procedure so that the child does not worry about it for days in advance. Parents should ensure that the child understands that the procedure is not a punishment. Some general guidelines for parents include the following:

- Explain the procedure in a simple language, using concrete terms and avoiding abstract terminology.
- Make sure that the child understands where on the body the procedure will be performed and that it will be limited to that area.
- Allow the child to yell, cry, or express anything, especially pain, verbally.
- Describe how the test will feel and be honest about any pain that may be felt.
- Allow the child to practice different positions or movements that will be required for the procedure.
- Stress the benefits of the procedure and anything that the child may find enjoyable afterwards, such as feeling better or going for a treat on the way home.
- Practice deep breathing and other relaxation exercises. Practice also to have the child hold your hand and tell him or her to squeeze it when he or she feels pain during the procedure.

### **School-age child preparation**

Explanations should be limited to 20 minutes, and repeated if required. The older the child, the earlier a parent can start preparation. Guidelines for parents include the ones provided for preschoolers, as well as the following:

- Suggest ways for maintaining control during the procedure; for example, counting, deep breathing, and relaxation (thinking pleasant thoughts).
- Include the child in the decision-making process; for example, the time of day or the body site where the procedure will be performed. These of course depend on the scheduling constraints of the physician and the type of procedure being performed.
- Encourage the child to participate in the procedure; for example, by holding an instrument, if allowed by the attending hospital staff.

- Encourage the child to hold your hand or the hand of a nurse. Physical contact does help reduce pain and anxiety.

### **Adolescent preparation**

An adolescent is best prepared by being provided with detailed information and reasons for the procedure. Adolescents should be encouraged to make as many decisions as possible. An adolescent may or may not wish a parent to be present during the procedure, and such wishes should be respected, since privacy is important during adolescence. Other guidelines include the following:

- Explain the procedure in correct medical terminology, and provide the reason for it.
- As clearly as possible, describe the equipment that will be involved in concrete terms.
- Discuss potential risks honestly and openly.

### **Aftercare**

After the needle is removed, the biopsy site is covered with a clean, dry pressure bandage. The patient must remain lying down and is observed for bleeding for one hour. The patient's pulse, breathing, blood pressure, and temperature are monitored until they return to normal. The biopsy site should be kept covered and dry for several hours.

The patient should be able to leave the clinic and resume most normal activities immediately. Patients who have received a sedative often feel sleepy for the rest of the day, so driving, cooking, and other activities that require clear thinking and quick reactions should be avoided. Walking or prescribed **pain** medications usually ease any discomfort felt at the biopsy site, and ice can be used to reduce swelling.

A doctor should be notified if the patient:

- feels severe pain for more than 24 hours after the procedure
- experiences persistent bleeding or notices more than a few drops of blood on the wound dressing
- has a temperature above 101°F (38.3°C)
- has inflammation and pus at the biopsy site and other signs of infection

### **Risks**

A small amount of bleeding and moderate discomfort often occur at the biopsy site. Rarely, reactions to anesthetic agents, infection, and hematoma (blood clot) or hemorrhage (excessive bleeding) also may develop. In rare instances, the heart or a major

blood vessel is pierced when marrow is extracted from the sternum during bone marrow biopsy. This can lead to severe hemorrhage.

### **Normal results**

Healthy adult bone marrow contains yellow fat cells, connective tissue, and red marrow that produces blood. Bone marrow is evaluated for cellularity; megakaryocyte production; M:E ratio; differential (classification of blood-forming cells); iron content; lymphoid, bone, and connective tissue cells; and bone and blood vessel abnormalities. The bone marrow of a healthy infant is primarily red (75–100% cellularity), and the distribution of blood-forming cells is very different from adult marrow. Consequently, age-related normal values must be used.

### **Abnormal results**

Microscopic examination of bone marrow can reveal leukemia, granulomas, **myelofibrosis**, myeloma, lymphoma, or metastatic cancers; bone marrow infection; and bone disease. Bone marrow evaluation usually is not needed to diagnose anemia, but may be useful in cases that cannot be classified by other means.

### **Resources**

#### **BOOKS**

- Bain, Barbara J. *Blood Cells: A Practical Guide*, 4th ed. Malden, MA: Blackwell, 2006.  
Farhi, Diane C. *Pathology of Bone Marrow and Blood Cells*, 2nd ed. Baltimore, MD: Lippincott William & Wilkins, 2009.

#### **OTHER**

- “Bone Marrow Diseases.” MedlinePlus. January 19, 2010. [http://www.nlm.nih.gov/medlineplus/bonemarrow\\_diseases.html](http://www.nlm.nih.gov/medlineplus/bonemarrow_diseases.html)  
Falck, Tony C. and Darlyn C. Falck. “Bone Marrow Biopsy.” emedicinehealth.com. January 11, 2006. [http://www.emedicinehealth.com/bone\\_marrow\\_-biopsy/article\\_em.htm](http://www.emedicinehealth.com/bone_marrow_-biopsy/article_em.htm)

#### **ORGANIZATIONS**

- American Cancer Society, 1599 Clifton Rd., NE, Atlanta, GA, 30329, (404) 320-3333, (800) ACS-2345, <http://www.cancer.org>.  
Leukemia & Lymphoma Society, 1311 Mamaroneck Avenue, Suite 310, White Plains, NY, 10605, (914) 949-5213, (800) 955-4572, <http://www.leukemia-lymphoma.org>.  
National Cancer Institute Public Inquires Office, 6116 Executive Boulevard, Room 3036A, Bethesda, MD, 20892-8322, (800) 4-CANCER, TTY (800) 332-8615, <http://www.cancer.gov>.

National Marrow Donor Program, 3001 Broadway Street NE, Suite 100, Minneapolis, MN, 55413-1753, (800) MARROW-2 (627-7692), patientinfo@nmdp.org, <http://www.marlow.org>.

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## Bone marrow transplantation

### Definition

Bone marrow transplantation involves extracting bone marrow containing normal stem cells or peripheral stem cells from a healthy donor and transferring it to a recipient whose body cannot manufacture proper quantities of normal blood cells. The goal of the transplant is to rebuild the recipient's blood cells and immune system and hopefully cure the underlying disease.

### Purpose

The bone marrow—the sponge-like tissue found in the center of certain bones—contains stem cells that are the precursors of white blood cells, red blood cells, and platelets. These blood cells are vital for normal body functions, such as oxygen transport, defense against infection and disease, and clotting. Blood cells have a limited life span and are constantly being replaced; therefore, the production of healthy stem cells is vital.

In association with certain diseases, stem cells may produce too many, too few, or abnormal blood cells. Also, medical treatments may destroy stem cells or alter blood cell production. Blood cell abnormalities can be life threatening.

A person's red blood cells, white blood cells, and platelets may be destroyed or may be abnormal due to disease. Also, certain medical therapies, particularly **chemotherapy** or **radiation therapy**, may destroy a person's stem cells. The consequence to an individual's health is severe. Under normal circumstances, red blood cells carry oxygen throughout the body and remove carbon dioxide from the body's tissues. White blood cells form the cornerstone of the body's immune system and defend it against infection. Platelets limit bleeding by enabling the blood to clot if a blood vessel is damaged.

A bone marrow transplant is used to rebuild the body's capacity to produce these blood cells and bring their numbers to normal levels. Illnesses that may be treated with a bone marrow transplant include both cancers and noncancerous diseases.

Cancerous diseases may or may not specifically involve blood cells, but **cancer** treatment can destroy the body's ability to manufacture new blood cells. Bone marrow transplantation may be used in conjunction with additional treatments, such as chemotherapy, for various types of leukemia, Hodgkin's disease, lymphoma, breast and **ovarian cancer**, renal cell carcinoma, myelodysplasia, **myelofibrosis**, germ cell cancer, and other cancers. Noncancerous diseases for which bone marrow transplantation can be a treatment option include **aplastic anemia**, **sickle cell disease**, **thalassemia**, and severe **immunodeficiency**.

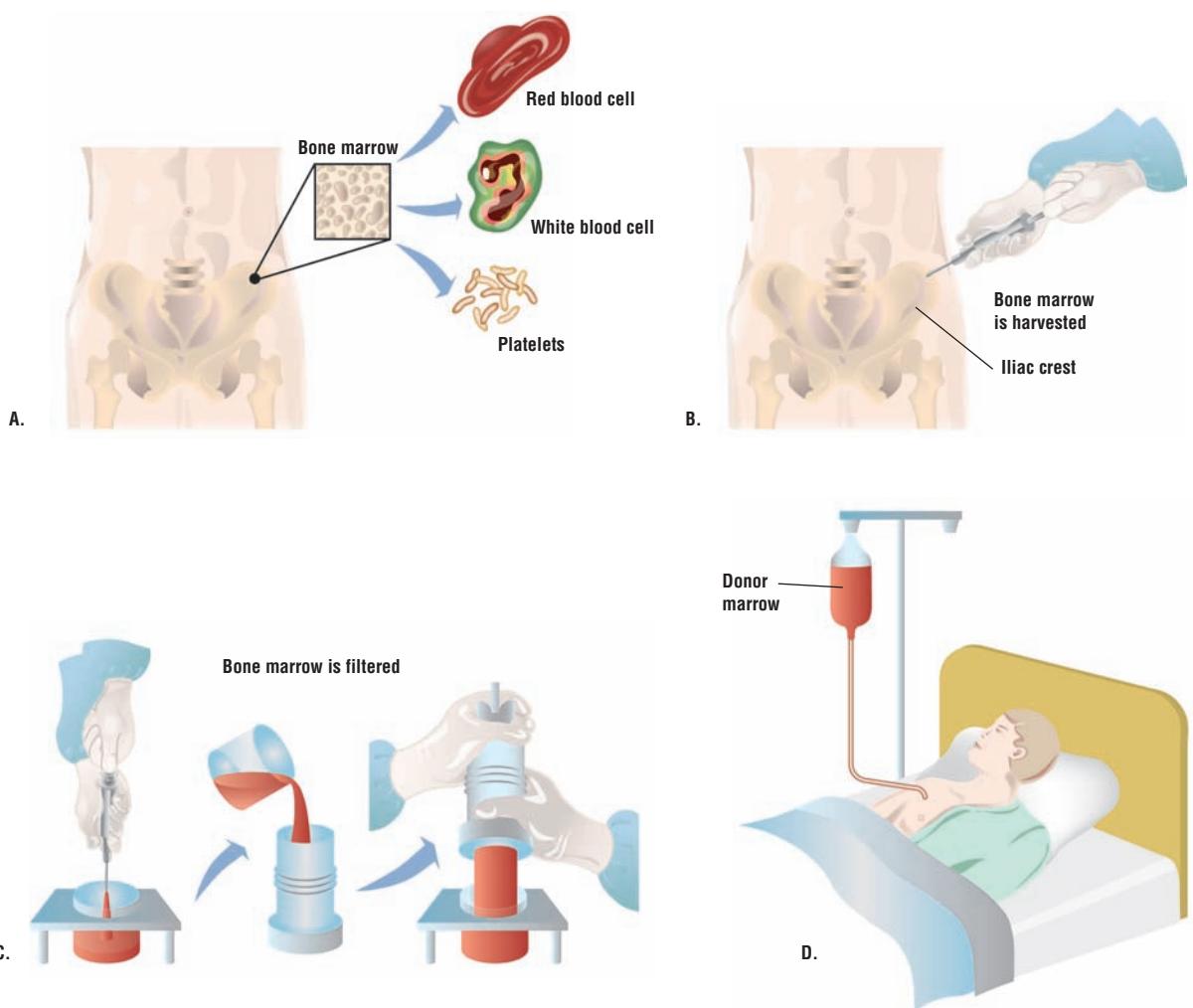
### Demographics

The decision to prescribe a bone marrow transplant is based on the patient's age, general health status, diagnosis, and stage of the disease. A person's age or state of health may prohibit use of a bone marrow transplant. The typical cut-off age for a transplant ranges from 40–55 years; however, a person's health usually is the more important factor. Before undergoing a bone marrow transplant, the bone marrow transplant team will ensure that the patient understands the potential benefits and risks of the procedure.

### Description

The first successful bone marrow transplant took place in 1968 at the University of Minnesota. The recipient was a child with **severe combined immunodeficiency** disease and the donor was a sibling. In 1973, the first unrelated bone marrow transplant was performed at Memorial Sloan-Kettering Cancer Center in New York City on a five-year-old patient with severe combined immunodeficiency disease. In 1984, Congress passed the National Organ Transplant Act, which included language to evaluate unrelated marrow transplantation and determine if a national donor registry was feasible. The National Bone Marrow Donor Registry (NBMDR), now called the National Marrow Donor Program (NMDP), was established in 1986. In 2010, the NMDP had more than 8 million volunteer donors and 100,000 cord blood units. It facilitates about 4,800 BMTs each year.

Transplant physicians specially trained in bone marrow transplantation should perform this procedure. Bone marrow transplant physicians have

**Bone marrow transplant**

In a bone marrow transplant, bone marrow is harvested from the donor's pelvic bone at the iliac crest (B). The marrow is filtered (C) before being introduced into a large vein in the recipient's chest via a catheter (D). (Illustration by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

extensive experience in hematology/oncology and bone marrow transplant.

Selecting a transplant center that has a multidisciplinary team of specialists is important. The bone marrow transplant team should include transplant physicians, **infectious disease** specialists, pharmacologists, registered nurses, and transplant coordinators. Other transplant team members may include registered dietitians, social workers, and financial counselors.

When selecting a transplant center, the patient should find out where the center is accredited. Some examples of accrediting organizations include the

Foundation for the Accreditation of Cellular Therapy, the American Association of Blood Banking, the National Marrow Donor Program, and other state-level accreditation organizations.

#### *Autologous and allogeneic transplants*

Two important requirements for a bone marrow transplant are a donor and a recipient. Sometimes, the donor and the recipient may be the same person. This type of transplant is called an autologous transplant. It typically is used in cases in which a person's bone marrow generally is healthy but will be destroyed due

## KEY TERMS

**ABO antigen**—Protein molecules located on the surfaces of red blood cells that determine a person's blood type: A, B, or O.

**Allogeneic**—Referring to bone marrow transplants between two different, genetically dissimilar people.

**Anemia**—Decreased red cell production that results in a deficiency in oxygen-carrying capacity of the blood.

**Antigen**—A molecule that is capable of provoking an immune response.

**Aplastic anemia**—A disorder in which the body produces inadequate amounts of red blood cells and hemoglobin due to underdeveloped or missing bone marrow.

**Autologous**—Referring to bone marrow transplants in which recipients serve as their own donors.

**Bone marrow**—A spongy tissue located within flat bones, including the hip and breast bones and the skull. This tissue contains stem cells, which are the precursors of platelets, red blood cells, and white blood cells.

**Bone marrow biopsy**—A test involving the insertion of a thin needle into the breastbone or, more commonly, the hip, in order to aspirate (remove) a sample of the marrow. A small piece of cortical bone may also be obtained for biopsy.

**Bone marrow transplant**—Healthy marrow is infused into people who have had high-dose chemotherapy for one of the many forms of leukemias, immunodeficiencies, lymphomas, anemias, metabolic disorders, and sometimes solid tumors.

**Chemotherapy**—Medical treatment of a disease, particularly cancer, with drugs or other chemicals.

**Chest x ray**—A diagnostic procedure in which a very small amount of radiation is used to produce an image of the structures of the chest (heart, lungs, and bones) on film.

**Chronic myelogenous leukemia (CML)**—Also called chronic myelocytic leukemia, a malignant disorder that involves abnormal accumulation of white cells in the marrow and bloodstream.

**Computed tomography scan (CT or CAT)**—Computed axial tomography uses x rays and computers to produce an image of a cross-section of the body.

**Conditioning**—Process of preparing a patient to receive marrow donation, often through the use of chemotherapy and radiation therapy.

**Echocardiogram**—An imaging procedure used to create a picture of the heart's movement, valves and chambers. The test uses high-frequency sound waves that come from a hand wand placed on the chest. Echocardiogram may be used in combination with Doppler ultrasound to evaluate the blood flow across the heart's valves.

**Electrocardiogram (ECG, EKG)**—A test that records the electrical activity of the heart using small electrode patches attached to the skin on the chest.

**Graft versus host disease**—A life-threatening complication of bone marrow transplants in which the donated marrow causes an immune reaction against the recipient's body.

**Histocompatibility**—The major histocompatibility determinants are the human leukocyte antigens (HLA), which characterize how well the patient and donor are matched.

**Hodgkin disease**—A type of cancer involving the lymph nodes and potentially affecting non-lymphatic organs in the later stage.

**Human leukocyte antigen (HLA)**—A group of protein molecules located on bone marrow cells that can provoke an immune response. A donor's and a recipient's HLA types should match as closely as possible to prevent the recipient's immune system from attacking the donor's marrow as a foreign material that does not belong in the body.

**Immunodeficiency**—A disorder in which the immune system is ineffective or disabled due either to acquired or inherited disease.

**Leukemia**—A type of cancer that affects leukocytes, a particular type of white blood cell. A characteristic symptom is excessive production of immature or otherwise abnormal leukocytes.

**Lymphoma**—A type of cancer that affects lymph cells and tissues, including certain white blood cells (T cells and B cells), lymph nodes, bone marrow, and the spleen. Abnormal cells (lymphocyte/leukocyte) multiply uncontrollably.

**Match**—How similar the HLA typing, out of a possible six antigens, is between the donor and the recipient.

**Myelodysplasia**—Also called myelodysplastic syndrome, it is a condition in which the bone marrow does not function normally and can affect the various types of blood cells produced in the bone marrow. Often referred to as a preleukemia and may progress and become acute leukemia.

**Myelofibrosis**—An anemic condition in which bone marrow cells are abnormal or defective and become fibrotic.

**Non-myeloablative allogeneic bone marrow transplant**—Also called “mini” bone marrow transplants. This type of bone marrow transplant involves receiving low doses of chemotherapy and radiation therapy, followed by the infusion of a donor’s bone marrow or peripheral stem cells. The goal is to suppress the patient’s own bone marrow with low-dose chemotherapy and radiation therapy to allow the donor’s cells to engraft.

**Peripheral stem cells**—Stem cells that are taken directly from the circulating blood and used for transplantation. Stem cells are more concentrated in the bone marrow, but they can also be extracted from the bloodstream.

**Peripheral stem cell transplant**—The process of transplanting peripheral stem cells instead of using bone marrow. The stem cells in the circulating blood that are similar to those in the bone marrow are given to the patient after treatment to help the bone marrow recover and continue producing healthy blood cells. A peripheral stem cell transplant may also be used to supplement a bone marrow transplant.

**Platelets**—Fragments of a large precursor cell, a megakaryocyte found in the bone marrow. These fragments adhere to areas of blood vessel damage and release chemical signals that direct the formation of a blood clot.

**Pulmonary function test**—A test that measures the capacity and function of the lungs, as well as the blood’s ability to carry oxygen.

**Radiation therapy**—The use of high-energy radiation from x rays, cobalt, radium, and other sources to kill cancer cells and shrink tumors. Radiation may come from a machine outside the body (external beam radiation therapy) or from materials called radioisotopes. Radioisotopes produce radiation and are placed in or near the tumor or in the area near the

cancer cells. This type of radiation treatment is called internal radiation therapy, implant radiation, interstitial radiation, or brachytherapy. Systemic radiation therapy uses a radioactive substance, such as a radio-labeled monoclonal antibody that circulates throughout the body.

**Red blood cell (RBC)**—Cell that contains hemoglobin (the molecule that transports oxygen) and helps remove wastes from tissues throughout the body.

**Remission**—Disappearance of the signs and symptoms of cancer. When this happens, the disease is said to be “in remission.” A remission can be temporary or permanent.

**Sickle cell disease**—An inherited disorder characterized by a genetic flaw in hemoglobin production. (Hemoglobin is the substance within red blood cells that enables them to transport oxygen.) The hemoglobin that is produced has a kink in its structure that forces the red blood cells to take on a sickle shape, inhibiting their circulation and causing pain. This disorder primarily affects people of African descent.

**Stem cells**—Unspecialized cells, or “immature” blood cells, that serve as the precursors of white blood cells, red blood cells, and platelets.

**Syngeneic**—Referring to a bone marrow transplant from one identical twin to the other.

**Thalassemia**—A group of inherited disorders that affects hemoglobin production. Because hemoglobin production is impaired, a person with this disorder may suffer mild to severe anemia. Certain types of thalassemia can be fatal.

**Umbilical cord blood transplant**—A procedure in which the blood from a newborn’s umbilical cord, which is rich in stem cells, is used as the donor source for bone marrow transplants. Currently, umbilical cord blood transplants are mainly used for sibling bone marrow transplants or to store blood for an anonymous donation. In most cases, umbilical cord blood does not contain enough stem cells to safely use for adult bone marrow transplants.

**White blood cells**—A group of several cell types that occur in the bloodstream and are essential for a properly functioning immune system.

to medical treatment for diseases such as **breast cancer** and Hodgkin's disease. Autologous transplants also are possible if the disease affecting the bone marrow is in remission. If a person's bone marrow is unsuitable for an autologous transplant, the bone marrow must be derived from another person in an allogeneic transplant.

An allogeneic bone marrow donor may be a family member or an unrelated donor. The donated bone marrow/peripheral stem cells must perfectly match the patient's bone marrow. The matching process matches human leukocyte antigens (HLA). Antigens are markers in cells that stimulate antibody production. HLA antigens are proteins on the surface of bone marrow cells. HLA testing is a series of blood tests that evaluate the closeness of tissue between the donor and the recipient. If the donor and the recipient have very dissimilar antigens, the recipient's immune system regards the donor's bone marrow cells as foreign invaders and launches a destructive attack against them. Such an attack negates any benefits offered by the transplant.

#### *Non-myeloablative ("mini") allogeneic transplants*

A "mini" transplant, also called a reduced intensity transplant or adoptive immunotherapy, involves receiving low doses of chemotherapy and radiation therapy, followed by the infusion of a donor's bone marrow or peripheral stem cells. The goal is to suppress the patient's own bone marrow with low-dose chemotherapy and radiation therapy to allow the donor's cells to engraft (settle into the bone marrow and begin reproducing). If cancer cells remain in the patient's body, the donated cells are able to identify the cancer cells as foreign and trigger an immune response, killing the cancer cells. This is called the graft-versus-tumor effect.

#### *Peripheral blood stem cell transplants*

In **stem cell transplantation**, peripheral blood stem cells are used instead of cells from the bone marrow. Peripheral blood stem cells (PBSCs) are obtained from circulating blood rather than from bone marrow, but the amount of stem cells found in the peripheral blood is much smaller than the amount of stem cells found in the bone marrow. Peripheral blood stem cells can be used in either autologous or allogeneic transplants. The majority of PBSC transplants are autologous. However, clinical studies indicate that PBSCs are being used more frequently than bone marrow for allogeneic bone marrow transplantation.

The advantages of PBSC transplants when compared to bone marrow transplants are that, in allogeneic transplantation, hematopoietic (the ability to form blood cells) and immune recovery are faster with PBSCs. In autologous transplantation, the use of PBSCs can result in faster blood count recovery. Also, some medical conditions exist in which the recipient cannot accept bone marrow transplants but can accept PBSC transplants. A possible disadvantage to PBSC transplant versus bone marrow transplantation is that so much more fluid volume is necessary to collect enough PBSCs that, at the time that the new stem cells are infused into the recipient, the fluid can collect in the lungs. Also, the time commitment for the donor for a PBSC transplant is considerable. When the PBSCs are being collected, several outpatient sessions are needed and each session lasts approximately between two and four hours.

**UMBILICAL CORD BLOOD TRANSPLANT.** Umbilical cord blood transplant is a procedure in which umbilical cord blood from a newborn is used as the donor source. Umbilical cord blood is rich in stem cells, the cells that are needed for transplantation, and these cells are theoretically "immunologically naïve," reducing chances of rejection and making it a good source for donation. The matching criteria are the same as for bone marrow. Most programs use this procedure for a sibling or store cord blood for anonymous donation. Umbilical cord blood can be an excellent source for children. One potential problem with umbilical cord blood transplantation is the low volume of stem cells contained in the umbilical cord. In many instances, there is inadequate volume to safely use for a transplant in an adult recipient.

#### *The transplant procedure*

**HLA MATCHING.** There are only five major HLA classes or types—designated HLA-A, -B, -C, -D, and class III, but much variation exists within each group. For example, HLA-A from one individual may be similar to, but not the same as, HLA-A in another individual; such a situation can render a transplant from one to the other impossible.

HLA matching is more likely if the donor and recipient are related, particularly if they are siblings; however, an unrelated donor may be a potential match. The only case in which matching HLA types between two people is not an issue is if the recipient has an identical twin. Identical twins carry the same genes, and, therefore, the same antigens. A bone marrow transplant between identical twins is called a syngeneic transplant.

**BONE MARROW TRANSPLANTATION.** The bone marrow extraction, or harvest, is the same for autologous and allogeneic transplants. Harvesting is done under **general anesthesia**, and discomfort is usually minimal afterwards. Bone marrow is drawn from the iliac crest (the part of the hip bone on either side of the lower back) with a special needle and a syringe. Several punctures usually are necessary to collect the needed amount of bone marrow, approximately 1–2 quarts. (This amount is only a small percentage of the total bone marrow and is typically replaced within four weeks.) The donor remains at the hospital for 24–48 hours and can resume normal activities within a few days.

If the bone marrow is meant for an autologous transplant, it is stored at -112– -320°F (-80– -196°C) until it is needed. If a patient's own bone marrow can be used for transplantation or if a donor is not found, peripheral stem cells may be harvested from the patient's circulating blood. Bone marrow for an allogeneic transplant sometimes is treated to remove the donor's T cells (a type of white blood cell) or to remove ABO (blood type) antigens; otherwise, it is transplanted without modification.

The bone marrow or peripheral stem cells are administered to the recipient via a catheter (a narrow, flexible tube) inserted into a large vein in the chest. The donor cells look like a bag of blood and are infused for about 20–30 minutes. During the infusion, the patient's blood pressure, pulse, and breathing are monitored. From the bloodstream, the marrow migrates to the cavities within the bones where bone marrow is normally stored. If the transplant is successful, the bone marrow begins to produce normal blood cells once it is in place (engrafted).

**PERIPHERAL BLOOD STEM CELL TRANSPLANTATION.** Before collection for a PBSC transplant, donors receive four injections daily of the drug G-CSF, or filgrastim. (Patients can give it to themselves at home, if necessary.) These pretreatments stimulate the body to release stem cells into the blood. After these pretreatments, the donors' experience is similar to that of a whole blood donor's experience—PBSC donors' blood is collected at a clinic or hospital as an outpatient procedure. The differences are that several sessions will be needed over days or weeks, and the blood is collected in a process called apheresis. The blood travels from one arm into a blood cell separator that removes only the stem cells, and the rest of the blood is returned back to the donor in the other arm. The cells are then frozen for later use.

The PBSCs are administered to the recipient using the same methods as those used in bone

marrow transplantation. As stated, the amount of fluid with PBSCs infused into the recipient's body can be an issue.

### Costs

Bone marrow transplantation is an expensive procedure. (Bone marrow donors are volunteers and do not pay for any part of the procedure.) Insurance companies and health maintenance organizations (HMOs) may not cover the costs. Many insurance companies require precertification letters of medical necessity. As soon as bone marrow transplantation is discussed as a treatment option, it is important for the patient to contact his or her insurance provider to determine what costs will be covered.

### Preparation

Several tests are performed before the bone marrow transplant to identify any potential problems ahead of time. Tests include:

- tissue typing and a variety of blood tests
- chest x ray
- pulmonary function tests
- computed tomography scan (CT or CAT)
- heart function tests, including an electrocardiogram and echocardiogram
- bone marrow biopsy
- skeletal survey

In addition, a complete dental exam is needed before the bone marrow transplant to reduce the risk of infection. Other precautions will be taken before the transplant to reduce the patient's risk of infection.

A triple lumen, central venous catheter (a slender, hollow flexible tube) is surgically inserted into a large vein in the chest during a simple outpatient procedure. The catheter is used to draw blood and infuse chemotherapy and other medications, as well as donor cells, blood product, fluids, and sometimes nutritional solutions. The central venous catheter usually stays in place for about six months after the bone marrow transplant.

Hormone-like medications called colony-stimulating factors may be given before the transplant to stimulate the patient's white blood cells. These medications stimulate the white blood cells to multiply, mature, and function. These medications also help the patient's white blood cells recover from chemotherapy and reduce the risk of infection.

In preparation for receiving the transplant, the recipient undergoes "conditioning," a preparative

regimen (also called marrow ablation) in which the bone marrow and abnormal cells are destroyed. Conditioning rids the body of diseased cells and makes room for the marrow or peripheral stem cells to be transplanted. It typically involves chemotherapy and/or radiation treatment, depending on the disease being treated. Unfortunately, this treatment also destroys healthy cells and has many side effects such as extreme weakness, **nausea**, **vomiting**, and **diarrhea**. These side effects may continue for several weeks.

### Aftercare

A bone marrow transplant recipient can expect to spend three to four weeks in the hospital, depending on the rate of recovery. A two- to four-week waiting period follows the marrow transplant before its success can begin to be evaluated. The marrow recipient is kept in **isolation** during this time to minimize potential infections. The recipient also receives intravenous antibiotic, antiviral, and antifungal medications, as well as blood and platelet transfusions to help fight infection and prevent excessive bleeding. Blood tests are performed daily to monitor the patient's kidney and liver function, as well as nutritional status. Other tests are performed as necessary. Further side effects, such as **nausea** and **vomiting**, can be treated with other medications. Once blood counts are normal and the side effects of the transplant abate, the recipient is taken off **antibiotics** and usually no longer needs blood and platelet transfusions.

Following discharge from the hospital, the recipient is monitored through home visits by nurses or outpatient visits for up to a year. For the first several months out of the hospital, the recipient needs to be careful in avoiding potential infections. For example, contact with other people who may be ill should be avoided or kept to a minimum. Further blood transfusions and medications may be necessary, but barring complications, the recipient can return to normal activities about six to eight months after the transplant.

### Risks

The procedure has a lower success rate the greater the recipient's age. Complications are exacerbated for people whose health is already seriously impaired, as in late-stage cancers.

Bone marrow transplants are accompanied by serious and life-threatening risks. Furthermore, they are not always an absolute assurance of a cure for the underlying ailment; a disease may recur in the future.

Even in the absence of complications, the transplant and associated treatments are hard on the

recipient. Bone marrow transplants are debilitating. A person's ability to withstand the rigors of the transplant is a key consideration in deciding to use this treatment.

In the short term, there is the danger of **pneumonia** or other infectious disease, excessive bleeding, or liver disorder caused by blocked blood vessels. The transplant may be rejected by the recipient's immune system, or the donor bone marrow may launch an immune-mediated attack against the recipient's tissues. This complication is called acute graft-versus-host disease, and it can be a life-threatening condition. Characteristic signs of the disease include **fever**, rash, diarrhea, liver problems, and a compromised immune system.

Approximately 25%–50% of bone marrow transplant recipients develop long-term complications. Chronic graft-versus-host disease symptoms include skin changes, such as dryness, altered pigmentation, and thickening; abnormal **liver function tests**; **dry mouth** and eyes; infections; and weight loss. Other long-term complications include **cataracts** (due to radiation treatment), abnormal lung function, hormonal abnormalities resulting in reduced growth or **hypothyroidism**, secondary cancers, and **infertility**.

### Morbidity and mortality rates

Approximately 30% of people receiving allogeneic transplants do not survive. Autologous transplants have a much better survival rate—nearly 90%—but are not appropriate for all types of ailments requiring a bone marrow transplant. Furthermore, autologous transplants have a higher failure rate with certain diseases, specifically leukemia. At two years, the survival rate for patients with chronic myelogenous leukemia is 52% if they received a transplant in a chronic phase of their disease, 30% for patients in an accelerated phase, and 15% for patients in the blast phase.

### Normal results

In a successful bone marrow transplant, the donor's marrow migrates to the cavities in the recipient's bones and produces normal numbers of healthy blood cells. Bone marrow transplants can extend a person's life, improve quality of life, and may aid in curing the underlying ailment.

### Alternatives

Complementary therapies are used along with standard cancer treatments. These treatments are aimed at bringing about some overall improvement in general health and well being. Complementary therapies can be helpful in managing symptoms and improving quality of life. They can be used to help alleviate

**pain**; reduce nausea; strengthen muscles; and decrease depression, **anxiety**, and **stress**. It is important to distinguish between alternative therapies (unproven methods promoted for use instead of mainstream treatment) and complementary therapies, which are used along with, rather than instead of, standard treatment. Complementary therapies are noninvasive and soothing. However, before trying them, patients should check with their oncologist to make sure the complementary therapy will not interfere with standard cancer therapy or cause harm. Examples of complementary therapies are **massage therapy**, **aromatherapy**, **meditation**, **yoga**, **biofeedback**, music, art and dance therapies, and group and individual therapy or counseling.

Hormone therapy is the treatment of cancer by removing, blocking, or adding hormones. Hormones are chemical substances produced by glands in the body that enter the bloodstream and cause effects in other tissues. Hormone therapies may be used to treat breast and prostate cancers. Hormone therapy may also be used in some situations for other cancers.

Immunotherapy, also called biological therapy, is a type of treatment that uses the body's immune system to fight cancer. The therapy mainly consists of stimulating the immune system with highly purified proteins that help it do its job more effectively.

Radiation therapy is the use of high-energy x rays, electron beams, or radioactive isotopes to attack cancer. Radiation therapy causes cancer cell **death** by ionization or by damaging the chromosomes in the cancer cells so they cannot multiply. Radiation therapy is a local treatment aimed directly at the cancer. Even though the radiation is aimed only at the cancer, it must often pass through skin and other organs to reach the tumor. Thus, some healthy cells may become damaged, too. The body, however, is able to repair the healthy cells that have been damaged and restore them to their proper function. Aside from its use as a single treatment, radiation therapy has been shown to enhance the effects of chemotherapy. It can be used in combination with chemotherapy to shrink a tumor. Successful radiation therapy depends on delivering the proper amount of radiation to the cancer in the best, and most effective way.

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## ORGANIZATIONS

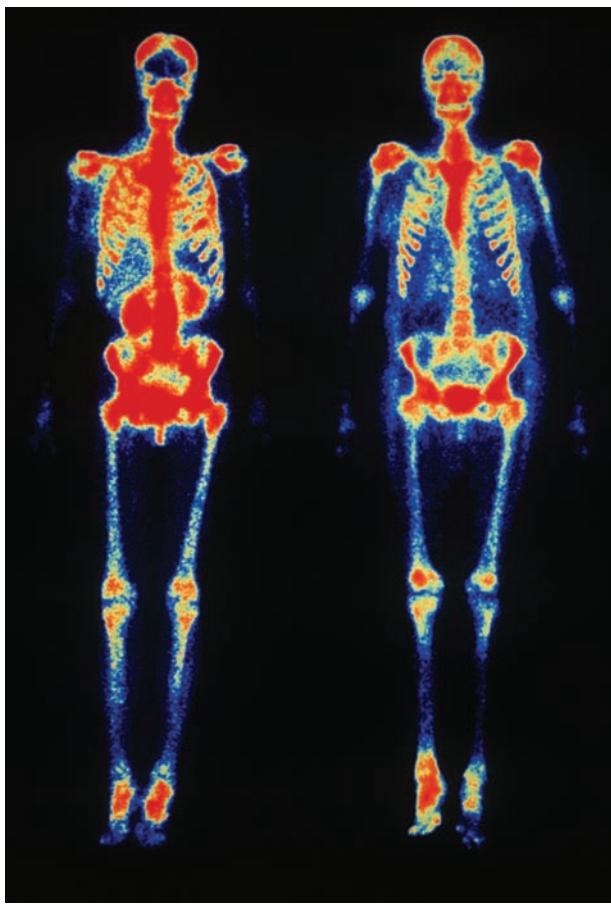
- American Cancer Society, 1599 Clifton Rd., NE, Atlanta, GA, 30329, (404) 320-3333, (800) ACS-2345 <http://www.cancer.org>.
- BMT Infonet (Blood and Marrow Transplant Information Network), 2900 Skokie Valley Road, Suite 104, Highland Park, IL, 60035, (847) 433-3313, (888) 597-7674, (847) 433-4599 [help@bmtinfonet.org](mailto:help@bmtinfonet.org), <http://www.bmtinfonet.org>.
- Leukemia & Lymphoma Society, 1311 Mamaroneck Avenue, Suite 310, White Plains, NY, 10605, (914) 949-5213, (800) 955-4572 <http://www.leukemia-lymphoma.org>.
- National Cancer Institute Public Inquires Office, 6116 Executive Boulevard, Room 3036A, Bethesda, MD, 20892-8322, (800) 4-CANCER, TTY (800) 332-8615, <http://www.cancer.gov>.
- National Marrow Donor Program, 3001 Broadway Street NE, Suite 100, Minneapolis, MN, 55413-1753, (800) MARROW-2 (627-7692) [patientinfo@nmdp.org](mailto:patientinfo@nmdp.org), <http://www.marrow.org>.

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## Bone scan

### Definition

A bone scan is a diagnostic procedure used to evaluate abnormalities involving bones and joints. A radioactive substance is injected intravenously, and the image of its distribution in the skeletal system is analyzed to detect certain diseases or conditions.



**Full body bone scan revealing cancer metastases.** (Scott Camazine & Sue Trainor/Science Source/Photo Researchers, Inc.)

## Purpose

Bone scans are most frequently ordered to check whether a **cancer** that originated elsewhere has spread to the bones. Cancers that begin in the breasts, kidneys, lungs, prostate, thyroid, or urinary bladder are most likely to spread, or metastasize, to the bones. If metastases are found, periodic bone scans may be ordered to see if therapy is effective against a cancer.

Some cancers arise in bone. These are called primary bone cancers. When an abnormality is found on an x ray of a bone, a bone scan may be helpful in deciding if it is a primary bone cancer, or a noncancerous (benign) condition.

Infection in the bone (**osteomyelitis**) can be detected or confirmed by a bone scan, often days or weeks before an x ray would reveal it. Bone scans are useful in diagnosing early arthritic changes, and monitoring both the progression of the disease and the effectiveness of treatment. Unexplained **pain** may be evaluated

## KEY TERMS

**Osteoarthritis**—A form of arthritis that occurs mainly in older people and involves the gradual degeneration of the cartilage of the joints.

**Osteomalacia**—A softening of bones caused by lack of vitamin D and/or calcium in the diet.

**Osteoporosis**—A condition found in older individuals in which bones decrease in density and become fragile and more likely to break. It can be caused by lack of vitamin D and/or calcium in the diet.

**Radioisotope**—A radioactive, or radiation-emitting form, of an element.

**Radiologist**—A medical doctor specially trained in radiology (x ray) interpretation and its use in the diagnosis of diseases and injuries.

**Radionuclide**—A substance that emits radiation as it disintegrates.

with a bone scan, because it can demonstrate **fractures** that are difficult to detect on x ray. Bone scans can be used to see if artificial joints have loosened or become infected. Suspected **child abuse** may be evaluated with a bone scan, due to its ability to show an overall pattern of repeated trauma. Abnormalities caused by altered circulation to the bone may be diagnosed with a bone scan.

## Precautions

Women who are pregnant or **breastfeeding** should not have this test. A patient who is unable to remain still for an extended period of time may require **sedation** for a bone scan.

## Description

This test is performed in a radiology facility, either in a hospital department or an outpatient x-ray center. The patient usually sits or lies down while a radioactive substance is injected through a vein in the arm. For a bone scan, the radionuclide used is specifically chosen to accumulate in the bone. The patient then waits from three to four hours for the substance to collect within the skeletal system. During this time, he or she will be instructed to drink several glasses of water. Patients are free to get up and move around as they desire during this waiting time, and should urinate frequently. Just before the scanning begins, the patient should empty his or her bladder again. This

ensures that a lot of radioactive material is not concentrated in the urinary bladder, which could obscure part of the pelvic bones.

During the scan, the patient lies on his or her back on a table, but may be repositioned to the stomach or side during the study. It is important for the patient not to move, except when directed to by the technologist.

The radionuclide scanner, sometimes called a gamma camera, or scintillation camera, is positioned against the body part to be examined. Either the camera, the table, or both, may change position during the study. For a total body bone scan, the patient is scanned from head to foot, over a period of 30–60 minutes. Patients should experience no discomfort from this examination.

A special kind of bone scan, called a SPECT (**single photon emission computed tomography**) scan, may be added to study a particular part of the body in more detail. Suspected diseases of the hips, lower back, or jaw are often evaluated using this study. It usually takes an additional 30–45 minutes. The camera circles completely around the area in question or multiple cameras are used to create a cross-sectional image. This helps pinpoint the location of the abnormality being evaluated.

The bone scan might be done in phases. The procedure is the same, except the scanning takes place immediately after the radioactive substance is injected, then again at set intervals to image how the radioactive tracer pools and distributes in the body and bone. For example, a two-phase bone scan for osteomyelitis may involve a scan about five minutes after injection, then about three hours later.

## Preparation

Some specialized blood studies should be drawn before this study is begun. Jewelry or metallic objects need to be removed. No other special physical preparation is required.

The patient should understand that there is no danger of radioactive exposure to themselves or others, as only small amounts of the radioisotope are used. The total dose of radiation absorbed is minimal, often less than the amount received from ordinary x rays. The radionuclide scanner does not emit any radiation at all, but detects and records it from the patient.

## Aftercare

Fluids are encouraged after the scan to aid in the excretion of the radioisotope. It is almost completely eliminated from the body within 24 hours. However, since increased airport security methods resulting from the September 11, 2001, attacks, isolated cases of

people who have had recent diagnostic nuclear medicine procedures setting off airport security systems have occurred. One state's Homeland Security Department has warned people having nuclear medicine procedures and flying soon afterward to bring adequate documentation of the procedure along to the airport.

## Normal results

The normal appearance of the scan will vary according to the patient's age. In general, a uniform concentration of radionuclide uptake is present in all bones in a normal scan.

## Abnormal results

A high concentration of radionuclide occurs in areas of increased bone activity. These regions appear brighter and may be referred to as "hot spots." They may indicate healing fractures, tumors, infections, or other processes that trigger new bone formation. Lower concentrations of radionuclide may be called "cold spots." Poor blood flow to an area of bone or bone destruction from a tumor may produce a cold spot.

The bone scan is a very sensitive test and can detect subtle conditions more readily than other studies. However, it is not a very specific examination, and often cannot distinguish exactly what disease process is causing an abnormality. Results need to be correlated with the patient's medical history and other radiologic and laboratory studies to make a definite diagnosis.

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American College of Radiology, 1891 Preston White Drive, Reston, VA, 20191, (703) 648-8900 <http://www.acr.org>.  
Radiological Society of North America (RSNA), 820 Jorie Blvd, Oak Brook, IL, 60523-2251, (630) 571-2670, (800) 381-6660, (630) 571-7837 <http://www.rsna.org>.

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Bone tumor see **Sarcomas**

## Bone x rays

### Definition

Bone x rays are a diagnostic test in which ionizing radiation passing through the bones being examined enables an image to be produced on film.

### Purpose

Bone x rays are ordered to detect disease or injury to the bone such as broken bones, tumors, and other problems. They can determine bone density, texture, erosion, and changes in bone relationships. Bone x rays also evaluate the joints for diseases such as **osteoarthritis**.

### Precautions

Precautions should be taken to protect patients from unnecessary exposure to radiation. Patients should be shielded with lead aprons as much as possible. Women of childbearing age who could be pregnant should not have x rays of their trunk or pelvic regions. The fetus is especially at risk during the first trimester of **pregnancy**. Women who are pregnant should not have x rays of their pelvic region, lumbar spine, and abdomen unless absolutely necessary. If other types of x rays are necessary, a lead apron should be used to shield the abdominal and pelvic regions.

### Description

X rays are a common diagnostic test in which a form of energy called x-ray radiation penetrates the patient's body. In bone x rays, electrical current passes through an x-ray tube and produces a beam of ionizing radiation that passes through the bone(s) being examined. This produces a picture of the inside of the body on film. The physician reads the developed x ray on a wall-mounted light box.

Digital x rays are a new type of x ray in which conventional equipment is used to take the x ray but the image is produced via computer. In a digital x ray, the image is created on a reusable plate. After being read by a laser reader, the information is sent in digital form to a storage unit connected to a computer network from which the radiologist reads the image. An electronic report can then be sent to the patient's physician.

Problems with bones that x rays can detect result from injury or from disease caused by a malfunction in the patient's bone chemistry. Bone injuries, especially broken bones (**fractures**), are common and can be accurately diagnosed by bone x rays. X rays are especially

### KEY TERMS

**Arthritis**—A disease of the joints that arises from wear and tear, age, and, less often, from inflammation.

**Osteogenesis imperfecta**—Also called brittle bones, this is a condition present at birth in which bones are abnormally fragile, brittle, and break easily.

**Osteomalacia**—A disease in which bones gradually soften and bend.

**Osteomyelitis**—An infection of the bone marrow and the bone.

**Osteoporosis**—A disease that occurs primarily in postmenopausal women in which the amount of bone is reduced or skeletal tissue wastes away.

**Paget's disease**—A disease, whose cause is unknown, that is generally found in older people. Symptoms include bone pain, bowed legs, curved spine, and broken bones. Another name for this disease is osteitis deformans.

helpful in diagnosing simple and incomplete fractures that can't be detected during a **physical examination**. X rays can also be used to check for bone position in a fracture. Some bone diseases can be definitively diagnosed with bone x rays while others require additional tests.

**Osteoporosis**, a common bone disease, can be detected in bone x rays but other tests are then ordered to determine the extent of the disease. For osteomalacia and **rickets**, a blood test and x rays of the affected bone are usually definitive; in some cases a **bone biopsy** (microscopic analysis of a small amount of tissue) is also done. In a rare bone disease called Paget's disease, x rays may be used in conjunction with bone, blood, and urine tests to make a diagnosis. In another rare bone disease, fibrous dysplasia, bone x rays or a bone biopsy (microscopic analysis of a small amount of tissue) are used to confirm the diagnosis. Bone x rays are definitive in diagnosing **osteogenesis imperfecta**. For **osteomyelitis**, bone x rays are used in conjunction with a blood test, **bone scan**, or needle biopsy to make the diagnosis. For arthritis, x rays of the bone are occasionally used in conjunction with blood tests. For bone tumors, bone x rays are helpful but they may not be definitive.

Bone x rays are performed by a technologist and interpreted by a radiologist. They are taken in a physician's office, radiology department, outpatient clinic, or diagnostic clinic. Bone x rays generally take less

than 10 minutes. There is no **pain** or discomfort associated with the test, but some people find it difficult to remain still. The results are often available in minutes.

During the test, the patient lies on a table. The technologist taking the x ray will check the patient's positioning and place the x-ray machine over the part of the body being examined. After asking the patient to remain motionless, the technologist steps out of the area and presses a button to take the picture.

## Preparation

The patient is asked to remove clothing, jewelry, and any other metal objects from the area being x rayed. If appropriate, a lead shield will be placed over other body parts to minimize exposure to radiation.

## Aftercare

The patient can immediately resume normal activities.

## Risks

The human body contains some natural radiation and is also exposed to radiation in the environment. There is a slight risk from exposure to radiation during bone x rays; however, the amount of radiation is small and the risk of harm is very low. If reproductive organs are exposed to radiation, genetic alterations may occur. Excessive or repeated doses of radiation can cause changes in other types of body tissue. No radiation remains in the body after the x ray.

## Normal results

Normal bones show no fractures, **dislocations**, or other abnormalities.

## Abnormal results

Results that indicate the presence of bone injury or disease differ in appearance according to the nature of the injury/disease. For example, fractures show up as clear breaks in the bones, while osteoporotic bone has the same shape as a normal bone on an x ray but is less dense. Even though a bone x ray may not show definite results, it often is the first imaging choice, to be followed up by another imaging technique such as **magnetic resonance imaging** (MRI). Bone x rays are still the easiest way to show a typical bone fracture and to check on healing of broken bones.

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## Borderline personality disorder

### Definition

Borderline personality disorder (BPD) is a mental disorder characterized by disturbed and unstable interpersonal relationships and self-image, along with impulsive behavior, unstable mood, and suicidal behavior.

### Demographics

Borderline personality disorder accounts for 30%–60% of all **personality disorders** and is present in approximately 2% of Americans. About 20% of all psychiatric hospitalizations are due to the disorder. Women are affected more frequently than men; as many as 80% of patients are female. Young women are the most frequently affected group. BPD usually is initially diagnosed in young adults, and is rarely first diagnosed in individuals over age 40.

### Description

Individuals with BPD have a history of unstable interpersonal relationships. They have difficulty interpreting reality and view significant people in their lives as either completely flawless or extremely unfair and uncaring, a phenomenon known as "splitting." These alternating feelings of idealization and devaluation are one major feature of borderline personality disorder. Because borderline patients set up excessive and unrealistic expectations for others, they are inevitably disappointed when their expectations are not realized.

The term "borderline" was originally used by psychologist Adolf Stern in the 1930s to describe patients whose condition bordered somewhere between **psychosis** and neurosis, although today, the term "borderline" used in this sense is considered a misnomer. The term is better used in describing the borderline states of consciousness these patients sometimes feel when they experience dissociative symptoms (a feeling of disconnection from oneself). The syndrome itself is considered a complex disorder, rather than one lying on a border between psychosis and neurosis.

**Borderline personality disorder**

**Diagnostic criteria for borderline personality disorder**

**Affective (mood-related) symptoms**

1. Unstable mood caused by brief but intense episodes of depression, irritability, or anxiety
2. Chronic feelings of emptiness
3. Inappropriate and intense anger or difficulty controlling anger

**Impulsive symptoms**

4. Impulsive behavior in at least two areas (e.g., spending money, substance abuse, binge eating)
5. Recurrent suicidal behavior, gestures, or threats, or recurring acts of self-mutilation
6. Pattern of unstable and intense interpersonal relationships

**Interpersonal symptoms**

7. Extreme, persistently unstable perception of self
8. Frantic efforts to avoid abandonment

**Cognitive symptoms**

9. Stress-related paranoia and/or feeling disconnected from oneself

*The Diagnostic and Statistical Manual of Mental Disorders states that the presence of five or more symptoms is necessary to diagnose BPD.*

**Diagnostic criteria for borderline personality disorder according to the *Diagnostic and Statistical Manual of Mental Disorders (DSM IV)*.** (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

### Risk factors

The National Institute of Mental Health reports that studies have found between 40% and 71% of individuals diagnosed with BPD report being sexually abused as children, most often by an individual who was not their primary caregiver. Many individuals with BPD report some kind of traumatic event in childhood such as **abuse**, separation, or abandonment. This, of course, is not true of every individual with BPD, and many individuals who experience traumatic childhood events will not develop the disorder. Abuse is considered a risk factor, but it is an environmental contributor thought to interact with inherited traits. Twin studies suggest that at least some features of this disorder are highly heritable. Mood instability and impulsivity are about 50% heritable, and studies of BPD specifically suggest a similar level of heritability. The root biological cause may be disruptions in signaling pathways involving serotonin, a nerve-signaling molecule, but more studies are necessary to confirm the biological basis of BPD. BPD has not been found to be related to race; it is believed to occur about as commonly in all races and ethnicities.

### Causes and symptoms

The feelings of inadequacy and self-loathing that arise from situations of abuse or neglect may contribute to the development of a borderline personality. It has also been theorized that these patients try to compensate for the care they were denied in childhood through the idealized demands they now make on themselves and on others as adults.

The handbook used by mental health professionals to diagnose mental disorders is the *Diagnostic and Statistical Manual of Mental Disorders* fourth edition, text revised (*DSM-IV-TR*). Published by the American Psychiatric Association, it contains diagnostic criteria, research findings, and treatment information for mental disorders. It is the primary reference for mental health professionals in the United States. BPD was first listed as a disorder in the third edition *DSM-III*, which was published in 1980.

The *DSM-IV-TR* requires that at least five of the following symptoms be present in an individual for a diagnosis of BPD, although some researchers suggest

## KEY TERMS

**Bipolar disorder**—Formerly called manic depressive disorder. A mood disorder characterized by alternating periods of overconfidence and activity (manic highs) and depressive lows.

**Cognitive-behavioral therapy**—A type of psychotherapy in which people learn to recognize and change negative and self-defeating patterns of thinking and behavior.

**Depression**—A mental condition in which a person feels extremely sad and loses interest in life. A person with depression may also have sleep problems and loss of appetite and may have trouble concentrating and carrying out everyday activities. Severe depression may instigate a suicide attempt.

**Dialectical behavior therapy**—A type of cognitive-behavioral therapy designed specifically to treat borderline personality disorder.

that criteria from each of three dimensions (groupings) should actually be met.

### DIMENSION: AFFECTIVE (MOOD-RELATED) SYMPTOMS.

- Unstable mood caused by brief but intense episodes of depression, irritability, or anxiety. These episodes generally are much briefer than the highs and lows of bipolar disorder. The strongest tendency is to have outbursts of anger. The level of mood instability can be a strong predictor of whether suicide will be attempted.
- Chronic feelings of emptiness.
- Inappropriate and intense anger or difficulty controlling anger displayed through temper outbursts, physical fights, and/or sarcasm.

### DIMENSION: IMPULSIVE SYMPTOMS.

- Impulsive behavior in at least two areas (e.g., spending, sex, substance abuse, reckless driving, binge eating).
- Recurrent suicidal behavior, gestures, or threats, or recurring acts of self-mutilation (e.g., cutting or burning oneself). This behavior results from the combination of impulsivity and rapidly and intensely changeable mood.
- Pattern of unstable and intense interpersonal relationships, characterized by alternating between idealization and devaluation (“love-hate” relationships).

### DIMENSION: INTERPERSONAL SYMPTOMS.

- Extreme, persistently unstable self-image and sense of self.
- Frantic efforts to avoid real or perceived abandonment.

In addition, there is a cognitive criterion for diagnosis that includes stress-related **paranoia** that passes fairly quickly and/or severe dissociative symptoms—feeling disconnected from oneself, as if one is an observer of one’s own actions. Studies have found that as many as 40% of patients with BPD reported having semi-psychotic thoughts, and that the presence of psychotic symptoms can be a predictor of self-harm in patients who have personality disorders.

Some patients with BPD are mistakenly diagnosed with **bipolar disorder** or with **schizophrenia**. BPD can be distinguished from bipolar disorder based on the brevity of the extreme mood swings, which typically last only hours rather than days or weeks. In spite of the fact that auditory **hallucinations** can occur in people with BPD, it is distinguished from schizophrenia because the patient with BPD knows the hallucinations are not real, whereas the patient with schizophrenia does not.

## Diagnosis

Borderline personality disorder typically first appears in early adulthood, with the usual age of onset around 18 years. Although the disorder may occur in adolescence, it may be difficult to diagnose, since borderline symptoms such as impulsive and experimental behaviors, insecurity, and mood swings are common—even developmentally appropriate—occurrences at this age.

Assessment is based first on determination of whether the person meets at least five of the nine *DSM-IV-TR* criteria. The next step typically involves completion of a personality assessment, which involves interviewing the patient but also can involve talking with the patient’s family members or friends, with the patient’s agreement. Last, the symptoms of BPD that suggest the diagnosis must have been present consistently over time.

Borderline symptoms also may be the result of chronic **substance abuse** and/or medical conditions (specifically, disorders of the central nervous system). These should be ruled out before making the diagnosis of borderline personality disorder.

BPD commonly occurs with **mood disorders** (e.g., depression, **anxiety**), **post-traumatic stress disorder** (PTSD), **eating disorders**, and attention deficit/hyperactivity disorder (ADHD). Another accompanying health problem may be a substance abuse disorder. It has also been suggested by some researchers that borderline personality disorder is not a true pathological condition in and of itself, but rather a number of overlapping personality disorders; it is, however,

commonly recognized as a separate and distinct disorder by the American Psychiatric Association and by most mental health professionals.

## Treatment

Individuals with borderline personality disorder seek psychiatric help and hospitalization at a much higher rate than people with other personality disorders, probably because of their fear of abandonment and their need to seek idealized interpersonal relationships. These patients represent the highest percentage of diagnosed personality disorders.

### Traditional

Providing effective therapy for the borderline personality patient is a necessary, but difficult, challenge. The therapist-patient relationship is subject to the same inappropriate and unrealistic demands that borderline personalities place on all their significant interpersonal relationships. Individuals with BPD often are chronic treatment seekers who become easily frustrated with their therapist if they feel they are not receiving adequate attention or empathy, and symptomatic anger, impulsivity, and self-destructive behavior can impede the therapist-patient relationship. However, their fear of abandonment and of ending the therapy relationship may cause them to discontinue treatment as soon as progress is made.

**Psychotherapy**, typically in the form of **cognitive-behavioral therapy**, usually is the treatment of choice for borderline personalities. Dialectical behavior therapy (DBT), a cognitive-behavioral technique, has emerged as an effective therapy for borderline personalities with suicidal tendencies. The treatment focuses on giving the borderline patient self-confidence and coping tools for life outside of treatment through a combination of social skills training, mood-awareness, meditative exercises, and education about the disorder. **Group therapy** also is an option for some borderline patients, although some may feel threatened by the idea of "sharing" a therapist with others.

### Drugs

Medication is not considered a first-line treatment choice but may be useful in treating some symptoms of the disorder and/or the mood disorders that often are diagnosed in conjunction with BPD. Some patients with BPD may find themselves taking several different medications, each designed to address one of the main manifestations of BPD, but there are no data from clinical trials supporting such a regimen.

## Prognosis

The disorder usually peaks in young adulthood and frequently stabilizes after age 30. In many cases symptoms improve by later adulthood, especially by around age 40. Individuals with BPD are at a very high risk of attempting **suicide**. Estimates vary widely, but some studies have found that as many as 80% of individuals with BPD attempt suicide at least once, and as many as 10% of individuals with BPD complete a suicide attempt. Managing this highly prevalent suicidality is one of the greatest therapeutic challenges in BPD. The behavior usually peaks when the patient is in the mid-20s, but most of the completed suicides actually occur among patients older than 30 years, most often in patients who have experienced no recovery after many treatment attempts. If the borderline patient also has been diagnosed with a depressive disorder, the risk of suicide is much higher. For this reason, swift diagnosis and appropriate interventions are critical. Self-harming behaviors are generally not considered to be attempted suicide but instead serve as a relief from an extreme emotional state.

## Prevention

There is no known way to successfully prevent borderline personality disorder. It is believed to have a complex set of causes, all of which are likely required to be present for the disorder to develop. Prompt treatment can help in preventing serious symptoms of the disorder from getting worse. Prompt, appropriate treatment also is crucial in helping to prevent suicide and suicide attempts.

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## ORGANIZATIONS

- Mental Health America, 2000 N. Beauregard St., 6th Floor, Alexandria, VA, 22311, (703) 684-7722, (800) 969-6642, (703) 684-5968 <http://www.nmha.org>.
- National Education Alliance for Borderline Personality Disorder, PO Box 974, Rye, NY, 10580, info@borderlinepersonalitydisorder.com, <http://www.borderlinepersonalitydisorder.com>.
- Treatment and Research Advancements, National Association for Personality Disorder, 23 Greene Street, New York, NY, 10013, (212) 966-6514, <http://www.tara4bpd.org>.

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*Bordetella pertussis* infection see **Whooping cough**

*Borrelia burgdorferi* infection see **Lyme disease**

Botanical medicine see **Herbalism, western**

Botox injections see **Botulinum toxin injections**

## KEY TERMS

**Antibodies**—A protein developed in response to the presence of a foreign substance.

**Antigen**—A foreign substance inducing an antibody response within the body.

**Immunoresistance**—The presence of circulating antibodies.

**Neuromuscular junction**—Interface between motor nerve ending and muscle tissue.

**Serotype**—Microorganisms differing in the type of surface antigens.

the FDA. The application of the therapy seems to be growing continuously beyond its more popularly known cosmetic uses.

### Precautions

Botulinum toxin is produced from the bacterium that causes **food poisoning** in humans. High doses of the toxin can be fatal; however, doses administered therapeutically are so small that harmful effects are uncommon.

### Description

The number of potential applications for botulinum toxin extends to every muscle group. The first therapeutic use of Botox was in the treatment of **strabismus** (eyes are unable to direct toward the same object) and since then it has been used to treat a variety of involuntary muscle contractions or disorders. Its cosmetic use is the result of treatment for facial spasms where smoothing of facial lines was reported by patients. In general, 90% of injections for facial spasms are resolved satisfactorily.

Toxin type A has a duration of effect that lasts approximately three months and is the therapeutic agent of choice for most conditions.

### Preparation

The dosage of Botox must be monitored and adjusted, with multiple injections showing a lower incidence of complications versus administration by one larger dose.

### Risks

In over 30 years of therapeutic use in humans, botulinum toxin has proven to be remarkably safe. Some difficulties associated with administration of

toxin are that different patients may experience different effects at the same dose, patients new to the treatment may experience exaggerated effects at subsequent visits, and neighboring muscles may become activated at subsequent treatments. Patients should ask about their provider's experience with injecting Botox before receiving the procedure.

Additional side effects may include excessive muscle weakness at the injection site or adjacent muscles. These effects typically resolve quickly. Occasionally, patients report flu-like symptoms but they are usually self-limited.

A certain percentage of patients may also experience resistance to the toxin. The presence of circulating antibodies to the toxin is presumed to be the primary reason for resistance to Botox injections. Patients who have little reaction to Botox A may benefit from injections using one of the other six serotypes. Using the smallest effective dose limits the likelihood of immunoresistance in unresponsive patients.

### Normal results

The anticipated outcome of Botox injections is relaxation of the target muscle tissue. The pharmacological effects of botulinum toxin are typically isolated to local areas and do not result in tissue destruction or prolonged **paralysis**. Varying the dose can deliver a precise amount of toxin to achieve graded degrees of paralysis for the desired level of response.

### Abnormal results

Most side effects, such as weakness in the injected muscle or overall muscle soreness, will go away quickly. Some patients have received too much of the substance when having Botox for cosmetic purposes and have been unhappy with the results. Physicians and patients should discuss the procedure and the amount to be used. Many clinicians believe that it is best to err on the side of low dosage with a return trip for more, rather than too high a dosage that might result in unwanted cosmetic effects.

### Resources

#### BOOKS

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## Botulism

### Definition

Botulism is caused by botulinum toxin, a natural poison produced by certain bacteria in the *Clostridium* genus. Exposure to the botulinum toxin occurs mostly from eating contaminated food, or in infants, from certain clostridia growing in the intestine. Botulinum toxin blocks the motor nerves' ability to release acetylcholine, the neurotransmitter that relays nerve signals to muscles, and flaccid **paralysis** occurs. As botulism progresses, the muscles that control the airway and breathing fail.

### Description

Botulism occurs rarely, but it causes concern because of its high fatality rate. Clinical descriptions of botulism possibly reach as far back in history as ancient Rome and Greece. However, the relationship between contaminated food and botulism wasn't defined until the late 1700s. In 1793 the German physician Justinus Kerner deduced that a substance in spoiled sausages, which he called *wurstgift* (German for sausage poison), caused botulism. The toxin's origin and identity remained elusive until Emile von Ermengem, a Belgian professor, isolated *Clostridium botulinum* in 1895 and identified it as the poison source.

Three types of botulism have been identified: food-borne, wound, and infant botulism. The main difference between types hinges on the route of exposure to the toxin. In the United States, there are approximately 110 cases of botulism reported annually. Food-borne botulism accounts for 25% of all botulism cases and usually can be traced to eating contaminated home-preserved food. Infant botulism accounts for 72% of all cases, but the recovery rate is good (about 98%) with proper treatment. From 1990

## KEY TERMS

**Acetylcholine**—A chemical released by nerve cells to signal other cells.

**Antitoxin**—A substance that inactivates a poison (e.g., toxin) and protects the body from being injured by it.

**CT scan**—The abbreviated term for computed or computerized axial tomography. The test may involve injecting a radioactive contrast into the body. Computers are used to scan for radiation and create cross-sectional images of internal organs.

**Electromyography test**—A medical test that determines a muscle's response to electrical stimuli. The test results allow medical personnel to assess how nerves to the muscle are functioning.

**Flaccid paralysis**—Paralysis characterized by limp, unresponsive muscles.

**Lumbar puncture**—A procedure in which a small amount of cerebrospinal fluid is removed from the lower spine. Examination of this fluid helps diagnose certain illnesses.

**MRI**—The abbreviated term for magnetic resonance imaging. MRI uses a large circular magnet and radio waves to generate signals from atoms in the body. These signals are used to construct images of internal structures.

**Neurotransmitter**—A chemical found in nerves that relays nerve signals to other cells. Acetylcholine is a neurotransmitter.

**Sepsis**—The presence of infection-causing organisms or associated toxins in the blood or within body tissues.

**Spores**—A state of “suspended animation” that some bacteria can adopt when conditions are not ideal for growth. Spores are analogous to plant seeds and can germinate into growing bacteria when conditions are right.

**Toxin**—A poisonous substance produced by a microorganism, plant, or animal.

**Tracheostomy**—The procedure used to open a hole in the neck to the trachea, or windpipe. It is sometimes used in conjunction with a respirator.

to 2000, 263 cases of food-borne cases were reported in the United States, most of them in Alaska. Though most were related to home canning, two restaurant-associated outbreaks affected 25 people.

Though domestic **food poisoning** is a problem worldwide, there has been a growing concern regarding the use of botulism toxin in biological warfare and terrorist acts. The Iraqi government admitted in 1995 that it had loaded 11,200 liters of botulinum toxin into SCUD missiles during the Gulf War. Luckily, these special missiles were never used. There are 17 countries known to be developing biological weapons, including the culture of botulism toxins.

### Causes and symptoms

Toxin produced by the bacterium *Clostridium botulinum* is the main culprit in botulism. Other members of the *clostridium* genus can produce botulinum toxin, namely *C. argentinense*, *C. butyricum*, and *C. baratii*, but they are minor sources. To grow, these bacteria require a low-acid, oxygen-free environment that is warm (40–120°F or 4.4–48.8°C) and moist. Lacking these conditions, the bacteria transform themselves into spores that, like plant seeds, can remain dormant for years. Clostridia and their spores exist all over the

world, especially in soil and aquatic sediments. They do not threaten human or animal health until the spores encounter an environment that favors growth. The spores then germinate, and the growing bacteria produce the deadly botulism toxin.

Scientists have discovered that clostridia can produce at least seven types of botulism toxin, identified as A, B, C, D, E, F, and G. Humans are usually affected by A, B, E, and very rarely F. Domesticated animals such as dogs, cattle, and mink are affected by botulism C toxin, which also affects birds and has caused massive die-offs in domestic bird flocks and wild waterfowl. Botulism D toxin can cause illness in cattle, and horses succumb to botulism A, B, and C toxin. There have been no confirmed human or animal botulism cases linked to the G toxin.

In humans, botulinum toxin latches onto specific proteins in nerve endings and irreversibly destroys them. These proteins control the release of acetylcholine, a neurotransmitter that stimulates muscle cells. With acetylcholine release blocked, nerves are not able to stimulate muscles. Ironically, botulinum toxin has found a beneficial niche in the world of medicine due to this action. Certain medical disorders are characterized by involuntary and uncontrollable muscle contractions.

Medical researchers have discovered that injecting a strictly controlled dose of botulinum toxin into affected muscles inhibits excessive muscle contractions. The muscle is partially paralyzed and normal movement is retained. This is commonly referred to as Botox injection.

The three types of human botulism include the following symptoms:

- Food-borne. Food that has been improperly preserved or stored can harbor botulinum toxin-producing clostridia. Botulism symptoms typically appear within 18–36 hours of eating contaminated food, with extremes of four hours to eight days. Initial symptoms include blurred or double vision and difficulty swallowing and speaking. Possible gastrointestinal problems include constipation, nausea, and vomiting. As botulism progresses, the victim experiences weakness or paralysis, starting with the head muscles and progressing down the body. Breathing becomes increasingly difficult. Without medical care, respiratory failure and **death** are very likely.
- Infant. Infant botulism was first described in 1976. Unlike adults, infants younger than 12 months are vulnerable to *C. botulinum* colonizing the intestine. Infants ingest spores in honey or simply by swallowing spore-containing dust. The spores germinate in the large intestine and, as the bacteria grow, they produce botulinum toxin that is absorbed into the infant's body. The first symptoms include constipation, lethargy, and poor feeding. As infant botulism progresses, sucking and swallowing (thus eating) become difficult. A nursing mother will often notice breast engorgement as the first sign of her infant's illness. The baby suffers overall weakness and cannot control head movements. Because of the flaccid paralysis of the muscles, the baby appears "floppy." Breathing is impaired, and death from respiratory failure is a very real danger.
- Wound. Confirmed cases of wound botulism have been linked to trauma such as severe crush injuries to the extremities, surgery, and illegal drug use. Wound botulism occurs when clostridia colonize an infected wound and produce botulinum toxin. The symptoms usually appear four to 18 days after an injury occurs and are similar to food-borne botulism, although gastrointestinal symptoms may be absent.

## Diagnosis

Diagnosis of botulism can be tricky because symptoms mimic those presented by other diseases. Botulism may be confused with Guillain-Barre syndrome, **myasthenia gravis**, drug reactions, **stroke**, or

nervous system infection, intoxications (e.g. carbon monoxide or atropine), or shellfish poisoning. **Sepsis** is the most common initial diagnosis for infant botulism. **Failure to thrive** may also be suspected. Some reports have linked infant botulism to 5–15% of **sudden infant death syndrome** (SIDS, crib death) cases. Laboratory tests are used for definitive diagnosis, but if botulism seems likely, treatment starts immediately.

While waiting for laboratory results, doctors ask about recently consumed food and work to dismiss other disease possibilities. A **physical examination** is done with an emphasis on the nervous system. As part of this examination, CT scans, MRIs, electromyographic tests, or lumbar punctures may be ordered. Laboratory tests involve testing a suspected food and/or the patient's serum, feces, or other specimens for traces of botulinum toxin or clostridia.

## Treatment

### Drugs

Adults with botulism are treated with an antitoxin derived from horse serum that is distributed by the Centers for Disease Control and Prevention. The anti-toxin (effective against toxin types A, B, and E) inactivates only the botulinum toxin that is unattached to nerve endings. Early injection of antitoxin (usually within 24 hours of onset of symptoms) can preserve nerve endings, prevent progression of the disease, and reduce mortality.

Infants, however, cannot receive the antitoxin used for adults. For them, human botulism immune globulin (BIG) is available in the United States through the Infant Botulism Treatment and Prevention Program in Berkeley, California. BIG neutralizes toxin types A, B, C, D, and E before they can bind to nerves. This antitoxin can provide protection against A and B toxins for approximately four months. Though many infants recover with supportive care, BIG cuts hospital stay in half, and therefore reduces hospital costs by 50% as well.

Aside from antitoxin, no drugs are used to treat botulism. **Antibiotics** are not effective for preventing or treating botulism. In fact, antibiotic use is discouraged for infants because dying bacteria could potentially release more toxin into a baby's system. Antibiotics can be used, however, to treat secondary respiratory tract and other infections.

### Respiratory support

Treatment for infants usually involves intensive respiratory support and tube feeding for weeks or even months. Once an infant can breathe unaided, **physical therapy** is initiated to help the child relearn

how to suck and swallow. A respirator is often required to help adult patients breathe, and a tracheostomy may also be necessary.

### Surgery

Surgery may be necessary to clean an infected wound and remove the source of the bacteria that is producing the toxin. Antimicrobial therapy may be necessary.

### Gastric lavage

When botulism is caused by food, it often is necessary to flush the gastrointestinal tract (gastric lavage). Often cathartic agents or **enemas** are used. It is important to avoid products that contain magnesium, since magnesium enhances the effect of the toxin.

### Prognosis

With medical intervention, botulism victims can recover completely, though slowly. It takes weeks to months to recover from botulism, and severe cases can take years before a total recovery is attained. Recovery depends on the nerve endings building new proteins to replace those destroyed by botulinum toxin.

### Prevention

Vaccines against botulism do not exist to prevent infant botulism or other forms of the disease. However, scientists announced in 2004 that they had successfully vaccinated mice and ducks against type C and D, which may help lead to vaccines for humans. Food safety is the surest prevention for botulism. Botulinum toxin cannot be seen, smelled, or tasted, so the wisest course is to discard any food that seems spoiled *without tasting it*. Home canners must be diligent about using sterile equipment and following U.S. Department of Agriculture canning guidelines. If any part of a canned food container is rusty or bulging, the food should not be eaten. Infant botulism is difficult to prevent, because controlling what goes into an infant's mouth is often beyond control, especially in regard to spores in the air. One concrete preventive is to never feed honey to infants younger than 12 months since it is one known source of botulism spores. As infants begin eating solid foods, the same food precautions should be followed as for adults.

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Bovine spongiform encephalopathy see  
**Creutzfeldt-Jakob disease**

Bowel incontinence see **Fecal incontinence**

## Bowel preparation

### Definition

Bowel preparation is a procedure usually undertaken before a diagnostic procedure or treatment can be initiated for certain colorectal diseases. Bowel preparation is a cleansing of the intestines from fecal matter and secretions.

### Purpose

The ultimate goal of bowel preparation is to empty and cleanse the bowel for a diagnostic procedure (using x rays to detect a disease process in the intestines) or for surgical intervention (such as removal of polyps, **cancer**, or narrowing of the intestinal diameter). **Colonoscopy** is an effective treatment procedure for polyps (a growing mass of tissue). This procedure enables the doctor to visualize the entire large bowel. During a colonoscopy, polyps can be cauterized (applying an electric current that incinerates the polyp). The procedure can be both diagnostic and therapeutic. A **sigmoidoscopy** scope is a flexible tube that allows clinicians to view the sigmoid colon (the part of the large intestine before the rectum). This procedure is important for detection of colorectal cancer. It is safe, quick to perform (usually 30–45 minutes in about 90% of cases), and an effective diagnostic tool for evaluation of:

- rectal bleeding
- other abnormalities detected by imaging studies
- removal of polyps
- biopsy
- evaluation of chronic diarrhea or inflammatory bowel disease
- recurrences of colorectal cancer or polyps
- relieving a twisted bowel

## KEY TERMS

**Lesion**—An abnormal change in tissues.

**Polyp**—A growing mass of tissue.

- foreign body removal
- treating bleeding lesions
- preventive surveillance of cancer in patients with a positive family history of colon cancer

### Precautions

Antibiotic **prophylaxis** is not routinely recommended. In some cases of prosthetic heart valves, **antibiotics** can be prescribed. Evidence exists that evacuation of intestinal waste products in conjunction with antibiotics before (prophylactic) the procedure reduces the possibility of **sepsis** (infection which spreads from the primary site to blood).

### Description

The bowel is emptied of any contents for such procedures as **barium enema** (introducing a compound containing barium to promote better visualization of intestines during x rays) or colonoscopy. Preparation of the bowel distally—from the rectum—is necessary for such diagnostic procedures as sigmoidoscopy. Bowel emptying is done through taking oral laxative solutions that speed up the excretion of the contents of the lower bowel together with restrictions on solid food intake.

A newer type of imaging study may eventually make current laxative methods of bowel preparation obsolete. According to a group of researchers in the United Kingdom, computed tomography (CT) colonography (sometimes called virtual colonoscopy) has shown itself to be as accurate in diagnosing colorectal tumors as optical colonoscopy. CT colonography allows a radiologist to examine the colon and nearby organs in less than 30 seconds.

### Preparation

Bowel preparation for visualization of the colon is performed to ensure the procedure will be accurate and complete. There are several effective cleansing preparations including polyethylene glycol solution (Colyte), **sodium** phosphate solution (Phospho-Soda), magnesium citrate with bisacodyl tablets, and castor oil with bisacodyl tablets. One of these preparations should be administered starting at 4:00 p.m. the day before the procedure. Patients are usually asked to avoid solid

foods for about 36 hours before diagnostic procedures. Such clear liquids as vegetable or beef broth, apple or white grape juice, soda pop, or fruit-flavored gelatin are permitted, although some doctors ask patients to avoid red-colored beverages or gelatin flavors on the grounds that the red food coloring in these products may make bleeding more difficult to detect.

In most cases, patients may continue to take other prescription medications at the usual times while they are restricted to clear liquids. It is a good idea, however, to check with the doctor beforehand.

### Aftercare

Patients should have a friend or relative to drive them home after the procedure, as the combination of a period of dietary restriction, frequent bowel movements, and the procedure itself leaves most people feeling tired and slightly weak. Many doctors advise patients to postpone vigorous physical activity or work requiring mental concentration until the day after the procedure. Patients can resume eating solid foods as soon as they get home.

Some patients may notice a small amount of blood on toilet tissue or underwear following a colonoscopy or other examination of the lower digestive tract. Spotting is not cause for concern; however, patients who have steady or heavy bleeding from the rectum should call their doctor as soon as possible.

### Risks

The current standard of care dictates that patients receive antibiotic prophylaxis if they are at increased risk of developing an infection. High-risk patients include those with cardiac diseases or patients with prostheses.

Bowel preparation can be stressful for some patients, particularly those with pre-existing nutritional problems associated with cancer treatment or malabsorption. In addition, many patients find the various oral solutions unpleasant to the taste and difficult to swallow for that reason. According to one British study, oral solutions flavored with lemon are more acceptable to patients than unflavored forms. Both Colyte and Phospho-Soda are available with flavoring added; patients may wish to ask their pharmacist for these specific products. Mild **nausea**, **vomiting**, stomach cramps, intestinal gas, **dry mouth**, and increased thirst are common side effects of these products. Some patients are helped by taking an electrolyte supplement along with oral sodium phosphate solution to lower the risk of **dehydration**.

Some people may have severe allergic reactions to commonly used oral **laxatives** used for bowel preparation. Patients who develop **hives**, swelling of the face or hands, swelling or **tingling** in the throat or mouth, difficulty breathing, or tightness in the chest should call their doctor *at once*. This type of reaction is a medical emergency.

### Normal results

Absence of anatomical changes or abnormalities in the intestines would result in normal diagnosis.

### Abnormal results

Polyps can be treated with electrocautery. A biopsy is taken of any suspicious polyps and further analyzed. Sigmoidoscopy can detect masses, bleeding, and ulcerative disease.

### Resources

#### BOOKS

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#### ORGANIZATIONS

American College of Gastroenterology, P. O. Box 342260, Bethesda, MD, 20827-2260, (301) 263-9000, <http://www.acg.gi.org>.

American Society of Health-System Pharmacists (ASHP), 7272 Wisconsin Avenue, Bethesda, MD, 20814, (301) 657-3000, (866) 279-0681, <http://www.ashp.org>.

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## Bowel resection

### Definition

A bowel resection is a surgical procedure in which a part of the large or small intestine is removed.

### Purpose

Bowel resection may be performed to treat various disorders of the intestine, including **cancer**, obstruction, inflammatory bowel disease, ruptured diverticulum, **ischemia** (compromised blood supply), or traumatic injury.

### Description

The preferred type of bowel resection involves removal of the diseased portion of intestine, and surgically rejoining the remaining ends. In this procedure, the continuity of the bowel is maintained and normal passage of stool is preserved. When deemed necessary by the surgeon, the diseased portion of the bowel may be removed, and the functioning end of the intestine may be brought out onto the surface of the abdomen, forming a temporary or permanent **ostomy**. Use of the large intestine to form the ostomy results in a **colostomy**; use of small intestine to form the ostomy results in an ileostomy.

### Preparation

As with any surgical procedure, the patient will be required to sign a consent form after the procedure is explained thoroughly. Blood and urine studies, along with various x rays and an electrocardiogram (EKG) may be ordered as the doctor deems necessary. In order to empty and cleanse the bowel, the patient may be placed on a low-residue diet for several days prior to surgery. A liquid diet may be ordered for at least the day before surgery, with nothing taken by mouth after midnight. A series of **enemas** and/or oral preparations (GoLyte or Colyte) may be ordered to empty the bowel of stool. Oral anti-infectives (neomycin, erythromycin, or kanamycin sulfate) may be ordered to decrease bacteria in the intestine and help prevent post-operative infection. A nasogastric tube is inserted through the nose into the stomach on the day of surgery or during surgery. This removes the gastric secretions and prevents **nausea and vomiting**. A urinary catheter (thin tube inserted into the bladder) may also be inserted to keep the bladder empty during surgery, giving more space in the surgical field and decreasing chances of accidental injury.

### Aftercare

Post-operative care for the patient who has had a bowel resection, as with those who have had any major surgery, involves monitoring of blood pressure, pulse, respirations, and temperature. Breathing tends to be shallow because of the effect of anesthesia and the patient's reluctance to breathe deeply and experience

## KEY TERMS

**Diverticulum**—Small tubes or pouches that project off the wall of the intestine, visible as opaque on an x ray after the patient has swallowed a contrast (dye) substance.

**Embolism**—Blockage of a blood vessel by any small piece of material traveling in the blood. The

emboli may be caused by germs, air, blood clots, or fat.

**Ischemia**—A compromise in blood supply to body tissues that causes tissue damage or death.

**Ostomy**—A surgically created opening in the abdomen for elimination of waste products (urine or stool).

**pain** that is caused by the abdominal incision. The patient is instructed how to support the operative site during deep breathing and coughing, and is given pain medication as necessary. Fluid intake and output is measured, and the operative site is observed for color and amount of wound drainage. The nasogastric tube will remain in place, attached to low intermittent suction until bowel activity resumes. Fluids and electrolytes are infused intravenously until the patient's diet can gradually be resumed, beginning with liquids and advancing to a regular diet as tolerated. The patient is generally out of bed approximately eight to 24 hours after surgery. Postoperative weight loss follows almost all bowel resections. Weight and strength are slowly regained over a period of months.

### Risks

Potential complications of this abdominal surgery include:

- excessive bleeding
- surgical wound infection
- incisional hernia (an organ projects through the muscle wall that surrounds it, and the hernia occurs through the surgical scar)
- thrombophlebitis (inflammation and blood clot in veins in the legs)
- pneumonia
- pulmonary embolism (blood clot in the lungs)

### Normal results

Complete healing is expected without complications after bowel resection. The period of time required for recovery from the surgery may vary depending on the patient's overall health status prior to surgery.

### Abnormal results

The doctor should be made aware of any of the following problems after surgery:

- increased pain, swelling, redness, drainage, or bleeding in the surgical area
- headache, muscle aches, dizziness, fever
- increased abdominal pain or swelling, constipation, nausea or vomiting, rectal bleeding, or black, tarry stools

### ORGANIZATIONS

United Ostomy Association, Inc. (UOA), PO Box 512, Northfield, MN, 55057-0512, (800) 826-0826, info@ostomy.org, <http://www.ostomy.org>.

Wound Ostomy and Continence Nurses Society, 15000 Commerce Parkway, Suite C, Mt. Laurel, NJ, 08054, (888) 224-9626, <http://www.wocn.org>.

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Bowel surgery with ostomy see **Colostomy**

## Bowel training

### Definition

Bowel training helps to reestablish normal bowel movements in persons who suffer from **constipation**, **diarrhea**, incontinence, or irregularity. Healthy bowel activity is considered one or two movements of moderate size every day.

### Purpose

Many people for many reasons have irregular bowel function. In some cases, the irregularity lasts beyond the condition that caused it. The bowels by themselves develop bad habits that can be retrained with suitable exercises and education. Normal bowel habits not only improve the quality of life, they help prevent several common diseases—for example, **diverticulitis** and fecal impaction. Gall stones, **appendicitis**, **colon cancer**, **hiatal hernia**, diabetes, and heart

## KEY TERMS

- Defecate**—To pass feces (stool) out of the rectum through the anus.
- Diverticulitis**—Infection of outpouchings in the large bowel.
- Fecal impaction**—Obstruction of the rectum by a large mass of feces (stool).
- Hiatal hernia**—Part of the stomach displaced through the diaphragm into the chest.

disease have also been related to the quality of bowel movements and the foods that affect them.

- One of the most common causes of constipation is the laxative habit. Repeated artificial stimulation of the bowels destroys their natural emptying reflex, so that they will no longer move without artificial stimulants. The laxative habit begins innocently enough with the correct belief that bowels should move every day; however, laxatives will cause the evacuation of several days worth of stool in a single movement. Impatient for stool to reaccumulate for the necessary few days, the patient takes another laxative, and the cycle begins.
- The other major cause of constipation is a diet with insufficient bulk or roughage. The bowel works more smoothly the more contents it has. Western diets of highly refined foods have eliminated most of the residue from food. The result is that most food is absorbed, leaving little to pass through and be excreted as feces.
- Constipation occurs acutely with impaction—the presence in the rectum of a mass of feces too large to pass. Fecal impaction is usually the result of poor bowel habits, a diet with too little liquid and roughage, and inadequate physical activity.
- Diarrhea, whether acute or chronic, can disrupt the bowel's normal rhythm and lead to irregularity.
- Several diseases of the nervous system affect bowel reflexes.

### Description

Bowel training reestablishes the bowel's normal reflexes by repeating a routine until it becomes a habit. Naturally the patient must be able and willing to cooperate. Some patients are so convinced they need daily **laxatives** that they are afraid to do without them. It takes time for a changed diet to affect the bowels and for the bowel to regain its normal rhythm. Trust and patience are necessary.

After gaining the patient's cooperation, the next step is to optimize the diet. Healthy bowel movements require ingestion of a large amount of liquids and bulk foods. The patient should drink two to three quarts of liquids every day, with liberal inclusion of prune juice and perhaps coffee for their natural laxative effects. Bulk comes from unrefined foods. Oat bran, wheat bran, brown rice, green vegetables, apples, and pears are a few examples of high residue foods. Many patients will benefit from adding bulk preparations of psyllium. Constipating foods like bananas and cheese should be avoided until a natural rhythm is well established.

To assure that stools are soft enough to pass easily, it is a good idea to add a pure stool softener like DOSS (dioctyl **sodium** sulfosuccinate), two to four per day as needed. DOSS also helps prevent impaction.

There is usually a time of day when bowel movements are more likely to occur. In anticipation of this time, the patient should participate in activities that stimulate a normal bowel movement. Walking, eating unrefined foods, and drinking prune juice or coffee encourage natural evacuation. It is acceptable to use lubricants such as glycerine suppositories or oil **enemas** at this time. For severe constipation, water enemas may be needed to initiate a movement.

It is also important for the patient to recognize the urge to defecate and to respond right away to that urge. The longer stool sits in the rectum, the more water the rectum will absorb from it, making it harder and more difficult to pass.

### Normal results

With patience and diligence, normal bowel habits and the health that comes with them will return in most patients.

### Resources

#### BOOKS

Fiebach, Nicholas H., et al. *Principles of Ambulatory Medicine*. Philadelphia: Lippincott Williams & Wilkins, 2007.

J. Ricker Polsdorfer, MD

Braces see **Immobilization**

Braces, orthodontic see **Orthodontics**

Brachytherapy see **Radioactive implants**

## Brain abscess

### Definition

Brain **abscess** is a bacterial infection within the brain.

### Description

The brain is usually well insulated from infection by bacteria, protected by the skull, the meninges (tissue layers surrounding the brain), the immune system, and the highly regulated barrier between the bloodstream and the brain. Under certain circumstances, however, bacteria can invade the brain and cause a localized infection called an abscess. Brain abscess is relatively rare, accounting for 1 in 10,000 hospital admissions. Single abscess occurs in 75% of cases, and the remainder of cases involve multiple abscesses. If not treated, brain abscess is almost always fatal.

### Causes and symptoms

One-half of all brain abscesses are caused by the spread of bacteria from a nearby infection. Sources of bacteria include:

- middle ear infections (otitis media) or infections in the bony spaces in front of the middle ear (mastoiditis)
- sinus infections
- an abscessed tooth

Other sources of bacteria include lung infections, abdominal infection, infection of the heart's lining (**endocarditis**), penetrating heart **wounds**, and **neurosurgery**.

Acquired immune deficiency syndrome (**AIDS**) or the presence of another immune deficiency greatly increases the risk of brain abscess. Approximately 25% of cases have no detectable cause of infection.

Brain abscess can be caused by a variety of organisms, many of them related to ear and sinus infections. Many times brain abscess cases are caused by two or more bacteria. In 30%–60% of cases, the bacteria combination includes streptococci, microorganisms that can live without oxygen (anaerobes), and enterobacteria. A small number of cases are caused by yeast, fungi, and single-cell organisms (protozoa).

The symptoms of brain abscess often develop slowly, usually within a period of about two weeks. The most common symptoms are:

- headache
- neurologic symptoms related to the specific part of the brain that is infected
- altered mental status
- seizures

### KEY TERMS

**Aspiration**—Removal of fluid from a closed space through a needle.

**Biopsy**—The removal of a tissue sample for examination.

### Diagnosis

Diagnosis of brain abscess is performed by using a computed tomography scan (CT) or a **magnetic resonance imaging** (MRI) scan to determine the site of infection. Tissue removal (biopsy) is usually performed as well. A biopsy is performed to determine the type of bacterium involved. Biopsies can also be used to rule out tumor or other noninfectious localized lesions, which may look the same on the scans.

Other tests are performed to determine the source of the infection. These tests include blood cultures, x rays of the chest, and a physical exam of the ears, sinuses, and teeth. A test for human **immunodeficiency** virus (HIV) is usually also performed.

### Treatment

Treatment for brain abscess begins with intravenous **antibiotics**, chosen to match the infecting bacterium if known, or to cover a wide spectrum of possibilities if not. Treatment usually continues for six to eight weeks.

Aspiration surgery is almost always done to drain the abscess. In this procedure, a needle is guided to the infected site by CT scan, and fluid is removed (aspirated) from the abscess. Aspiration may be repeated several times until the bacteria are completely killed or removed. Surgical removal of infected or dead tissue may be needed in some cases. For patients with many sites of infection, aspiration or surgical removal is not done because of the increased difficulty and risk of the procedure. For these patients, antibiotic therapy alone is used. Steroid treatment is controversial, but may be indicated in some cases.

### Prognosis

Even with prompt treatment, brain abscess is fatal in about 20% of cases. About half of those who survive have some residual neurological problems, including seizures in many patients.

There are several reasons why patients with brain abscess can have a poor prognosis. The illness may not be diagnosed correctly or an accurate diagnosis may take additional time. The patient may receive an

antibiotic that does not match the infecting organism. Sometimes the infection may not be limited to a definite area in the brain, making diagnosis and treatment difficult. The small number of cases caused by fungal infection may take additional time to diagnose. A patient may also have a poor prognosis because there is more than one abscess, the location of the abscess is deep within the brain, or the infection has moved into many locations within the brain. Severe complications can result from brain abscess, including coma and brain rupture. In 80%–100% of cases involving brain rupture, the patient dies.

## Prevention

Brain abscess may be preventable by prompt and aggressive treatment of the infections that give rise to it, especially sinus and ear infections.

## Resources

### BOOKS

Fauci, Anthony S., et al., eds. *Harrison's Principles of Internal Medicine*. 17th ed. New York: McGraw-Hill Professional, 2008.

Richard Robinson

**Brain aneurysm** see **Cerebral aneurysm**

## Brain biopsy

### Definition

A brain biopsy is the removal of a small piece of brain tissue for the diagnosis of abnormalities of the brain, such as **Alzheimer's disease**, tumors, infection, or inflammation.

### Purpose

By examining the tissue sample under a microscope, the biopsy sample provides doctors with the information necessary to guide diagnosis and treatment.

### Precautions

Imaging of the brain is performed to determine the precise positioning of the needle to enter the brain.

### Description

When an abnormality of the brain is suspected, stereotactic (probing in three dimensions) brain needle biopsy is performed and guided precisely by a computer

## KEY TERMS

**Alzheimer's disease**—A progressive, neurodegenerative disease characterized by loss of function and death of nerve cells in several areas of the brain, leading to loss of mental functions such as memory and learning.

**Computed axial tomography (CT)**—An x-ray technique that has the ability to image soft tissue, bone, and blood vessels.

**Cortex**—The thin, convoluted surface of the brain comprised primarily of cell bodies of neurons.

**Magnetic resonance imaging (MRI)**—An imaging technique that uses radiowaves, magnetic fields, and computer analysis to visualize body tissue and structures.

**Stereotactic brain needle biopsy**—In this procedure a computer uses information from a CT or MRI to create a three-dimensional map of the operation site to better guide the needle to perform the biopsy.

system to avoid serious complications. A small hole is drilled into the skull, and a needle is inserted into the brain tissue guided by computer-assisted imaging techniques (CT or MRI scans). Historically, the patient's head was held in a rigid frame to direct the probe into the brain; however, since the early 1990s it has been possible to perform these biopsies without the frame. Since the frame was attached to the skull with screws, this advancement is less invasive and better tolerated by the patient. The doctor (pathologist) prepares the sample for analysis and studies it further under a microscope.

### Preparation

A CT or MRI brain scan is done to find the position where the biopsy will be performed. Prior to the biopsy, the patient is placed under **general anesthesia**.

### Aftercare

The patient is monitored in the recovery room for several hours and is usually required to spend a few days in the hospital since general anesthesia is required.

### Risks

The procedure is invasive and includes risks associated with anesthesia and surgery. Brain injury may

occur due to removal of brain tissue. The resulting scar left on the brain has the potential to trigger seizures.

### Normal results

After examining the brain tissue directly, no abnormalities are detected.

### Abnormal results

Various brain abnormalities can be diagnosed by microscopic analysis of the tissue sample. The pathologist (a physician trained in how disease affects the body's tissues) looks for abnormal growth, changes in cell membranes, and/or abnormal collections of cells. In Alzheimer's disease, the cortex of the brain contains abnormal collections of plaques. If infection is suspected, the infectious organism can be cultured from the tissue and identified. Classification of tumors is also possible after biopsy.

#### ORGANIZATIONS

Alzheimer's Association, 225 N. Michigan Ave., Fl. 17, Chicago, IL, 60601-7633, (312) 335-8700, (866) 699-1246, (800) 272-3900, info@alz.org, http://www.alz.org.

American Brain Tumor Association, 2720 River Road, Des Plaines, IL, 60018, (847) 827-9910, (847) 827-9918, (800) 886-2282, info@abta.org, http://www.abta.org/.

National Institute of Neurological Disorders and Stroke (NINDS), NIH Neurological Institute, P. O. Box 5801, Bethesda, MD, 20824, (301) 496-5751, (800) 352-9424, http://www.ninds.nih.gov/.

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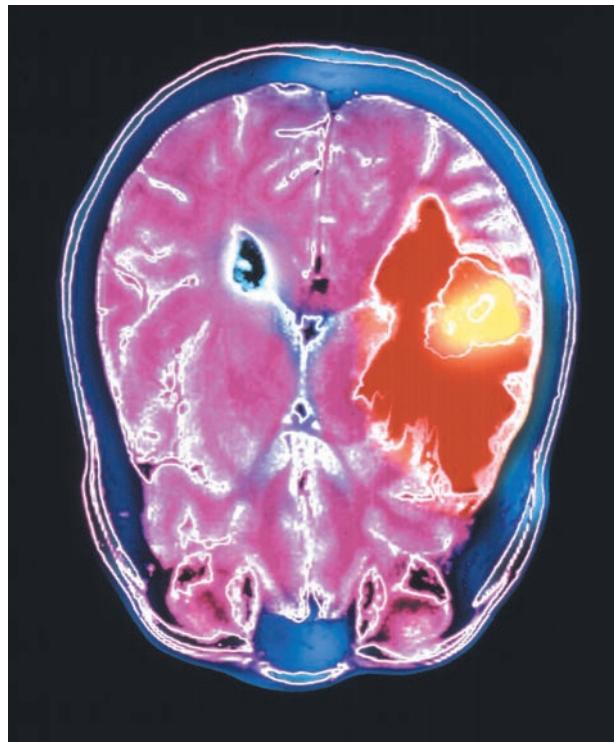
**Brain circulation scan** see **Transcranial**

### Doppler ultrasonography

**Brain infection** see **Encephalitis**

**Brain injury** see **Head injury**

**Brain surgery** see **Craniotomy**



**Magnetic resonance imaging (MRI) scan of axial section of human brain showing a metastatic tumor (yellow in image).**  
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it is composed of harmless cells located in an area where it suppresses one or more vital functions.

### Demographics

Each year, more than 22,000 malignant brain tumors are diagnosed in adults and children in the United States, according to the American Cancer Society. An estimated 13,000 people died from brain tumors in the United States in 2009. Brain tumors can develop at any age but are most commonly diagnosed in children between the ages of 3–12 and in adults aged 55–65. The overall risk for developing a malignant brain tumor is less than 1%.

### Description

#### Risk factors

Primary tumors of the brain and central nervous system are often associated with HIV infection. Men and Caucasians tend to have a higher risk of developing brain tumors. Individuals considered at high risk for the development of brain cancer include children with a history of previous radiation treatment to the head for cancer and patients with certain cancers (nervous

## Brain tumor

### Definition

A brain tumor is an abnormal growth of tissue in the brain. Unlike other tumors, brain tumors spread by local extension and rarely metastasize (spread) outside the brain. A benign brain tumor is composed of noncancerous cells and does not metastasize beyond the part of the brain where it originates. A brain tumor is considered malignant if it contains **cancer** cells, or if

system, salivary gland, colon). Other risk factors include having an older father; occupational exposure to vinyl chloride, lead, and pesticides; history of **epilepsy**; and a history of certain genetic conditions (tuberous sclerosis, **neurofibromatosis**, von Hippel Lindau, **familial polyposis**, Osler-Weber-Rendu, Li-Fraumeni).

About half of all primary brain tumors are benign but in life-threatening locations. The rest are malignant and invasive.

### ***Benign brain tumors***

Benign brain tumors, composed of harmless cells, have clearly defined borders, can usually be completely removed, and are unlikely to recur. Benign brain tumors do not infiltrate nearby tissues but can cause severe **pain**, permanent brain damage, and **death**. Benign brain tumors sometimes become malignant.

### ***Malignant brain tumors***

Malignant brain tumors do not have distinct borders. They tend to grow rapidly, increasing pressure within the brain (ICP) and can spread in the brain or spinal cord beyond the point where they originate. It is highly unusual for malignant brain tumors to spread beyond the central nervous system (CNS).

### ***Primary brain tumors***

Primary brain tumors originate in the brain. They represent about 1% of all cancers and 2.5% of all cancer deaths.

### ***Metastatic or secondary brain tumors***

Metastatic brain tumors are much more common than primary brain tumors with more than 100,000 patients per year in the United States dying from the effects of metastatic brain tumors. As many as 25% of all cancer patients develop secondary or metastatic brain tumors when cancer cells spread from another part of the body to the brain. Secondary brain tumors are most apt to occur in patients who have:

- breast cancer
- colon cancer
- kidney cancer
- lung cancer
- melanoma (cancer) of the skin; these metastatic brain tumors can develop on any part of the brain or spinal cord
- cancer within the nasal passages and/or throat, which could follow the nerve pathways into the skull and metastasize to the brain

### ***Naming and grading brain tumors***

The name of a brain tumor describes where it originates, how it grows, and what kind of cells it contains. A tumor in an adult is also graded or staged according to:

- how malignant it is
- how rapidly it is growing and how likely it is to invade other tissues
- how closely its cells resemble normal cells (the more abnormal a tumor cell looks, the faster it is likely to grow)

Low-grade brain tumors usually have well-defined borders. Some low-grade brain tumors form or are enclosed (encapsulated) in cysts. Low-grade brain tumors grow slowly, if at all. They may spread throughout the brain, but rarely metastasize to other parts of the body.

Mid-grade and high-grade tumors grow more rapidly than low-grade tumors. Described as “truly malignant,” these tumors usually infiltrate healthy tissue. The growth pattern makes it difficult to remove the entire tumor, and these tumors recur more often than low-grade tumors.

A single brain tumor can contain several different types of cells. The tumor’s grade is determined by the highest-grade (most malignant) cell detected under a microscope, even if most of the cells in the tumor are less malignant. An infiltrating tumor is a tumor of any grade that grows into surrounding tissue.

### ***Types of brain tumors***

Glioma is the term used to refer to the most prevalent primary brain tumors. Gliomas arise from glial tissue, which supports and nourishes cells that send messages from the brain to other parts of the body. These tumors may be either malignant or benign. Astrocytomas, ependymomas, and mixed gliomas are three of the most common gliomas.

**ASTROCYTOMAS.** Named for the star-like shape of their cells, astrocytomas can develop on any part of the brain or spinal cord. Non-infiltrating astrocytomas grow slowly, and rarely spread to nearby tissue. Mild-to-moderately anaplastic astrocytomas with well-differentiated borders do not grow as slowly as non-infiltrating astrocytomas, and they do spread to surrounding tissues.

Anaplastic astrocytomas, which are also called Grade III astrocytomas, look more abnormal and grow more rapidly than non-infiltrating or mild-to-moderately anaplastic tumors.

Grade IV astrocytomas are also called glioblastoma multiforme (GBM) tumors. Accounting for 30%

of all primary brain tumors, GBMs are the most common brain tumors in middle-aged adults. GBMs are the most malignant of all brain tumors. They contain a greater mixture of cells than any other brain tumors making them the most difficult to treat.

**EPENDYOMOMAS.** Also called ependymal tumors, ependymomas account for 9% of all gliomas, and 5% of all intracranial tumors. These tumors, which are most common in children and adolescents, begin in the very thin membranes that help form cerebrospinal fluid (CSF) and line the brain cavities (ventricles) that contain it.

Ependymomas are usually benign, have well-differentiated borders, resemble normal cells, and grow very slowly. The cells of anaplastic (malignant) ependymomas look abnormal and grow more rapidly than the cells of benign tumors.

**MIXED GLIOMAS.** Heterogeneous tumors containing elements of astrocytomas and ependymomas and/or oligodendrogiomas are called mixed gliomas. These are rare tumors that usually occur in middle-aged adults, grow slowly, and do not usually spread beyond the part of the brain where they originate. Mixed gliomas behave like tumors composed of the highest-grade cells they contain.

#### *Non-glial brain tumors*

The most common brain tumors that do not develop from glial cells are medulloblastomas, meningiomas, and Schwannomas.

**MEDULLOBLASTOMAS.** Scientists once thought medulloblastomas (MDLs) developed from glial cells. These fast-growing, malignant tumors are now believed to originate in developing cells not normally present in the body after birth. They are sometimes called primitive neuroectodermal tumors (PNET).

MDL tumors are most common in children and are more common in boys than in girls. Only 30% of MDL tumors occur in adults. MDL tumors usually originate in the cerebellum (the part of the brain that controls coordination and some muscle activity) and are often carried to other parts of the brain by cerebrospinal fluid. MDL tumors rarely metastasize beyond the brain and spinal cord.

**MENINGIOMAS.** Meningiomas, which represent more than 20% of all primary brain tumors, originate in the membranes that enclose the brain and spinal cord (meninges). These tumors are usually benign and most often occur in women aged 30–50 years old. Meningiomas grow so slowly that the brain can sometimes become accustomed to their presence.

Meningiomas compress, rather than invade, brain tissue and may grow to be quite large before any symptoms appear.

**SCHWANNOMAS.** Schwannomas originate in the Schwann cells. These cells produce myelin, the material that protects the acoustic nerve, which controls hearing. These benign tumors are twice as common in women as in men, and are most often diagnosed in patients between the ages 30–60.

Schwannomas grow very slowly, and many people adapt to the slight **hearing loss** and balance problems that are the tumors' earliest symptoms. A pear-shaped Schwannoma can cause sudden or gradual loss of hearing in an ear. As the tumor progresses, it can press on the nerves that control movement and feeling in the face and cause headaches and facial **numbness** or **tingling**. The patient may have trouble walking, swallowing, or controlling eye movements, and the sense of taste can be affected. A Schwannoma that grows large enough to press on the brain stem can be deadly.

Gliomas, meningiomas, pituitary adenomas, acoustic neuromas, and metastatic brain tumors constitute about 95% of all brain tumors.

**CHILDHOOD BRAIN TUMORS.** Brain tumors that occur in children are described as supratentorial (in the upper part of the brain) or infratentorial (in the lowest part of the brain). Astrocytomas and ependymomas are common supratentorial tumors. Infratentorial tumors include medulloblastomas, astrocytomas, and ependymomas.

#### **Causes and symptoms**

The cause of primary brain tumors is unknown, but people who work with rubber and certain chemicals have a greater-than-average risk of developing them. There is no evidence that **head injury** causes brain tumors, but researchers are trying to determine the relationship, if any, between brain tumors and viruses, family history, and long-term exposure to electromagnetic fields.

Results of an international study released in 2010 concluded there was no increased risk of developing glioma or meningioma in people who use mobile phones. However, the researchers cautioned that additional research in this area is needed, particularly as it relates to heavy users of mobile phones.

Symptoms do not usually appear until the tumor grows large enough to displace, damage, or destroy delicate brain tissue. When that happens, the patient may experience:

## KEY TERMS

**Central nervous system (CNS)**—The division of the nervous system that consists of the brain and spinal cord.

**Cerebrospinal fluid (CSF)**—Clear liquid that fills brain cavities and protects the brain and spinal cord.

**Gamma knife**—High-dose radiation treatment for intracranial tumors.

**Intracranial**—Located within or on the surface of the brain.

- headaches that become increasingly painful and are most painful when lying down
- nausea and vomiting or sudden attacks of vomiting not accompanied by nausea
- seizures
- dizziness or loss of coordination or balance
- personality changes
- sudden loss of vision
- memory loss
- speech problems
- sensory changes
- mental impairment
- weakness or paralysis on one side of the body

A doctor should be notified whenever a patient experiences one or more of these symptoms.

### Diagnosis

Although brain tumor symptoms resemble those of many other illnesses, the presence of a brain tumor may be indicated by:

- persistent headaches with vomiting or convulsions
- progressive deterioration of sight, speech, hearing, or touch, or deterioration in the ability to use an arm, hand, foot, or leg

### Examination

When a patient experiences one or more symptoms, a primary care physician will perform a complete **physical examination**, take a detailed medical history, and conduct a basic neurologic examination to evaluate:

- balance and coordination
- abstract thinking and memory

- eye movements
- hearing, touch, and sense of smell
- reflexes
- control of facial muscles and movements of the head and tongue
- awareness

### Tests

If the results of the examination suggest a patient may have a brain tumor, a neurologist will recommend some or all of these additional diagnostic tests:

- computed tomography scan (CT scan) to reveal brain abnormalities
- magnetic resonance imaging (MRI) to detect tumors beneath the bones of the skull
- perfusion MRI to detect the pattern of blood flow in the brain
- complex imaging techniques such as positron emission tomography (PET scan) or single photon emission computed tomography (SPECT scan)
- electroencephalography (EEG) to measure electrical activity in the brain
- x rays to reveal any distortion in the bones of the skull
- angiography to outline a tumor and the blood vessels that lead to it
- a brain scan to identify and record the location of abnormal cells in the brain
- radionuclide brain scintigraphy to view the capillaries feeding the tumor after highlighting them with a radioactive substance
- myelography (x ray of the spine) to detect a spinal cord tumor
- a lumbar puncture (spinal tap) to obtain spinal fluid, which may contain tumor cells

### Procedures

Interpreting these images and results of laboratory analysis allows neurologists to determine whether a tumor is present, but microscopic examination of tumor tissue (biopsy) is the only way to identify the kind of cells it contains.

### Treatment

Brain tumors are treated by multidisciplinary teams of highly skilled specialists whose decisions are based on:

- results of diagnostic tests
- tumor size, position, and growth pattern

- the patient's health history and current medical status
- the wishes of the patient and his family

### *Traditional*

**SURGERY.** Surgery is the treatment of choice for accessible brain tumors that can be removed without causing serious neurologic damage. The procedure most often performed is a **craniotomy**, but the goals of any type of brain tumor surgery include:

- removing as much of the tumor as possible (called debulking the tumor)
- removing tumor tissue for microscopic analysis
- allowing neurosurgeons to see exactly how the tumor is situated and how it is growing
- creating an entry channel for chemotherapy drugs and forms of radiation that are implanted in the brain

Depending on the type of brain tumor, its location, and its size, a number of different techniques may be used to surgically remove it. Surgical techniques include:

- classic operation
- laser microsurgery (uses high temperatures to vaporize tumor cells)
- ultrasonic aspiration (uses ultrasound waves to break up the tumor into smaller bits that can be “vacuumed” out)

Before undergoing brain surgery, patients are often given **steroids** to reduce swelling of brain tissue and/or undergo radiation treatments to reduce tumor size. Anticonvulsant medications may be prescribed to prevent or control seizures.

Patients whose benign brain tumors can be completely removed may not require any additional treatment, but periodic physical and neurologic examinations and CT or MRI scans are sometimes recommended to determine whether the tumor has returned. Because surgeons cannot be sure that every bit of an infiltrating or metastasizing tumor has been removed, radiation and **chemotherapy** are used to eradicate cells that may have escaped the scalpel.

If a tumor cannot be completely removed, removing a portion of it (debulking) can alleviate the patient's symptoms, enhance the sense of well-being, and increase the effectiveness of other treatments.

**RADIATION THERAPY.** External radiotherapy, generally delivered on an outpatient basis, directs radiation to the tumor and the area around it. Newer techniques are used to ensure that radiation is targeted as precisely

as possible to the tumor. These techniques include three-dimensional conformal **radiation therapy** (3D-CRT), intensity modulated radiation therapy (IMRT), and conformal proton beam radiation therapy.

Implant radiation therapy involves placing tiny pieces of radioactive material in the brain. Left in place permanently, or for a short time, these radioactive pellets release measured doses of radiation each day. This technique is called brachytherapy.

Brachytherapy and external beam radiation therapy may be used concurrently to treat the tumor.

Stereotactic radiosurgery involves fitting the patient with a frame to stabilize the head, using imaging techniques to determine the exact location of tumor cells, and using a sophisticated instrument to administer radiation precisely to that point. Methodologies used for delivery of radiation by this technique include particle beam therapy, photon-based therapy (Gamma Knife), and the movable linear accelerator (X-Knife, Cyberknife, and Clinac).

A variety of drugs may also be given during radiation therapy to protect brain cells from the effects of radiation (radioprotective drugs), to increase the sensitivity of tumor cells to radiation (radiosensitizers), or to boost radiation's effects (radioenhancers).

### *Drugs*

**CHEMOTHERAPY.** One or more cancer-killing drugs may be taken by mouth or injected into a blood vessel or the cerebrospinal fluid. Chemotherapy may be used with radiation and surgery as part of a patient's initial treatment, or used alone to treat tumors that recur in the same place or in another part of the body. The usual chemotherapy regimen for a brain tumor is a combination approach. Chemotherapy drugs commonly used in the treatment of brain cancers include procarbazine, lomustine (CCNU), carmustine (BCNU), temozolomide, carboplatin, cisplatin, etoposide, irinotecan, methotrexate, and vincristine.

New methods of delivering chemotherapy are being used as well. These include:

- intrathecal chemotherapy, which instills the medications right into the spinal fluid;
- intra-arterial chemotherapy, which uses tiny catheter tubes to delivery high-dose chemotherapy directly into the arteries of the brain;
- interstitial chemotherapy, which is performed at the time of surgery. A chemotherapy-soaked wafer, carmustine (Gliadel), is placed in the cavity left after tumor removal.

Potentially toxic chemotherapy drugs can be wrapped in special biologic envelopes called liposomes, to allow the drugs to be delivered to the tumor without adversely affecting other healthy tissues along the way.

When a young child has a brain tumor, chemotherapy is often used to eliminate or delay the need for radiation.

### **Targeted therapy**

Therapies are being developed that target specific proteins on tumor cells. A type of targeted therapy used in the treatment of glioblastoma is the monoclonal antibody bevacizumab (Avastin).

### **Other treatments**

If a brain tumor cannot be cured, treatment is designed to make the patient as comfortable as possible and preserve as much of his neurologic functioning as possible. The patient's doctor may prescribe:

- analgesics to relieve pain
- anticancer drugs to limit tumor growth
- anticonvulsants to control seizures
- steroids to reduce swelling of brain tissue

### **Alternative treatment**

Alternative treatments have not been shown to cure brain tumors and should never be substituted for conventional therapy. However, complementary therapies (used with, not instead of, standard treatments) can help some patients cope with the **stress** of their illness and side effects of their treatment.

Massage, **meditation**, and **reflexology** help some patients relax, while **yoga** is said to soothe the body, spirit, and mind. **Hydrotherapy** uses ice, liquid, and steam to improve circulation and relieve pain. **Therapeutic touch** practitioners say they can relieve pain and other symptoms by moving their hands in slow, rhythmic motions several inches above the patient's body.

Botanical therapies, homeopathic treatment, **traditional Chinese medicine** treatments, nutritional focuses on diet and supplements, and **detoxification** can also be incorporated as complementary therapies.

### **Prognosis**

The patient's prognosis depends on where the tumor is located, what type of cells it contains, the size of the tumor, and the effect it has already had on adjacent brain structures. A patient whose tumor is discovered early and removed completely may make a

full recovery, but the surgery itself can harm or destroy normal brain tissue, causing:

- problems with thought, speech, and coordination
- seizures
- weakness
- personality changes

Although these post-operative problems may initially be more severe than the symptoms produced by the tumor, they can potentially diminish or disappear in time.

**Occupational therapy** can teach patients and their families new ways to approach daily tasks. **Physical therapy** can benefit patients who have difficulty keeping their balance, expressing their thoughts, speaking, or swallowing. Children may need special tutors before and after returning to school. For patients who have incurable brain tumors, hospice care may be available. Hospices provide a supportive environment and help patients manage pain and remain comfortable.

### **Inoperable tumors**

Brain tumors that cannot be removed may cause irreversible brain damage and death.

### **Prevention**

The cause of primary brain tumors has not been determined, so there is no known way to prevent them.

The best way to prevent secondary or metastatic brain tumors is to eliminate such risk factors as:

- poor nutrition and a low-fiber diet, since these contribute to development of intestinal cancers that can metastasize to the brain
- smoking, which causes lung cancer
- excessive use of alcohol, which is associated with liver cancer
- excessive exposure to the sun, which can cause melanoma (a deadly form of skin cancer)

Monthly self-examinations of the breasts and testicles can detect breast and **testicular cancer** at their earliest, most curable stages.

### **Resources**

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American Cancer Society. "Brain and Spinal Cord Tumors in Children." May 13, 2009. <http://www.cancer.org/Cancer/BrainCNSTumorsinChildren/DetailedGuide/index> (accessed July 31, 2010).

#### ORGANIZATIONS

American Brain Tumor Association, 2720 River Road, Des Plaines, IL, 60018, (847) 827-9910, (800) 886-2289, <http://www.abta.org>.

Brain Tumor Foundation for Children, Inc., 6065 Roswell Rd, Suite 505, Atlanta, GA, 30328-4015, (404) 452-4107 <http://www.braintumorkids.org>.

Brain Tumor Information Services, Box 405, Room J341, University of Chicago Hospitals, 5841 S. Maryland Avenue, Chicago, IL, 60637, (312) 684-1400.

National Brain Tumor Society, 124 Watertown St., Suite 2 D, Watertown, MA, 02472, (800) 934-2873, <http://www.braintumor.org>.

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can include a breast lump felt during physical self-examination or tissue changes noticed from a mammogram test. Before a biopsy is performed, it is important to make sure that the threat of **cancer** cannot be disproved or ruled out by a simpler, less invasive examination. A lump may be obviously harmless when examined by ultrasound. If this is not decisive, the presence of cancer or a variety of benign breast conditions can be determined using a biopsy.

#### Precautions

The type of biopsy recommended should be considered. This will depend on whether the area can be felt, how well it can be seen on mammogram or ultrasound, and how suspicious it feels or appears. Specialized equipment is needed for different types of biopsy and availability may vary. Generally, needle biopsy is less invasive than surgical biopsy. It is appropriate for most, but not all, situations. However, some surgeons feel it is far less accurate.

#### Description

##### *Surgical biopsy*

If an abnormality is not felt during a self-examination, there are signs that indicate the need for medical attention. These include:

- severe breast pain
- changes in the size of a breast or the nipple
- changes in the shape of both breast or nipple
- pitting, dumpling, or redness of the breast skin
- nipple redness, irritation, or inversion
- changes in the pattern of veins visible on the surface of the breast
- some types of nipple discharge

If the abnormality is not felt, a needle localization must be done before the actual surgery. After local anesthetic is administered, a fine wire is placed in the area of concern. Either x ray or ultrasound guidance is used. The patient is awake and usually sitting up.

There are two types of breast biopsy considered here, excisional and incisional. An excisional biopsy is a surgical procedure, where the entire area of concern and some surrounding tissue is removed. It is usually done as an outpatient procedure in a hospital or free-standing surgery center. The patient may be awake, and is sometimes given medication to induce drowsiness. The area to be operated on is numbed with local anesthetic. Infrequently, **general anesthesia** is used.

An excisional biopsy itself usually takes under one hour. The total amount of time spent at the facility

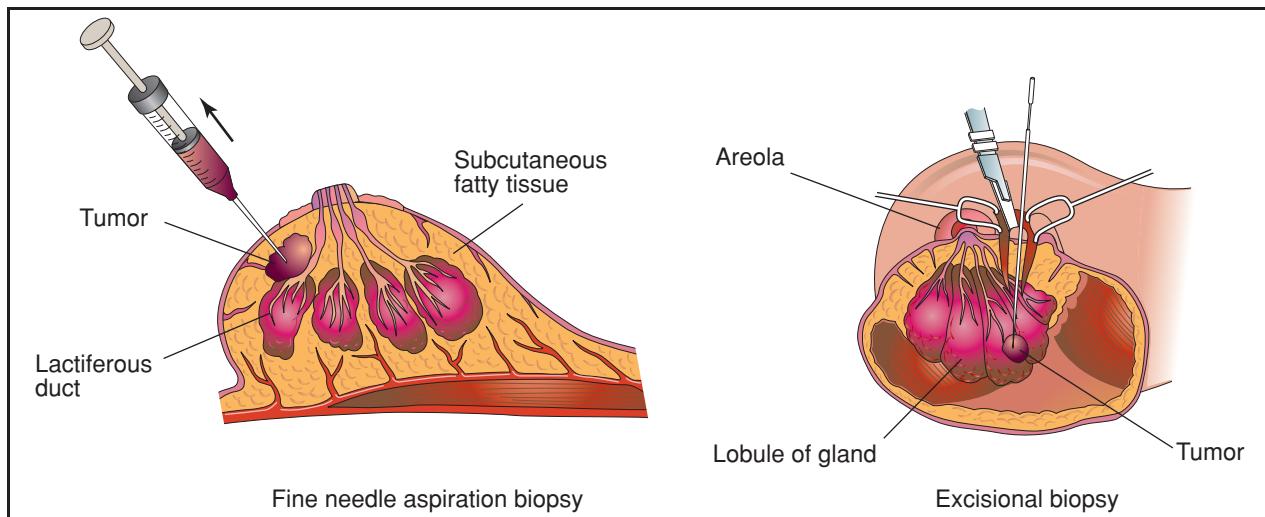
## Breast biopsy

### Definition

A breast biopsy is removal of breast tissue for examination by a pathologist. This can be accomplished surgically, or by withdrawing tissue through a needle.

### Purpose

A biopsy is recommended when a significant abnormality is found, either on **physical examination** and/or by an imaging test. Examples of abnormality



**A fine needle aspiration biopsy uses a very thin needle to withdraw fluid and cells from the breast to be examined. An excisional biopsy is a surgical procedure in which the entire area of concern and some surrounding tissue is removed for analysis.**  
*(Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)*

depends on the type of anesthesia used, whether a needle localization was done, and the extent of the surgery.

If a mass is very large, an incisional biopsy may be performed. In this case only a portion of the area is removed and sent for analysis. The procedure is the same as an excisional biopsy in other respects.

### Needle biopsy

A needle biopsy removes part of the suspicious area for examination. There are two types, aspiration biopsy (using a fine needle), and large core needle biopsy. Either of these may be called a percutaneous needle biopsy. Percutaneous refers to a procedure done through the skin.

A fine needle aspiration biopsy uses a very thin needle to withdraw fluid and cells that can be studied. It can be done in a doctor's office, clinic, or hospital. Local anesthetic may be used but is sometimes withheld, as it may be more painful than the biopsy needle. The area to place the needle may be located by touch. No specialized equipment is needed. However, using ultrasound guidance enables the physician to feel and see the lesion at the same time. The actual withdrawing of fluid and cells can be visualized as it occurs. This helps ensure that the specimen is taken from the right place.

A large core needle biopsy uses a larger diameter needle to remove small pieces of tissue, about the size of a grain of rice. It can be done in a clinic or hospital that has the appropriate facilities. Local anesthetic is

routinely used. Ultrasound or x ray is used for guidance of a large core needle biopsy.

If the suspicious area is seen best with x ray, a stereotactic device is used. This means that x rays are taken from several angles. This information is fed into a computer, which analyzes the data and guides the needle to the correct place. The patient may be sitting up, or she may be lying on her stomach, with her breast positioned through an opening in the table. The breast is held firmly but comfortably between a plastic paddle and a metal plate, similar to those used for mammograms (a set of x rays taken of the front and side of the breast). X rays may be taken before, during, and after the tissue is drawn into the needle, to confirm that the correct spot is biopsied. This procedure may also be referred to as a stereotactic core biopsy, or a mammotomy.

Ultrasound is used to guide needle placement for some lesions. The patient lies on her back or side. After the area is numbed, sterile gel is applied. The physician places a transducer, an instrument about the size of an electric shaver, over the skin. This produces an image from the reflection of sound waves. A special needle, usually in a spring-loaded device, is used to obtain the tissue. The procedure is observed on a monitor as it is happening.

### Preparation

A surgical breast biopsy may require the patient to have nothing to eat or drink for a period of time before the operation. This will typically be from midnight the

## KEY TERMS

**Fine needle aspiration biopsy**—A procedure using a thin needle to remove fluid and cells from a lump in the breast.

**Large core needle biopsy**—A procedure using a thicker needle to remove a core of tissue, about the size of a grain of rice, from the breast.

night before, if general anesthesia is planned. No food restrictions are necessary for needle biopsy. It is advisable to eat lightly before the procedure. This is especially important if the patient will be lying on her stomach for a stereotactic biopsy.

### Aftercare

After a surgical biopsy, the incision will be closed with stitches and covered with a bandage. The bandage can usually be removed in one or two days. Stitches are taken out approximately one week afterward. Depending on the extent of the operation, normal activities can be resumed in approximately one to three days. Vigorous **exercise** may be limited for one to three weeks.

The skin opening for a needle biopsy is minimal. It may be closed with thin, clear tape, called a steri strip, or covered with a bandaid and a small gauze bandage. The patient can return to her usual routine immediately after the biopsy. Strenuous activity or heavy lifting is not recommended for 24 hours. Any **bandages** can be removed one or two days after the biopsy.

### Risks

Infection is always a possibility when the skin is broken, although this rarely occurs. Redness, swelling, or severe **pain** at the biopsy site would indicate a possible infection. Another possible consequence of a breast biopsy is a hematoma. This is a collection of blood at the biopsy site. It is usually absorbed naturally by the body. If it is very large and uncomfortable, it may need to be drained. A surgical breast biopsy may produce a visible scar on the breast. Sometimes this may make future mammograms harder to interpret accurately.

A false negative pathology report is another risk. This means that no cancer was found when a cancer was present. The incidence of this varies with the biopsy technique. In general, fine needle aspiration

biopsies have the highest rate of false negative results, but there may be variation in results between facilities.

### Normal results

A normal pathology report indicates no malignancy is present. The tissue sample may be further classified as a benign breast condition, such as tumor of the breast (**fibroadenoma**) or connective tissue that resembles fiber (fibrosis). Studies have demonstrated that approximately 80% of all breast biopsies result in a benign pathology report.

### Abnormal results

An abnormal pathology report indicates a cancer is present. If a fine needle aspiration biopsy was performed, the pathologist has viewed individual cells under a microscope to see if they appear cancerous. Large core needle biopsy and surgical biopsy will be able to give more information. This includes the type of cancer, whether it has invaded surrounding tissue, and how likely it is to spread quickly. There are some conditions that are not malignant but indicate high risk for future development of **breast cancer**. If these are identified, more frequent monitoring of the area may be recommended.

### ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, <http://www.cancer.org>.

National Cancer Institute (National Institutes of Health), NCI Office of Communications and Education, 6116 Executive Blvd. Suite 300, Bethesda, MD, 20892-8322, (800) 4-CANCER (422-6237), [cancergovstaff@mail.nih.gov](mailto:cancergovstaff@mail.nih.gov), <http://www.cancer.gov/>.

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## Breast cancer

### Definition

Breast **cancer** is caused by the development of abnormal cells in the breast. The abnormal cells originate in the lining of either the milk glands or the ducts of the breast (ductal epithelium), defining this malignancy as a cancer. Cancer cells are characterized by uncontrolled division leading to abnormal growth and the ability of these cells to invade normal tissue locally or to spread throughout the body, a process called metastasis.

## Breast cancer

- An estimated 207,090 **female** breast cancer cases were diagnosed in 2010.
- An estimated 1,970 **male** breast cancer cases were diagnosed in 2010.
- The lifetime risk of developing invasive breast cancer is 1 in 8 in females and 1 in 1,000 in males.
- In 2010, there were more than **2.5 million** breast cancer survivors living in the United States.

SOURCE: American Cancer Society, "What are the key statistics about breast cancer?" and "What are the key statistics about breast cancer in men?" Available online at <http://www.cancer.org/index> (accessed August 23, 2010).

(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

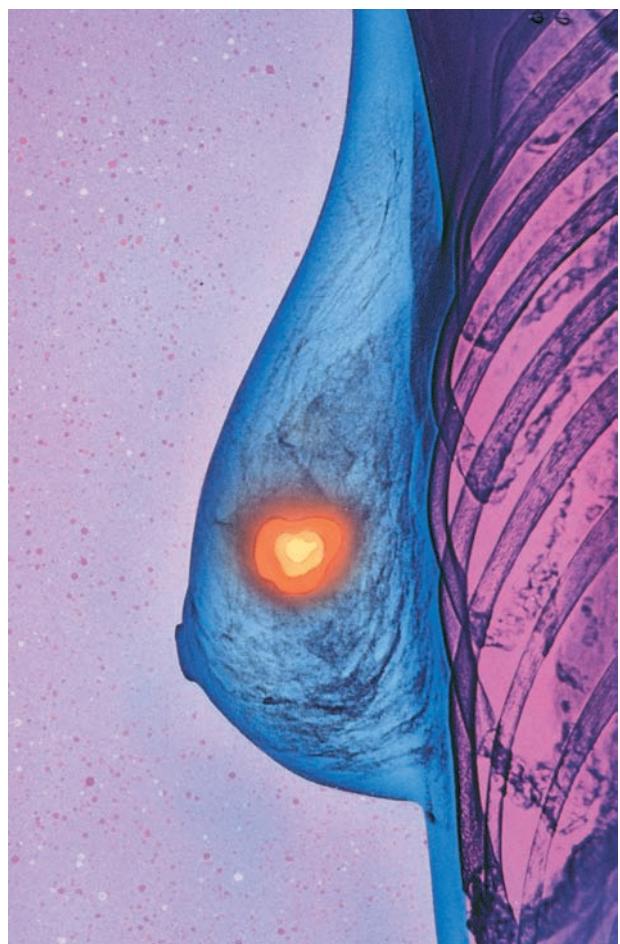
## Demographics

The American Cancer Society estimated that about 207,090 new cases of breast cancer and 54,010 cases of cancer *in situ* would be diagnosed in the United States in 2010. About 40,000 American women die of breast cancer each year; breast cancer is the second leading cause of cancer **death** in women. However, in the United States, there are 2.5 million breast cancer survivors. Both deaths from breast cancer and the number of newly diagnosed cases have declined in recent years in the United States. This is thought to be the result of earlier diagnosis from screening mammograms, improving therapies, and a dramatic decrease in the use of **hormone replacement therapy** (HRT) in postmenopausal women.

Male breast cancer is rare and accounts for less than 1% of all breast cancers. The American Cancer Society estimated that in 2010 1,970 new cases of invasive breast cancer would be diagnosed in men and about 390 men would die from the disease.

## Description

Breast cancer often arises in the milk-producing glands of the breast tissue. Groups of glands in normal breast tissue are called lobules. The products of these glands are secreted into a ductal system that leads to the nipple. Depending on where in the glandular or ductal unit of the breast the cancer arises, it will develop certain characteristics that are used to sub-classify breast cancer into types. Ductal carcinoma begins in the ducts, and lobular carcinoma has a pattern involving the lobules or glands. The pathologist will note the subtype at the time of evaluation with the microscope. The more important classification is related to the evaluated tumor's capability to invade, as this characteristic defines the disease as a true

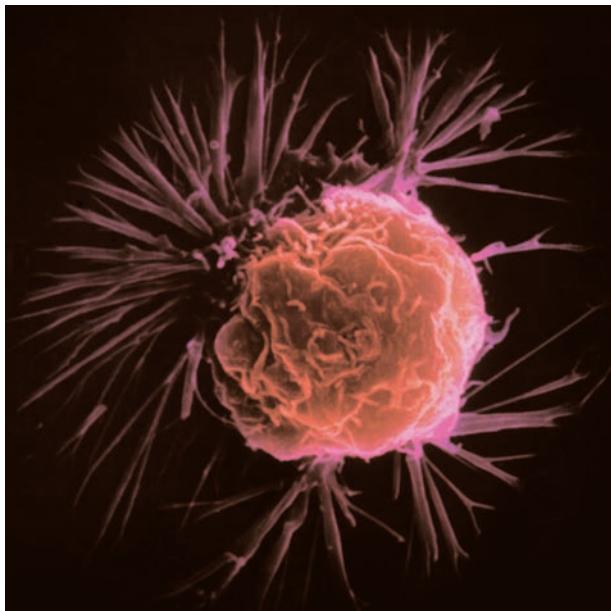


**Mammogram indicating a tumor in the center of the breast.**  
(Chris Bjornberg/Photo Researchers, Inc.)

cancer. The stage before invasive cancer is called *in situ*, meaning that the early malignancy has not yet become capable of invasion. Thus, ductal carcinoma *in situ* is considered a minimal breast cancer.

## How breast cancer spreads

The primary tumor begins in the breast itself, but once it becomes invasive, it may progress beyond the breast to the regional lymph nodes or travel (metastasize) to other organ systems in the body and become systemic in nature. Lymph is the clear, protein-rich fluid that bathes the cells throughout the body. Lymph works its way back to the bloodstream via small channels known as lymphatics. Along the way, the lymph is filtered through cellular stations known as lymph nodes. Nearly all organs in the body have a primary lymph node group filtering fluid that comes from that organ. In the breast, the primary lymph nodes are under the armpit, or axilla. Classically, the



**A breast cancer cell.** (© NIH/Phototake. — All rights reserved.)

primary tumor begins in the breast and the first place to which it is likely to spread is the regional lymph nodes. Cancer, as it invades in its place of origin, may also work its way into blood vessels. If cancer gets into the blood vessels, the blood vessels provide yet another route for the cancer cells to spread to other organs of the body.

Breast cancer follows this classic progression, although it often becomes systemic or widespread early in the course of the disease. By the time one can feel a lump in the breast it is often 0.4 inches (1 cm) in size and contains roughly one million cells. Research suggests that a tumor of this size may take one to five years to develop. During that time, the cancer may metastasize, or spread by lymphatics or blood to areas elsewhere in the body.

When primary breast cancer spreads, it may first go to the axillary nodes. If this occurs, regional metastasis exists. If it proceeds elsewhere either by lymphatic or blood-borne spread, the patient develops systemic metastasis that may involve a number of other organs in the body. Favorite sites of systemic involvement for breast cancer are the lung, bones, liver, skin, and soft tissue. As it turns out, the presence and actual number of regional lymph nodes containing cancer remains the single best indicator of whether or not the cancer has become widely metastatic. Because tests to discover metastasis in other organs may not be sensitive enough to reveal minute deposits of cancer cells, the evaluation of the lymph nodes

under the armpit for regional metastasis becomes very important in making treatment decisions for this disease.

If breast cancer spreads to other major organs of the body, its presence will compromise the function of those organs. Death is the result of extreme compromise of vital organ function.

### Risk factors

Every woman is at risk for breast cancer. If she lives to be 85, there is a one in eight chance (12%) that she will develop breast cancer sometime during her life. The rate is slightly higher for white women and slightly lower for black women. As a woman ages, her risk of developing breast cancer rises dramatically regardless of her ethnicity or family history. The breast cancer risk of a 25-year-old woman is only one out of 19,608; by age 45, it is one in 93. In fact, fewer than 5% of cases are discovered before age 35 and the majority of all breast cancers are found in women over age 50.

There are a number of other risk factors for the development of breast cancer; however, among experts there is some disagreement about how important each of these factors is. Risk factors include:

- a family history of breast cancer in mother or sister
- carrying the BRCA1 and BRCA2 genes; women with these genes account for 5–10% of breast cancer cases and have an 80% chance of developing breast cancer at some time during their life.
- history of abnormal breast biopsies or previous history of breast cancer
- having first menstruation before age 12 or entering menopause after age 55
- having no children or having a first child after age 30
- daily alcohol consumption of two drinks or more
- obesity and a high fat diet
- breast exposure to radiation (e.g., in treatment of other cancers)
- postmenopausal hormone replacement therapy (HRT) with a combination estrogen/progesterone drug; estrogen alone does not appear to increase risk, but the longer a woman uses HRT, the more her risk increases.

HRT provides significant relief of menopausal symptoms, prevention of **osteoporosis**, and possibly protection from cardiovascular disease and **stroke**. While physicians have long known a small increased risk for breast cancer was linked to use of HRT, a landmark study released in 2003 proved the risk was greater than thought. The Women's Health Initiative found that even relatively short-term use of estrogen

## KEY TERMS

**Adjvant therapy**—Treatment involving radiation, chemotherapy (drug treatment), or hormone therapy, or a combination of all three given after the primary treatment for the possibility of residual microscopic disease.

**Aneuploid**—An abnormal number of chromosomes in a cell.

**Benign**—Not malignant, noncancerous.

**Biopsy**—A procedure in which suspicious tissue is removed and examined by a pathologist for cancer or other disease. For breast biopsies, the tissue may be obtained by open surgery, or through a needle.

**Hormone**—Chemical produced by glands in the body that circulates in the blood and controls the actions of cells and organs. Estrogens are hormones that affect breast cancer growth.

**Hormone therapy**—Treating cancers by changing the hormone balance of the body, instead of by using cell-killing drugs.

**Lumpectomy**—A surgical procedure in which only the cancerous tumor in the breast is removed, together with a rim of normal tissue.

**Lymph nodes**—Small, bean-shaped masses of tissue scattered along the lymphatic system that act as filters and immune monitors, removing fluids, bacteria, or cancer cells that travel through the lymph system. Breast cancer cells in the lymph nodes under the arm or in the chest are a sign that the cancer has spread, and that it might recur.

**Malignant**—Cancerous.

**Mammography**—X-ray imaging of the breast that can often detect lesions in the tissue too small or too deep to be felt.

plus progestin is associated with increased risk of breast cancer, diagnosis at a more advanced stage of the disease, and a higher number of abnormal mammograms.

### Causes and symptoms

All cancer is thought to occur because of small changes (mutations) in genes. A gene is a small packet of deoxyribonucleic acid (DNA), the genetic master molecule of all cells that is inherited from each parent. Genes control all aspects of development and metabolism. Small changes in the structure of genes can cause changes in proteins that regulate metabolic functions. In healthy cells, cell division is controlled by proteins regulated by genes. Specific genes make proteins that signal healthy cells when to stop dividing. In cancer, the controlling gene(s) is damaged or mutated and does not produce the proteins necessary to signal cells to stop dividing. The mutations that cause breast cancer do not have a single cause. Genetic, environmental, and lifestyle factors all play a role in determining who gets breast cancer.

Of all the risk factors listed above, family history appears to be the most important. Some studies have found that about half of all familial breast cancer cases (families in which there is a high breast cancer frequency) have mutations affecting the genes BRCA1 or BRCA2. Other genes (e.g., ATM, CHEK2, p53, PTEN) have been identified that may influence the development of breast cancer, but their impact is

much less than the BRCA genes. Nevertheless, breast cancer due to heredity accounts for only a small proportion of breast cancer cases; only 5%–10% of all breast cancer cases will be women who inherited a high susceptibility through their genes.

Although there are many recognized risk factors, it is important to note that more than 70% of women who get breast cancer have no known risk factors. Having several risk factors may increase a woman's chance of developing breast cancer, but the interplay of predisposing factors is complex. In addition to those accepted factors listed above, some studies suggest that high-fat **diets, obesity**, or the use of alcohol can contribute to the risk profile.

Not all lumps detected in the breast are cancerous. Fibrocystic changes in the breast are extremely common. Also known as **fibrocystic condition of the breast**, fibrocystic changes are a leading cause of noncancerous lumps in the breast. Fibrocystic changes also cause symptoms of **pain**, swelling, or discharge and may become evident to the patient or physician as a lump that is either solid or filled with fluid. Complete diagnostic evaluation of any significant breast abnormality is mandatory because, although women commonly develop fibrocystic changes, breast cancer also is common, and the signs and symptoms of fibrocystic changes overlap with those of breast cancer. Certain benign changes in the breast also may be linked to increased risk for breast cancer.

## Diagnosis

The diagnosis of breast cancer is accomplished by the biopsy of any suspicious lump or mammographic abnormality that has been identified. (A biopsy is the removal of tissue for examination by a pathologist. A mammogram is a low-dose, 2-view, x-ray examination of the breast.) The patient may be prompted to visit her doctor upon finding a lump in a breast, or she may have noticed skin dimpling, nipple retraction, or discharge from the nipple. A patient may not have noticed a symptom or abnormality before a lump was detected by a screening mammogram.

### *When a patient has no signs or symptoms*

Screening involves the evaluation of women who have no symptoms or signs of a breast problem. **Mammography** has been helpful in detecting breast cancer that cannot be identified on **physical examination**. More than 90% of all breast cancers are detected by mammogram screening. However, about 10% of breast cancer does not show up on mammography, and a similar number of patients with breast cancer have an abnormal mammogram and a normal physical examination. These figures emphasize the need for regular examination as part of the screening process.

### *Screening*

All women are encouraged to do regular, monthly breast self-examinations. This involves feeling the breasts for any abnormal lumps or pain. If an uncertainty or a lump is found, evaluation by an experienced physician and a mammogram is recommended. The American Cancer Society (ACS) has made recommendations for the use of mammography on a screening basis. In 2009, the ACS guidelines recommended that women should begin annual screening at age 40. For women at high risk for breast cancer, the ACS recommends beginning screenings at an earlier age, having screening at more frequent intervals, and having **magnetic resonance imaging (MRI)** screening in addition to a standard mammogram. A list of conditions considered to put women at high risk for breast cancer can be found on the ACS Web site.

Because of the greater awareness of breast cancer in recent years, screening evaluations by examinations and mammography are performed much more frequently than in the past and is likely to be paid for by health insurance. As a result, the number of breast cancers diagnosed has increased, but the disease is being diagnosed at an earlier stage than previously. The earlier the stage of disease at the time it is discovered, the better the long-term outcome (prognosis) becomes.

### *When a patient has physical signs or symptoms*

A common finding that leads to diagnosis is the presence of a lump within the breast. Skin dimpling, nipple retraction, or discharge from the nipple are less frequent initial findings prompting biopsy. Though bloody nipple discharge is distressing, it is most often caused by benign disease. Skin dimpling or nipple retraction in the presence of an underlying breast mass on examination is a more advanced finding. Actual skin involvement, with swelling (**edema**) or ulceration of the skin, are late findings.

The presence of a breast lump is a common sign of breast cancer. If the lump is suspicious and the patient has not had a mammogram by this point, a study should be done on both breasts before anything else so that the original characteristics of the lesion can be studied. The opposite breast should also be evaluated mammographically to determine if other problems exist that were undetected by physical examination.

Whether an abnormal screening mammogram or one of the signs mentioned above followed by a mammogram prompted suspicion, the definitive diagnosis is established by obtaining tissue by biopsy of the area. There are different types of biopsies, each used with its own indication. If signs of widespread metastasis are already present, biopsy of the metastasis itself may establish diagnosis.

### *Biopsy*

Depending on the situation, different types of biopsy may be performed. The types include incisional and excisional biopsies. In an incisional biopsy, the physician takes a sample of tissue, and in excisional biopsy, the mass is removed. Fine needle aspiration biopsy and core needle biopsy are kinds of incisional biopsies.

**FINE NEEDLE ASPIRATION BIOPSY.** In a fine needle aspiration biopsy, a fine-gauge needle may be passed into the lesion and cells from the area suctioned into the needle can be quickly prepared for microscopic evaluation (cytology). (The patient experiencing nipple discharge also can have a sample taken of the discharge for cytological evaluation.) Fine needle aspiration is a simple procedure that can be done under **local anesthesia**, and will tell if the lesion is a fluid-filled cyst or whether it is solid. The sample obtained will yield much diagnostic information. Fine needle aspiration biopsy is an excellent technique when the lump is palpable and the physician can easily hit the target with the needle. If the lesion is a simple cyst, the fluid will be evacuated and the mass will disappear. If it is solid, the diagnosis may be obtained. Care must

be taken, however, because if the mass is solid and the specimen is nonmalignant, a complete removal of the lesion may be appropriate to be sure.

**CORE NEEDLE BIOPSY.** Core needle biopsies also are obtained simply under local anesthesia. The larger piece of tissue obtained with its preserved architecture may be helpful in confirming the diagnosis short of open surgical removal. An open surgical incisional biopsy is rarely needed for diagnosis because of the needle techniques. If there remains question as to diagnosis, a complete open surgical biopsy may be required.

**EXCISIONAL BIOPSY.** When performed, the excisional (complete removal) biopsy is a minimal outpatient procedure often done under local anesthesia.

**NON-PALPABLE LESIONS.** As screening increases, non-palpable lesions (abnormalities that cannot be felt by hand examination) demonstrated only by mammography are becoming more common. The use of x rays and computers to guide the needle for biopsy or to place markers for the surgeon performing the excisional biopsy are commonly employed. Some benign lesions can be fully removed by multiple directed core biopsies. These techniques are very appealing because they are minimally invasive; however, the physician needs to be careful to obtain a good sample.

### *Other tests*

If a lesion is not palpable and has simple cystic characteristics on mammography, ultrasound may be used both to determine that it is a cyst and to guide its evacuation. Ultrasound may also be used in some cases to guide fine needle or core biopsies of the breast.

Computed tomography (CT) scans are used only rarely in the evaluation of breast lesions. MRI is recommended for high-risk women and to follow up on suspicious findings from mammograms or for certain patients.

### *Staging*

Once diagnosis is established and before treatment is begun, more tests are done to determine if the cancer has spread beyond the breast. These tests include a **chest x ray** and blood count with **liver function tests**. Along with the liver function measured by the blood sample, the level of alkaline phosphatase, an enzyme from bone, is also determined. A radionuclear **bone scan** may be ordered. This test looks at the places in the body to which breast cancer usually metastasizes. A CT scan also may be ordered. The physician will do a careful examination of the axillae to assess likelihood of regional metastasis. Sometimes, the physician will remove all of the axillary lymph nodes

to assess breast cancer stage. However, recent studies show great success with sentinel **lymph node biopsy**. This technique removes the sentinel lymph node, or that lymph node that receives fluid drainage first from the area where the cancer is located. If this node is free of cancer, staging can be assigned accordingly. This method saves women the discomfort and side effects associated with removing additional lymph nodes in her armpit.

Using the results of these studies, the stage of cancer is defined for the patient. This helps establish a treatment protocol and prognosis. In the United States, formal staging is done using the TNM system. This system considers the tumor size and how much it has grown (T), whether the cancer has spread to the lymph nodes (N), and whether it has metastasized (M) to distant sites in the body. Stages are summarized below.

- Stage I. The cancer is no larger than 2 cm and no cancer cells are found in the lymph nodes.
- Stage II. The cancer is no larger than 2 cm but has spread to the lymph nodes or is larger than 2 cm but has not spread to the lymph nodes.
- Stage IIIA. Tumor is larger than 5 cm and has spread to the lymph nodes or is smaller than 5 cm and has spread to the lymph nodes, which have grown into each other.
- Stage IIIB. Cancer has spread to tissues near the breast or to lymph nodes inside the chest wall, along the breastbone.
- Stage IV. Cancer has spread to skin and lymph nodes near the collarbone or to other organs of the body.

### **Treatment**

Surgery, radiation, and **chemotherapy** all may be used in the treatment of breast cancer. Depending on the stage, they will be used in different combinations or sequences to effect an appropriate strategy for the type and stage of the disease being treated.

### *Surgery*

Historically, surgical removal of the entire breast and axillary lymph nodes, along with the muscles down to the chest wall (radical **mastectomy**), was performed as the preferred therapy for breast cancer. In the past 30 years, surgery remains a primary option, but other therapies have risen in importance. Recent studies have suggested that breast conserving treatment (as opposed to radical mastectomy) improves the quality of life for women without compromising survival. Ultimately, the extent of surgery depends on the type of breast cancer, whether the disease has spread, and the patient's age and health.

If the tumor is less than 1.5 in. (4 cm) in size and located so that it can be removed without destroying the reasonable cosmetic appearance of the residual breast, just the primary tumor and a rim of normal tissue will be removed. The axillary nodes will still be removed for staging purposes, usually through a separate incision. Because of the risk of recurrence in the remaining breast tissue, **radiation therapy** is used to lessen the chance of local recurrence. This type of primary therapy is known as **lumpectomy** (or segmental mastectomy) and axillary dissection.

Sentinel lymph node biopsy, a technique for identifying which nodes in the axilla drain the tumor, has been developed to provide selective sampling and further lessen the degree of surgical trauma the patient experiences.

When patients are selected appropriately based on the preoperative clinical stage, all of these surgical approaches have been shown to produce similar results. In planning primary surgical therapy, it is imperative that the operation is tailored to fit the clinical circumstance of the patient.

The pathologic stage of the cancer is evaluated after surgical treatment and defines additional treatment. In addition to stage, other tests may be necessary to aid in decisions regarding additional adjuvant therapies. Adjuvant therapies are treatments used after the primary treatment to help ensure that no microscopic disease exists and to help prolong patients' survival time or reduce pain.

### **Radiation therapy**

Like surgical therapy, radiation therapy is a local modality—it treats only the specific tissue exposed to radiation and not the rest of the body. Radiation is usually given post-operatively after surgical **wounds** have healed. The pathologic stage of the primary tumor is now known and this aids in treatment planning. The extent of the local surgery also influences the planning. Radiation may not be needed at all after modified radical mastectomy for stage I disease but is usually used when breast-preserving surgery is performed. If the tumor was extensive or if multiple nodes were involved, the field of tissue exposed will vary accordingly. Radiation is used as an adjunct to surgical therapy and is considered important to gaining local control of the tumor. In the past, radiation was used as an alternative to surgery on occasion. However, now that breast-preserving surgical protocols have been developed, primary radiation treatment of the tumor is no longer performed. Radiation also has an important role in the treatment of the patient with widespread

(disseminated) disease, particularly if it involves the skeleton. Radiation therapy can affect pain control and prevention of fracture in this circumstance.

### **Chemotherapy**

Survival after breast cancer surgery is improved by the addition of postoperative chemotherapy. Post-surgical chemotherapy therapy in patients who have no evidence of residual disease is now performed on the basis that some patients have metastases that are too small to be detectable. This occurs because it is unlikely that the surgeon has removed every single cancerous cell. Loose cancer cells, if not killed by chemotherapy, may travel through the circulatory system and form new tumors elsewhere. Chemotherapy may also be given in some circumstances before surgery. Chemotherapy is administered either orally or by injection into a blood vessel and usually involves multiple drugs. It is given in cycles, followed by a period of time for recovery, followed by another course of drugs.

Chemotherapy can produce significant side effects, including **nausea and vomiting**, temporary hair loss, mouth or vaginal sores, **fatigue**, weakened immune system, and **infertility**. Complementary therapies are often helpful in reducing some of these side effects.

### **Hormone therapy**

Many breast cancers, particularly those originating in postmenopausal women, are responsive to hormones. These cancers have receptors on their cells for the hormone estrogen. Part of the post-surgery primary tumor assessment is evaluation for the presence of estrogen and progesterone receptors. If they are present on the cancer cells, altering the hormone status of the patient will slow tumor growth and have a positive impact on survival. Hormonal status may be changed with drug therapy. The drug tamoxifen binds to estrogen receptors on the cancer cells, so that hormones cannot interact with the cells and stimulate their growth. If the patient has these receptors present, tamoxifen is commonly prescribed for five years as an adjunct to primary treatment. In women whose cancer cells have estrogen receptors, tamoxifen reduces the chance of breast cancer reoccurring by about 50%.

Toremifene (Fareston) and fulvestrant (Faslodex) are drugs similar to tamoxifen in that they target hormone receptors on cancer cells. They are often used when cancer cells are unresponsive to tamoxifen. In addition, a new group of drugs called aromatase inhibitors, which block the enzymes that produce estrogen

in postmenopausal (but not premenopausal) women, have been used to treat both early and late advanced breast cancer. These drugs include letrozole (Femara), anastrozole (Arimidex), and exemestane (Aromasin). Because of these agents, there is rarely any need for surgical removal of hormone-producing glands, such as the ovary or adrenal, that was sometimes necessary in the past.

### Biotherapeutics

Biotherapeutics are a type of targeted therapy. Large amounts of antibodies of a single type (called monoclonal antibodies) that react with specific receptors on cancer cells are made in the laboratory. When given to the patient, they inactivate or destroy those cells containing that specific receptor, but do not react with other cells. Trastuzumab (Herceptin) and Lapatinib (Tykerb) target cells that contain a growth protein known as HER/2. Between 15% and 25% of women have breast cancer that responds to these drugs. Bevacizumab (Avastin) is a biotherapeutic used to treat breast cancer that has metastasized. It helps prevent tumors from becoming established by interfering with the growth of blood vessels into the tumor. Without access to nutrients in the blood, the tumors cannot increase in size. Biotherapeutics are normally used in addition to chemotherapy drugs.

### Complementary treatments

Complementary treatments are alternative therapies used along with conventional medicine. They often are successful in moderating side effects of conventional treatment and improving the patient's quality of life. For example, **acupuncture** and **guided imagery** may be useful tools in treating pain symptoms and side effects of chemotherapy associated with breast cancer. Acupuncture involves the placement of a series of thin needles into the skin at targeted locations on the body, known as acupoints, in order to harmonize the energy flow within the human body. Guided imagery involves creating a visual mental image of pain. Once the pain can be visualized, the patient can adjust the image to make it more pleasing, and thus more manageable.

Many herbal remedies are available to lessen pain symptoms and chemotherapy side effects such as **nausea**, and to promote relaxation and healing. However, breast cancer patients should consult with their health-care professional before taking any herbal treatments. Depending on the preparation and the type of herb, these remedies may interact with and enhance or diminish the effects of other prescribed medications. One herb that is generally regarded as helpful in relieving

the nausea that accompanies chemotherapy is ginger (*Zingiber officinale*).

### Prognosis

The prognosis for breast cancer depends on the type and stage of cancer. Lymph node involvement is one of the best indicators of breast cancer survival rates. According to the American Cancer Society, As of 2010, the five-year survival rate for American women with carcinoma *in situ* and stage I breast cancer was 88%–93%. The five-year survival rate for women with stage II breast cancer was 74%–81%. Forty-one percent to 67% of stage III patients survive five years, and about 15% of stage IV patients do so.

### Prevention

Breast cancer cannot be prevented, but making lifestyle choices that eliminate the risk factors listed above is both prudent and promotes general health and well being. While regular breast exams and screening mammograms will not prevent breast cancer, they significantly aid in its early detection and treatment, thus increasing the chances of survival.

### Resources

#### BOOKS

- Hirshaut, Yashar and Peter Pressman. *Breast Cancer: The Complete Guide*, 5th ed. New York: Bantam Books, 2008.  
 Lewis, Shelley. *Five Lessons I Didn't Learn From Breast Cancer (And One Big One I Did)*. New York: Penguin Books, 2008.  
 Link, John S. *Breast Cancer Survival Manual: A Step-by-Step Guide for the Woman With Newly Diagnosed Breast Cancer*, 4th ed. New York: H. Holt, 2007  
 Miller, Kenneth D. *Choices in Breast Cancer Treatment: Medical Specialists and Cancer Survivors Tell You What You Need to Know*. Baltimore: Johns Hopkins University Press, 2008.

#### OTHER

- "Breast Cancer." Centers for Disease Control and Prevention. July 6, 2009 [September 22, 2009]. <http://www.cdc.gov/cancer/breast>.  
 "Breast Cancer." MedlinePlus. September 22, 2009 [September 23, 2009]. <http://www.nlm.nih.gov/medlineplus/breastcancer.html>.  
 "What You Need to Know About Breast Cancer." National Cancer Institute. November 1, 2007 [September 22, 2009]. <http://www.cancer.gov/cancertopics/wyntk/breast>.

#### ORGANIZATIONS

- American Cancer Society, 1599 Clifton Rd., NE, Atlanta, GA, 30329, (404) 320-3333, (800) ACS-2345 <http://www.cancer.org>.

Breast Cancer Network of Strength Headquarters, 135 S. LaSalle Street, Ste 2000, Chicago, IL, 60603, (312) 986-8338, (800) 221-2141 (English); (800) 986-9505 (Español), (312) 294-8597, <http://www.networkofstrength.org>.

Cancer Research and Prevention Foundation, 1600 Duke Street, Suite 500, Alexandria, VA, 22314, (703) 836-4412, (800) 227-2732 [info@preventcancer.org](mailto:info@preventcancer.org), <http://www.preventcancer.org>.

National Cancer Institute Public Inquires Office., 6116 Executive Boulevard, Room 3036A, Bethesda, MD, 20892-8322, (800) 4-CANCER, TTY (800) 332-8615, <http://www.cancer.gov>.

Richard A. McCartney, MD  
Tish Davidson, A.M.

Breast enlargement see **Breast implants**

## Breast implants

### Definition

Breast implantation is a surgical procedure for enlarging the breast. Breast-shaped sacks made of a silicone outer shell and filled with silicone gel or saline (salt water), called implants, are used.

### Purpose

Breast implantation is usually performed to make normal breasts larger for cosmetic purposes. Sometimes a woman having a **breast reconstruction** after a **mastectomy** will need the opposite breast enlarged to make the breasts more symmetric. Breasts that are very unequal in size due to trauma or congenital



A silicone breast implant. (AP Images.)

deformity may also be corrected with an enlargement procedure.

### Precautions

A woman in poor health or with a severe chronic disease is not a good candidate for this procedure.

A cosmetic breast enlargement is usually an outpatient procedure. It may be done under local or **general anesthesia**, depending on patient and physician preference. The incision is made through the armpit, under the breast, or around the areola (the darkened area around the nipple). These techniques create the most inconspicuous **scars**. The implant is placed between the breast tissue and underlying chest muscle, or under the chest muscle. The operation takes approximately one to two hours. The cost of a cosmetic procedure is rarely covered by insurance. However, if enlargement is part of breast reconstruction after a mastectomy, health plans may pay for some or all of it. The surgeon's fee ranges from \$2,700–\$4,200 and up. The procedure may also be called breast augmentation or augmentation mammoplasty.

### Preparation

Before the surgery is performed, the woman should have a clear understanding of what her new breasts will look like. She and her physician should agree about the desired final result. Many surgeons find it helpful to have the patient review before and after pictures, to clarify expectations.

### Aftercare

Driving and normal activities may be restricted for up to one week. Stitches are usually removed in seven to ten days. Typically, a woman can resume all routines, including vigorous **exercise**, in about three weeks. The scars will be red for approximately one month, but will fade to their final appearance within one or two years.

### Risks

Risks that are common to any surgical procedure include bleeding, infection, anesthesia reaction, or unexpected scarring. A breast enlargement may also result in decreased sensation in the breast or may interfere with **breastfeeding**. Implants can make it more difficult to read and interpret mammograms, possibly delaying **breast cancer** detection. The implant itself can rupture and leak, or become displaced. A thick scar that normally forms around the implant, called a capsule, can become very hard. This

is called capsular contracture, and may result in **pain** and/or an altered appearance of the breast. The older the implant, the greater the chances that these problems will occur.

There has been intermittent publicity about possible health risks from breast implants. Most concerns have focused on silicone gel-filled implants. The Food and Drug Administration (FDA) previously restricted the use of this type of implant but reapproved the use of silicone implants in 2006. Recent studies have shown no evidence of long-term health risks from silicone implants. However, research on the possible links between these implants and autoimmune or connective tissue diseases is continuing.

### Normal results

Breasts of expected size and appearance would be the normal results of this surgery.

#### ORGANIZATIONS

American Society of Plastic Surgeons, 444 E. Algonquin Rd, Arlington Heights, IL, 60005, (847) 228-9900, <http://www.plasticsurgery.org/>.

Ellen S. Weber, MSN

Breast infection see **Mastitis**

Breast radiography see **Mammography**

## Breast reconstruction

### Definition

Breast reconstruction is a series of surgical procedures performed to recreate a breast. Reconstructions are commonly done after one or both breasts are removed as a treatment for **breast cancer**. Also, a breast may need to be refashioned for other reasons, such as trauma or abnormalities that occur during breast development.

### Purpose

Many authorities consider reconstruction an integral part of the therapy for breast **cancer**. A breast that appears natural offers a sense of wholeness and normalcy, which can aid in the psychological recovery from breast cancer. It eliminates the need for an external prosthesis (false breast), which many women find physically uncomfortable as well as inconvenient.

### Precautions

Not all women are good candidates for breast reconstruction. Overall poor physical health, or specific problems such as cigarette **smoking**, **obesity**, high blood pressure, or diabetes, will increase the chance of complications. Also, a difficult and/or prolonged recovery period or failure of the reconstruction may occur. A woman's physical ability to cope with major surgery and recuperation also need to be considered.

### Description

Breast reconstruction is done in two stages, with the ultimate goal of creating a breast that looks and feels as natural as possible. It is important to remember that while a good result may mimic a normal breast closely, there will inevitably be **scars** and loss of sensation. The reconstructed breast cannot be exactly like the original.

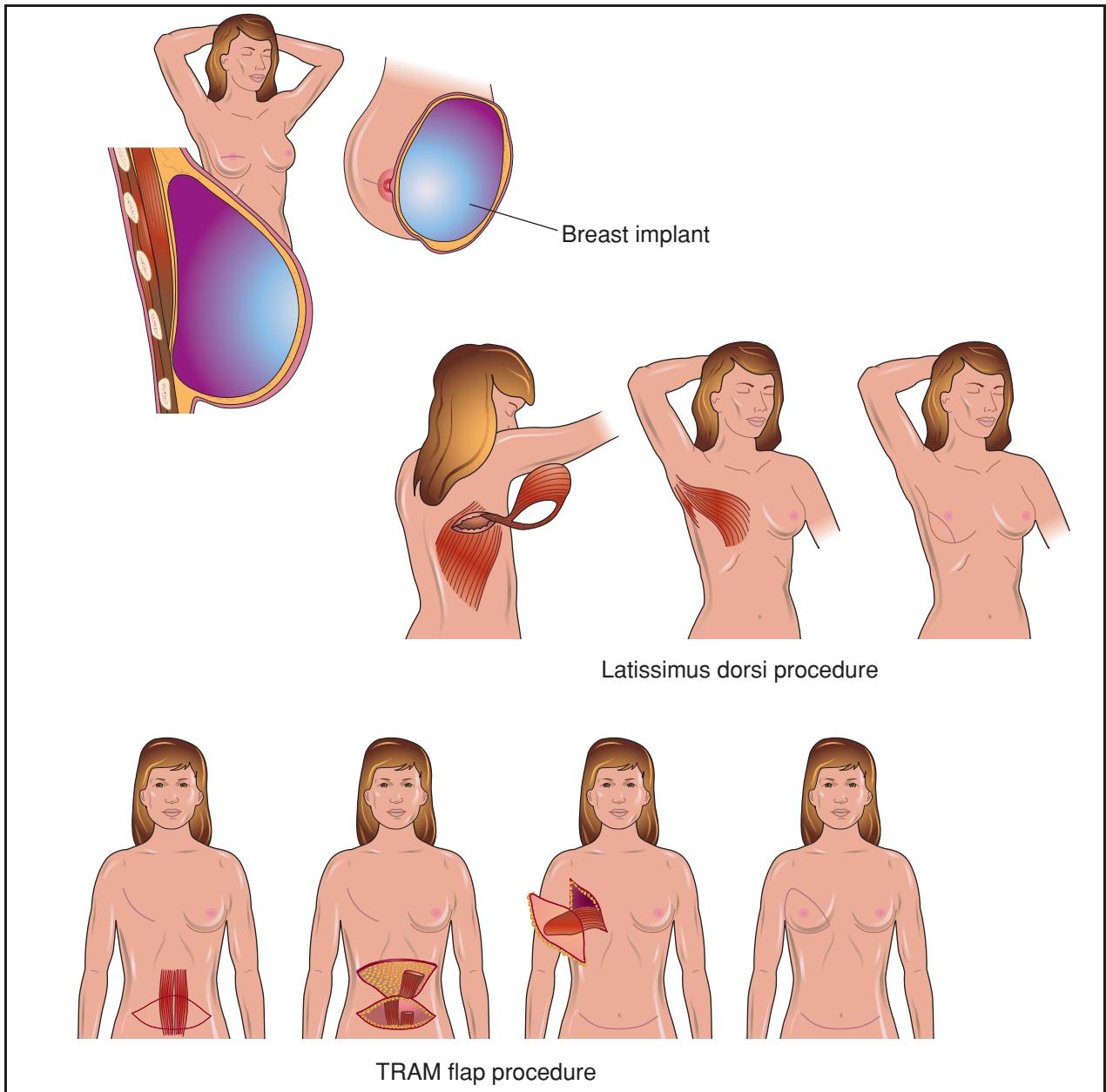
The first step is to form a structure called a breast mound. This can be accomplished using artificial materials called **breast implants**, or by using tissues from other parts of the woman's body. The second step involves creating a balance between the newly constructed breast and the breast on the opposite side. The nipple and areolar complex (darker area around the nipple) are recreated. This is usually done several months after the mound is created, to allow swelling to go down. Other procedures may be necessary, such as lifting the opposite breast (mastopexy), or making it larger or smaller to match the reconstructed breast.

### *Timing, immediate or delayed reconstruction*

While immediate reconstruction (IR) is not recommended for women with breast cancer who need to undergo other, more important treatments, breast reconstruction can be done almost anytime. It even can be done during the same procedure as the **mastectomy**, or it can be delayed. There are psychological benefits to IR. The ability to return to normal activities and routines is often enhanced when reconstruction follows immediately after mastectomy. A better appearance may result from IR. There is less skin removal, often resulting in a shorter scar. The surgeon is better able to preserve the normal boundaries of the breast, so it is easier to match the opposite breast more closely.

The cost of IR is generally lower than the cost of delayed reconstruction (DR). There is one fewer operation and hospital stay. Surgeon's fees may be lower for a combined procedure than for two separate surgeries.

There are disadvantages of IR as well. The surgery itself is longer, causing more time under anesthesia.



Breast reconstruction surgery may be performed by inserting an artificial substance, or implant, to replace breast tissue. Autologous reconstruction, in which a woman's own tissues are used, includes the latissimus dorsi flap, where skin and muscle taken from the back are rotated around to the breast area, and the TRAM flap, in which abdominal fat and muscle are tunneled under the skin to the breast area. (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

Post-operative **pain** and recovery time will be greater than for mastectomy alone.

Other authorities contend that delayed reconstruction (DR) offers different physical and psychological advantages. The initial mastectomy procedure alone takes less time, and has a shorter recovery period and less pain than mastectomy and IR. The patient has more

time to adjust to her diagnosis and recover from additional therapy. She is better able to research her options, and to formulate realistic goals for reconstruction. Some **reconstructive surgery** requires blood transfusions. With DR, the patient can donate her own blood ahead of time (autologous **transfusion**), and/or arrange to have family and friends donate blood for her use (directed donation).

## KEY TERMS

**Autologous**—From the same person. An autologous breast reconstruction uses the woman's own tissues. An autologous blood transfusion is blood removed then transfused back to the same person at a later time.

**Capsular contracture**—Thick scar tissue around a breast implant, which may tighten and cause discomfort and/or firmness.

**Flap**—A section of tissue moved from one area of the body to another.

**Free flap**—A section of tissue detached from its blood supply, moved to another part of the body, and reattached by microsurgery to a new blood supply.

**Mastopexy**—Surgical procedure to lift up a breast. May be used on opposite breast to achieve symmetrical appearance with a reconstructed breast.

**Pedicle flap**—Also called an attached flap. A section of tissue with its blood supply intact, which is maneuvered to another part of the body.

The psychological **stress** of living without a breast is a disadvantage of DR. The extra procedure DR entails results in higher costs. Although initial recovery is faster, an additional recuperation period is required after the delayed operation.

### Type of reconstruction

There are two basic choices for breast reconstruction. The breast tissue can be replaced with an implant or the breast is created using some of the woman's own tissues (autologous reconstruction).

**ARTIFICIAL IMPLANTS.** In general, implant procedures take less time and are less expensive than autologous ones. Implants are breast-shaped pouches. They are made of silicone outer shells, which may be smooth or textured. The inside may contain silicone gel, saline (salt water), or a combination of both.

An implant may be a fixed-volume type, which cannot change its size. Implants that have the capacity to be filled after insertion are called tissue expanders. These may be temporary or permanent.

The initial procedure for any implant insertion uses the mastectomy incision to make a pocket of tissue, usually underneath the chest wall muscle. In DR, the mastectomy scar may be re-opened and used for this purpose, or a more cosmetic incision may be made. The implant is inserted into the pocket, and the skin is stretched as needed and stitched closed.

If there is inadequate tissue to achieve the desired size, or a naturally sagging breast is desired, a tissue expander is used. It resembles a partially deflated balloon, with an attached valve or port through which saline can be injected. After the initial surgical incision is healed, the woman returns to the doctor's office, on a weekly or biweekly basis, to have small amounts of saline injected. Injections can continue for about six to

eight weeks, until the preferred size is obtained. In some cases it may be overfilled, and later partially deflated to allow for a more pliable, natural result. A temporary tissue expander will be removed after several months and replaced with a permanent implant.

IR surgery using an implant takes approximately two to three hours, and usually requires up to a three-day hospital stay. Implant insertion surgery, as part of DR, takes one to two hours and can sometimes be done as an outpatient, or it may entail overnight hospitalization.

**AUTOLOGUS RECONSTRUCTION.** Attached flap and free flap are two types of surgery where a woman's tissue is used in reconstruction. An attached flap uses skin, muscle, and fat, leaving blood vessels attached to their original source of blood. The flap is maneuvered to the reconstruction site, keeping its original blood supply for nourishment. This may also be known as a pedicle flap. The second kind of surgery is called a free flap. This also uses skin, muscle, and fat, but severs the blood vessels, and attaches them to other vessels where the new breast is to be created. The surgeon uses a microscope to accomplish this delicate task of sewing blood vessels together. Sometimes the term microsurgery is used to refer to free flap procedures. Either type of surgery may also be called a myocutaneous flap, referring to the skin and muscle used.

The skin and muscle used in autologous reconstruction can come from one of several possible places on the body, including the abdomen (TRAM flap or "tummy tuck"), the back (latissimus dorsi flap), or the buttocks (gluteus maximus free flap).

### Finishing the reconstruction

Other procedures may be necessary to achieve the goal of symmetrical breasts. It may be necessary

to make the opposite breast larger (augmentation), smaller (reduction), or higher (mastopexy). These or any other refinements should be completed before the creation of a nipple and areola. Tissue to form the new nipple may come from the reconstructed breast itself, the opposite breast, or a more distant donor site, such as the inner thigh or behind the ear. The nipple and areolar construction is usually an outpatient procedure. A final step, often done in the doctor's office, is tattooing the new nipple and areola to match the color of the opposite nipple and areola as closely as possible.

### Insurance

Insurance coverage for breast reconstruction varies widely. Some policies will allow procedures on the affected breast, but refuse to pay for alterations to the opposite breast. Other plans may cover the cost of an external prosthesis, or reconstructive surgery, but not both.

Implants may pose additional insurance concerns. Some companies will withdraw coverage for women with implants, or add a disclaimer for future implant-related problems. Careful reading of insurance policies, including checking on the need for pre-approval and/or a second opinion, is strongly recommended.

### Preparation

Routine preoperative preparations, such as taking nothing to eat or drink the night before surgery, are needed for reconstructive procedures. If blood transfusion is required, the patient or family and friends will donate several weeks before the surgery.

Emotional preparation is also important. Breast reconstruction will not resolve a psychological problem the woman had before mastectomy, nor make an unstable relationship strong. An expectation of physical perfection is unrealistic. A woman who cites any of these reasons for reconstruction shows that she has not been adequately informed or prepared. Complete understanding of the benefits and limitations of this surgery is necessary for a satisfactory result.

### Aftercare

The length of the hospital stay, recovery period, and frequency of visits to the doctor after surgery vary considerably with the different kinds of reconstruction. In general, autologous procedures require longer hospitalization and recovery time than implant procedures. **Bandages** and drainage tubes remain in place for at least a day for all surgeries. Microsurgical or free flaps are most closely monitored in the first day or two after surgery. The circulation to the breast may be checked as often as

every hour. Complete breast reconstruction requires at least one additional surgery to create a nipple and areola. Scars may remain red and raised for a month or longer. The true, final appearance of the breasts will not be visible for at least one year.

### Risks

Some women have reported various types of autoimmune-related connective tissue disorders, which they attribute to their implants—usually involving silicone gel implants. Food and Drug Administration (FDA) guidelines issued in 1992 limited their use, but these restrictions were removed in 2006 due to a lack of evidence. However, the use of silicone gel-filled implants will continue to be closely monitored, and manufacturers of these implants are required to conduct 10-year consumer studies. Saline-filled implants are permitted for all uses, although manufacturers must also collect data on possible risks.

There are a number of risks common to any surgical procedure such as bleeding, infection, anesthesia reaction, or unexpected scarring. Hematoma (accumulation of blood at the surgical site) or seroma (collection of fluid at the surgical site) can delay healing if not drained. Any breast reconstruction also poses a risk of asymmetry and/or the need for unplanned surgical revision. Persistent pain is another potential complication possible with all types of breast reconstruction.

Implants have some unique problems that may develop. A thick scar, also called a capsule, forms around the implant, as part of the body's normal reaction to a foreign substance. Capsular contracture occurs when the scar becomes firm or hardened. This may cause pain and/or change the texture and appearance of the breast. Implants can rupture and leak, deflate, or become displaced. The chances of capsular contracture or rupture increase with the age of the implant. These complications can usually be remedied with outpatient surgery to loosen the capsule or remove and/or replace the implant as needed. There is some evidence that using implants with textured surfaces may decrease the incidence of these problems. An implant tends to remain firm indefinitely. It will not grow larger or smaller as the woman's weight changes. Asymmetry can develop if a woman gains or loses a large amount of weight.

The autologous procedures all carry a risk of flap failure—loss of blood supply to the tissue forming the new breast. If a large portion of the flap develops inadequate blood supply, another reconstructive technique may be necessary. TRAM flap procedures can result in decreased muscle tone and weakness in the

abdomen and/or abdominal **hernia**. Arm weakness may occur after latissimus dorsi flap surgery.

### Normal results

A normal result of breast reconstruction depends on the woman's goals and expectations. It will not be the same as the breast it replaces. In general, it should be similar in size and shape to the opposite breast, but will have less sensation and be less mobile than a natural breast. A reconstruction using implants will usually be firmer and rounder than the other breast. It may feel cooler to touch, depending on the amount of tissue over it. Scars are unavoidable, but should be as unobtrusive as possible.

Breast reconstruction surgery may be performed by inserting an artificial substance, or implant, to replace breast tissue. Autologous reconstruction, in which a woman's own tissues are used, includes the latissimus dorsi flap, where skin and muscle taken from the back is rotated around to the breast area, and the TRAM flap, in which abdominal fat and muscle are tunneled under the skin to the breast area.

### ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, <http://www.cancer.org>.

American Society of Plastic Surgeons, 444 E. Algonquin Rd, Arlington Heights, IL, 60005, (847) 228-9900, <http://www.plasticsurgery.org/>.

Ellen S. Weber, MSN

## Breast reduction

### Definition

Breast reduction is a surgical procedure performed in order to decrease the size of the breasts.

### Purpose

Women with very large breasts (macromastia or mammary hyperplasia) seek breast reduction for relief of **pain** in the back, shoulder, and neck. They may also feel uncomfortable about their breast size and have difficulty finding clothing that will fit properly. Additionally, breast reduction may be needed after **reconstructive surgery** following the surgical removal of cancerous breast tissue (**mastectomy**), to make the breasts more symmetric.

### KEY TERMS

**Gynecomastia**—Overly developed or enlarged breasts in a male.

**Macromastia**—Excessive size of the breasts.

**Mammary hyperplasia**—Increased size of the breast.

Men who have enlarged breasts (**gynecomastia**) may also be candidates for breast reduction. However, excessive alcohol intake, smoking marijuana, or using anabolic **steroids** may cause gynecomastia, and surgery is not recommended for men who continue to use these products.

### Precautions

Breast reduction is not recommended for women whose breasts are not fully developed or who plan to breast feed.

### Description

Breast reduction may also be called reduction mammoplasty. It is most often done in the hospital, under general anesthetic. However, studies have suggested that an outpatient procedure using local anesthetic and mild **sedation** may be appropriate for some patients. The operation takes approximately two to four hours. The most commonly made incision encircles the areola (darkened area around the nipple) and extends downward and around the underside of the breast. This produces the least conspicuous scar. The excess tissue, fat, and skin are removed, and the nipple and areola are repositioned. In certain cases, **liposuction** (fat suctioning) is used to remove extra fat from the armpit area. A hospital stay of up to three days may be needed for recovery.

If deemed medically necessary, breast reduction is covered by some insurance plans. However, a specified amount of breast tissue may need to be removed in order to qualify for coverage. Surgeon's fees range from \$4,800–\$6,500 and up.

### Preparation

Consultation between surgeon and patient is important to ensure that the woman understands and agrees with the expected final results of the procedure. Measurements and photographs may be taken. Many doctors also recommend a mammogram before the operation, to make sure there is no **cancer**.

## Aftercare

After the surgery, an elastic bandage or special supportive bra is placed over gauze **bandages** and drainage tubes. The bandages and tubes are removed in a day or two. The bra will need to be worn around the clock for several weeks. Stitches are removed one to three weeks after the operation. Normal activities, including sexual relations, may be restricted for several weeks. **Scars** will typically remain red and perhaps lumpy for up to several months, but will gradually fade and become less noticeable. It may take up to a year before the breasts achieve their final position and size.

## Risks

Risks common to any operation include bleeding, infection, anesthesia reactions, or unexpected scarring. Breast reduction may result in decreased feeling in the breasts or nipples and/or impaired ability to breastfeed. When healing is complete, the breasts may be slightly uneven, or the nipples may be asymmetric.

## Normal results

Smaller breast size should be achieved, and with that, the accompanying pain and discomfort should be alleviated.

### ORGANIZATIONS

American Society of Plastic Surgeons, 444 E. Algonquin Rd, Arlington Heights, IL, 60005, (847) 228-9900, <http://www.plasticsurgery.org/>.

Ellen S. Weber, MSN

# Breast self-examination

## Definition

A breast self-examination (BSE) is an inspection by a woman of her breasts to detect **breast cancer**.

## Purpose

A BSE is one of three tests the American Cancer Society recommends to help detect breast cancer in its earliest stages. By regularly examining her own breasts, a woman is more likely to find any changes that may have occurred. The best time to perform a BSE is about a week after a woman's period ends, when her breasts are not tender or swollen. If her periods are not regular, a BSE should be completed on the same day every month. A BSE should also be regularly completed by women who are pregnant, **breastfeeding**, or have **breast implants**. By

combining a BSE with a **mammography** and clinical breast examination, a woman is offered the best opportunity for reducing chances of **death** from breast cancer through early detection. Close to 90% of breast cancers are found through a BSE. The American Cancer Society recommends that beginning at the age of 20, women complete a BSE each month by feeling for lumps or anything suspicious, as well as looking at their breasts carefully in a mirror for any changes in contour, swelling, dimpling, puckering of the skin, or changes in the nipple.

## Description

To complete a monthly BSE:

- When lying down, place a pillow under the right shoulder and position the right arm behind the head. Using the finger pads of the three middle fingers on the left hand, check the entire breast area. Use small circles and follow an up-and-down pattern while pressing firmly enough to know how the breast feels from month to month. This exam should then be repeated on the left breast using the finger pads of the right hand with the pillow under the left shoulder.
- When standing before a mirror, any changes in the shape or look of the breasts should be checked. In order to look for any skin or nipple changes such as dimpling or nipple discharge, the arms should first be placed at the sides and then overhead. Hands are then placed firmly on hips to flex chest muscles, and then the body should be bent forward.
- When taking a shower, the right arm should be raised. By using soapy hands and flat fingers the right breast and outer part of the breast can be examined. The same small circles and up-and-down pattern used when lying down should be used in an upright position. Repeat on the left breast.

## Preparation

Before beginning a monthly BSE, a woman's breasts should be completely exposed.

## Normal results

Each woman's breasts have their own normal look and feel. By completing a BSE each month, a woman can determine what is normal for her and check for changes that may arise. A regular pattern of lumpiness in the breasts is normal.

## Abnormal results

If any changes are noticed during a monthly BSE, such as a new, hard lump in the breast or underarms, a doctor should examine the area immediately. Other trouble signs that should not be ignored include:

- change in breast size or shape
- dimpling or puckering of the skin
- redness, swelling, or warmth that does not go away
- a pain in one area that does not vary with a woman's monthly cycle
- a nipple that pulls in
- discharge from the nipple that begins suddenly and appears only in one breast
- one nipple that has an itchy, sore, or scaling area

## Resources

### BOOKS

Sarg. Michael J., and Ann D. Gross. *The Cancer Dictionary*. 3rd ed. New York: Checkmark Books, 2007.

### OTHER

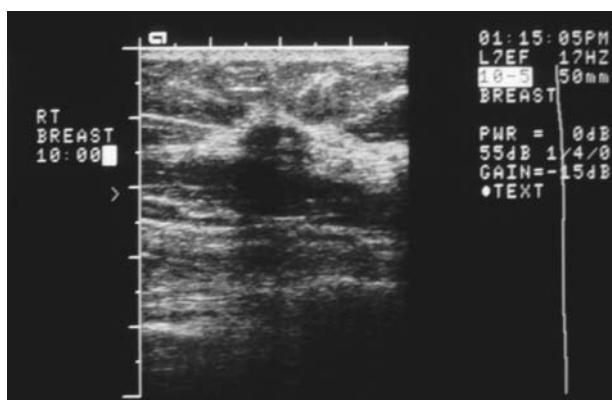
"How to do a Breast Self-Exam." Women.com. May 5, 2001. <http://www.women.com>.

### ORGANIZATIONS

American Cancer Society, 1599 Clifton Rd. NE, Atlanta, GA, 30329, (800) 227-2345, <http://www.cancer.org>.  
Komen Foundation, 5005 LBJ Freeway, Suite 250, Dallas, TX, 75244, (877) GO KOMEN, <http://www.komen.org/>.

Beth A. Kapes

Breast sonogram see **Breast ultrasound**



**Breast ultrasound**

**A breast ultrasound image.** (Custom Medical Stock Photo, Inc. Reproduced by permission.)

mammograms can be difficult to interpret due to the density of their breast tissue. In 2003, a new study found that ultrasound was more accurate than **mammography** at diagnosing **breast cancer** in women under age 45. However, mammography still works as a screening tool, with breast ultrasound as the follow-up examination. Another study in that year found that combining ultrasound with **magnetic resonance imaging** (MRI) direction greatly improved diagnostic decisions about breast cancer lesions. The lesions detected by MRI could also be localized using ultrasound needle guidance for follow-up biopsy.

The lack of radiation used with ultrasound makes it ideal for studying breast abnormalities in women who are pregnant. Assessing **breast implants** for leakage or rupture is another use for ultrasound. Breast inflammation, where pockets of infection or abscesses may form, can be diagnosed and monitored by ultrasound.

Thickened and swollen breast skin may be a sign of inflammatory breast cancer. Ultrasound can sometimes identify a cancerous growth within the breast causing the thickened skin. These cases are usually followed by a core biopsy guided by ultrasound.

Breast ultrasound is employed to observe and guide a needle for several interventional procedures. These include cyst aspiration, fine needle aspiration, large core needle biopsy (as a first step in determining treatment for a lesion that is likely to be cancerous), and needle localization in surgical **breast biopsy**. Biopsies guided by ultrasound have distinct advantages. Patients usually find that the procedure is less traumatic and more comfortable than surgical biopsies. Ultrasound is known for its accuracy in determining how far a cancerous growth extends into the surrounding tissue in lesions that cannot be felt. Biopsies guided

## Breast ultrasound

### Definition

Breast ultrasound (or sonography) is an imaging technique for diagnosing breast disease, such as **cancer**. It uses harmless, high frequency sound waves to form an image (sonogram). The sound waves pass through the breast and bounce back or echo from various tissues to form a picture of the internal structures. It is not invasive and involves no radiation.

### Purpose

Breast ultrasound may be used in several ways. The most common application is to investigate a specific area of the breast where a problem is suspected. A palpable lump and/or a lump or density discovered by x-ray imaging (mammogram) can be further evaluated by ultrasound. It is especially helpful in distinguishing between a fluid-filled cyst and a solid mass. It also can identify small lesions that are too tiny to be felt.

Breast ultrasound is often the first study performed to evaluate masses in women under 35 whose

## KEY TERMS

**Cyst**—A thin-walled, fluid-filled benign structure in the breast.

**Ductal carcinoma**—A type of cancer that accounts for as much as 80% of breast cancers. These tumors feel bigger than they look on ultrasound or mammogram.

**Fibroadenoma**—A benign breast growth made up of fibrous tissue. It is the most common mass in women under 35 years of age, and is found in both breasts in 3% of cases.

**Infiltrating lobular carcinoma**—A type of cancer that accounts for 8% to 10% of breast cancers. In breasts that are especially dense, ultrasound can be useful in identifying these masses.

**Microcalcifications**—Tiny flecks that are too small to be felt. They are important markers of cancer that show up on ultrasound and mammogram.

**Mucinous (colloid) carcinoma**—A type of cancer that accounts for 1% to 2% of breast cancers. Resembles medullary carcinoma in ultrasound and mammogram, but usually affects older women.

**Nonpalpable**—Cannot be felt by hand. In cancer, growths that are nonpalpable are too small to be felt, but may be seen on ultrasound or mammogram.

**Papillary carcinoma**—A type of breast cancer that primarily occurs in older women. On ultrasound, this type of tumor may look like a solid or complex mass, or it may show up as solid tissue protruding into a cyst.

**Tubular carcinoma**—A type of cancer that accounts for approximately 1% to 2% of breast cancers. Can appear small on ultrasound or mammogram.

by ultrasound are generally less costly than surgical biopsies. Additionally, if the abnormality that requires biopsy can be seen on both a mammogram and ultrasound, an ultrasound-guided biopsy is often more comfortable for the patient as no compression is necessary.

### Description

Ultrasound can be done in a doctor's office or another outpatient setting, such as a hospital or imaging center.

The patient removes her clothing from the waist up and puts on a hospital gown, open in the front. She lies on her back or side on an examining table. A gel that enhances sound transmission is spread over the area to be examined. The technologist then places a transducer, an instrument about the size of an electric shaver, against the skin. The images from reflected sound waves appear on a monitor screen.

A physician called a radiologist interprets the images obtained from ultrasound imaging. In 2003, it was reported that new computer-aided diagnosis (CAD) technology that had recently been widely added to mammography may help improve ultrasound as well. The CAD system uses computer algorithms applied to a three-dimensional ultrasound image to assign scores to mass characteristics. Though the technology will not replace human observation and judgment, it may soon be added to support the radiologist's interpretation.

A good ultrasound study is difficult to obtain if the patient is unable to remain quietly in one position. **Obesity** may hinder clear viewing of internal structures, and the accuracy of an ultrasound study is highly dependent on the skill of the person performing the examination. The images recorded vary with the angle and pressure of the transducer and the equipment settings. The examination may take from 30 to 45 minutes. Most insurance plans cover the cost of an ultrasound examination.

### Normal results

An ultrasound examination may reveal either normal tissue or a benign condition such as a cyst. Ultrasound can confidently diagnose a benign structure that has certain characteristics of a simple cyst. In the case of a simple cyst with no symptoms, additional treatment beyond continued observation is usually not needed.

### Abnormal results

A potentially malignant mass can be identified by breast ultrasound. Abnormal results fall into the following categories: benign fibrous nodule, complex cyst, suspicious lesion, and lesion highly suggestive of cancer. In cases where ultrasound shows the presence of a complex cyst or fibrous nodule, a biopsy is justified because 10% to 15% of these growths are malignant. Lesions falling into the last two categories (suspicious or highly suggestive of cancer) have a higher chance of

being cancerous and should be investigated further, either by biopsy or surgery.

Breast cancers such as the following may be identified on ultrasound: ductal carcinoma, infiltrating lobular carcinoma, medullary carcinoma, mucinous (colloid) carcinoma, tubular carcinoma, and papillary carcinoma. On ultrasound, the shape of a lesion and the type of edges it has can sometimes indicate if it is benign or cancerous, but there are exceptions. For example, benign fibroadenomas are usually oval, and some cancers can be similarly shaped. Cancerous tumors usually have jagged edges, but some benign growths can have these edges as well. Ultrasound is not a definitive test. Tissue diagnosis is often required.

## Resources

### PERIODICALS

- “CAD Software Improves Breast Ultrasound, Digital Mammograms.” *Cancer Weekly* (December 23, 2003): 13.
- Rubin, Eva, et al. “Reducing the Cost of Diagnosis of Breast Carcinoma: Impact of Ultrasound and Imaging-Guided Biopsies on a Clinical Breast Practice.” *Cancer* 91 (January 2001): 324–31.
- Trevino, Merlino. “MR-directed US Provides Economical Breast Diagnosis — Ultrasound Characterizes Indeterminate Lesions Already Found by MRI.” *Diagnostic Imaging* (April 1, 2003): 59.

Ellen S. Weber, MSN  
Teresa G. Odle

Breast x ray see **Mammography**

<b>Breastfeeding and medication interactions</b>	
<b>Drug name</b>	<b>Use or condition treated</b>
<b>Safe to take in prescribed or standard doses:</b>	
Acetaminophen (e.g., Tylenol)	Pain relief
Antacids (e.g., Maalox, Tums)	Heartburn, upset stomach
Caffeine	Stimulant
Clotrimazole (Lotrimin, Mycelex)	Antifungal
Decongestant nasal sprays (e.g., Afrin)	Nasal congestion
Fexofenadine (Allegra)	Antihistamine
Ibuprofen (e.g., Advil, Motrin)	Pain relief
Inhalers, bronchodilators, and corticosteroids	Asthma
Insulin	Diabetes
Loratadine (Claritin)	Antihistamine
Metoprolol (Lopressor, Toprol)	Hypertension
Penicillins	Bacterial infection
Propranolol (Inderal)	Hypertension
Warfarin (Coumadin)	Anticoagulant
<b>Not safe to take in any dose:</b>	
Amantadine	Influenza or Parkinson's disease
Antilipemics (excluding resins) or lipid-lowering drugs	High cholesterol
Antineoplastic agents	Cancer
Aspirin (large doses)	Arthritis
Clozapine	Schizophrenia
Salicylates, large doses	Arthritis

SOURCE: BabyCenter, “Drug safety during breastfeeding.” Available online at: [http://www.babycenter.com/0\\_drug-safety-during-breastfeeding\\_8790.bc](http://www.babycenter.com/0_drug-safety-during-breastfeeding_8790.bc) (accessed September 20, 2010). Information derived from the U.S. National Library of Medicine’s Drugs and Lactation Database (LactMed), available online at: <http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?LACT>.

(Table by PreMediaGlobal. Reproduced by permission of Gale, a part of Cengage Learning.)

## Description

The mother’s body prepares for breastfeeding while she is pregnant. The fatty tissue of the breast is replaced by glandular tissue that is necessary to produce milk. When baby suckles the breast the hormone oxytocin is released. This causes the muscle cells of the breast to squeeze milk from the milk ducts to the nipple.

## History

Since the advent of humans, mothers have breastfed their babies. During ancient times mothers breastfed their babies for 12–18 months or until the mother’s menstrual cycle returned.

For thousands of years breastfeeding was the only source of nutrition for the first part of a baby’s life. Before the invention of infant formula, few alternatives were available. If a mother could not breastfeed, a wet

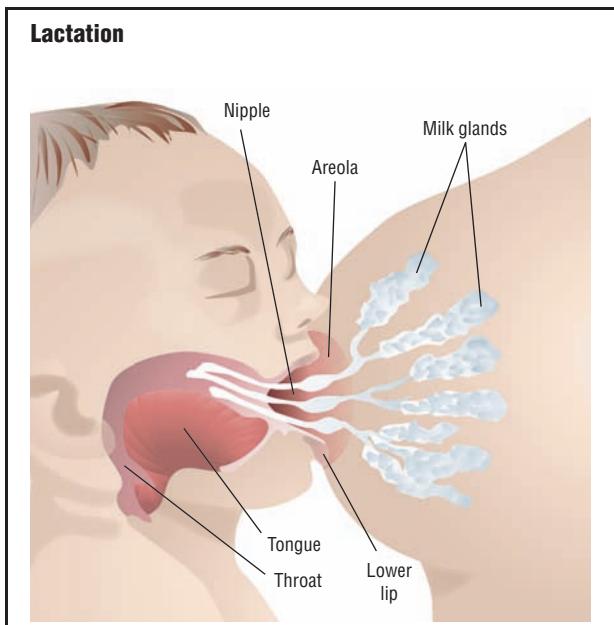
## Breastfeeding

### Definition

Breastfeeding is the practice of feeding an infant milk through the mother’s breast. According to La Leche League International (LLL), human milk is “a living fluid that protects babies from disease and actively contributes to the development of every system in baby’s body.” Breastfeeding stimulates the immune systems of babies and helps to protect against **diarrhea** and infection.

### Purpose

The purpose of breastfeeding is to provide healthy **nutrition** for a newborn infant at low cost.



**When an infant is properly latched onto the breast, the baby's nose touches (or nearly touches) the breast. He or she takes the entire areola into the mouth, facilitating the intake of milk far back into the throat.** (Illustration by PreMediaGlobal.)

Reproduced by permission of Gale, a part of Cengage Learning.)

nurse was found or the baby was fed animal milk or "pap," a mixture of flour, rice, and water. In the early 1900s, most babies in America were still breastfed, and over half of them were breastfed for one year or longer. However, as more women entered the workforce and supplemental methods of feeding were introduced, breastfeeding rates in America decreased. According to a survey from Ross Labs, by 1971 only 24.7% of American babies were breastfed at birth, and of these babies, only 5.4% of them were still breastfed at 6 months. Beginning in the mid 1980s, breastfeeding began to be strongly encouraged in the United States. Breast milk is today considered the best nutrition for an infant, although infants can still grow and thrive on infant formula.

## Demographics

In 1982, the United States experienced resurgence in breastfeeding and rates have continued to increase. The National Immunization Survey conducted by the Centers for Disease Control and Prevention (CDC) in 2005 revealed that 72% of American babies were breastfed at birth and 39% were still breastfed at 6 months.

The developing world has experienced a decline in breastfeeding rates as well due to urbanization, social change, and the promotion of formula. Mothers who

choose to feed their babies formula often encounter unsafe hygienic conditions in which to prepare the bottles, or they cannot afford to purchase the fuel needed to heat the water to sterilize the bottle and preparation equipment. Two of the major causes of infant mortality in developing countries are diarrhea and acute respiratory infections. Both are conditions that breastfeeding can protect against.

The World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) are working together to bring about a change in the global breastfeeding culture. In 2002, they developed "The Global Strategy for Infant and Young Child Feeding," which recommends that all babies are exclusively breastfed for the first 6 months of life with continued breastfeeding up to 2 years or beyond. Exclusive breastfeeding means that breast milk is the child's only source of nutrition for the first 6 months of life and that no other solids or liquids, such as formula or water, are introduced at this time, with the exception of liquid **vitamins** or medicines. Despite this recommendation, only one-third of all babies in the developing world were exclusively breastfed for 6 months in 2004. The highest rates of exclusive breastfeeding were in the East Asia/Pacific region (43%) and the lowest rates were in the Western/Central Africa region (20%).

## Composition of breast milk

Breast milk is the perfect food for an infant. It contains all the nutrients a baby needs to grow and stay healthy, such as:

- **Fats.** Breast milk contains omega-3 fatty acids essential for the growth and development of the brain and nerve tissue. The amount of fat a baby receives depends on the length of the feeding. The milk at the beginning of the feeding is called the foremilk. It is the low-fat milk. The hindmilk that comes at the end of the feeding contains higher concentrations of fat. Therefore, the longer the baby nurses the higher the fat content.
- **Proteins.** The whey proteins found in breast milk are easier to digest than formula. Taurine, an amino acid that is important in the development of brain tissue, is found in breast milk but not in cow's milk.
- **Sugars.** Breast milk contains lactose, a milk sugar that provides energy. Breast milk contains 20%–30% more lactose than cow's milk.
- **Vitamins and minerals.** Breast milk provides the most balanced source of vitamins and minerals for an infant.
- **Immune system boosters.** White blood cells and immunoglobulins are responsible for fighting and destroying infection.

## KEY TERMS

**Celiac disease**—A condition in children and adults where the body is unable to tolerate wheat protein (gluten).

**Eczema**—A disease in which the skin becomes dry, red, itchy, and thickened.

**Foremilk**—Thin watery milk found at the beginning of breast feeding.

**Galactosemia**—A rare genetic disorder where an infant cannot metabolize the sugar in breast milk, and therefore cannot breastfeed.

**Immunoglobulin (Ig)**—A substance made by B cells that neutralizes specific disease-causing substances and organisms. Also called “antibody.” Immunoglobulins are divided into five classes: IgA, IgD, IgE, IgG, and IgM.

**Lactose**—A sugar found in milk that provides energy.

**Omega-3 fatty acids**—A class of fatty acids which lowers the level of cholesterol in the blood. Omega-3 fatty acids are also essential for the growth and development of the brain and nerve tissue.

**Osteoporosis**—A condition found in older individuals in which bones decrease in density and become fragile and more likely to break. It can be caused by lack of vitamin D and/or calcium in the diet.

**Oxytocin**—A hormone that stimulates contractions during child labor and the production of breast milk.

**Taurine**—An amino acid that is important in the development of brain tissue. Taurine is a key component of bile which is needed to digest fats.

**Type 1 diabetes**—A chronic immune system disorder in which the pancreas does not produce sufficient amounts of insulin, a hormone that enables cells to use glucose for energy. Also called juvenile diabetes, it must be treated with insulin injections.

**Type 2 diabetes**—Formerly called adult-onset diabetes. In this form of diabetes, the pancreas either does not make enough insulin or cells become insulin resistant and do not use insulin efficiently.

The content of breast milk varies from feeding to feeding, at different times of day, and as the baby grows.

### Benefits

#### *Benefits for baby*

There are many benefits for the breastfeeding baby, including:

- Increased immunity. Breast milk contains antibodies that are relayed by the mother and help to protect the baby from bacteria and viruses. These immunoboosters are not found in formula.
- Lower incidence of ear infections and respiratory infections.
- Potentially higher intelligence. Several studies have found higher levels of brain-boosting Docosahexaenoic acid (DHA) in the blood levels of breastfed babies than in formula-fed babies.
- Improved digestion and less constipation.
- Decreased risk of diarrhea, pneumonia, urinary tract infections, and certain types of spinal meningitis.
- Decrease in food allergies and eczema.
- More normal weight gain. Breastfed babies are less likely to be overweight than formula-fed babies.

- Reduced risk of type 1 (juvenile) and type 2 (adult onset) diabetes, celiac disease, cancer, rheumatoid arthritis, multiple sclerosis, liver disease, and acute appendicitis.

- Lower risk of sudden infant death syndrome (SIDS).
- Reduced risk of breast cancer (in daughters who have been nursed).
- Better development of jaw and facial structure
- Strong bonding between mother and child.

#### *Benefits for mother*

Breastfeeding women also enjoy many benefits:

- Reduced risk of breast, ovarian, and uterine cancers.
- Natural contraceptive. Many women who breastfeed exclusively for six months experience a delay of fertility.
- Faster postpartum recovery. Breastfeeding uses up extra calories so it is easier for moms to lose their pregnancy weight. Nursing also helps the uterus shrink back to its normal size faster.
- Relaxation. When a mother is breastfeeding her body produces oxytocin, a hormone that induces a calm, content feeling.
- Protection from osteoporosis.

- Savings in time and money. Breast milk is cheaper than formula and the mother does not have to spend time preparing bottles.
- Better stewardship of the environment, as there are no bottles to wash or cans to dispose of.

## Maternal nutrition

The ideal diet of a breastfeeding woman is comprised of healthy and nutritious foods from the five basic food groups. Foods high in carbohydrate such as pastas, grains, and fruits should make up about half of the daily food intake. Healthy fats, such as fatty fish and avocados, should be 30%, and proteins should equal 15%–20%. Breastfeeding women should make sure to eat foods that contain a lot of **calcium**, such as dairy products, broccoli, and beans, and make sure they eat plenty of iron-rich foods like lean red meat, fish, and poultry.

In order to compensate for the energy they expend breastfeeding their babies, breastfeeding women should add 300–500 extra nutritious calories to their diet each day and drink extra fluids. Breastfeeding mothers should also continue to take a prenatal vitamin.

## Precautions

Almost every substance that a breastfeeding mother puts into her body has the potential to pass to her baby through her breast milk. This includes food, medicine, alcohol, and cigarettes.

- Foods: Foods such as dairy products, caffeine, grains and nuts, gassy foods, and spicy foods may cause the baby to fuss if the food upsets the baby's stomach. If this occurs, the mother should eliminate the suspect food from her diet for 10–14 days to see if the trouble stops.
- Medications: Any medication taken while breastfeeding should be approved by a doctor.
- Birth control pills: The high estrogen type of birth control pills may decrease a breastfeeding mother's milk supply and are not recommended. A progestin-only pill such as the "mini-pill" is the least likely to cause milk supply issues.
- Alcohol: Infants have a hard time detoxifying from the alcohol that passes through their mother's breast milk to them. It is recommended to limit alcohol consumption while breastfeeding.
- Cigarettes: Cigarettes contain toxins that can pass through to the baby and are not recommended for breastfeeding women.

## When breastfeeding is not an option

Although breastfeeding is the optimal way to feed an infant, sometimes it is not possible or feasible. A small percentage of women have conditions that prevent breast milk production, such as insufficient development of milk production glands, and cannot breastfeed. Women with HIV infection are advised against breastfeeding, as the virus may be passed to their babies. Women who are newly diagnosed with infectious **tuberculosis** should not breastfeed unless they are on medication. Other health conditions may require that the woman take medication that prevents them from breastfeeding. Babies with **galactosemia**, a rare genetic disorder that prevents them from metabolizing the sugar in breast milk, cannot breastfeed.

## Resources

### BOOKS

- Meek, Joan Younger, MD. *American Academy of Pediatrics New Mother's Guide to Breastfeeding*, 4th ed. Sudbury, MA: Jones and Bartlett Publishers, 2009.
- Riordan, Jan and Karen Wambach. *Breastfeeding and Human Lactation*. New York, NY: Penguin Group, 2004.
- Rubin, Stacey H. *The ABCs of Breastfeeding: Everything a Mom Needs to Know for a Happy Nursing Experience*. New York: AMACOM, 2008.

### OTHER

"Breast Feeding." MedlinePlus. January 13, 2010. <http://www.nlm.nih.gov/medlineplus/breastfeeding.html>

### ORGANIZATIONS

- American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, (847) 434-8000 <http://www.aap.org>.
- La Leche League International, PO Box 4079, Schaumburg, IL, 60168-4079, 1-800-525-3243, 1-847-519-9585 <http://www.llli.org/>.
- United Nations Children Fund (UNICEF), 3 United Nations Plaza, New York, NY, 10017, (212) 326-7000, (212) 887-7465, <http://www.llli.org/>.
- United States Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (404) 639-3534, (800) CDC-INFO (800-232-4636), TTY: (888) 232-6348, [inquiry@cdc.gov](mailto:inquiry@cdc.gov), <http://www.cdc.gov>.
- World Health Organization, Avenue Appia 20, 1211 Geneva 27, Switzerland, +22 41 791 21 11, +22 41 791 31 11, [info@who.int](mailto:info@who.int), <http://www.who.int>.

Jennifer L. Byrnes  
Tish Davidson, A.M.

## Breast-feeding problems

### Definition

Breast-feeding problems are a variety of physical, behavioral, and emotional difficulties with nursing an infant.

### Description

**Breastfeeding**, or nursing, is the practice of nourishing an infant with milk from the human breast. Full-term babies have a natural suckling instinct, and breastfeeding comes naturally to most as soon as they leave the womb. After delivery, levels of prolactin, the hormone that triggers milk production, begin to rise in the body. At first, babies feed on a nutrient-rich substance known as colostrum, which is produced by the breast before regular milk production begins. New mothers will experience engorgement in the days following the birth of their babies when breast milk “comes in” and engorges the breasts. After this time, regular feedings and proper breastfeeding techniques usually ensure a healthy milk supply for most babies until it is time to wean. However, breastfeeding can be a complex process and sometimes there is a problem with the infant’s suckling technique, the mother’s milk supply, or other factors.

### Causes and symptoms

Inadequate weight gain and a **failure to thrive** in nursing infants is the most obvious sign that there is a breastfeeding problem.

Many factors may interfere with successful breastfeeding. These include:

- Milk supply problems. A variety of factors can cause an inadequate supply in new mothers. Milk production is largely a supply and demand process. If the baby does not nurse frequently enough or eat enough at each feeding, milk production will adjust itself and decrease accordingly.
- Latching problems. Some babies, particularly preterm infants, have difficulty suckling. This can be due to an abnormality of the mouth or simply to a lack of coordination of the jaw muscles. In addition, the mother may not be placing her breast into the infant’s mouth properly.
- Scheduling problems. Very young infants need to be breastfed very frequently, about every 2 to 3 hours during the first month of life. As the baby gets older he or she will eat more at each feeding and need to feed less frequently. Newborns should not go more

than 4 hours between feedings, even during the night. Scheduling may become a problem for women who work outside the home, as they often find that their milk flow diminishes after they return to work.

- Nipple and breast problems. Infants may have difficulty latching on to inverted or flat nipples. Other structural problems, such as insufficient mammary glandular tissue, may result in reduced milk production. In addition, cracked and sore nipples and breast infection (mastitis) can make nursing painful.
- Retained placenta. If a woman’s milk has not come in, and she continues to experience abnormal bleeding after delivery, she may still be retaining pieces of the placenta within her uterus.
- Stomach sleeping. A nursing mother who sleeps on her stomach may experience decreased milk production due to the extended pressure on her breasts.
- Stress and fatigue. New mothers need proper rest in order to produce an adequate milk supply. The ability to relax is also fundamental to proper breastfeeding. Women who are stressed can have difficulty achieving milk “let-down,” the sensation of the mammary glands releasing milk.
- Psychological issues. Some women are unable to breastfeed because of preconceived notions about the practice, or ideas instilled by their parents and peers that have put up a psychological barrier for them. Many women are uncomfortable breastfeeding in public and may even abandon the practice because they do not want to be shut off from others or feel squeamish about feeding their babies even in front of friends and family members.

### Diagnosis

Breastfeeding problems are usually first suspected when an infant is not gaining weight as expected. Most babies lose some weight in the first few days of life. However, they should regain the weight quickly and be back at their birth weight at two weeks of age. An average weight gain of 6–8 ounces per week should be maintained through the second or third month. After that, growth charts can demonstrate whether the child is gaining adequate weight.

Failure to gain weight regularly can be a sign of many different problems with a newborn, some very serious. The baby’s pediatrician can do a variety of tests and take a complete history of the baby including regularity of soiling diapers, frequency of feeding, fussiness, and other factors. The tests and history can help the pediatrician determine if a problem with breastfeeding is causing the lack of weight gain.

## KEY TERMS

**Areola**—The pigmented, circular area surrounding the nipple of each breast.

**Lactation**—Secretion of milk from the breasts; the act of breastfeeding.

**Latch-on**—The process whereby the baby opens the mouth widely and first exerts negative pressure on the mother's nipple and then positive pressure. Good latch-on will result in adequate transfer of milk into the baby's mouth and prevent sore nipples from occurring.

**Postpartum**—Refers to the six-week period after childbirth.

**Prolactin**—A hormone secreted after delivery that stimulates the production of milk.

Once a breastfeeding problem has been established, a healthcare practitioner will ask questions about the baby's feeding schedule and may observe the mother's breastfeeding technique to determine if an improper latching-on technique or inadequate suckling is causing the difficulty. **Lactation** counselors may be helpful in diagnosing these problems. Further **physical examination** and tests may be necessary to determine if structural breast problems or placental fragments are the root of the problem.

### Treatment

Proper treatment for breastfeeding difficulties depends on the cause of the problem.

#### Inadequate milk production

Milk production can be boosted in several ways. The easiest way is for the mother to encourage more frequent feedings at the breast. If this is impractical or the baby does not cooperate, milk production often can be increased through intermittent use of a breast pump, a device that expresses milk from the breast. Breast pumps are available in manual and electric models and can be purchased or rented. Pumped breast milk can be bottled or frozen and fed by bottle to the baby at a later time, although if milk production is a problem the mother will probably want to put the baby to the breast at every opportunity.

Milk thistle, or *Silybum marianum*, is sometimes prescribed to promote increased breast milk secretion. Although the herb is considered safe for nursing mothers, it should be acquired from a reputable source and

prescribed by an herbalist, naturopathic physician, or other healthcare professional familiar with its use.

Each breast contains both foremilk and the richer, fat-laden hindmilk. Infants need the nutrients and fat of the hindmilk, but must get through the foremilk to reach it. This can be encouraged by the mother completely emptying one breast before starting the baby on the other one. If the baby does not completely empty a breast, the job can be finished with the aid of a breast pump. The next time the mother nurses, she should start the child on the opposite breast.

#### Latching problems

To ensure proper breastfeeding, the mother should encourage the baby to latch on to the entire nipple, with his or her lips past the outside perimeter of the areola, before starting to suck. The mother will likely have to guide the breast into the baby's mouth, and repositioning may be required.

Practice makes perfect, and sometimes all an infant needs to improve his latching and suckling technique is time. If the baby has a structural problem in the mouth, such as a **cleft palate**, a breast pump may be required to keep milk production going. In some cases where sucking does not improve, feeding with a supplementary **nutrition** system may be required. The system consists of a feeding bottle containing the mother's own breast-pumped milk, and two tubes that run down from the bottle and attach to the nipples. Milk flows easily from the tubes with a weak sucking action from the baby. Both baby and mother can still maintain closeness while providing the baby with adequate milk flow.

#### Scheduling problems

Nursing newborns who are sleeping through the night without a feeding are probably not getting enough milk. They should go no longer than four hours at night without feeding, and may require waking to ensure they get enough to eat.

Women who have returned to work can use a portable breast pump at least once during the workday to encourage sustained milk flow and to store milk for their babies to eat during their time away from home.

#### Nipple and breast problems

Liquid vitamin E applied regularly to sore or cracked nipples can soothe the **pain** and help the healing process. Women who think they have a breast infection should see their healthcare provider immediately, as they will probably require a course of **antibiotics**.

Women with inverted nipples may find that the baby has a hard time latching on. Inverted nipples do not usually preclude breastfeeding, but may require extra time and effort to help the baby learn to feed effectively. A lactation consultant can help the woman find a technique that works for her and her baby.

### **Retained placenta**

Minor surgery known as a **dilatation and curettage** (D and C) usually is required to remove pieces of placenta that have been retained by the uterus. Once the placenta has been removed, prolactin levels normally rise, stimulating milk production.

### **Stress and fatigue**

Relaxation exercises, **yoga, meditation**, massage, and **aromatherapy** can all be useful tools for relieving **stress**. Women should establish a quiet, restful environment for nursing. Warm compresses to the breast may also assist in milk let down. If it is feasible, taking naps when the baby is sleeping can help to ease the **fatigue** caused by nighttime feedings.

### **Psychological issues**

Support from family and friends is necessary for any new mother, especially one that chooses to nurse her child. If no familiar support network exists, women may seek help from groups for nursing mothers such as the La Leche League.

Many hospitals offer mothers and their spouses classes on breastfeeding techniques and nursing issues. Women who have negative feelings about breastfeeding may find classes helpful in overcoming these issues.

### **Expected results**

In most cases, treatment for breastfeeding problems is successful and mother and baby do well. Other women may be able to breastfeed in limited amounts, but require supplementing their child's diet with formula to ensure proper weight gain and adequate nutrition. For a small percentage of women, physical problems or psychological issues may prevent successful nursing altogether.

### **Prevention**

The best way for a new mother to prevent nursing problems is to take care of herself by eating right, drinking plenty of fluids, and staying rested and relaxed. It is important, because breastfeeding incidence and duration are both believed to be associated

with reduced risk of some female cancers and possibly with improved bone health later in life.

## **Resources**

### **BOOKS**

Lauwers, Judith. *Quick Reference for the Lactation Professional*. Sudbury, MA: Jones & Bartlett Publishers, 2009.

Lauwers, Judith, and Anna Swisher. *Counseling the Nursing Mother: A Lactations Consultant's Guide*, 5th ed. Sudbury, MA: Jones & Bartlett Learning, 2011.

Walker, Marsha. *The Nipple in Breastfeeding and Lactation*. Amarillo, TX: Hale, 2010.

### **PERIODICALS**

Hegney, Desley, et al. "Against All Odds: A Retrospective Case-Controlled Study of Women Who Experienced Extraordinary Breastfeeding Problems." *Journal of Clinical Nursing*, (May 2008) 17(9), 1182–92.

Otsuka, Keiko et al. "The Relationship Between Breastfeeding Self-Efficacy and Perceived Insufficient Milk Amount Japanese Mothers." *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, (September–October 2008) 37(5), 546–55.

Thulier, Diane and Judith Mercer. "Variables Associated with Breastfeeding Duration." *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, (May–June 2009) 38(3), 259–68.

### **ORGANIZATIONS**

International Board of Lactation Consultant Examiners, 6402 Arlington Boulevard, Suite 350, Falls Church, VA, 22042, (703) 560-7330, (703) 560-7332, [iblce@iblce.org](mailto:iblce@iblce.org), [www.iblce.org](http://www.iblce.org).

La Leche League International, PO Box 4079, Schaumburg, IL, 60168-4079, (800) 525-3243, (847) 519-9585, <http://www.llli.org>.

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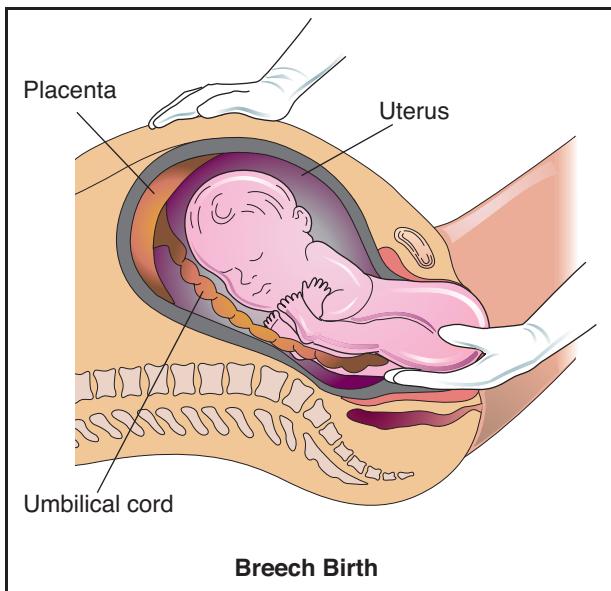
## **Breech birth**

### **Definition**

In a breech birth, the presenting part of the fetus, or the part that enters the woman's birth canal first, is the buttocks or leg(s).

### **Demographics**

In almost 97% of vaginal births, the head is the part of the baby to be born first (i.e., vertex presentation). During a woman's **pregnancy**, the fetus moves



**Approximately 4 in 100 babies will start labor in the breech (buttocks first) position. While this is a potentially dangerous situation, many full-term babies can be safely delivered from the breech position.** (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

freely inside the uterus, cushioned by the amniotic fluid. At 20 weeks of gestation, the midway point in the pregnancy, about 24% of fetuses are in a breech position. By 34 weeks, only about 7% are in a breech position. As the pregnancy progresses toward term (37–42 weeks), the growing fetus has less room in which to turn around, and usually remains more in an inverted (head down) position. However, in about 3–4% of births, the buttocks or feet present first.

## Description

There are three types of breech presentations:

- Complete breech, in which the buttocks present first, the baby's thighs are tight against the abdomen, the legs are crossed, and the feet are flexed. In this position, the fetus is curled up tightly in a ball.
- Frank breech, in which the knees are straight (i.e., not bent), and the legs are held tightly against the abdomen and head. This breech position comes closest to filling the pelvic inlet, as would the fetus's head.
- Footling breech, in which one or both legs enter the birth canal first. The fetus appears to be standing in an upright position.

## Risk factors

Risks of a vaginal breech delivery include:

- Prolapse of the umbilical cord. This is especially true in a footling presentation, where the feet and legs are small and provide room for the umbilical cord to slip alongside and into the birth canal. Any pressure on the cord compresses the sides of the cord, decreasing blood flow and oxygen to the fetus. This may result in anoxia.
- Entrapment of the head. This occurs when the body passes through the cervix, but the head, which is the largest part of the body, cannot fit through the cervical opening. This may occur because the cervix was incompletely dilated at the time of the birth, or when the head is larger than the pelvic opening.
- Trauma to the head or neck of the neonate during delivery. This could result in permanent brain damage or paralysis of the infant.
- Trauma to the spine or an arm resulting in fracture of a bone.
- Meconium aspiration. The breech position may cause an early rupture of the amniotic fluid membranes, and meconium (the infant's first stool) may be released. If the neonate breathes in any of the meconium, he or she risks obstruction of the airway by the meconium, and pneumonia.
- Dysfunctional labor. A fetal breech position can cause labor to be drawn out, exhausting the mother, and diminishing her ability to push as the time of delivery approaches.
- Higher level of perinatal morbidity and mortality.

Accurate imaging of the fetus *in utero* has decreased the number of breech births by alerting obstetricians and midwives to this presentation before delivery. A technique called external version may be used to encourage the fetus to rotate into a vertex position. However, as the practice of external version has increased, practitioners have had less experience delivering a breech baby vaginally. A successful vaginal delivery of a breech presentation depends to a great extent on the skill and experience of the practitioner.

Twins present a special challenge and take one of several possible birth positions:

- Vertex-vertex. In this, the safest of positions for delivery, the twins both present in the vertex, or head-down position. It occurs in about 40%–45% of twin births.
- Vertex-breech or breech-vertex. This position offers the most efficient use of the uterine space, but is not the best presentation for delivery. Vertex-breech and vertex-transverse positions occur in about 35%–40% of twin births. Breech-vertex positioning occurs in about 15%–20% of births.

## KEY TERMS

**Anoxia**—An absence of oxygen.

**Cephalopelvic disproportion**—Occurs when the fetus's head is larger than the mother's pelvic inlet.

**Meconium**—The first feces passed by the newborn. If passed before birth, the fetus can inhale this material, causing medical complications.

**Nuchal cord**—The term used when the umbilical cord is looped around the fetus's neck in utero.

**Presentation**—The part of the fetus's body that enters into the birth canal first.

**Prolapsed umbilical cord**—Occurs when the cord falls into the birth canal, and may even hang out of the mother's vagina. This can cause compression of the cord and lead to decreased oxygen and blood flow to the fetus.

**Transverse**—A position in which the fetus lies sideways against the birth canal, with a shoulder or arm possibly entering the canal.

- decreased muscle tone of the fetus
- a congenital disorder of the fetus, especially neuromuscular in nature
- a space-related problem for the fetus, such as with uterine fibroids
- fetal anomaly, such as hydrocephalus
- uterine structural anomaly, such as a septum trapping the fetus in a breech position
- gestation of less than 40 weeks
- multiple gestation
- hydramnios, a condition in which excess amniotic fluid is produced and the fetus has too much room in which to move

## Diagnosis

There are three primary ways in which a breech position is discovered, including imaging, position of the fetal heartbeat, and external palpation on the mother's abdomen.

## Examination

Leopold's maneuvers consist of a series of four external palpations of the mother's abdomen to determine fetal position in the uterus. The fetal head is hard and can move separately from the rest of the body. The buttocks feel soft and move with the body. As the time for delivery draws near, a vaginal examination may be required, as Leopold's maneuvers can sometimes be misleading. In a vaginal examination, the baby's fontanelles are palpated.

## Procedures

There are a variety of imaging technologies, varying in safety, cost, and ease of access. **Magnetic resonance imaging** (MRI) is very accurate, but is extremely expensive, not as readily available, and would rarely provide more information than an ultrasound to justify its use. Ultrasound is the most widely used method of imaging during pregnancy, as it uses sound waves instead of radiation, is readily available, and is cost efficient. Ultrasound is considered safe to use at all stages in pregnancy.

## Treatment

When dealing with a breech presentation, there are three choices for delivery: attempt to rotate the fetus into a vertex presentation prior to delivery; attempt a trial of vaginal delivery in the breech position; or deliver by **cesarean section**. Some hospitals may not have the mother attempt a vaginal delivery and instead opt for cesarean section.

## Causes and symptoms

The specific cause of a particular breech presentation may not be understood about 80% of the time. Causes of breech presentation may include:

- an inability of the fetus to have full movement inside the uterus
- the position of the placenta, such as a low-lying placenta previa, and a short umbilical cord

### *Traditional*

The traditional and commonly used treatment within Western medical standards is external version. In external version, the fetus is rotated manually by the physician, who exerts pressure on the mother's abdomen to cause the fetus to somersault into the vertex position. Medication may be given to the mother to relax the uterine muscles before the procedure. The vertex position allows the fetus more mobility and decreases the chance of uterine contractions, which lead to early labor. Before attempting version, an ultrasound is performed to confirm the position of the fetus. The timing of version is important. Done too early, the fetus may rotate back into a breech position if too much space is still available. Performed at 35–37 weeks gestation, the success rate has shown to be up to 65%. In approximately 1–2% of cases, complications arise following version, leading to the need for immediate delivery via cesarean section.

Version should always be done in a hospital, where there are facilities for immediate cesarean delivery available in the cases of cord compression or **placental abruption**. Some research has indicated that giving the mother an epidural for the version procedure increases its success rate. The version can be accomplished by two health care professionals. Mineral oil may be applied to the mother's abdomen so that the obstetrician's hands can smoothly slide over the surface. The fetal heart rate should be monitored closely for any signs of fetal distress, and should be continued for about an hour after the procedure to assure fetal stability. Mothers who are Rh-negative may be given Rh immune globulin, which would prevent incompatibility should fetal-to-mother **transfusion** occur during the version. About 90% of babies turned by version remain in this position for delivery.

Version has risks and is contraindicated in the following situations:

- uterine structural anomalies
- third-trimester bleeding
- hydramnios, excess amniotic fluid production
- nuchal cord, or the cord around the baby's neck (not always seen on ultrasound)
- previous uterine surgery, such as cesarean section, that has weakened the uterine walls
- cephalopelvic disproportion (CPD), a condition in which the baby's head is too big for the mother's pelvic inlet, as evidenced on ultrasound or other imaging tools

### *Surgery*

In a cesarean birth, an incision is made through the mother's abdominal wall into the uterus. The amniotic fluid membranes are broken and the neonate is extracted. A vertical incision in the uterus along the mother's abdominal midline is called a classical cut. This provides the fastest access to the infant and may be chosen in the event of an emergency delivery. The fetus can be removed from the uterus in minutes. If a woman has had the classical uterine incision, she will not be allowed to attempt a vaginal delivery in the future, because the uterine wall can rupture during the next labor. When time permits, the preferred incision is a transverse one, just above the pubic bone. This incision is sometimes referred to as a bikini cut. Healing time is decreased and may allow a woman to successfully deliver vaginally in the future.

### *Alternative*

The preferred mode of delivery is a vaginal birth with the fetus in vertex presentation. Attempts are made to rotate the fetus from a breech into a vertex position. One method has been to have the mother assume different positions (e.g., knee-chest) in the hope that this would cause the fetus to move into a more favorable position. Research studies have not shown this to be very successful, although periodic anecdotal accounts of success have been reported. In the November 11, 1998, issue of the *Journal of the American Medical Association*, researchers reported on the use of **traditional Chinese medicine** to cause the fetus to rotate. In this study, moxa, a combustible Chinese herb, was used over a two-week period to stimulate an **acupuncture** point on the toe. Stimulation of this point is believed to increase fetal activity, during which the fetus then moves into the vertex position. After two weeks of treatment with moxa, 75% of the 130 fetuses studied rotated into the vertex position. Only 48% of the control (no intervention, just routine obstetrical care) fetuses rotated. However, the results of this study have not been replicated.

### *Attempted vaginal delivery*

During a breech birth more nursing personnel may be needed to assist the obstetrician and provide support for the mother. A neonate that has been in a breech position *in utero* may maintain an unusual position for a few days after birth. An explanation by the nurse can greatly reduce the mother's concern that there is something wrong with her baby.

When a vaginal breech birth is attempted, the pace of the delivery is very important. Fetal heart

rate and uterine contractions need to be closely monitored. During a vertex vaginal delivery, the head is molded coming down the birth canal, and the labor process slows the pace of the delivery. In a breech vaginal birth, the smaller body may slip more quickly through the canal. If the head becomes caught, fetal **anoxia** (lack of oxygen) can occur. The head does not mold during a rapid breech birth, and if the neonate is allowed to deliver quickly, perhaps due to a detected prolapsed cord, the rapid change in pressure can result in intracranial hemorrhage. To assist the breech delivery, the mother may be asked to assume a squatting position, as this increases the birth canal volume by about 28%. (This position is not popular in the United States.) Forceps may be used to protect the neonate's neck and head from trauma and to assist in the delivery. If the vaginal birth attempt causes fetal distress, an emergency cesarean delivery may be required.

## Prognosis

About half the attempts of a vaginal breech delivery result in a cesarean birth. Discovery of breech presentation before the time of delivery allows attempts to be made to rotate the fetus. If these attempts prove unsuccessful, a cesarean birth can then be scheduled. A scheduled cesarean allows the mother and her partner to be informed and participate, to some degree, in the process. Anesthesia can be chosen that allows the mother to be awake during the birth of her child. If emergency cesarean delivery is required, the mother is given a **general anesthesia** to shorten the time required to extract the fetus in distress. If complications do not occur, the prognosis is excellent.

## Prevention

None of the known causes of breech presentation are preventable, and in many breech presentations, there is no known cause. While it is not possible to prevent this presentation, attempts such as version are made to prevent a breech delivery, or to minimize its inherent risks.

## Resources

### OTHER

"Breech Babies: What Can I Do if My Baby is Breech?"

American Academy of Family Physicians, *Familydoctor.org*. April 2008. <http://familydoctor.org/online/famdoc/home/women/pregnancy/labor/310.html> (accessed June 1, 2010).

Jenis, Andrew D. "Pregnancy, Breech Delivery." eMedicine. October 26, 2009. <http://emedicine.medscape.com/article/797690-overview> (accessed June 1, 2010).

## ORGANIZATIONS

American College of Obstetricians and Gynecologists, P.O. Box 96920, Washington, DC, 20090-6920, (202) 638-5577, <http://www.acog.org>.  
Association of Women's Health, Obstetric, and Neonatal Nurses, 2000 L St., NW, Suite 740, Washington, DC, 20036, (202) 261-2400, (800) 673-8499, Toll free in Canada (800) 245-0231, (202) 728-0575, [customerservice@awhonn.org](mailto:customerservice@awhonn.org), <http://www.awhonn.org>.

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Breech presentation see **Breech birth**

Brill-Zinsser disease see **Typhus**

Brittle bone disease see **Osteogenesis imperfecta**

Broken nose see **Nasal trauma**

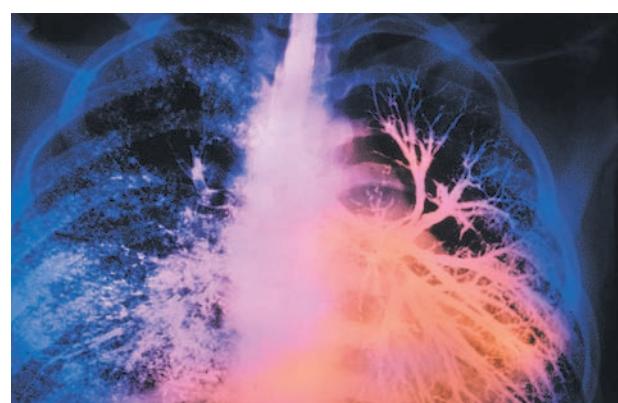
## Bronchiectasis

### Definition

Bronchiectasis is a condition in which an area of the bronchial tubes is permanently and abnormally widened (dilated), with accompanying infection.

### Description

The bronchial tubes are the networks of branching tubes that deliver air to the tiny sacs of the lungs (alveoli). In bronchiectasis, the diameter of the bronchi is unusually large. Examination of the walls of the bronchial tubes reveals destruction of the normal structural elements, with replacement by scar tissue.



**Colorized bronchogram of lungs—right tree has almost no structure, caused by chronic inflammation.** (Mehau Kulyk/Photo Researchers, Inc.)

Pus collects within the bronchi, and the normal flow of oxygen into the lungs, and carbon dioxide out of the lungs (air exchange) is impaired. The bronchi show signs of inflammation, with swelling and invasion by a variety of immune cells. The inflamed areas show signs of increased growth of blood vessels. The area of the lung that should be served by a diseased bronchial tube is also prone to inflammation and infection.

### Causes and symptoms

Prior to the widespread use of immunizations, bronchiectasis was often the result of a serious infection with either **measles** or **whooping cough**. Currently, viruses that cause **influenza** (flu) or influenza-like syndromes, as well as a number of bacteria may precede the development of bronchiectasis. Patients who have been infected with **tuberculosis** or the virus that causes **AIDS** (HIV or human **immunodeficiency** virus) also have an increased chance of bronchiectasis.

A number of pre-existing conditions may cause an individual to be more susceptible than normal to infection, with increased risk of bronchiectasis developing. These conditions include disorders of cilia and immune disorders.

Cilia are the tiny hairs that usually line the bronchial tubes. Cilia wave constantly, sweeping the bronchial tubes clean of bacterial or viral invaders and cleaning away excess secretions (mucus, sputum) that may be produced by the bronchi. When these cilia are abnormal or absent at birth, various bacterial or viral invaders may remain in the respiratory tract, multiply, and cause serious infections.

Immune disorders include decreased production of certain immune chemicals (immunoglobulins) that usually serve to fight off infection by bacterial or viral invasion. When these immunoglobulins are not produced in large enough quantity, bacterial and viral invaders are not effectively killed off, and infection occurs.

Other causes of bronchiectasis include an abnormally blocked (obstructed) airway. This can be due to tumor growth within the bronchial tube, or due to a child accidentally inhaling a small object, which then blocks off the bronchial tube. People with the disease called **cystic fibrosis** (CF) often have their bronchial tubes obstructed by the thick, sticky mucus that is a hallmark of CF. Toxic exposures (breathing ammonia, for example) can harm the bronchi and lead to bronchiectasis. An extreme allergic response of the immune system to the presence of certain fungi (especially one called *Aspergillus*) can

### KEY TERMS

**Bronchi**—The network of tubular passages that carry air to the lung and allow air to be expelled from the lungs.

**Cilia**—Hair-like projections that line the bronchial tubes (also present in other areas of the body). Normal cilia beat consistently, sweeping the bronchi clean of bacteria, viruses, and mucus.

also damage the bronchial tubes enough to result in bronchiectasis.

Symptoms of bronchiectasis include constant **cough** and the production of infected sputum (sputum is a mixture of mucus and pus), which may be bloody. In some cases, there may be **wheezing** and **shortness of breath**. The constant, low level of infection may flare, resulting in increased production of sputum, worsening of the cough, and **fever**. The area of the lung served by the affected bronchial tube may become severely infected, resulting in **pneumonia**.

### Diagnosis

**Chest x ray** may reveal evidence of bronchiectasis, and CT scans are particularly good at revealing the thick, dilated bronchial walls of bronchiectasis. Sputum will need to be collected and cultured (grown in a laboratory dish) in order to examine it microscopically for the specific type of organism responsible for infection. A careful search for other underlying diseases is important, looking in particular for ciliary abnormalities, cystic fibrosis, or immunoglobulin deficiencies.

### Treatment

Treatment should involve efforts to resolve any underlying disorder. Infections will require **antibiotics**; obstruction may require the removal of a foreign object or tumor. Medications are available to help thin the sputum, so that it can be more effectively coughed up. Rhythmic clapping on the chest and back while the patient assumes a number of positions (head down, primarily) may help the lungs to drain more effectively. This is called **chest physical therapy**, or percussion and postural drainage.

When a particular area of the lung is constantly and severely infected, surgery may be needed to remove it. When bleeding occurs from irritated bronchial tubes and overgrown bronchial blood vessels, surgery may be required either to remove an area of the bronchial tube,

or to inject the bleeding blood vessel with a material to stop the bleeding.

In some patients, bronchiectasis eventually leads to a constantly low level of blood oxygen, despite other treatments. These patients usually have an associated increase in the size of the right side of their hearts, along with a decrease in the heart's ability to pump blood through the lungs. Some patients with extremely severe symptoms and disability have been treated with **lung transplantation**.

## Prognosis

Prognosis varies widely, depending on how widespread or focal the bronchiectasis, and on the presence of other underlying disorders.

## ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave. NW, Suite 800, Washington, DC, 20001, (202) 758-3355, (202) 452-1805, (800) 548-8252, [info@lungusa.org](mailto:info@lungusa.org), <http://www.lungusa.org/>.

Rosalyn Carson-DeWitt, MD

# Bronchiolitis

## Definition

Bronchiolitis is an acute viral infection of the small air passages of the lungs called the bronchioles.

## Demographics

Bronchiolitis is extremely common. It occurs most often in children between the ages of two and 24 months, with peak infection occurring between three and six months of age. About 25% of infants have bronchiolitis during their first year, and 95% have had the disease by their second birthday. Bronchiolitis occurs more often in boys than girls, with boys being hospitalized at 1.5 times the rate of girls. In temperate climates, bronchiolitis peaks from winter to late spring. In subtropical climates, the disease peaks from October to February.

## Description

Bronchiolitis is an acute inflammation of the upper and lower respiratory tract. In children with bronchiolitis, the small airways (bronchioles) can become blocked. Infants, especially those born prematurely, and toddlers are at risk because their airways are so small and easily obstructed. Bronchiolitis makes it

difficult to breathe. The child coughs and wheezes. The danger in bronchiolitis arises from an inability to get enough oxygen in and out of the lungs. Bronchiolitis can be fatal to the very young.

## Risk factors

Children who attend daycare or who live in crowded conditions and those who are exposed to secondhand smoke at home are more likely to develop bronchiolitis. Premature infants and children born with heart and lung defects or HIV/AIDS are more likely to have severe, life-threatening infections. Bronchiolitis is a significant cause of respiratory disease worldwide. The World Health Organization (WHO) has funded research to develop a vaccine against the disease, but attempts have been unsuccessful.

## Causes and symptoms

Bronchiolitis is caused by several different viruses. The most common of these is respiratory syncytial virus (RSV), which is responsible for about 100,000 hospitalizations of children under age four each year. Two subtypes of RSV have been identified, one of which causes most of the severe bronchiolitis infections. In addition, bronchiolitis can be caused by **influenza**, parainfluenza, and adenoviruses, all of which are common from fall through spring. These viruses are spread in tiny drops of fluid from an infected person's nose and mouth through direct contact, such as shaking hands or kissing. The viruses can also live several hours on countertops, toys, or used tissues and easily infect people who handle contaminated items. The time from infection to the appearance of symptoms varies from two to seven days.

Bronchiolitis affects individuals differently depending on their age. In adults, older children, and some infants, bronchiolitis viruses cause symptoms similar to a mild cold—runny nose, stuffy head, and mild **cough**. The lungs are not involved, and these symptoms clear up without any medical treatment. In some children under age two, the cold-like upper respiratory symptoms worsen after a day or two. The lung tissue begins to swell and produce mucus, and the cells lining the bronchioles begin to slough off into the air passages. As the airways narrow from swelling and mucus accumulation, breathing becomes difficult, and the child makes a **wheezing** or whistling sound with each breath. Lung involvement can occur quite rapidly.

The most common signs of bronchiolitis involve the infant's struggle to breathe. The child may take 50–60 breaths per minute and may develop brief periods

## KEY TERMS

**Bronchiole**—A thin air passage in the lung that branches off a larger airway.

**Congenital**—A condition that is present at birth.

when they stop breathing (apnea) and begin to turn blue (**cyanosis**). This occurs most often in babies who were born very prematurely or who are under six weeks of age and babies with congenital heart and lung problems and compromised immune systems. Babies may also stop eating, because it becomes difficult for them to swallow and breathe at the same time. They may have a low **fever**, cough, and **vomiting**.

### Diagnosis

#### *Examination*

Bronchiolitis is usually diagnosed through a **physical examination** by a pediatrician or family physician. The physician often finds an increased heart rate; rapid, labored breathing; and crackles in the lungs when the child inhales. Signs of ear infection (**otitis media**) and throat infection (pharyngitis) are sometimes present.

#### *Tests*

Although laboratory tests are available that can within in a few hours confirm the presence of RSV, these tests are not routinely necessary. The oxygen level in the blood may be measured through pulse oximetry in babies who are having difficulty breathing. Inadequate oxygen in the blood is an indication that hospitalization is necessary. Chest x rays may be done on severely ill children to rule out other conditions.

#### *Procedures*

More invasive procedures are not usually necessary unless required for further diagnosis or treatment of an accompanying illness or complication.

### Treatment

#### *Traditional*

The degree of respiratory distress determines treatment. Individuals with mild symptoms are treated as if they have a cold with rest, fluids, and a cool air humidifier. Babies who are struggling to breathe may be

hospitalized and given supplemental humidified oxygen. Their breathing is monitored and, if necessary, fluids are given intravenously to prevent **dehydration**. Occasionally, infants need mechanical ventilation to fill and empty the lungs until the airways open.

### *Drugs*

As of 2010, there were no drugs that were substantially effective in treating bronchiolitis.

Children with compromised immune systems from diseases such as congenital HIV/AIDS and transplant patients are at highest risk for severe infections, serious complications, and **death**. Children with congenital heart and lung disorders are also at higher risk, as are infants under six weeks old. These high-risk children may be admitted to pediatric intensive care units and treated with ribavarin (Virazole), a drug that keeps the virus from reproducing. This drug is reserved for the most critical cases.

### *Alternative*

Although there are alternative treatments for cold symptoms, such as **echinacea** and zinc, parents should consult their health practitioner about the appropriateness of using these treatments in very young children.

### Prognosis

The majority of children who get bronchiolitis, even severe infections, recover without complications in one to two weeks, although **fatigue** and a light cough may linger longer. About 60% of people develop only cold-like symptoms without lung involvement. However, the disease accounts for about 100,000 pediatric hospitalizations and 4,500 deaths each year. Deaths usually occur because medical care is not sought soon enough.

While many viral illnesses, such as **chickenpox**, can be contracted only once, after which individuals develop immunity, people can get bronchiolitis multiple times. However, after the first infection, the symptoms are usually mild.

### Prevention

The viruses that cause bronchiolitis spread very easily, making prevention difficult. Common sense measures such as frequent hand washing and keeping children away from crowds and sick individuals are only partially effective. Certain very high-risk babies can be treated during the peak virus season with monthly injections of antiviral immunoglobulins to

protect against RSV infection. These injections cost several thousand dollars per child per season and are reserved for children whose life could be at risk if they became infected. Antiviral immunoglobulins are used only for prevention and are not effective as a treatment once the infection has been acquired.

## Resources

### OTHER

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### ORGANIZATIONS

- American Academy of Family Physicians, P.O. Box 11210, Shawnee Mission, KS, 66207, (913) 906-6000, (800) 274-2237, (913) 906-6075, <http://familydoctor.org>.
- American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL, 60007-1098, (847) 434-4000, (847) 434-8000, <http://www.aap.org>.

Tish Davidson, AM

## Bronchitis

### Definition

Bronchitis is an inflammation of the air passages between the nose and the lungs, including the windpipe or trachea and the larger air tubes of the lung that bring air in from the trachea (bronchi). Bronchitis can either be of brief duration (acute) or have a long course (chronic). Acute bronchitis usually is caused by a viral infection, but also can be caused by a bacterial infection; it can heal without complications. Chronic bronchitis is a sign of serious lung disease that may be slowed but cannot be cured.

## Demographics

Acute bronchitis is extremely common. Worldwide, it is one of the top five reasons for a child to see a doctor. The National Center for Health Statistics estimates that about 9% of Americans develop bronchitis each year. In European studies, as many as 20% of school-age children developed bronchitis.

Anyone can get acute bronchitis, but infants, young children, and the elderly are more likely to get the disease because people in these age groups generally have weaker immune systems. Smokers and people with heart or other lung diseases are also at higher risk of developing acute bronchitis. Individuals exposed to chemical fumes or high levels of air pollution also have a greater chance of developing acute bronchitis.

Chronic bronchitis is a major cause of disability and **death** in the United States. The American Lung Association estimates that about 14 million Americans have the disease. Like acute bronchitis, chronic bronchitis is an inflammation of airways accompanied by coughing and spitting up of phlegm. In chronic bronchitis, these symptoms are present for at least three months in each of two consecutive years.

## Description

Although acute and chronic bronchitis are both inflammations of the air passages, their causes and treatments are different. Acute bronchitis is most prevalent in winter. It usually follows a viral infection, such as a cold or the flu, and can be accompanied by a secondary bacterial infection. Acute bronchitis resolves within two weeks, although the **cough** may persist longer. Acute bronchitis, like any upper airway inflammatory process, can increase a person's likelihood of developing **pneumonia**.

Chronic bronchitis is caused by inhaling bronchial irritants, especially cigarette smoke. Until recently, more men than women developed chronic bronchitis, but as the number of women who smoke has increased, so has their rate of chronic bronchitis. Because this disease progresses slowly, middle-aged and older people are more likely to be diagnosed with chronic bronchitis.

Chronic bronchitis is one of a group of diseases that fall under the name **chronic obstructive pulmonary disease** (COPD). Other diseases in this category include **emphysema** and chronic asthmatic bronchitis. Chronic bronchitis may progress to emphysema, or both diseases may be present together.

### Risk factors

**Smoking**, heart or lung disease, and exposure to chemical fumes or high levels of air pollution increase

## KEY TERMS

**Acute**—Disease or condition characterized by the rapid onset of severe symptoms.

**Bronchi**—The larger air tubes of the lung that bring air in from the trachea.

**Chronic**—Disease or condition characterized by slow onset over a long period of time.

**Chronic obstructive pulmonary disease (COPD)**—A term used to describe chronic lung diseases, like chronic bronchitis, emphysema, and asthma.

**Emphysema**—A chronic obstructive pulmonary disease in which the destruction of air sac walls form abnormally large air sacs that have reduced gas exchange ability and tend to retain air within the lungs. Symptoms include labored breathing, the inability to forcefully blow air out of the lungs, and an increased susceptibility to respiratory tract infections.

an individual's risk for bronchitis. Infants, young children, and the elderly are also at greater risk because they are more likely to have a weak immune system.

### Causes and symptoms

#### Acute bronchitis

Acute bronchitis usually begins with the symptoms of a cold, such as a runny nose, sneezing, and dry cough. However, the cough soon becomes deep and painful. Coughing brings up a greenish-yellow phlegm or sputum. These symptoms may be accompanied by a **fever** of up to 102°F (38.8°C). **Wheezing** after coughing is common.

In uncomplicated acute bronchitis, the fever and most other symptoms, except the cough, disappear after three to five days. Coughing may continue for several weeks. Acute bronchitis is often complicated by a bacterial infection, in which case the fever and a general feeling of illness persist. To be cured, the bacterial infection should be treated with **antibiotics**.

#### Chronic bronchitis

Chronic bronchitis is caused by inhaling respiratory tract irritants. The most common irritant is cigarette smoke. The American Lung Association estimates that 80%–90% of COPD cases are caused by smoking. Other irritants include chemical fumes, air pollution, and environmental irritants, such as mold or dust.

Chronic bronchitis develops slowly over time. The cells that line the respiratory system contain fine, hair-like outgrowths from the cell called cilia. Normally, the cilia of many cells beat rhythmically to move mucus along the airways. When smoke or other irritants are inhaled, the cilia become paralyzed or snap off. When this occurs, the cilia are no longer able to move mucus, and the airways become inflamed, narrowed, and clogged. This leads to difficulty breathing and can progress to the life-threatening disease emphysema.

A mild cough, sometimes called smokers' cough, is often the first visible sign of chronic bronchitis. Coughing brings up phlegm, although the amount varies considerably from person to person. Wheezing and **shortness of breath** may accompany the cough. Diagnostic tests show a decrease in lung function. As the disease advances, breathing becomes difficult and activity decreases. The body does not get enough oxygen, leading to changes in the composition of the blood.

### Diagnosis

#### Examination

Initial diagnosis of bronchitis is based on observing the patient's symptoms and health history. The physician listens to the patient's chest with a stethoscope for specific sounds that indicate lung inflammation, such as moist rales and crackling, and wheezing, which indicates airway narrowing. Moist rales consist of a bubbling sound heard with a stethoscope. The sound is caused by fluid secretion in the bronchial tubes.

#### Tests

A **sputum culture** may be performed, particularly if the sputum is green or has blood in it, to determine whether a bacterial infection is present and to identify the disease-causing organism so that an appropriate antibiotic can be selected. Normally, the patient is asked to cough deeply, then spit the material that comes up from the lungs (sputum) into a cup. This sample is then grown in the laboratory to determine which organisms are present. The results are available in two to three days, except for tests for **tuberculosis**, which can take as long as two months.

#### Procedures

Occasionally, in diagnosing a chronic lung disorder, the sample of sputum is collected using a procedure called a **bronchoscopy**. In this procedure, the patient is given a local anesthetic, and a tube is passed into the airways to collect a sputum sample.

A pulmonary function test is important in diagnosing chronic bronchitis and other variations of COPD. This test uses an instrument called a spirometer to measure the volume of air entering and leaving the lungs. The test is done in the doctor's office and is painless. It involves breathing into the spirometer mouthpiece either normally or forcefully. Volumes less than 80% of the normal values indicate an obstructive lung disease.

To better determine what type of obstructive lung disease a patient has, the doctor may do a chest x ray, electrocardiogram (ECG), and blood tests. An electrocardiogram is an instrument used to measure the electrical activity of the heart and is useful in the diagnosis of heart conditions. Other tests may be used to measure how effectively oxygen and carbon dioxide are exchanged in the lungs.

## Treatment

### *Acute bronchitis*

When no secondary infection is present, acute bronchitis is treated in the same way as the **common cold**. Home care includes drinking plenty of fluids, resting, not smoking, increasing moisture in the air with a cool mist humidifier, and taking **acetaminophen** (Datril, Tylenol, Panadol) for fever and **pain**. **Aspirin** should not be given to children because of its association with the serious illness **Reye's syndrome**.

Expectorant cough medicines, unlike **cough suppressants**, do not stop the cough. Instead they are used to thin the mucus in the lungs, making it easier to cough up. This type of cough medicine may be helpful to individuals suffering from bronchitis. People who are unsure about what type of medications are in over-the-counter cough syrups should ask their pharmacist for an explanation.

If a secondary bacterial infection is present, the infection is treated with an antibiotic. Patients need to take the entire amount of antibiotic prescribed. Stopping the antibiotic early can lead to a return of the infection. Tetracycline or ampicillin is often used to treat adults. Other possibilities include trimethoprim/sulfamethoxazole (Bactrim or Septra) and the newer erythromycin-like drugs, such as azithromycin (Zithromax) and clarithromycin (Biaxin). Children under age eight are usually given amoxicillin (Amoxil, Pentamox, Sumox, Trimox), because tetracycline discolors permanent teeth that have not yet come in.

### *Chronic bronchitis*

The treatment of chronic bronchitis is complex and depends on the stage of chronic bronchitis and

whether other health problems are present. Lifestyle changes, such as quitting smoking and avoiding secondhand smoke or polluted air, are an important first step. Controlled **exercise** performed on a regular basis is also important.

### *Drugs*

Drug therapy begins with **bronchodilators**. These drugs relax the muscles of the bronchial tubes and allow increased airflow. They can be taken by mouth or inhaled using a nebulizer. A nebulizer is a device that delivers a regulated flow of medication into the airways. Common bronchodilators include albuterol (Ventolin, Proventil, Apo-Salvent) and metaproterenol (Alupent, Orciprenaline, Metaprel, Dey-Dose).

Anti-inflammatory medications are added to reduce swelling of the airway tissue. **Corticosteroids**, such as prednisone, can be taken orally or intravenously. Other **steroids** are inhaled. Long-term steroid use can have serious side effects. Other drugs, such as ipratropium (Atrovent), are given to reduce the quantity of mucus produced.

As the disease progresses, the patient may need supplemental oxygen. Complications of COPD are many and often require hospitalization in the latter stages of the disease.

### *Alternative treatment*

Alternative practitioners focus on prevention by eating a healthy diet that strengthens the immune system and practicing **stress** management. Bronchitis can become serious if it progresses to pneumonia; therefore, antibiotics may be required. In addition, there are a multitude of botanical and herbal medicines that can be formulated to treat bronchitis. Some examples include inhaling eucalyptus or other essential oils in warm steam. Herbalists recommend a tea made of mullein (*Verbascum thapsus*), coltsfoot (*Tussilago farfara*), and anise seed (*Pimpinella anisum*). **Homeopathic medicine** and **traditional Chinese medicine** may also be useful for bronchitis, and **hydrotherapy** can contribute to cleaning the chest and stimulating immune response.

### *Prognosis*

When treated, acute bronchitis normally resolves in one to two weeks without complications, although a cough may continue for several more weeks. The progression of chronic bronchitis, on the other hand, may be slowed, and an initial improvement in symptoms may be achieved. Unfortunately, there is no cure for chronic bronchitis, and the disease can often lead to or coexist with emphysema.

## Prevention

The best way to prevent bronchitis is to not begin smoking or to stop smoking. Smokers are ten times more likely to die of COPD than nonsmokers. Smokers who stop show improvement in lung function. Other preventative steps include avoiding chemical and environmental irritants, such as air pollution, and maintaining good overall health. Immunizations against certain types of pneumonia, as well as **influenza**, are an important preventative measure for anyone with lung or immune system diseases.

## Resources

### OTHER

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### ORGANIZATIONS

American Lung Association, 1301 Pennsylvania Ave., NW Suite 800, Washington, DC, 20004, (212) 315-8700, (800)LUNG-USA (548-8252), <http://www.lungusa.org>.

Global Alliance Against Chronic Respiratory Diseases (GARD), World Health Organization, Department of Chronic Diseases and Health Promotion, 20, Avenue Appia, CH-1211 27, Geneva, Switzerland, <http://www.who.int/gard/en/index.html>.

National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105 (301) 592-8573; TTY: (240) 629-3255, (240) 629-3246, [nhlbiinfo@nhlbi.nih.gov](mailto:nhlbiinfo@nhlbi.nih.gov), <http://www.nhlbi.nih.gov>.

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## Bronchodilators

### Definition

Bronchodilators are medicines that help open the bronchial tubes (airways) of the lungs, allowing more air to flow through them.

### Purpose

People with **asthma** have trouble breathing because their airways are inflamed and become narrowed. Normally, air moves smoothly from the mouth and nose through the airways and into the tiny air sacs of the lungs as a person breathes in. Breathing out (exhalation) happens automatically when the person

## KEY TERMS

**Anti-inflammatory**—Medicine used to relieve swelling, pain, and other symptoms of inflammation.

**Bronchitis**—Inflammation of the air passages of the lungs.

**Chronic**—A word used to describe a long-lasting condition. Chronic conditions often develop gradually and involve slow changes.

**Emphysema**—A lung disease in which breathing becomes difficult.

**Inflammation**—Pain, redness, swelling, and heat that usually develop in response to injury or illness.

**Nebulizer**—A device that turns liquid forms of medicine into a fine spray that can be inhaled.

**Sulfite**—A type of preservative that causes allergic reactions in some people.

stops breathing in. In a person with asthma, breathing in (inhaling) is not a problem. Incoming air can slide around the blockage, because the act of breathing in makes the airways expand. The problem comes when the person with asthma tries to breathe out. The air can no longer get past the blockage, and it remains trapped in the lungs. The person can then only take shallow breaths. Bronchodilators work by relaxing the smooth muscles that line the airways. This makes the airways open wider and allows air to leave the lungs. These drugs also are used to relieve breathing problems associated with **emphysema**, chronic **bronchitis**, and other lung diseases.

### Description

Some bronchodilators are inhaled, using a nebulizer or an inhalation aerosol. Others are taken as injections or by mouth. Most are available only by prescription, but a few, such as ephedrine, can be bought without a physician's prescription. Examples of bronchodilators are albuterol (Proventil, Ventolin), epinephrine (Primatene), ipratropium (Atrovent), metaproterenol (Alupent, Metaprel), and terbutaline (Brethine).

### Recommended dosage

The recommended dosage depends on the type of bronchodilator and may be different for different patients. The physician who prescribed the drug or the pharmacist who filled the prescription can recommend correct dosage.

## Precautions

Bronchodilators come with patient instructions that must be carefully read before using the medicine. If there is any confusion about how to use the medicine, patients should check with the physician or pharmacist. These medicines must be used exactly as directed. Taking larger than recommended doses or using the medicine too often can lead to serious side effects and even **death**.

If symptoms do not improve or if they get worse after using a bronchodilator, the patient should call a physician right away.

Although some bronchodilators are available without a physician's prescription, these medicines should not be used unless a physician has diagnosed the patient's condition as asthma.

Research shows that frequent bronchodilator use over time can tighten airway muscles in some people. Some physicians advise patients to consider controlling asthma with anti-inflammatory drugs including inhaled **steroids** such as beclomethasone dipropionate (Beclovent, Vanceril), flunisolide (AeroBid) or triamcinolone acetonide (Azmacort). A 2004 Canadian study has questioned a standard practice of increasing steroids after asthma attacks or worsened symptoms. Additional research in 2004 showed that people with asthma who worked closely with their physicians to self-manage their asthma had fewer attacks, which reduces the need for bronchodilators. Carefully managing asthma also reduces visits to the emergency department and hospitalizations.

Persons with diabetes should be aware that the bronchodilator epinephrine may raise their blood sugar levels.

Patients who are using an aerosol bronchodilator and an aerosol form of either ipratropium or a corticosteroid such as beclomethasone dipropionate (Beclovent, Vanceril) should use the bronchodilator first, then wait five minutes before using the other medicine. A physician should be consulted before using any other inhaled medications or other asthma medicines. The physician must determine the proper amount of time between doses.

Some bronchodilator products contain sulfites that trigger an allergic reaction in certain people. Anyone who has a sulfite allergy should read the label carefully or check with a physician or pharmacist before using a bronchodilator. Call a physician immediately if any of these signs of an allergic reaction to sulfite occur:

- bluish coloration of the skin
- flushed or red face or skin

- faintness
- severe dizziness
- increased wheezing or other breathing problems
- skin rash, hives, or itching
- swelling of the face, lips, or eyelids

## *Special conditions*

People with certain medical conditions or who are taking certain other medicines can have problems if they use bronchodilators. Before using these drugs, a physician should be made aware of any of these conditions:

**ALLERGIES.** Anyone who has had unusual reactions to any bronchodilator or an inhaled form of any other drug in the past should let his or her physician know before taking the drugs again. The physician should also be told about any **allergies** to foods, dyes, preservatives, or other substances.

Patients who are allergic to soybeans, soy lecithin, peanuts, or drugs based on atropine should not use the bronchodilator ipratropium (Atrovent).

**PREGNANCY.** In studies of laboratory animals, some bronchodilators cause **birth defects** or **miscarriage** when the animals are given doses many times the usual human dose. Whether these drugs cause such problems in humans is unknown. Any woman who is pregnant or plans to become pregnant should check with her physician before using a bronchodilator.

**BREASTFEEDING.** Some bronchodilators pass into breast milk. **Breastfeeding** mothers should check with their physicians before using bronchodilators.

**OTHER MEDICAL CONDITIONS.** Before using bronchodilators, people with any of these medical problems should make sure their physicians are aware of their conditions:

- glaucoma
- brain damage
- convulsions (seizures)—recently or anytime in the past
- mental illness
- Parkinson's disease
- diabetes
- heart or blood vessel diseases
- rapid or irregular heartbeat
- high blood pressure
- overactive thyroid
- enlarged prostate
- obstruction of the neck of the bladder

**USE OF CERTAIN MEDICINES.** Using bronchodilators with certain other drugs may affect the way the drugs work or may increase the chance of side effects.

### Side effects

Some patients have a dry or irritated throat or a **dry mouth** after using bronchodilators. To help prevent these problems, gargling and rinsing the mouth or taking a sip of water after each dose.

The most common side effects are nervousness or restlessness and trembling. These problems usually go away as the body adjusts to the drug and do not require medical treatment. Less common side effects such as bad taste in the mouth, coughing, **dizziness** or lightheadedness, drowsiness, **headache**, sweating, fast or pounding heartbeat, **muscle cramps** or twitches, **nausea**, **vomiting**, **diarrhea**, sleep problems, and weakness also may occur and do not need medical attention unless they do not go away or they interfere with normal activities.

More serious side effects are not common, but may occur. If any of the following side effects occur, the physician who prescribed the medicine should be contacted as soon as possible:

- chest pain or discomfort
- irregular or fluttery heartbeat
- unusual bruising
- hives or rash
- swelling
- wheezing or other breathing problems
- numbness in the hands or feet
- blurred vision

Other side effects are possible. Anyone who has unusual symptoms after using a bronchodilator should get in touch with his or her physician.

### Interactions

Bronchodilators may interact with a number of other medicines. When this happens, the effects of one or both of the drugs may change or the risk of side effects may be greater. Anyone who takes these drugs should let the physician know all other medicines he or she is taking. Among the drugs that may interact with bronchodilators are:

- monoamine oxidase inhibitors (MAO inhibitors) such as phenelzine (Nardil) and tranylcypromine (Parnate), used to treat depression
- other bronchodilators
- tricyclic antidepressants such as amitriptyline (Elavil) and imipramine (Tofranil)

- beta blockers such as propranolol (Inderal) and atenolol (Tenormin), used to control high blood pressure
- digitalis medicines, used to treat heart conditions, such as digoxin (Lanoxin)
- drugs, such as certain diuretics (water pills), that lower potassium levels
- ergoloid mesylates such as Hydergine, used to treat symptoms of Alzheimer's disease or multiple small strokes
- ergotamine (Cafergot, Ergostat, and other brands), used to treat migraine and cluster headaches
- the antidepressant maprotiline (Ludiomil)

The list above does not include every drug that may interact with bronchodilators. Be sure to check with a physician or pharmacist before combining bronchodilators with any other prescription or non-prescription (over-the-counter) medicine.

### Resources

#### PERIODICALS

- “Study Calls Standard Asthma Management Into Doubt.” *Doctor* July 15, 2004: 4.
- “What’s New in: Asthma and Allergic Rhinitis.” *Pulse* September 20, 2004: 50.
- “Wheezing? Check Your Inhaler.” *Prevention* September 2004: 34.

#### ORGANIZATIONS

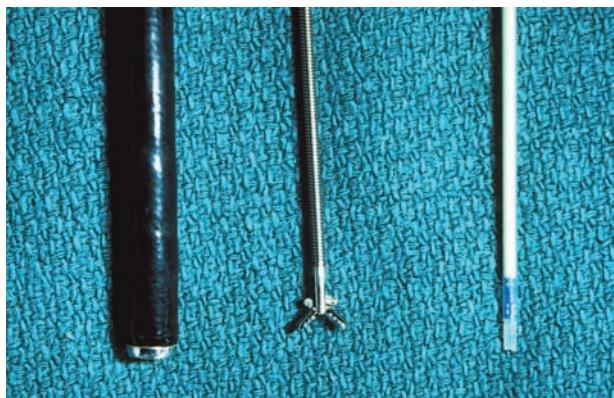
- American Academy of Allergy, Asthma & Immunology, 555 East Wells Street, Suite 1100, Milwaukee, WI, 53202-3823, (414) 272-6071, <http://www.aaaai.org>.
- Asthma and Allergy Foundation of America, 8201 Corporate Drive, Suite 1000, Landover, MD, 20785, (800) 727-8462, [info@aafa.org](mailto:info@aafa.org), <http://www.aafa.org/>.
- National Heart Lung and Blood Institute Health Information Center, P.O. Box 30105, Bethesda, MD, 20824-0105, (301) 592-8573, (240) 629-3246, <http://www.nhlbi.nih.gov>.

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## Bronchoscopy

### Definition

Bronchoscopy is a procedure in which a hollow, flexible tube called a bronchoscope is inserted into the airways through the nose or mouth to provide a view of the tracheobronchial tree. It can also be used to collect bronchial and/or lung secretions and to perform tissue biopsy.



**Instruments used in bronchoscopy procedures.** (Custom Medical Stock Photo, Inc. Reproduced by permission.)

### Purpose

During a bronchoscopy, the physician can visually examine the lower airways, including the larynx, trachea, bronchi, and bronchioles. The procedure is used to examine the mucosal surface of the airways for abnormalities that might be associated with a variety of lung diseases. Its use may be diagnostic or therapeutic.

Bronchoscopy may be used to examine and help diagnose all of the following:

- diseases of the lung, such as cancer or tuberculosis
- congenital deformity of the lungs
- suspected tumor, obstruction, secretion, bleeding, or foreign body in the airways
- airway abnormalities, such as tracheal stenoses
- persistent cough, or hemoptysis, that includes blood in the sputum

Bronchoscopy may also be used for the following therapeutic purposes:

- remove a foreign body in the lungs
- remove excessive secretions
- remove tumors in the airway
- treat stenosis (narrowing) of the airways, by using balloon dilatation or placing a stent

Bronchoscopy can also be used to collect the following biopsy specimens:

- sputum
- tissue samples from the bronchi or bronchioles
- cells collected from washing the lining of the bronchi or bronchioles

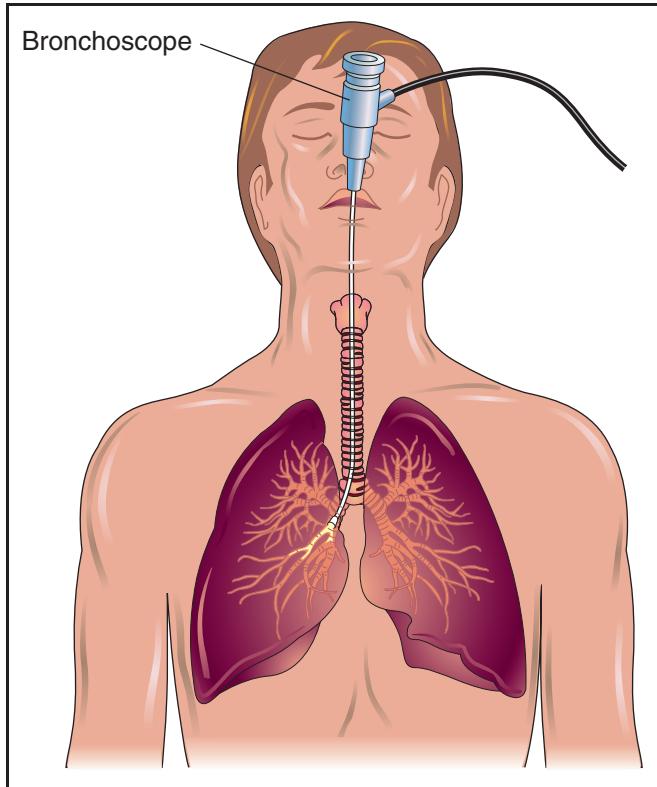
If the purpose of the bronchoscopy is to take tissue samples, or biopsy, a forceps or bronchial brush are used to obtain cells. Alternatively, if the purpose is to

identify an infectious agent, a bronchoalveolar lavage can be performed to gather fluid for culture purposes. If any foreign matter is found in the airways, it can be removed as well. Tumors can be debulked (made smaller) through the use of laser, electrocautery, or **cryotherapy** during the bronchoscopy. A balloon can be passed into a narrowed area of the airway and inflated in order to treat stenosis. A stent (tiny artificial tube) can be placed during bronchoscopy, in order to keep a portion of the airway open.

The instrument used in bronchoscopy, a bronchoscope, is a slender, flexible tube less than 0.5 in. (2.5 cm) wide and approximately 2 ft. (0.3 m) long that uses fiber-optic technology (very fine filaments that can bend and carry light). There are two types of bronchoscopes: a standard tube that is more rigid and a fiber-optic tube that is more flexible. The rigid instrument does not bend, does not see as far down into the lungs as the flexible one, and may carry a greater risk of causing injury to nearby structures. Because a standard tube can cause more discomfort than the flexible bronchoscope, it usually requires **general anesthesia**. However, it is useful for taking large samples of tissue and for removing foreign bodies from the airways. During the procedure, the airway is not blocked since oxygen can be supplied through the bronchoscope.

### Demographics

Nearly 500,000 bronchoscopies are performed annually in the United States. According to the National **Cancer** Institute, cancer of the lung and bronchi is the second most common cancer among both men and women and is the leading cause of cancer **death** in both sexes in the United States. Among men, lung cancer incidence rates per 100,000 people range from a low of approximately 14 among American Indians to a high of 117 among African Americans. Between these two extremes, rates fall into two groups, ranging from 42 to 53 for Hispanics, Japanese, Chinese, Filipinos, and Koreans, and from 71 to 89 for Vietnamese, Caucasians, Alaska Natives, and Hawaiians. The range among women is much narrower, from a rate of about 15 among Japanese to nearly 51 among Alaska Natives, only a three-fold difference. Rates for the remaining female populations fall roughly into two groups with low rates of 16–25 for Korean, Filipino, Hispanic, and Chinese women, and rates of 31–44 among Vietnamese, Caucasian, Hawaiian, and African American women. The rates among men are about two to three times greater than the rates among women in each of the racial/ethnic groups.



**Bronchoscopy** is a procedure in which a hollow, flexible tube is inserted into the airways, allowing the physician to visually examine the lower airways, including the larynx, trachea, bronchi, and bronchioles. It can also be used to collect specimens for bacteriological culture to diagnose infectious diseases such as tuberculosis. (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

## Description

Bronchoscopy is usually performed in an **endoscopy** room, but may also be performed at the bedside. The patient is placed on the back or sits upright. A pulmonologist, a specialist trained to perform the procedure, sprays anesthetic into the patient's mouth or throat. When anesthesia has taken effect and the area is numb, the bronchoscope is inserted into the mouth and passed into the throat. If the bronchoscope is passed through the nose, an anesthetic jelly is inserted into one nostril. While the bronchoscope is moving down the throat, additional anesthetic is put into the bronchoscope to anesthetize the lower airways. The physician observes the trachea, bronchi, and the mucosal lining of these passageways looking for any abnormalities that may be present. If samples are needed, a bronchial lavage may be performed, meaning that a saline solution is used to flush the area prior to collecting cells for laboratory analysis.

Very small brushes, needles, or forceps may also be introduced through the bronchoscope to collect tissue samples from the lungs. If the procedure is therapeutic in nature, laser, electrocautery, cryotherapeutic, or balloon dilatation instruments may be passed through the bronchoscope, and a stent may be placed.

## Preparation

The patient should fast for 6 to 12 hours prior to the procedure and refrain from drinking any liquids the day of the procedure. **Smoking** should be avoided for 24 hours prior to the procedure, and patients should also avoid taking any **aspirin** or ibuprofen-type medications. The bronchoscopy itself takes about 45–60 minutes. Prior to the bronchoscopy, several tests are usually done, including a **chest x ray** and blood work. Sometimes a bronchoscopy is done under general anesthesia, in which case the patient will have an intravenous (IV) line in the arm. More commonly, the procedure is performed under **local anesthesia**, which is sprayed into the nose or mouth. This is necessary to inhibit the gag reflex. A sedative may also be given. A signed consent form is necessary for this procedure.

## Aftercare

After the bronchoscopy, the vital signs (heart rate, blood pressure, and breathing) are monitored. Sometimes patients have an abnormal reaction to anesthesia. Any sputum should be collected in an emesis basin so that it can be examined for the presence of blood. If a biopsy was taken, the patient should not **cough** or clear the throat as this might dislodge any blood clot that has formed and cause bleeding. No food or drink should be consumed for about two hours after the procedure or until the anesthesia wears off. There is a significant risk for **choking** if anything (including water) is ingested before the anesthetic wears off and the gag reflex has returned. To test if the gag reflex has returned, a spoon is placed on the back of the tongue for a few seconds with light pressure. If there is no gagging, the process is repeated after 15 minutes. The gag reflex should return in one or two hours. Ice chips or clear liquids should be taken before the patient attempts to eat solid food. Patients should be informed that the throat may be irritated for several days.

Patients should notify their healthcare provider if they develop any of these symptoms:

- hemoptysis (coughing up blood)
- shortness of breath, wheezing, or any trouble breathing
- chest pain
- fever, with or without breathing problems

## KEY TERMS

**Anesthetic**—A drug that causes loss of sensation. It is used to lessen the pain of surgery and medical procedures.

**Biopsy**—Procedure that involves obtaining a tissue specimen for microscopic analysis to establish a precise diagnosis.

**Bronchi**—The network of tubular passages that carry air to the lungs and allow air to be expelled from the lungs.

**Bronchioles**—Small airways extending from the bronchi into the lobes of the lungs.

**Bronchoalveolar lavage**—Washing cells from the air sacs at the end of the bronchioles.

**Computed tomography (CT)**—A special radiographic imaging technique that uses a computer to acquire multiple x rays into a two-dimensional sectional image.

**Emesis basin**—A basin used to collect sputum or vomit.

**Endoscope**—A highly flexible viewing instrument.

**Endoscopy**—The visual inspection of any cavity of the body using an endoscope.

**Hemoptysis**—The expectoration of blood or of blood containing sputum.

**Larynx**—The voice box.

**Lavage**—Washing out.

**Neoplasm**—A new growth or tumor.

**Sputum**—Matter ejected from the lungs, bronchi, and trachea through the mouth.

**Stenosis**—Narrowing of a duct or canal.

**Trachea**—The windpipe.

**Tracheobronchial**—Pertaining both to the tracheal and bronchial tubes or to their junction.

## Risks

Use of the bronchoscope mildly irritates the lining of the airways, resulting in some swelling and inflammation, as well as hoarseness caused from abrading the vocal cords. If this abrasion is more serious, it can lead to respiratory difficulty or bleeding of the lining of the airways.

The bronchoscopy procedure is also associated with a small risk of disordered heart rhythm (arrhythmia), heart attacks, low blood oxygen (hypoxemia), and

**pneumothorax** (a puncture of the lungs that allows air to escape into the space between the lung and the chest wall). These risks are greater with the use of a rigid bronchoscope than with a fiber-optic bronchoscope. If a rigid tube is used, there is also a risk of chipped teeth. The risk of transmitting **infectious disease** from one patient to another by the bronchoscope is also present. The Centers for Disease Control (CDC) reported cases of patient-to-patient transmission of infections following bronchoscopic procedures using bronchoscopes that were inadequately reprocessed by the automated endoscope reprocessing (AER) system. Investigation of the incidents revealed inconsistencies between the reprocessing instructions provided by the manufacturer of the bronchoscope and the manufacturer of the AER; or that the bronchoscopes were inadequately reprocessed.

## Normal results

If the results of the bronchoscopy are normal, the windpipe (trachea) appears as smooth muscle with C-shaped rings of cartilage at regular intervals. There are no abnormalities either in the trachea or in the bronchi of the lungs.

Bronchoscopy results may also confirm a suspected diagnosis. This may include swelling, ulceration, or deformity in the bronchial wall, such as inflammation, stenosis, or compression of the trachea, neoplasm, and foreign bodies. The bronchoscopy may also reveal the presence of atypical substances in the trachea and bronchi. If samples are taken, the results could indicate cancer, disease-causing agents, or other lung diseases. Other findings may include constriction or narrowing (stenosis), compression, dilation of vessels, or abnormal branching of the bronchi. Abnormal substances that might be found in the airways include blood, secretions, or mucous plugs.

## Morbidity and mortality rates

Bronchoscopy belongs to the group of procedures associated with highest inpatient mortality with a 12.7% mortality rate.

## Alternatives

Depending upon the purpose of the bronchoscopy, alternatives may include a chest x ray or a computed tomography (CT) scan. If the purpose is to obtain biopsy specimens, one option is to perform surgery, which carries greater risks. Another option is percutaneous biopsy guided by CT.

## Resources

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### ORGANIZATIONS

American College of Chest Physicians, 3300 Dundee Road, Northbrook, IL, 60062, (800) 343-2227, <http://www.chestnet.org/accp>.

Association of Perioperative Registered Nurses (AORN), 2170 South Parker Road, Suite 300, Denver, CO, 80231-5711, (800) 755-2676, (800) 847-0045, [custsvc@aorn.org](mailto:custsvc@aorn.org), <http://www.aorn.org>.

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## Brucellosis

### Definition

Brucellosis is a bacterial disease caused by members of the *Brucella* genus that can infect humans but primarily infects livestock. Symptoms of the disease include intermittent **fever**, sweating, chills, aches, and mental depression. The disease can become chronic and recur, particularly if untreated.

### Description

Also known as undulant fever, Malta fever, Gibraltar fever, Bang's disease, or Mediterranean fever,

brucellosis is most likely to occur among those individuals who regularly work with livestock. The disease originated in domestic livestock but was passed on to wild animal species, including the elk and buffalo of the western United States. In humans, brucellosis continues to be spread via unpasteurized milk obtained from infected cows or through contact with the discharges of cattle and goats during **miscarriage**. In areas of the world where milk is not pasteurized, such as in Latin America and the Mediterranean, the disease is still contracted by ingesting unpasteurized dairy products. However, in the United States, the widespread pasteurization of milk and nearly complete eradication of the infection from cattle has reduced the number of human cases from 6,500 in 1940 to less than 200 today.

### Causes and symptoms

The disease is caused by several different species of parasitic bacteria of the genus *Brucella*. *B. abortus* is found in cattle and can cause cows to abort their fetuses. *B. suis* is most often found in hogs and is more deadly when contracted by humans than the organism found in cattle. *B. melitensis* is found in goats and sheep and causes the most severe illness in humans. *B. rangiferi* infects reindeer and caribou, and *B. canis* is found in dogs.

A human contracts the disease by coming into contact with an infected animal and either allowing the bacteria to enter a cut, breathing in the bacteria, or consuming unpasteurized milk or fresh goat cheese obtained from a contaminated animal. In the United States, the disease is primarily confined to slaughterhouse workers.

Scientists do not agree about whether brucellosis can be transmitted from one person to another, although some people have been infected from a tainted blood **transfusion** or bone marrow transplant. Newborn babies have also contracted the illness from their mothers during birth. Currently, it is believed that brucellosis can also be transmitted sexually.

The disease is not usually fatal, but the intermittent fevers (a source of its nickname, "undulant fever") can be exhausting. Symptoms usually appear between five days and a month after exposure and begin with a single bout of high fever accompanied by shivering, aching, and drenching sweats that last for a few days. Other symptoms may include **headache**, poor appetite, back-ache, weakness, and depression. Mental depression can be so severe that the patient may become suicidal.

In rare, untreated cases, the disease can become so severe that it leads to fatal complications, such as

## KEY TERMS

**Antibody**—A specific protein produced by the immune system in response to a specific foreign protein or particle called an antigen.

**Chronic**—Disease or condition characterized by slow onset over a long period of time.

**Parasite**—An organism living in or on, and obtaining nourishment from, another organism.

**Pasteurization**—The process of applying heat, usually to milk or cheese, for the purpose of killing, or retarding the development of, pathogenic bacteria.

**pneumonia** or bacterial **meningitis**. *B. melitensis* can cause miscarriages, especially during the first three months of **pregnancy**. The condition can also occur in a chronic form, in which symptoms recur over a period of months or years.

### Diagnosis

Brucellosis is usually diagnosed by detecting one or more *Brucella* species in blood or urine samples. The bacteria may be positively identified using biochemical methods or using a technique whereby, if present in the sample, the brucellosis bacteria are made to fluoresce. Brucellosis may also be diagnosed by culturing and isolating the bacteria from one of the above samples. Blood samples will also indicate elevated antibody levels or increased amounts of a protein produced directly in response to infection with brucellosis bacteria.

### Treatment

Prolonged treatment with **antibiotics**, including **tetracyclines** (with streptomycin), co-trimoxazole, and **sulfonamides**, is effective. Bed rest is also imperative. In the chronic form of brucellosis, the symptoms may recur, requiring a second course of treatment.

### Prognosis

Early diagnosis and prompt treatment is essential to prevent chronic infection. Untreated, the disease may linger for years, but it is rarely fatal. Relapses may also occur.

### Prevention

There is no human vaccine for brucellosis, but humans can be protected by controlling the disease in livestock. After checking to make sure an animal is not already infected, and destroying those that are, all livestock should be immunized. Butchers and those who work in slaughterhouses should wear protective

glasses and clothing, and protect broken skin from infection.

Some experts suggest that a person with the disease refrain from engaging in unprotected sex until free of the disease. The sexual partners of an infected person should also be closely monitored for signs of infection.

### Resources

#### OTHER

“Brucellosis.” Centers for Disease Control and Prevention. [http://www.cdc.gov/ncidod/dbmd/diseasesinfo/brucellosis\\_g.htm](http://www.cdc.gov/ncidod/dbmd/diseasesinfo/brucellosis_g.htm) (accessed November 24, 2010).

#### ORGANIZATIONS

Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Atlanta, GA, 30333, (800) 232-4636, [cdeinfo@cdc.gov](mailto:cdeinfo@cdc.gov), <http://www.cdc.gov>.

Carol A. Turkington

Brugian filariasis see **Elephantiasis**

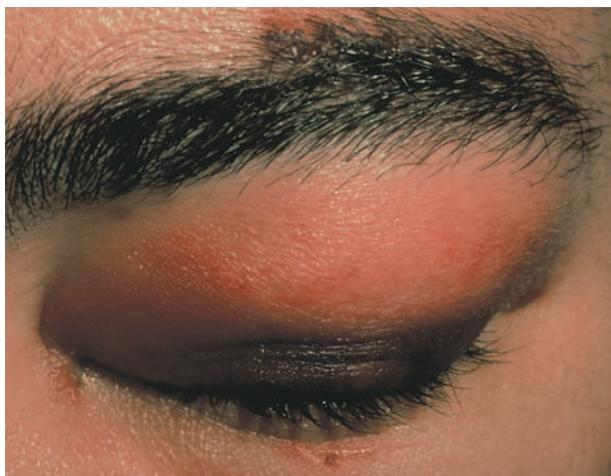
## Bruises

### Definition

Bruises, or ecchymoses, are a discoloration and tenderness of the skin or mucous membranes due to the leakage of blood from an injured blood vessel into the tissues. Pupura refers to bruising as the result of a disease condition. A very small bruise is called a petechia. These often appear as many tiny red dots clustered together, and could indicate a serious problem.

### Description

Bruises change colors over time in a predictable pattern, so it is possible to estimate when an injury occurred by the color of the bruise. Initially, a bruise will be reddish, the color of the blood under the skin. After one to two days, the red blood cells begin to break



**A close-up view of woman's bruised left eye.** (Custom Medical Stock Photo, Inc. Reproduced by permission.)

down, and the bruise will darken to a blue or purplish color. This fades to green at about day six. Around the eighth or ninth day, the skin over the bruised area will have a brown or yellowish appearance, and it will gradually diminish back to its normal color.

Long periods of standing will cause the blood that collects in a bruise to seep through the tissues. Bruises are actually made of little pools of blood, so the blood in one place may flow downhill after awhile and appear in another. For instance, bruising in the back of the abdomen may eventually appear in the groin; bruising in the thigh or the knee will work its way down to the ankle.

### Causes and symptoms

Healthy people may develop bruises from any injury that doesn't break through the skin. Vigorous **exercise** may also cause bruises due to bringing about small tears in blood vessels walls. In a condition known as purpura simplex, there is a tendency to bruise easily due to an increased fragility of the blood vessels. Bruises also develop easily in the elderly, because the skin and blood vessels have a tendency to become thinner and more fragile with **aging**, and there is an increased use of medications that interfere with the blood clotting system. In the condition known as purpura senilis, the elderly develop bruises from minimal contact that may take up to several months to completely heal.

The use of nonsteroidal anti-inflammatories such as ibuprofen (Advil) and naproxen (Aleve) may lead to increased bruising. **Aspirin**, antidepressants, **asthma**

medications, and cortisone medications also have this effect. The anti-clotting medications known as blood thinners, especially the drug Warfarin (Coumadin), may be the cause of particularly severe bruising.

Sometimes bruises are connected with more serious illnesses. There are a number of diseases that cause excessive bleeding or bleeding from injuries too slight to have consequences in healthy people. An abnormal tendency to bleed may be due to hereditary bleeding disorders, certain prescription medications, diseases of the blood such as leukemia, and diseases that increase the fragility of blood vessels. If there are large areas of bruising or bruises develop very easily, this may herald a problem. Other causes that should be ruled out include **liver disease**, **alcoholism**, **drug addiction**, and acquired immune deficiency syndrome (**AIDS**). Bruising that occurs around the navel may indicate dangerous internal bleeding; bruising behind the ear, called Battle's sign, may be due to a skull fracture; and raised bruises may point to autoimmune disease.

### Diagnosis

Bruising is usually a minor problem, which does not require a medical diagnosis. However, faced with extensive bruising, bruising with no apparent cause, or bruising in certain locations, a physician will pursue an evaluation that will include a number of blood tests. If the area of the bruise becomes hard, an x ray may be required.

### Treatment

A bruise by itself needs no medical treatment. It is often recommended that ice packs be applied on and off during the first 24 hours of injury to reduce the bruising. After that, heat, especially moist heat, is recommended to increase the circulation and the healing of the injured tissues. Rest, elevation of the affected part, and compression with a bandage will also retard the accumulation of blood. Rarely, if a bruise is so large that the body cannot completely absorb it or if the site becomes infected, it may have to be surgically removed.

### Alternative treatment

Several types of topical applications are usually recommend to speed healing and to reduce the **pain** associated with bruises. Vitamin K cream can be applied directly to the site of injury. Astringent herbs such as witch hazel, *Hamamelis virginiana*, can be used. This will tighten the tissues and therefore diminish the bruising.

The homeopathic remedy, *Arnica montana*, can be applied as a cream or gel to unbroken skin.

Oral homeopathic remedies may reduce bruising, pain, and swelling as well. *Arnica montana*, at 30 mL (1 oz), taken one to two times per day is highly recommended. For ledum, 30 mL (1 oz) one to two times per day is also useful.

## Prognosis

The blood under the skin that causes the discoloration of bruising should be totally reabsorbed by the body in three weeks or less. At that time, the skin color should completely return to normal.

Sometimes, a bruise may become solid and increase in size instead of dissolving. This may indicate blood trapped in the tissues, which may be need to be drained. This is referred to as a hematoma. Less commonly, the body may develop **calcium** deposits at the injury site in a process called heterotopic ossification.

## Prevention

Vitamin K promotes normal clotting in the blood, and therefore may help reduce the tendency to bruise easily. Green leafy vegetables, alfalfa, broccoli, seaweed, and fish liver oils are dietary sources of vitamin K. Other good foods to eat would be those containing bioflavonoids, such as reddish-blue berries. These can assist in strengthening the connective tissue, which will decrease the spread of blood and bruising. Zinc and vitamin C supplements are also recommended for this.

## Resources

### BOOKS

Editors of Prevention. *The Doctors Book of Home Remedies: Quick Fixes, Clever Techniques, and Uncommon Cures to Get You Feeling Better Fast*. New York: St. Martin's Press, 2009.

Patience Paradox

Bruton's agammaglobulinemia see **X-linked agammaglobulinemia**

## Bruxism

### Definition

Bruxism is the habit of clenching and grinding the teeth. It most often occurs at night during sleep, but it may also occur during the day. It is an unconscious

## KEY TERMS

**Enamel**—The hard outermost surface of a tooth.

**High spot**—An area of a tooth or restoration that feels abnormal or uncomfortable because it hits its opposing tooth before other teeth meet.

**Night guard**—A removable, custom-fitted plastic appliance that fits between the upper and lower teeth to prevent them from grinding against each other.

**Occlusion**—The way upper and lower teeth fit together during biting and chewing.

**Rolfing**—Based on the belief that proper alignment of various parts of the body is necessary for physical and mental health, rolfing uses deep tissue massage and movement exercises in an attempt to bring the body into correct alignment.

**Temporomandibular joint (TMJ)**—The jaw joint formed by the mandible (lower jaw bone) moving against the temporal bone of the skull.

behavior, perhaps performed to release **anxiety**, aggression, or anger.

## Description

Bruxism is one of the oldest disorders known, and approximately one in four adults experiences it. Most people are not aware of it before their teeth have been damaged.

## Causes and symptoms

While bruxism is typically associated with **stress**, it may also be triggered by abnormal occlusion (the way the upper and lower teeth fit together), or crooked or missing teeth.

Symptoms of bruxism include: dull headaches; sore and tired facial muscles; earaches; sensitive teeth; and locking, popping, and clicking of the jaw.

During a dental examination, a dentist may recognize damage resulting from bruxism, including enamel loss from the chewing surfaces of teeth, flattened tooth surfaces, loosened teeth, and fractured teeth and fillings. Left untreated, bruxism may lead to tooth loss and jaw dysfunction.

## Diagnosis

Medical and dental histories and examinations are necessary to differentiate bruxism from other conditions

that may cause similar **pain**, such as ear infections, dental infections, and temporomandibular joint (TMJ) dysfunction. However, uncommonly worn-down teeth strongly suggest a diagnosis of bruxism.

### Treatment

To prevent further damage to the teeth, bruxism is treated by placing a removable, custom-fitted plastic appliance called a night guard between the upper and lower teeth. Although the clenching and grinding behavior may continue, the teeth wear away the plastic instead of each other.

In some cases, abnormal occlusion may be adjusted and high spots removed so that the teeth fit together in a more comfortable position. Missing teeth may be replaced and crooked teeth may be straightened with orthodontic treatment to eliminate possible underlying causes of bruxism. In cases where jaw muscles are very tight, a dentist may prescribe **muscle relaxants**.

### Alternative treatment

Stress management and behavior modification techniques may be useful to break the habit of clenching and teeth grinding. Tight jaw muscles may be relaxed by applying warm compresses to the sides of the face. Herbal muscle relaxants also can be helpful. **Massage therapy** and deep tissue realignment, including **rolfing**, can assist in releasing the clenching pattern. This is a more permanent alternative treatment for bruxism.

### Prognosis

Bruxism may cause permanent damage to teeth and chronic jaw pain unless properly diagnosed and promptly treated. The behavior may be eliminated if its underlying causes are found and addressed.

### Prevention

Increased awareness in patients prone to anxiety, aggression, or anger may prevent the habit of bruxism from developing.

### ORGANIZATIONS

Academy of General Dentistry, 211 East Chicago Avenue, Suite 900, Chicago, IL, 60611-1999, (312) 440-0559, (888) 243-3368, <http://www.agd.org>.

American Dental Association, 211 E. Chicago Ave., Chicago, IL, 60611-2678, (312) 440-2500, <http://www.ada.org>.

Bethany Thivierge

Bubonic plague see **Plague**

## Budd-Chiari syndrome

### Definition

Budd-Chiari syndrome is a rare problem that results from blood clotting in the veins flowing out of the liver (hepatic veins). The high pressure of blood in these veins leads to an enlarged liver, and to an accumulation of fluid in the abdomen, called **ascites**.

### Demographics

The exact frequency of Budd-Chiari syndrome is unknown. The syndrome is seen in all races and in both males and females. It appears to be more prevalent in Asian countries, with individuals presenting clinical symptoms during ages 30 to 40; however it may occur in children and in older individuals, as well.

### Description

The liver, the largest internal organ in the human body, is responsible for many vital physiologic processes. Blood flow through the liver nourishes the liver, carries in substances that the liver will process, and carries away substances that the liver has produced. When blood cannot flow out freely from the liver, blood pressure rises in the veins of the liver, leading to **blood clots** within the liver. Also, some of the blood plasma can leak through the walls of the veins and accumulate within the abdomen (ascites).

### Causes and symptoms

The major symptoms include **pain** in the upper right-hand portion of the abdomen and a buildup of fluid in the abdomen. In the United States, blood disorders are the most common causes. Among these disorders are **polycythemia vera** (an increase in the number of red blood cells) and sickle cell anemia. In parts of the world where **liver cancer** is common, a form of liver **cancer** is the most frequent cause.

Other causes sometimes include:

- certain infections
- use of oral contraceptives
- body changes in pregnancy and the postpartum period
- phlebitis (inflammation of a vein)
- injury to the abdomen
- a membrane web that causes blockage of the inferior vena cava

## Diagnosis

Diagnosis of Budd-Chiari syndrome can be made by an internist (a specialist in diseases of the internal organs), a gastroenterologist (a specialist in the diseases of the digestive system), or a general surgeon. On **physical examination**, the doctor will note that the liver is larger than normal. Often an ultrasound scan of the liver will show abnormalities in the size of the liver, an abnormal pattern of the veins in the liver, and other abnormalities. A CT scan will often show similar abnormalities.

Once these abnormalities are confirmed, the key test is called hepatic vein catheterization. In this test, a narrow tube is snaked through the body until it reaches the hepatic veins. An instrument at the tip of the catheter can measure the pressure within each segment of the hepatic vein.

In some cases, a tiny amount of radioactive material is injected into a patient, and then an abnormal pattern of radioactivity in the liver can be revealed. In other cases, a **liver biopsy** enables a physician to examine cells from the liver itself. Cells damaged by Budd-Chiari syndrome have a characteristic appearance easily identifiable to a physician.

## Treatment

### Surgery

Most patients with Budd-Chiari syndrome must have surgery. A surgeon will re-route blood flow around the clotted hepatic vein into a large vein called the vena cava. The exact technique will depend on the specific location of the clots and other factors. In certain patients, other surgical techniques may be used. For patients who otherwise would have less than six months to live, **liver transplantation** is sometimes performed.

In a few patients, a “balloon catheter” can open the blocked blood vessels, without the need for major surgery.

### Drugs

Sometimes, anti-clotting drugs such as urokinase and tissue plasminogen activator (tPA) can be used for patients with a sudden onset of clotting in the veins of the liver. These drugs do not seem to work when the clots have become established.

## Prognosis

If surgery is done before permanent liver damage sets in, long-term survival is possible. In these cases, damaged liver cells can actually recover. If patients are

## KEY TERMS

**Ascites**—Accumulation of fluid in the abdomen.

**Biopsy**—Surgical removal of a tiny bit of tissue for examination under the microscope.

**Catheter**—A tubular surgical instrument.

**Phlebitis**—Inflammation of a vein.

**Polycythemia vera**—An excess number of red blood cells in the blood.

**Sickle cell anemia**—An inherited disease in which red blood cells take an unusual shape, leading to circulation problems.

already very sick with **liver disease**, the surgery may not be as helpful.

## Prevention

The best approach to prevention is to carefully control the blood disorders that can lead to Budd-Chiari syndrome.

## Resources

### BOOKS

Gordon, Fredric D. *100 Q&A About Liver Transplantation: A Lahey Clinic Guide*. Sudbury, MA: Jones and Bartlett Publishers, Inc, 2007.

Mahl, Thomas, M.D., and John O’Grady. *Liver Disorders*. Oxford, UK: Health Press, 2006.

Qontro Medical Guides. *Budd-Chiari Syndrome Medical Guide*. Minneapolis, MN: Qontro, 2008.

### ORGANIZATIONS

National Organization for Rare Diseases, P.O. Box 8923, Fairfield, CT, 06412, (213) 745–6518, <http://www.rarediseases.org>.

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## Buerger's disease

### Definition

Buerger’s disease is an inflammation of the arteries, veins, and nerves in the legs, leading to restricted blood flow. Left untreated, Buerger’s disease can lead to **gangrene** of the affected areas. Buerger’s disease is also known as thromboangiitis obliterans.

## KEY TERMS

**Gangrene**—A decay of the tissue in a part of the body that experiences restricted blood flow.

**Inflammation**—A local reaction to irritation, injury, or infection characterized by pain, swelling, redness, and occasional loss of function.

**Ischemia**—A decrease in the blood supply to an area of the body caused by obstruction or constriction of blood vessels.

**Phlebitis**—Inflammation of a vein.

## Causes and symptoms

The exact cause of Buerger's disease is not known. It is seen most often in young to middle-aged men (ages 20–40) who are heavy smokers of cigarettes. Cases of this disease in nonsmokers are very rare; hence, cigarette **smoking** is considered a causative factor. Approximately 40% of the patients have a history of inflammation of a vein (phlebitis), which may play a role in the development of Buerger's disease.

The disease is mainly seen in the legs of affected persons, but may also appear in their arms. Early symptoms include decrease in the blood supply (arterial **ischemia**) and superficial (near the skin surface) phlebitis. The main symptom is **pain** in the affected areas. Onset of the disease is gradual and first occurs in the feet or hands. Inflammation occurs in small and medium-sized arteries and veins near the surface of the limb. In advanced cases, blood vessels in other parts of the body may be affected. There is a progressive decrease in the blood flow to the affected areas. The pulse in arteries of the feet is weak or undetectable. The lack of blood flow can lead to gangrene, which is decay of tissue due to restricted blood supply. A cold sensitivity in the hands, similar to that seen in **Raynaud's disease**, can develop. In this case, the hands turn color—white, blue, and then red—when exposed to the cold.

## Diagnosis

Diagnosis is usually made from the clinical symptoms. Patients frequently complain of **numbness**, **tingling**, or burning sensations in the affected area before evidence of vascular inflammation becomes apparent.

## Treatment

There is no effective medication or surgery for this disease. Patients must stop smoking to halt further development of the symptoms. **Vasodilators**, drugs

that increase the diameter of the blood vessels, can be administered but may not be effective. Exposure of affected areas to heat or cold should be avoided. Trauma to the feet and other affected areas should be avoided and infections must be treated promptly.

## Prognosis

The disease is progressive in patients who do not stop smoking. Areas with gangrene must be removed surgically.

## Prevention

Smoking is the only known causative agent for this disease and should be avoided.

## Resources

### BOOKS

- Horwitz, Randy, and Daniel Muller. *Integrative Rheumatology*. New York: Oxford University Press, 2010.
- Miller, Marc L. *Little Black Book of Rheumatology*. Sudbury, MA: Jones and Bartlett Publishers, Inc., 2008.
- Miller, Max. *The Quit Smoking Companion: The Daily Guide to Freedom from Cigarettes*. Charleston, SC: BookSurge Publishing, 2009.

John T. Lohr, Ph.D.

Laura Jean Cataldo, RN, EdD

Bulging eyes see **Exophthalmos**

## Bulimia nervosa

### Definition

Bulimia nervosa is a potentially life-threatening eating disorder that involves repeated **binge eating** followed by purging the body of calories to avoid gaining weight. The person who has bulimia has an irrational fear of gaining weight and a distorted body image. Bulimia nervosa can have potentially fatal health consequences.

### Demographics

Bulimia nervosa is primarily a disorder of industrialized countries where food is abundant and the culture values a thin appearance. In Westernized countries, the rate of bulimia has been increasing since the 1950s. Bulimia is the most common eating disorder in the United States. Overall, about 3% of Americans are bulimic. Of these, 85%–90% are female. The rate is highest among adolescents and



The cuts on the knuckles shown in this photograph are due to the teeth breaking the skin during self-induced vomiting. (Custom Medical Stock Photo, Inc. Reproduced by permission.)

college women, averaging 5%–6%. In men, the disorder is more often diagnosed in homosexuals than in heterosexuals. Some experts believe that the number of diagnosed bulimics represents only the most severe cases and that many more people have bulimic tendencies but are successful in hiding their symptoms. In one study, 40% of college women reported isolated incidents of bingeing and purging.

Bulimia affects people from all racial, ethnic, and socioeconomic groups. The disorder usually begins later in life than **anorexia nervosa**. Most people begin bingeing and purging in their late teens through their twenties. Men tend to start at an older age than women. About 5% of people with bulimia begin the behavior after age 25. Bulimia is uncommon in children under age 14.

### Description

Bulimia is an eating disorder whose main feature is eating an unreasonably large amount of food in a short time and then following this binge by purging the body of calories. Purging most often is done by self-

induced **vomiting**, but it can also be done by laxative, enema, or diuretic **abuse**. Alternately, some people with bulimia do not purge but use extreme exercising and post-binge **fasting** to burn calories. Nonpurging bulimia is sometimes called exercise bulimia. Bulimia nervosa is officially recognized as a psychiatric disorder in the *Diagnostic and Statistical Manual for Mental Disorders Fourth Edition, Text Revision (DSM-IV-TR)* published by the American Psychiatric Association.

Many people with bulimia will consume 3,000–10,000 calories in an hour. For example, they will start out intending to eat one slice of cake and end up eating the entire cake. One distinguishing aspect of bulimia is how out of control people with bulimia feel when they are eating. They will eat and eat, continuing even when they feel full and become uncomfortable.

Most people with bulimia recognize that their behavior is not normal; they simply cannot control it. They usually feel ashamed and guilty over their binge/purge habits. As a result, they frequently become secretive about their eating and purging. They may, for example, eat at night after the family has gone to bed or buy

food at the grocery store and eat it in the car before going home. Many bulimics choose high-fat, high-sugar foods that are easy to eat and easy to regurgitate. They become adept at inducing **vomiting**, usually by sticking a finger down their throat and triggering the gag reflex. After a while, they can vomit at will. Repeated purging has serious physical and emotional consequences.

Many individuals with bulimia are of normal weight, and a fair number of men who become bulimic were overweight as children. This makes it difficult for family and friends to recognize someone suffering from this disorder. People with bulimia often lie about induced vomiting and laxative abuse, although they may complain of symptoms related to their binge/purge cycles and seek medical help for those problems. People with bulimia tend to be more impulsive than people with other **eating disorders**. Lack of impulse control often leads to risky sexual behavior, anger management problems, and alcohol and drug abuse.

A subset of people with bulimia also have anorexia nervosa. Anorexia nervosa is an eating disorder that involves self-imposed **starvation**. These people often purge after eating only a small or a normal-sized portion of food. Some studies have shown that up to 60% of people with bulimia have a history of anorexia nervosa. Some people are primarily anorexic and severely restrict their calorie intake while also purging the small amounts they do eat. Others move back and forth between anorectic and bulimic behaviors.

Dieting usually is the trigger that starts a person down the road to bulimia. The cycle might begin with a person going on a rigorous low-calorie diet. Unable to stick with the unrealistic diet, he or she then overeats, feels guilty about overeating, and then exercises or purges to get rid of the unwanted calories. At first this may happen only occasionally, but gradually these sessions of bingeing and purging become routine and start to intrude on the person's friendships, daily activities, and health. Eventually these practices have serious physical and emotional consequences that need to be addressed by healthcare professionals.

### Risk factors

Competitive athletes have an increased risk of developing bulimia nervosa, especially in sports where weight is tied to performance and where a low percentage of body fat is highly desirable. Jockeys, wrestlers, bodybuilders, figure skaters, cross-country runners, and gymnasts have higher than average rates of bulimia. People such as actors, models, cheerleaders, and dancers who are judged mainly on their appearance are

also at high risk of developing the disorder. This same group of people is also at higher risk for developing anorexia nervosa.

## Causes and symptoms

### Causes

Bulimia nervosa is a complex disorder that does not have a single cause. Research suggests that some people have a predisposition toward bulimia and that some catalyst then triggers the behavior, which then becomes self-reinforcing. Hereditary, biological, psychological and social factors all appear to play a role.

- **Heredity:** Twin studies suggest that there is an inherited component to bulimia nervosa but that it is small. Having a close relative, usually a mother or a sister, with bulimia slightly increases the likelihood of other (usually female) family members developing the disorder. However, when compared with other inherited diseases or even to anorexia nervosa, the genetic contribution to developing this disorder appears less important than many other factors. Family history of depression, alcoholism, and obesity also increase the risk of developing bulimia.
- **Biological factors:** There is some evidence that bulimia is linked to low levels of serotonin in the brain. Serotonin is a neurotransmitter. One of its functions is to help regulate the feeling of fullness or satiety that tells a person to stop eating. Neurotransmitters are also involved in other mental disorders that often occur with bulimia such as depression. Other research suggests that people with bulimia may have abnormal levels of leptin, a protein that helps regulate weight by telling the body to take in less food. Research in this area is relatively new, and the findings are still unclear.
- **Psychological factors:** Certain personality types appear to be more vulnerable to developing bulimia. People with bulimia tend to have poor impulse control. They are often involved in risky behaviors such as shoplifting, drug or alcohol abuse, and risky sexual activities. People with bulimia might have low-self worth and depend on the approval of others to feel good about themselves. They are aware that their behavior is abnormal. After a binge/purge session, they are ashamed and vow never to repeat the cycle, but the next time they are unable to control the impulse to eat and purge. They also tend to have a black-or-white, all-or-nothing way of seeing situations. Major depression, obsessive-compulsive disorder, and anxiety disorders are more common among individuals who are bulimic.

## KEY TERMS

**Diuretic**—A substance that removes water from the body by increasing urine production.

**Electrolyte**—Ions in the body that participate in metabolic reactions. The major human electrolytes are sodium ( $\text{Na}^+$ ), potassium ( $\text{K}^+$ ), calcium ( $\text{Ca}^{2+}$ ), magnesium ( $\text{Mg}^{2+}$ ), chloride ( $\text{Cl}^-$ ), phosphate ( $\text{HPO}_4^{2-}$ ), bicarbonate ( $\text{HCO}_3^-$ ), and sulfate ( $\text{SO}_4^{2-}$ ).

**Neurotransmitter**—One of a group of chemicals secreted by a nerve cell (neuron) to carry a chemical message to another nerve cell, often as a way of transmitting a nerve impulse. Examples of neurotransmitters

include acetylcholine, dopamine, serotonin, and norepinephrine.

**Obsessive-compulsive disorder**—A psychiatric disorder in which a person is unable to control the desire to repeat the same action over and over again.

**Serotonin**—5-Hydroxytryptamine; a substance that occurs throughout the body with numerous effects including neurotransmission. Inadequate amounts of serotonin are implicated in some forms of depression and obsessive-compulsive disorder.

- Social factors: The families of people who develop bulimia are more likely to have members who have problems with alcoholism, depression, and obesity. These families also tend to have a high level of open conflict and disordered, unpredictable lives. Often something stressful or upsetting triggers the urge to diet stringently and then begin binge/purge behaviors. This may be as simple as a family member teasing about the person's weight, nagging about eating junk food, commenting on how clothes fit, or comparing the person unfavorably to someone who is thin. Life events such as moving, starting a new school, and breaking up with a boyfriend can also trigger binge/purge behavior. Overlaying the family situation is the false but unrelenting media message that thin is "good" and fat is "bad."

### *Signs and symptoms*

People with bulimia are very good at hiding their behavior, and weight, heart rate, and blood pressure may all be normal. However, binge/purge cycles have physical consequences. These include:

- teeth damaged from repeated exposure to stomach acid from vomiting; eroded tooth enamel
- swollen salivary glands; sores in mouth and throat
- dehydration
- sores or calluses on knuckles or hands from using them to induce vomiting
- electrolyte imbalances revealed by laboratory tests
- dry skin
- fatigue
- irregular or absent menstrual cycles in women

### *Diagnosis*

Diagnosis is based on several factors including a patient history, **physical examination**, the results of laboratory tests, and a mental status evaluation. A patient history is less helpful in diagnosing bulimia than in diagnosing many diseases because many people with bulimia lie about their bingeing and purging and their use of **laxatives**, **enemas**, and medications. The patient may, however, complain about related symptoms such as **fatigue** or feeling bloated. Many people with bulimia express extreme concern about their weight during the examination.

A physical examination begins with weight and blood pressure and moves through the body looking for the signs listed above. Based on the physical exam and patient history, the physician will order laboratory tests. In general, these tests will include a **complete blood count** (CBC), **urinalysis**, and blood chemistries (to determine electrolyte levels). People suspected of being exercise bulimic may need to have x rays to look for damage to bones from overexercising.

### *Psychiatric assessment*

Several different evaluations can be used to examine a person's mental state. Psychiatric assessment usually includes four components:

- a thorough history of body weight, eating patterns, diets, typical daily food intake, methods of purging (if used), and concept of ideal weight
- a history of the patient's significant relationships with parents, siblings, and peers, including present or past physical, emotional, or sexual abuse
- a history of previous psychiatric treatment (if any) and assessment of comorbid (occurring at the same

time as the bulimia) mood, anxiety, substance abuse, or personality disorders

- administration of standardized instruments that measure attitudes toward eating, body size, and weight; common tests for eating disorders include the Eating Disorder Examination, the Eating Disorder Inventory, the Eating Attitude Test (EAT), and the Kids' Eating Disorder Survey (KEDS).

Once all information has been compiled, bulimia nervosa is diagnosed when most of the following conditions are present:

- Repeated episodes of binge eating followed by behavior to compensate for the binge (i.e., purging, fasting, over-exercising). Binge eating is defined as eating a significantly larger amount of food in a limited time than most people typically would eat.
- Binge/purge episodes occur at least twice a week for a period of three or more months.
- The individual feels unable to control or stop an eating binge once it starts and will continue to eat even if uncomfortably full.
- The individual is overly concerned about body weight and shape and puts unreasonable emphasis on physical appearance when evaluating his or her self-worth.
- Bingeing and purging does not occur exclusively during periods of anorexia nervosa.

### Tests

### Treatment

Treatment for bulimia nervosa typically involves several therapy approaches. It is, however, complicated by several factors.

First, patients diagnosed with bulimia nervosa frequently have coexisting psychiatric disorders that typically include major depression (estimated to occur in 40%–70% of people with bulimia), dysthemic disorder, **anxiety disorders**, **substance abuse** disorders, or **personality disorders**. In the case of depression, the mood disorder may either precede or follow the onset of bulimia. With regard to substance abuse, about 30% of patients diagnosed with bulimia nervosa abuse either alcohol or stimulants over the course of the eating disorder. The personality disorders most often diagnosed in bulimics are the Cluster B disorders—borderline, narcissistic, histrionic, and antisocial. **Borderline personality disorder** is a disorder characterized by stormy interpersonal relationships, unstable self-image, and impulsive behavior. People with narcissistic personality disorder believe that they are extremely special and important and are unable to have empathy for others. Individuals with

histrionic personality disorder seek attention almost constantly and are very emotional. Antisocial personality disorder is characterized by a behavior pattern of a disregard for others' rights—people with this disorder often deceive and manipulate others.

Although patients may have both bulimia nervosa and anorexia nervosa, a number of clinicians have noted that patients with predominate bulimia tend to develop impulsive and unstable personality disturbances, whereas patients with predominate anorexia tend to be more obsessional and perfectionistic. Estimates of the prevalence of personality disorders among patients with bulimia range between 2% and 50%. The clinician must then decide whether to treat the eating disorder and the comorbid conditions concurrently or sequentially. It is generally agreed, however, that a substance abuse disorder, if present, must be treated before the bulimia can be effectively managed. It is also generally agreed that **mood disorders** and bulimia can be treated concurrently, often using anti-depressant medication along with therapy.

### Traditional

Treatment choices depend on the degree to which the bulimic behavior has resulted in physical damage and whether the person is a danger to him or herself. Hospital impatient care may be needed to correct severe electrolyte imbalances that result from repeated vomiting and laxative abuse. Electrolyte imbalances can result in heart irregularities and other potentially fatal complications. Most people with bulimia do not require hospitalization. The rate of hospitalization is much lower than that for people with anorexia nervosa because many bulimics maintain a normal weight.

Day treatment or partial hospitalization where the patient goes every day to an extensive treatment program provides structured mealtimes, **nutrition** education, intensive therapy, medical monitoring, and supervision. If day treatment fails, the patient may need to be hospitalized or enter a full-time residential treatment facility.

Outpatient treatment provides medical supervision, nutrition counseling, self-help strategies, and **psychotherapy**. Self-help groups receive mixed reviews from healthcare professionals who work with bulimics. Some groups offer constructive support in stopping the binge/purge cycle, while others tend to reinforce the behavior.

### Drugs

Drug therapy helps many people with bulimia. **Selective serotonin reuptake inhibitors** (SSRIs) such as fluoxetine (Prozac) and sertraline (Zoloft) have been

approved by the United States Food and Drug Administration (FDA) for treatment of bulimia. These medications increase serotonin levels in the brain and are thought to affect the body's sense of fullness. They are used whether or not the patient shows signs of depression. Drug treatment should always be supplemented with psychotherapy.

Other drugs are being explored for use in the treatment of bulimia. Individuals with bulimia interested in entering a clinical trial at no cost can find a list and description of U.S. clinical trials currently enrolling volunteers at <http://www.clinicaltrials.gov>.

### ***Therapy***

Medical intervention helps alleviate the immediate physical problems associated with bulimia. Medication can help the person with bulimia break the binge/purge cycle. However drug therapy alone rarely produces recovery. Psychotherapy plays a major role helping the individual with bulimia recover from the disorder. Several different types of psychotherapy are used depending on the individual's situation. Generally, the goal of psychotherapy is to help the individual change his or her behavior and develop a healthy attitude toward their body and food.

Some types of psychotherapy that have been successful in treating people with bulimia are listed below.

- Cognitive behavior therapy (CBT) is designed to confront and then change the individual's thoughts and feelings about his or her body and behaviors toward food, but it does not address why those thoughts or feelings exist. Strategies to maintain self-control may be explored. This therapy is relatively short-term. CBT is often the therapy of choice for people with bulimia, and it is often successful at least in the short term.
- Interpersonal therapy is short-term therapy that helps the individual identify specific issues and problems in relationships. The individual may be asked to look back at his or her family history to try to recognize problem areas and work toward resolving them. Interpersonal therapy has about the same rate of success in people with bulimia as CBT.
- Family and/or couples therapy is helpful in dealing with conflict or disorder that may be a factor in triggering binge/purge behavior at home.
- Supportive-expressive therapy or group therapy may be helpful in addition to other types of therapy.

### ***Nutrition and diet counseling***

A nutrition consultant or dietitian is part of the team needed to successfully treat bulimia. These

professionals usually do a dietary review along with nutritional counseling so that the recovering bulimic can plan healthy meals and develop a healthy relationship with food.

The following dietary changes may be helpful for bulimic individuals:

- Eating small but nutritious meals at regularly scheduled hours.
- Avoiding sweet, baked goods or any other foods that may cause craving.
- Avoiding allergenic foods.
- Limiting intake of alcohol, caffeine, monosodium glutamate (MSG), and salty foods.

### ***Alternative and complementary therapies***

**SUPPLEMENTS.** The following supplements may help improve bulimic symptoms and prevent deficiency of essential **vitamins** and minerals:

- Multivitamin and mineral supplement to prevent deficiency of essential nutrients.
- Vitamin B complex with C.
- Zinc supplement. Bulimic patients may have zinc deficiency, and zinc is an important mineral needed by the body for normal hormonal activity and enzymatic function.

**HOMEOPATHY.** A homeopathic physician may prescribe patient-specific remedies for the treatment of bulimia.

**LIGHT THERAPY.** **Light therapy.** Exposure to artificial light, available through full spectrum light bulbs or specially designed "light boxes," may be useful in reducing bulimic episodes, especially during the dark winter months.

**HYPNOTHERAPY.** **Hypnotherapy** may help resolve unconscious issues that contribute to bulimic behavior.

**EXERCISE.** **Yoga**, **qigong**, **t'ai chi**, or dance not only make patients physically healthier but can also make them feel better about themselves.

### ***Other treatments.***

Other potentially beneficial treatments for bulimia include Chinese herbal therapy, **hydrotherapy** and **biofeedback** training.

### ***Prognosis***

The long-term outlook for recovery from bulimia is mixed. About half of all bulimics show improvement in controlling their behavior after short-term interpersonal or **cognitive-behavioral therapy** with nutritional

counseling and drug therapy. However, after three years, only about one-third are still doing well. Relapses are common, and binge/purge episodes and bulimic behavior often comes and goes for many years. **Stress** seems to be a major trigger for relapse.

The sooner treatment is sought, the better the chances of recovery. Without professional intervention, recovery is unlikely. Untreated bulimia can lead to **death** directly from causes such as rupture of the stomach or esophagus. Associated problems such as substance abuse, depression, **anxiety** disorders, and poor impulse control also contribute to the death rate.

## Prevention

Some ways to prevent bulimia nervosa from developing are as follows:

- If you are a parent, do not obsess about your own weight, appearance, and diet in front of your children.
- Do not tease your children about their body shapes or compare them to others.
- Make it clear that you love and accept your children as they are.
- Try to eat meals together as a family whenever possible.
- Remind children that the models they see on television and in fashion magazines have extreme, not normal or healthy, bodies.
- Do not put your child on a diet unless advised to by your pediatrician.
- Block your child from visiting pro-bulimia Web sites. These are sites where people with bulimia give advice on how to purge and support each other's binge/purge behavior.
- If your child is a competitive athlete, get to know the coach and the coach's attitude toward weight.
- Be alert to signs of low self-worth, anxiety, depression, and drug or alcohol abuse and seek help as soon as these signs appear.
- If you think your child has an eating disorder, do not wait to intervene and the professional help. The sooner the disorder is treated, the easier it is to cure.

Relapses happen to many people with bulimia. People who are recovering from bulimia can help prevent themselves from relapsing by:

- never dieting—instead plan healthy meals
- eating with other people, not alone
- staying in treatment and keeping therapy appointments
- monitoring negative self-talk and practicing positive self-talk

- spending time doing something enjoyable every day
- getting at least seven hours of sleep each night
- spending time with friends or family

## Resources

### BOOKS

Carleton, Pamela and Deborah Ashin. *Take Charge of Your Child's Eating Disorder: A Physician's Step-By-Step Guide to Defeating Anorexia and Bulimia*. New York: Marlowe & Co., 2007.

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Walsh, B. Timothy. *If Your Adolescent Has an Eating Disorder: An Essential Resource for Parents*. New York, NY: Oxford University Press, 2005.

### PERIODICALS

“Surfing for Thinness: A Pilot Study of Pro-Eating Disorder Web Site Usage in Adolescents With Eating Disorders.” *Pediatrics* 118, no. 6 (December 2006): e1635-43. <http://pediatrics.aappublications.org/cgi/content/full/118/6/e1635>

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“Eating Disorders.” MedlinePlus. May 15, 2009 [June 2, 2009]. <http://www.nlm.nih.gov/medlineplus/eatingdisorders.html>

Kalapatapu, Raj K., Kelda Harris Walsh, Gabirel Uwaifo, and Robert C. Daly. “Bulimia.” eMedicine.com August 12, 2008 [June 3, 2009]. <http://emedicine.medscape.com/article/286485-overview>

### ORGANIZATIONS

American Psychological Association, 750 First Street, NE, Washington, DC, 20002-4242, (202) 336-5500; TDD/TTY: (202) 336-6123, (800) 374-2721, [apa@psych.org](mailto:apa@psych.org), <http://www.apa.org>.

National Association of Anorexia Nervosa and Related Eating Disorders (ANAD), P.O. Box 7, Highland Park, IL, 60035, (847) 831-3438, (847) 433-3996, <http://www.anad.org>.

National Eating Disorders Association, 603 Stewart Street, Suite 803, Seattle, WA, 98101, (206) 382-3587, Help and Referral Line: (800) 931-2237, (206) 829-8501, info@NationalEatingDisorder.org, http://www.nationaleatingdisorders.org.

Tish Davidson, A.M.

Bulla see **Skin lesions**

Bumetanide see **Diuretics**

BUN see **Blood urea nitrogen test**

## KEY TERMS

**Electrocardiogram**—The pattern of the heart's electrical impulses that indicate the order and condition of the heart's components.

**QRS**—A pattern seen in an electrocardiogram that indicates the pulses in a heartbeat and their duration. Variations from a normal QRS pattern indicate heart disease.

## Causes and symptoms

Left bundle branch block usually happens as a consequence of other diseases such as arteriosclerosis, **rheumatic fever**, **congenital heart disease**, **myocarditis**, myocardial infarction, metastatic heart tumors, or other invasions of the heart tissue. Right bundle branch block happens less often from underlying heart disease.

## Diagnosis

Detection of BBB usually takes place during a normal **physical examination**. The block shows up as a widening of the second heart sound. Confirmation of BBB is obtained by electrocardiogram (ECG). The pattern seen in the electrocardiogram indicates pulses in a heartbeat and their duration. A QRS duration of greater than 110 milliseconds is a diagnostic indication of BBB. There is a unique ECG pattern for blocks in each of the three bundles.

## Treatment

There is no specific therapy for BBB. Patients are usually treated for associated heart diseases.

## Prognosis

The prognosis of blockage in any of the three bundle branches depends on the prognosis of the associated heart disease. The associated diseases determine the outcome of the patient's health. Occasionally, disruptions in bundle branches lead to complete infranodal A-V block, a more serious blockage of nerve impulses. Approximately 2% of patients with BBB develop infranodal A-V blockage and these patients often require artificial **pacemakers**.

## Resources

### BOOKS

Fuster, Valentin, et al. *Hurst's the Heart*. 12th ed. New York: McGraw-Hill Professional, 2007.

John T. Lohr, PhD

## Bunion

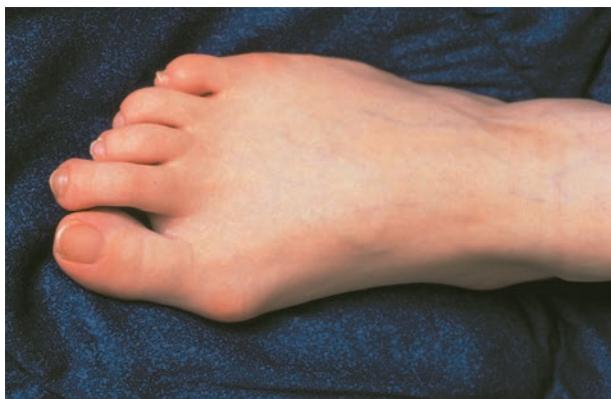
### Definition

A bunion is an abnormal enlargement of the joint (the first metatarsophalangeal joint, or MTPJ) at the base of the great or big toe (hallux). It is caused by inflammation and usually results from chronic irritation and pressure from poorly fitting footwear.

### Description

A displacement of two major bones of the foot (hallux valgus) causes bunions, although not everyone with this displacement will develop the joint swelling and bone overgrowth that characterize a bunion. One of the bones involved is called the first metatarsal bone. This bone is long and slender, with the big toe attached on one end and the other end connected to foot bones closer to the ankle. This foot bone is displaced in the direction of the four other metatarsals connected with the toes. The other bone involved is the big toe itself, which is displaced toward the smaller toes. As the big toe continues to move toward the smaller toes, it may become displaced under or over the second toe. The displacement of these two foot bones causes a projection of bone on the inside portion of the forefoot. The skin over this projection often becomes inflamed from rubbing against the shoe, and a callus may form.

The joint contains a small sac (bursa) filled with fluid that cushions the bones and helps the joint to move smoothly. When a bunion forms, this sac becomes inflamed and thickened. The swelling in the joint causes additional **pain** and pressure in the toe.



**Woman's right foot with bunion on big toe.** (Custom Medical Stock Photo, Inc. Reproduced by permission.)

### KEY TERMS

**Orthopedics**—A medical specialty concerned with treating diseases, injuries, and malformations of the bones and supporting structures, such as tendons, ligaments, and muscles.

**Orthotic**—A device or brace to control, correct, or compensate for a bone deformity.

**Podiatry**—A medical specialty concerned with treating diseases, injuries, and malformations of the feet.

### Causes and symptoms

Bunions may form as a result of abnormal motion of the foot during walking or running. One common example of an abnormal movement is an excessive amount of **stress** placed upon the inside of the foot. This leads to friction and irritation of the involved structures. Age has also been noted as a factor in developing bunions, in part because the underlying bone displacement worsens over time unless corrective measures are taken.

Wearing improperly fitting shoes, especially those with a narrow toe box and excessive heel height, often causes the formation of a bunion. This forefoot deformity is seen more often in women than men. The higher frequency in females may be related to the strong link between footwear fashion and bunions. In fact, in a recent survey of more than 350 women, nearly 90% wore shoes that were at least one size too small or too narrow.

Because genetic factors can predispose people to the hallux valgus bone displacement, a strong family history of bunions can increase the likelihood of developing this foot disorder. Various arthritic conditions and several genetic and neuromuscular diseases, such as **Down syndrome** and **Marfan syndrome**, cause muscle imbalances that can create bunions from displacement of the first metatarsal and big toe. Other possible causes of bunions are leg-length discrepancies, with the bunion present on the longer leg, and trauma occurring to the joint of the big toe.

Symptoms of bunions include the common signs of inflammation such as redness, swelling, and pain. The discomfort is primarily located along the inside of the foot just behind the big toe. Because of friction, a callus may develop over the bunion. If an overlapping of the toes is allowed, additional rubbing and pain occurs. Inflammation of this area causes a decrease in motion with associated discomfort in the joint between the big toe and the first metatarsal. If allowed to worsen, the

skin over the bunion may break down and cause an ulcer, which also presents a problem of potential infection. (Foot ulcers can be particularly dangerous for people with diabetes, who may have trouble feeling the ulcer forming and healing if it becomes infected.)

## Diagnosis

A thorough medical history and physical exam by a physician is always necessary for the proper diagnosis of bunions and other foot conditions. X rays can help confirm the diagnosis by showing the bone displacement, joint swelling, and, in some cases, the overgrowth of bone that characterizes bunions. Doctors will also consider the possibility that the joint pain is caused by or complicated by arthritis (which causes destruction of the cartilage of the joint), **gout** (which causes the accumulation of uric acid crystals in the joint), tiny **fractures** of a bone in the foot (stress fractures), or infection and may order additional tests to rule out these possibilities.

## Treatment

### Conservative

The first step in treating a bunion is to remove as much pressure from the area as possible. People with bunions should wear shoes that have enough room in the toe box to accommodate the bunion and avoid high-heeled shoes and tight-fitting socks or stockings. **Dressings** and pads help protect the bunion from additional shoe pressure. The application of splints or customized shoe inserts (orthotics) to correct the alignment of the big toe joint is effective for many bunions. Most patients are instructed to rest or choose exercises that put less stress on their feet, at least until the misalignment is corrected. In some cases, physicians also use steroid injections with local anesthetic around the bunion to reduce inflammation.

### Surgery

If conservative treatment is not successful, surgical removal of the bunion may be necessary to correct the deformity. This procedure is called a bunionectomy, and there are many variations on the operation, which is usually performed by a surgeon who specializes in treating bone conditions (orthopedics) or by one who specializes in treating the foot (podiatry). Surgeons consider the angle of the bone misalignment, the condition of the bursa, and the strength of the bones when they choose which procedure to use. Most bunionectomies involve the removal of a section of bone and the insertion of pins to rejoin the bone. Sometimes the surgeons may move ligaments (which connect bone to bone in the joint) or tendons (which connect bone to muscle) in order to

realign the bones. After this procedure, the bones and other tissues are held in place while they heal by compression dressings or a short cast. The individual must refrain from vigorous **exercise** for six weeks.

## Alternative treatment

Deep friction massage techniques by a physical or massage therapist can be helpful to increase circulation, reduce inflammation, and prevent soft tissue buildup. **Physical therapy** also provides useful approaches such as ultrasound to help retard or reverse the formation of the bunion. Various taping techniques can be useful to realign the toe and decrease friction and rubbing that may be present. The homeopathic tissue salt *Calcarea phosphorica* can be useful in balancing the bone formation/remodeling.

## Prognosis

Often modifications in footwear allow a good prognosis without surgery. If surgery is necessary, complete healing without complications requires approximately four to six weeks. Even after surgery corrects the bone misalignment, patients are usually instructed to continue wearing low-heeled, roomy shoes to prevent the bunion from reforming.

## Prevention

Prevention begins with proper foot wear. Shoes with a wide and deep toe box are best. High-heeled shoes should not be worn for long periods of time. If a bunion is present and becomes inflamed, the foot should be elevated with the application of an ice pack over the painful area for not more than 20 minutes every other hour. If pain and swelling continue, a podiatrist or physician should be contacted.

## Resources

### OTHER

Griffith, H. Winter. "Complete Guide to Symptoms, Illness & Surgery." ThriveOnline. <http://thriveonline.oxygen.com>.

### ORGANIZATIONS

American Orthopaedic Foot and Ankle Society, 6300 N. River Road, Suite 510, Rosemont, IL, 60018, (847) 698-4654, (800) 235-4855.

American Podiatric Medical Association, 9312 Old Georgetown Road, Bethesda, MD, 20814-1621, (301) 581-9200, <http://www.apma.org>.

Jeffrey P. Larson, RPT

Burkitt's lymphoma see **Malignant lymphomas**

# Burns

## Definition

Burns are injuries to tissues caused by heat, friction, electricity, radiation, or chemicals.

## Description

Burns are characterized by degree, based on the severity of the tissue damage. A first-degree burn causes redness and swelling in the outermost layers of skin (epidermis). A second-degree burn involves redness, swelling, and blistering, and the damage may extend beneath the epidermis to deeper layers of skin (dermis). A third-degree burn, also called a full-thickness burn, destroys the entire depth of skin, causing significant scarring. Damage also may extend to the underlying fat, muscle, or bone.

The severity of the burn is also judged by the amount of body surface area (BSA) involved. Health care workers use the “rule of nines” to determine the percentage of BSA affected in patients more than nine years old: each arm with its hand is 9% of BSA; each leg with its foot is 18%; the front of the torso is 18%; the back of the torso, including the buttocks, is 18%; the head and neck are 9%; and the genital area (perineum) is 1%. This rule cannot be applied to a young child’s body proportions, so BSA is estimated using the palm of the patient’s hand as a measure of 1% area.

The severity of the burn will determine not only the type of treatment, but also where the burn patient should receive treatment. Minor burns may be treated at home or in a doctor’s office. These are defined as first- or second-degree burns covering less than 15% of an adult’s body or less than 10% of a child’s body,

## Classification of burns

First-degree burn	The burned area is painful. The outer skin is reddened. Slight swelling is present.
Second-degree burn	The burned area is painful. Deeper layers of skin (the dermis) are affected. Blisters may form. The area may have a wet, shiny appearance because of exposed tissue.
Third-degree burn	The burned area is insensitive due to the destruction of nerve endings. Skin is destroyed. Muscle tissue and bone underneath may be damaged. The area may be charred, white, or grayish in color.

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or a third-degree burn on less than 2% BSA. Moderate burns should be treated at a hospital. These are defined as first- or second-degree burns covering 15%–25% of an adult’s body or 10%–20% of a child’s body, or a third-degree burn on 2%–10% BSA. Critical, or major, burns are the most serious and should be treated in a specialized burn unit of a hospital. These are defined as first- or second-degree burns covering more than 25% of an adult’s body or more than 20% of a child’s body, or a third-degree burn on more than 10% BSA. In addition, burns involving the hands, feet, face, eyes, ears, or genitals are considered critical. Other factors influence the level of treatment needed, including associated injuries such as bone fractures and smoke inhalation, presence of a chronic disease, or a history of being abused. Also, children and the elderly are more vulnerable to complications from burn injuries and require more intensive care.

## Causes and symptoms

Burns may be caused by even a brief encounter with heat greater than 120°F (49°C). The source of this heat may be the sun (causing a sunburn), hot liquids, steam, fire, electricity, friction (causing rug burns and rope burns), and chemicals (causing a caustic burn upon contact).

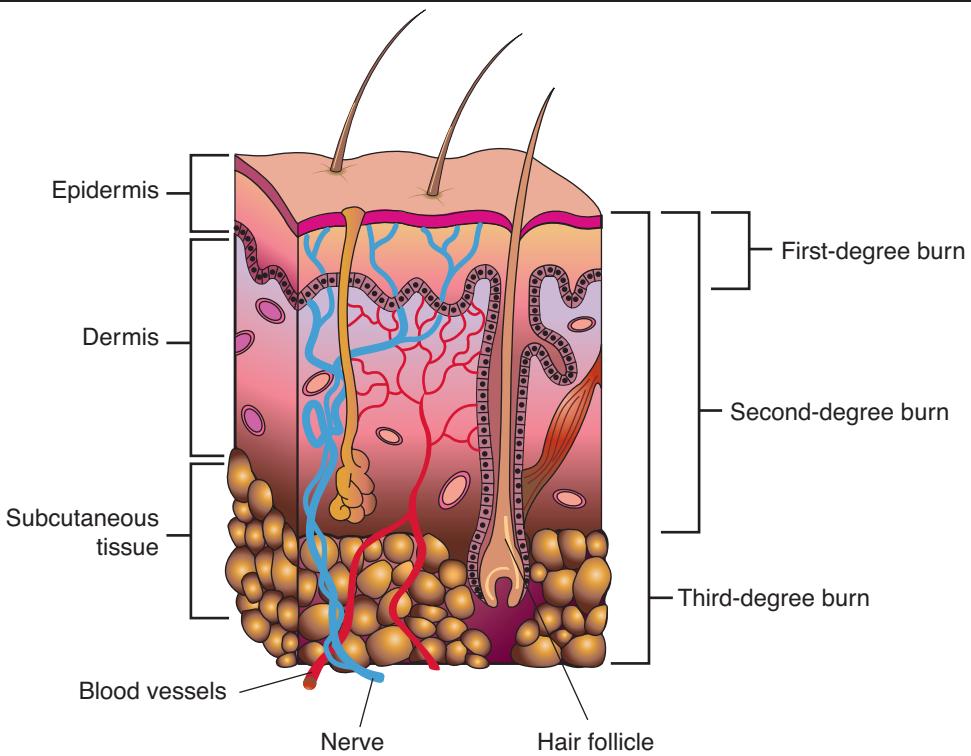
Signs of a burn are localized redness, swelling, and pain. A severe burn will also blister. The skin may also peel, appear white or charred, and feel numb. A burn may trigger a headache and fever. Extensive burns may induce shock, the symptoms of which are faintness, weakness, rapid pulse and breathing, pale and clammy skin, and bluish lips and fingernails.

## Diagnosis

A physician will diagnose a burn based upon visual examination, and will also ask the patient or family members questions to determine the best treatment. He or she may also check for smoke inhalation, carbon monoxide poisoning, cyanide poisoning, other event-related trauma, or, if suspected, further evidence of child abuse.

## Treatment

Burn treatment consists of relieving pain, preventing infection, and maintaining body fluids, electrolytes, and calorie intake while the body heals. Treatment of chemical or electrical burns is slightly different from the treatment of thermal burns but the objectives are the same.



**There are three classifications of burns: first-degree, second-degree, and third-degree.** (Illustration by Electronic Illustrators Group. Reproduced by permission of Gale, a part of Cengage Learning.)

### Thermal burn treatment

The first act of thermal burn treatment is to stop the burning process. This may be accomplished by letting cool water run over the burned area or by soaking it in cool (not cold) water. Ice should never be applied to the burn. Cool (not cold) wet compresses may provide some pain relief when applied to small areas of first- and second-degree burns. Butter, shortening, or similar salve should never be applied to the burn since it prevents heat from escaping and drives the burning process deeper into the skin.

If the burn is minor, it may be cleaned gently with soap and water. Blisters should not be broken. If the skin of the burned area is unbroken and it is not likely to be further irritated by pressure or friction, the burn should be left exposed to the air to promote healing. If the skin is broken or apt to be disturbed, the burned area should be coated lightly with an antibacterial ointment and covered with a sterile bandage. **Aspirin, acetaminophen** (Tylenol), or ibuprofen (Advil) may be taken to ease pain and relieve inflammation. A doctor should be consulted if these signs of infection appear: increased warmth, redness, pain, or swelling; pus or similar

drainage from the wound; swollen lymph nodes; or red streaks spreading away from the burn.

In situations where a person has received moderate or critical burns, lifesaving measures take precedence over burn treatment and emergency medical assistance must be called. A person with serious burns may stop breathing, and artificial respiration (also called mouth-to-mouth resuscitation or rescue breathing) should be administered immediately. Also, a person with burns covering more than 12% BSA is likely to go into shock; this condition may be prevented by laying the person flat and elevating the feet about 12 in (30 cm). Burned arms and hands should also be raised higher than the person's heart.

In rescues, a blanket may be used to smother any flames as the person is removed from danger. The person whose clothing is on fire should "stop, drop, and roll" or be assisted in lying flat on the ground and rolling to put out the fire. Afterwards, only burnt clothing that comes off easily should be removed; any clothing embedded in the burn should not be disturbed. Removing any smoldering apparel and covering the person with a light, cool, wet cloth, such as a

## KEY TERMS

**Debridement**—The surgical removal of dead tissue.

**Dermis**—The basal layer of skin; it contains blood and lymphatic vessels, nerves, glands, and hair follicles.

**Epidermis**—The outer portion of skin, made up of four or five superficial layers.

**Shock**—An abnormal condition resulting from low blood volume due to hemorrhage or dehydration. Signs of shock include rapid pulse and breathing, and cool, moist, pale skin.

sheet but not a blanket or towel, will stop the burning process.

At the hospital, the staff will provide further medical treatment. A tube to aid breathing may be inserted if the patient's airways or lungs have been damaged, as can happen during an explosion or a fire in an enclosed space. Also, because burns dramatically deplete the body of fluids, replacement fluids are administered intravenously. The patient is also given **antibiotics** intravenously to prevent infection, and he or she may also receive a **tetanus** shot, depending on his or her immunization history. Once the burned area is cleaned and treated with antibiotic cream or ointment, it is covered in sterile **bandages**, which are changed two to three times a day. Surgical removal of dead tissue (**debridement**) also takes place. As the burns heal, thick, taut scabs (eschar) form, which the doctor may have to cut to improve blood flow to the more elastic healthy tissue beneath. The patient will also undergo physical and **occupational therapy** to keep the burned areas from becoming inflexible and to minimize scarring.

In cases where the skin has been so damaged that it cannot properly heal, a skin graft is usually performed. A skin graft involves taking a piece of skin from an unburned portion of the patient's body (auto-graft) and transplanting it to the burned area. When doctors cannot immediately use the patient's own skin, a temporary graft is performed using the skin of a human donor (allograft), either alive or dead, or the skin of an animal (xenograft), usually that of a pig.

The burn victim also may be placed in a **hyperbaric chamber**, if one is available. In a hyperbaric chamber (which can be a specialized room or enclosed space), the patient is exposed to pure oxygen under high pressure, which can aid in healing. However, for

this therapy to be effective, the patient must be placed in a chamber within 24 hours of being burned.

### Chemical burn treatment

Burns from liquid chemicals must be rinsed with cool water for at least 15 minutes to stop the burning process. Any burn to the eye must be similarly flushed with water. In cases of burns from dry chemicals such as lime, the powder should be completely brushed away before the area is washed. Any clothing that may have absorbed the chemical should be removed. The burn should then be loosely covered with a sterile gauze pad and the person taken to the hospital for further treatment. A physician may be able to neutralize the offending chemical with another before treating the burn like a thermal burn of similar severity.

### Electrical burn treatment

Before electrical burns are treated at the site of the accident, the power source must be disconnected if possible and the victim moved away from it to keep the person giving aid from being electrocuted. Life-saving measures again take priority over burn treatment, so breathing must be checked and assisted if necessary. Electrical burns should be loosely covered with sterile gauze pads and the person taken to the hospital for further treatment.

### Alternative treatment

In addition to the excellent treatment of burns provided by traditional medicine, some alternative approaches may be helpful as well, though major burns should always be treated by a medical practitioner. The homeopathic remedies *Cantharis* and *Causticum* can assist in burn healing. A number of botanical remedies, applied topically, can also help burns heal. These include aloe (*Aloe barbadensis*), oil of **St. John's wort** (*Hypericum perforatum*), calendula (*Calendula officinalis*), comfrey (*Symphytum officinale*), and tea tree oil (*Melaleuca spp.*). Supplementing the diet with vitamin C, vitamin E, and zinc also is beneficial for wound healing.

### Prognosis

The prognosis is dependent upon the degree of the burn, the amount of body surface covered, whether critical body parts were affected, any additional injuries or complications like infection, and the promptness of medical treatment. Minor burns may heal in 5 to 10 days with no scarring. Moderate burns may heal in 10–14 days and may leave scarring. Critical or major burns take more than 14 days to heal and will leave significant

scarring. Scar tissue may limit mobility and functionality, but **physical therapy** may overcome these limitations. In some cases, additional surgery may be advisable to remove scar tissue and restore appearance.

## Prevention

Burns are commonly received in residential fires. Properly placed and working smoke detectors in combination with rapid evacuation plans will minimize a person's exposure to smoke and flames in the event of a fire. Children must be taught never to play with matches, lighters, fireworks, gasoline, and cleaning fluids.

Burns by scalding with hot water or other liquids may be prevented by setting the water heater thermostat no higher than 120°F (49°C), checking the temperature of bath water before getting into the tub, and turning pot handles on the stove out of the reach of children. Care should be used when removing covers from pans of steaming foods and when uncovering or opening foods heated in a microwave oven.

Thermal burns are often received from electrical appliances. Care should be exercised around stoves, space heaters, irons, and curling irons.

Sunburns may be avoided by the liberal use of a sunscreen containing either an opaque active ingredient such as zinc oxide or titanium dioxide or a nonopaque active ingredient such as PABA (para-aminobenzoic acid) or benzophenone. Hats, loose clothing, and umbrellas also provide protection, especially between 10 a.m. and 3 p.m. when the most damaging ultraviolet rays are present in direct sunlight.

Electrical burns may be prevented by covering unused electrical outlets with safety plugs and keeping electrical cords away from infants and toddlers who might chew on them. Persons should also seek shelter indoors during a thunderstorm to avoid being struck by lightning.

Chemical burns may be prevented by wearing protective clothing, including gloves and eyeshields. Chemical agents should always be used according to the manufacturer's instructions and properly stored when not in use.

## Resources

### OTHER

- “Burns.” MedlinePlus. <http://www.nlm.nih.gov/medlineplus/burns.html> (accessed November 24, 2010).
- “Burns: First aid.” MayoClinic.com. <http://www.mayoclinic.com/health/first-aid-burns/FA00022> (accessed November 24, 2010).

## ORGANIZATIONS

Shriners Hospitals for Children, 2900 Rocky Point Drive, Tampa, FL, 33607, (813) 281-0300, <http://www.shrinershq.org/Hospitals/Main>.

Bethany Thivierge

## Bursitis

### Definition

Bursitis is the painful inflammation of the bursa, a padlike sac found in areas subject to friction. Bursae cushion the movement between the bones, tendons and muscles near the joints. Bursitis is most often caused by repetitive movement and is known by several common names including weaver's bottom, clergyman's knee, and miner's elbow, depending on the affected individual's occupation and area of injury.

### Description

There are over 150 bursae in the human body. Usually bursae are present from birth, but they may form in response to repeated pressure. Each sac contains a small amount of *synovial fluid*, a clear liquid that acts as a lubricant. Inflammation causes **pain** on movement. The most common site for bursitis to occur is the shoulder (subdeltoid), but it also is seen in the elbows (olecranon), hips (trochanteric), knees, heels (Achilles), and toes. The affected area may be referred to as “frozen,” because movement is so limited. In the knee there are four bursae, and all can become inflamed with overuse.

### Causes and symptoms

The most common cause of bursitis is repeated physical activity, but it can flare up for no known reason. It can also be caused by trauma, **rheumatoid arthritis**, **gout**, and acute or chronic infection.

Pain and tenderness are common symptoms. If the affected joint is close to the skin, as with the shoulder, knee, elbow, or Achilles tendon, swelling and redness are seen and the area may feel warm to the touch. The bursae around the hip joint are deeper, and swelling is not obvious. Movement may be limited and is painful. In the shoulder, it may be difficult to raise the arm out from the side of the body. Putting on a jacket or combing the hair becomes a troublesome activity.

## KEY TERMS

**Arthritis**—Inflammation of a joint that may lead to changes in the joint's structure. It causes pain and swelling. Rheumatoid arthritis is a chronic disease that leads to crippling deformities.

**Diabetes mellitus**—A metabolic disease caused by a deficiency of insulin, which is essential to process carbohydrates in the body.

**Gout**—A hereditary metabolic disease that is a form of arthritis and causes inflammation of the joints. It is more common in men.

**Inflammation**—The reaction of tissue to injury.

**Kinesiology**—The science or study of movement.

In acute bursitis symptoms appear suddenly; with chronic bursitis, pain, tenderness, and limited movement reappear after **exercise** or strain.

### Diagnosis

When a patient has pain in a joint, a careful **physical examination** is needed to determine what type of movement is affected and if there is any swelling present. Bursitis will not show up on x rays, although sometimes there are also **calcium** deposits in the joint that can be seen. Inserting a thin needle into the affected bursa and removing (aspirating) some of the synovial fluid for examination can confirm the diagnosis. In most cases, the fluid will not be clear. It can be tested for the presence of microorganisms, which would indicate an infection, and crystals, which could indicate gout. In instances where the diagnosis is difficult, a local anesthetic (a drug that numbs the area) is injected into the painful spot. If the discomfort stops temporarily, then bursitis is probably the correct diagnosis.

### Treatment

Conservative treatment of bursitis is usually effective. The application of heat, rest, and **immobilization** of the affected joint area is the first step. A sling can be used for a shoulder injury; a cane is helpful for hip problems. The patient can take **nonsteroidal anti-inflammatory drugs** (NSAIDs) like **aspirin**, ibuprofen, and naproxen. They can be obtained without a prescription and relieve the pain and inflammation. Once the pain decreases, exercises of the affected area can begin. If the nearby muscles have become weak because of the disease or prolonged immobility, then

exercises to build strength and improve movement are best. A doctor or physical therapist can prescribe an effective regimen.

If the bursitis is related to an inflammatory condition like arthritis or gout, then management of that disease is needed to control the bursitis.

When bursitis does not respond to conservative treatment, an injection into the joint of a long-acting corticosteroid preparation, like prednisone, can bring immediate and lasting relief. A corticosteroid is a hormonal substance that is the most effective drug for reducing inflammation. The drug is mixed with a local anesthetic and works on the joint within five minutes. Usually one injection is all that is needed.

Surgery to remove the damaged bursa may be performed in extreme cases.

If the bursitis is caused by an infection, then additional treatment is needed. *Septic* bursitis is caused by the presence of a pus-forming organism, usually *staphylococcus aureus*. This is confirmed by examining a sample of the fluid in the bursa and requires treatment with **antibiotics** taken by mouth, injected into a muscle or into a vein (intravenously). The bursa will also need to be drained by needle two or three times over the first week of treatment. When a patient has such a serious infection, there may be underlying causes. There could be undiscovered diabetes, or an inefficient immune system caused by human **immunodeficiency** virus infection (HIV).

### Alternative treatment

Alternative treatments take into consideration the role of diet in causing bursitis. The faulty use of calcium by the body, magnesium deficiency, and **food allergies** may have a role. Diet changes and vitamin supplements may be helpful. The use of herbs, homeopathy, **aromatherapy**, and **hydrotherapy** can help relieve symptoms. Ginger is useful in reducing inflammation. **Acupuncture** has been proven effective in treating hip and shoulder pain caused by bursitis and other conditions. Other therapies that deal effectively with musculoskeletal problems (relating to the muscles and skeleton), may also be helpful, such as body work, **magnetic field therapy**, **naturopathic medicine**, **chiropractic**, and **applied kinesiology**.

### Prognosis

Bursitis usually responds well to treatment, but it may develop into a chronic condition if the underlying cause is not corrected.

## Prevention

Aggravating factors should be eliminated to prevent bursitis. Overexercising or the repetition of a movement that triggers the condition should be avoided. Doing exercises to strengthen the muscles around the joint will also help. When doing repetitive tasks, frequent breaks should be taken and the activity should be alternated with others using different parts of the body. To cushion the joints, it is a good idea to use cushioned chairs when sitting and foam kneeling pads for the knees. Leaning on the elbows, kneeling, or sitting on a hard surface for a long period of time should be avoided. Not wearing high heels can help prevent bursitis in the heel, as can changing to new running shoes as soon as the old ones are worn out.

## Resources

### OTHER

"Bursitis." MedlinePlus. <http://www.nlm.nih.gov/medlineplus/bursitis.html> (accessed November 24, 2010).

Karen Ericson, RN

Bypass surgery see **Coronary artery bypass graft surgery**

## Byssinosis

### Definition

Byssinosis is a chronic, asthma-like narrowing of the airways. Also called brown lung disease, byssinosis results from inhaling particles of cotton, flax, hemp, or jute.

### Description

Although inhaling cotton dust was identified as a source of respiratory disease more than 300 years ago, byssinosis has been recognized as an occupational hazard for textile workers for less than 50 years. More than 800,000 workers in the cotton, flax, and rope-making industries are exposed in the workplace to airborne particles that can cause byssinosis. Only workers in mills that manufacture yarn, thread, or fabric have a significant risk of dying of this disease.

In the United States, byssinosis is almost completely limited to workers who handle unprocessed cotton. More than 35,000 textile workers have been disabled by byssinosis and 183 died between 1979 and 1992. Most of the people whose deaths were due to

## KEY TERMS

**Wheeze**—A whistling sound made by the flow of high-velocity air through narrowed airways. Wheezing is a symptom of several respiratory diseases including byssinosis and asthma.

byssinosis lived in the textile-producing regions of North and South Carolina.

### Causes and symptoms

As many as 25% of workers with byssinosis have symptoms that continue or recur throughout the workweek. More severe breathing problems seem to result both from exposure to high levels of dust and from longer dust exposure. Workers who also smoke cigarettes suffer the most severe impairment.

### Diagnosis

Tests that detect decreasing lung capacity during the workday are used to diagnose byssinosis. Obstructive patterns are likely in patients who have had recurrent symptoms for more than 10 years.

### Treatment

Therapy for early-stage byssinosis focuses on reversing airway narrowing. **Antihistamines** may be prescribed to reduce tightness in the chest. **Bronchodilators** (drugs used to relax breathing passages and improve air flow) may be used with an inhaler or taken in tablet form. Reducing exposure is essential. Any worker who has symptoms of byssinosis or who has trouble breathing should transfer to a less-contaminated area.

### Prognosis

**Smoking**, impaired lung function, and a history of respiratory allergy increase a textile worker's risk of developing byssinosis. Prolonged exposure makes patients wheeze more often and can cause chronic **bronchitis**. It does not lead to permanently disabling lung disease.

### Prevention

Eliminating exposure to textile dust is the surest way to prevent byssinosis. Using exhaust hoods, improving ventilation, and employing wetting procedures are very successful methods of controlling dust levels to prevent byssinosis. Protective equipment required during certain

procedures also prevents exposure to levels of contamination that exceed the current United States standard for cotton dust exposure.

#### **ORGANIZATIONS**

American Lung Association, 1301 Pennsylvania Ave. NW,  
Suite 800, Washington, DC, 20001, (202) 758-3355,

(202) 452-1805, (800) 548-8252, [info@lungusa.org](mailto:info@lungusa.org),  
<http://www.lungusa.org/>.  
Centers for Disease Control and Prevention (CDC), 1600  
Clifton Road, Atlanta, GA, 30333, (800) 232-4636,  
[cdcinfo@cdc.gov](mailto:cdcinfo@cdc.gov), <http://www.cdc.gov>.

Maureen Haggerty