

NINTH EDITION

Clinician's Pocket Reference

Leonard G. Gomella Steven A. Haist

COMMONLY USED EMERGENCY CARE MEDICATIONS (See Chapter 21 for details)

MEDICATION GENERIC (TRADE)	ADULT DOSE
Abciximab (ReoPro)	ACS with PCI is 24 h; 0.25 mg/lg IV bolus up to 1 h before, then 0.125 µg/kg/lV; use with hepseln.
Adenosine (Adenocard)	6 mg over 1-3 s, then 20 mL MS bokes, elevate exhemity; repeat 12 mg in 1-2 min PRN
Atteplase, Recombinant (Activase)	Altit rapid leff (or 3-h ind see Chapter 21); 15 mg bolux, then 0.75 mg/kg over 30 min. (50 mg/kg over 30 min.) Acute ischemic stroker. 0.9 mg/kg IV (max 90 mg) over 60 min. 15% mg max). Acute ischemic stroker. 0.9 mg/kg IV (max 90 mg) over 60 min. 10% of dose over 1 min, remaining 10% some.)
Amiodarone (Contarone, Pacerone)	Cardiac arrest: 300 mg IV push: 150 mg IV push 3-5 mm PRN: Refresteiny pushelses VTNP: 5 mg/kg napid IV bolux Perhasing arrhythmias: Load: 5 mg/kg NVNO over 25-60 mm Ingensi; max 15 mg/kg/kg.
Ammone	0.75 mg/tg over 10-15 min, then 5-15 µg/tg/min titrated (do not mix with destrose)
Anisbeplase (Eminase)	30 IU IV over 2-5 min
Aspirin	160-325 mg PO ASAP (chewing preferred at ACS onset)
Atendial (Tenomini)	5 mg NV over 5 min; in 10 min; 5 mg slow IV; if totersted in 10 min; start 50 mg PO; Then 50 mg PO bid:
Atropine Sullate	Anystoke or PEA: mg IV push. Repeat every 3-5 min (if asystoke penials) to 0.03-0.04 mg/kg max. Bradysardiac 0.5-1.0 mg IV every 3-5 min as needed; max 0.03-0.04 mg/kg ET 2-3 mg in 15 ml, NS
Calcium Chloride	Hypperhalemia/calclum channel blocker overdose: 8-16 mg/kg (usually 5-10 mL) Nr2-4 mg/kg (usually 2 ml,) IV before IV calclum blockers.
Dillazem (Cardizem)	Acute rate control: 15-20 mg (0.25 mg/kg) IV over 2 min. Repeat in 15 min at 20-25 mg (0.35 mg/kg) over 2 min.
Dobutamine (Dobutnex)	2-20 upharmin, thrate to HR not >10% of baseline
Doparrine (Intropin)	Titrata Low: 1-5 uphghmin (henai doses'). Moderate: 5-19 uphghmin (handac doses'). High: 10 to 20 uphghmin (hasopressor doses').
Epinghina	1.0 mg Nr pusht, repeat q 3–5 mirr, (0.2 mg/kg max) if 1 mg dose fasis. Mr. 30 mg (30 mg (30 mg Nr 1100) authorion) in 250 mL. NS or DyW, at 100 mil.h., terate. ET 2.0-2.5 mg in 20 mL. MS, Prefound bradycardialhypotensien: 2-10 yginini (1 mg of 1:1000 in 500 mL, NS), infuse 1-5 mL/min).



CLINICIAN'S POCKET REFERENCE

EDITED BY

LEONARD G. GOMELLA, MD, FACS

The Bernard W. Godwin, Jr., Associate Professor Department of Urology Jefferson Medical College Thomas Jefferson University Philadelphia, Pennsylvania

WITH

Steven A. Haist, MD, MS, FACP

Professor of Medicine Division of General Internal Medicine Department of Internal Medicine University of Kentucky Medical Center Lexington, Kentucky

Based on a program originally developed at the University of Kentucky College of Medicine Lexington, Kentucky

McGraw-Hill

MEDICAL PUBLISHING DIVISION

New York Chicago San Francisco Lisbon London Madrid Mexico City Milan New Delhi San Juan Seoul Singapore Sydney Toronto

McGraw-Hill



A Division of The McGraw-Hill Companies

Copyright © 2002 by Leonard G.Gomella. All rights reserved. Manufactured in the United States of America. Except as permitted under the United States Copyright Act of 1976, no part of this publication may be reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without the prior written permission of the publisher.

0-07-139444-3

The material in this eBook also appears in the print version of this title: 0-8385-1552-5.

All trademarks are trademarks of their respective owners. Rather than put a trademark symbol after every occurrence of a trademarked name, we use names in an editorial fashion only, and to the benefit of the trademark owner, with no intention of infringement of the trademark. Where such designations appear in this book, they have been printed with initial caps.

McGraw-Hill eBooks are available at special quantity discounts to use as premiums and sales promotions, or for use in corporate training programs. For more information, please contact George Hoare, Special Sales, at george_hoare@mcgraw-hill.com or (212) 904-4069.

TERMS OF USE

This is a copyrighted work and The McGraw-Hill Companies, Inc. ("McGraw-Hill") and its licensors reserve all rights in and to the work. Use of this work is subject to these terms. Except as permitted under the Copyright Act of 1976 and the right to store and retrieve one copy of the work, you may not decompile, disassemble, reverse engineer, reproduce, modify, create derivative works based upon, transmit, distribute, disseminate, sell, publish or sublicense the work or any part of it without McGraw-Hill's prior consent. You may use the work for your own noncommercial and personal use; any other use of the work is strictly prohibited. Your right to use the work may be terminated if you fail to comply with these terms.

THE WORK IS PROVIDED "AS IS". McGRAW-HILL AND ITS LICENSORS MAKE NO GUARANTEES OR WARRANTIES AS TO THE ACCURACY, ADEQUACY OR COMPLETENESS OF OR RESULTS TO BE OBTAINED FROM USING THE WORK. INCLUDING ANY INFORMATION THAT CAN BE ACCESSED THROUGH THE WORK VIA HYPERLINK OR OTHERWISE, AND EXPRESSLY DISCLAIM ANY WARRANTY, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICU-LAR PURPOSE. McGraw-Hill and its licensors do not warrant or guarantee that the functions contained in the work will meet your requirements or that its operation will be uninterrupted or error free. Neither McGraw-Hill nor its licensors shall be liable to you or anyone else for any inaccuracy, error or omission, regardless of cause, in the work or for any damages resulting therefrom. McGraw-Hill has no responsibility for the content of any information accessed through the work. Under no circumstances shall McGraw-Hill and/or its licensors be liable for any indirect, incidental, special, punitive, consequential or similar damages that result from the use of or inability to use the work, even if any of them has been advised of the possibility of such damages. This limitation of liability shall apply to any claim or cause whatsoever whether such claim or cause arises in contract, tort or otherwise.

DOI: 10.1036/0071394445



Want to learn more?

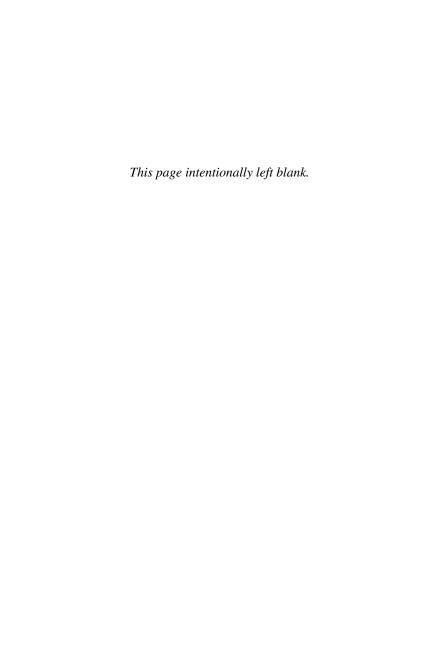
We hope you enjoy this McGraw-Hill eBook! If you'd like more information about this book, its author, or related books and websites, please <u>click here</u>.

To Tricia, Mom, Dad, Leonard, Patrick, Andrew, Michael and Aunt Lucy

"We don't drive the trucks, we only load them."

Nick Pavona, MD

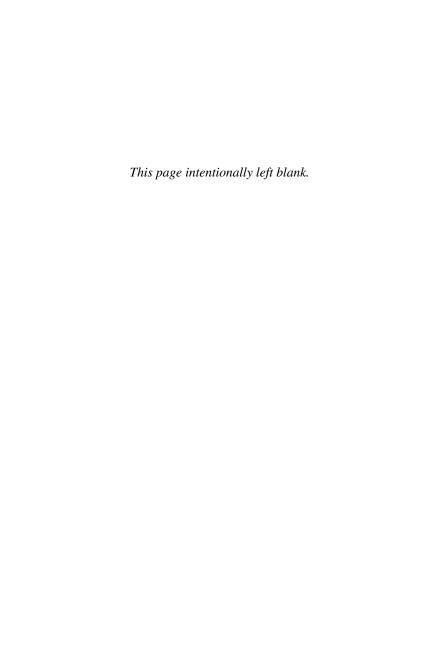
UKMC Class of 1980



For more information about this book, click here.

CONTENTS

	Consulting Editors	VII
	Contributors	viii
	Preface	xiii
	Abbreviations	ΧV
	"So You Want to Be a Scut Monkey": An Introduction to Clinical Medicine	1
1	History and Physical Examination	9
2	Chartwork	33
3	Differential Diagnosis: Symptoms, Signs, and Conditions	41
4	Laboratory Diagnosis: Chemistry, Immunology, and Serology	53
5	Laboratory Diagnosis: Clinical Hematology	95
6	Laboratory Diagnosis: Urine Studies	109
7	Clinical Microbiology	121
8	Blood Gases and Acid-Base Disorders	161
9	Fluids and Electrolytes	1 <i>77</i>
0	Blood Component Therapy	193
1	Diets and Clinical Nutrition	205
2	Total Parenteral Nutrition (TPN)	227
3	Bedside Procedures	239
4	Pain Management	315
5	Imaging Studies	325
6	Introduction to the Operating Room	339
7	Suturing Techniques and Wound Care	345
8	Respiratory Care	359
9	Basic ECG Reading	367
20	Critical Care	389
21	Emergencies	445
22	Commonly Used Medications	475
	Appendix	639
	Index	659
	Emergency Medications (inside front and back covers)	



CONSULTING EDITORS

MARIANNE BILLETER, PharmD, BCPS

Associate Professor of Pharmacy Practice, Division of Distance Education, Bernard J. Dunn School of Pharmacy, Shenandoah University, Winchester, Virginia

TRICIA L. GOMELLA, MD

Part-Time Clinical Assistant Professor of Pediatrics, Johns Hopkins University School of Medicine, Baltimore, Maryland

IRA HOROWITZ, MD

Professor of Gynecology and Obstetrics and Oncology, Director of Gynecologic Oncology, Emory University, Atlanta, Georgia

ALAN T. LEFOR, MD, MPH, FACS

Director, Division of Surgical Oncology, Director, Surgical Education and Academic Affairs, Department of Surgery, Cedars-Sinai Medical Center, Los Angeles, California; Associate Professor of Clinical Surgery, Department of Surgery, University of California, Los Angeles, Los Angeles, California

JOHN A. MORRIS, MD

Director, Division of Trauma, Department of Surgery, Vanderbilt University Medical Center. Nashville, Tennessee

CONTRIBUTORS

Aimee G. Adams, PharmD

Director, Primary Care Pharmacy Practice Residency, University of Kentucky Medical Center; Assistant Professor College of Pharmacy and Department of Medicine, University of Kentucky, Lexington, Kentucky

Marianne Billeter, PharmD, BCPS

Associate Professor of Pharmacy Practice, Division of Distance Education, Bernard J. Dunn School of Pharmacy, Shenandoah University, Winchester, Virginia

Pasquale Casale, MD

Chief Resident, Department of Urology, Thomas Jefferson University, Philadelphia, Pennsylvania

Murray Cohen, MD

Clinical Associate Professor of Surgery, Director, Division of Trauma/Critical Care, Department of Surgery, Jefferson Medical College, Philadelphia, Pennsylvania

Marisa Davis

Doctor of Pharmacy Candidate, Bernard J. Dunn School of Pharmacy, Shenandoah University, Winchester, Virginia

Neil M. Davis, PharmD, FASHP

Professor Emeritus of Pharmacy, Temple University, Philadelphia, Pennsylvania; Director, Safe Medication Practice Consulting, Inc., Huntingdon Valley, Pennsylvania

Ehab A. El Gabry, MD

Fellow, Department of Urology, Thomas Jefferson University, Philadelphia, Pennsylvania

Sue Fosson, MA

Former Associate Dean for Student Affairs, University of Kentucky College of Medicine, Lexington, Kentucky

Leonard G. Gomella, MD, FACS

The Bernard W. Godwin, Jr., Associate Professor, Department of Urology, Jefferson Medical College, Thomas Jefferson University, Philadelphia, Pennsylvania

Contributors

Steven A. Haist, MD, MS, FACP

Professor of Medicine, Division of General Internal Medicine, Department of Internal Medicine, University of Kentucky Medical Center, Lexington, Kentucky

Sara Maria Haverty, MD

Senior Resident, Department of Obstetrics and Gynecology, Thomas Jefferson University, Philadelphia, Pennsylvania

Mohamed Ismail, MD

Senior Resident, Department of Urology, Thomas Jefferson University, Philadelphia, Pennsylvania

Gregory C. Kane, MD

Clinical Associate Professor of Medicine, Program Director, Internal Medicine Residency, Jefferson Medical College, Philadelphia, Pennsylvania

Matthew J. Killion, MD

Assistant Professor of Medicine, Jefferson Medical College, Philadelphia, Pennsylvania

Alan T. Lefor, MD, MPH, FACS

Director, Division of Surgical Oncology, Director, Surgical Education and Academic Affairs, Department of Surgery, Cedars-Sinai Medical Center, Los Angeles, California; Associate Professor of Clinical Surgery, Department of Surgery, University of California, Los Angeles, Los Angeles, California

Layla F. Makary, MD, MSC, PhD

Lecturer, Department of Anesthesia, Cairo University, Clinical Fellow, Department of Anesthesia, Cleveland Clinic Foundation, Cleveland, Ohio

John Moore, MD

Clinical Associate Professor, Department of Surgery, Division of Plastic Surgery, Jefferson Medical College, Philadelphia, Pennsylvania

Nick A. Pavona, MD

Associate Professor, Department of Surgery, Division of Urology, Benjamin Franklin University Medical Center, Chadds Ford, Pennsylvania

Roger J. Pomerantz, MD, FACP

Professor of Medicine, Biochemistry and Molecular Pharmacology, Division of Infectious Diseases and Center for Human Virology, Jefferson Medical College, Thomas Jefferson University, Philadelphia, Pennsylvania

Ganesh Raj, MD, PhD

Senior Resident, Division of Urology, Department of Surgery, Duke University Medical Center, Durham, North Carolina **X** Contributors

Steven Rosensweig, MD

Director, Jefferson Center for Integrative Medicine, Jefferson Medical College, Philadelphia, Pennsylvania

Paul J. Schenarts, MD

Instructor in Surgery, Section of Surgical Sciences, Vanderbilt University, Nashville, Tennessee

Francis G. Serio, DMD, MS

Associate Professor and Chairman, Department of Periodontics, University of Mississippi School of Dentistry, Jackson, Mississippi

Kelly Smith, PharmD

Clinical Associate Professor, Division of Pharmacy Practice & Science, University of Kentucky College of Pharmacy; Director, Pharmacy Practice Residency, University of Kentucky Medical Center, Lexington, Kentucky

PREFACE

The Clinician's Pocket Reference is based on a University of Kentucky house manual entitled So You Want to Be a Scut Monkey: Medical Student's and House Officer's Clinical Handbook. The Scut Monkey Program at the University of Kentucky College of Medicine began in the summer of 1978 and was developed by members of the Class of 1980 to help ease the often frustrating transition from the preclinical to the clinical years of medical school. From detailed surveys at the University of Kentucky College of Medicine and 44 other medical schools, a list of essential information and skills that third-year students should be familiar with at the start of their clinical years was developed. The Scut Monkey Program was developed around this core of material and consisted of reference manuals and a series of workshops conducted at the start of the third year. Presented originally as a pilot program for the University of Kentucky College of Medicine Class of 1981, the program has been incorporated into the third-year curriculum. It is the responsibility of each new fourthyear class to orient the new third-year students. The basis of the program's success is the fact that it was developed and taught by students for other students. This method has allowed us to maintain perspective on those areas that are critical not only for learning while on the wards but also for delivering effective patient care. Information on the Scut Monkey Orientation Program is available from Todd Cheever, MD, Associate Dean for Academic Affairs at the University of Kentucky College of Medicine.

Through the last eight editions, the book has undergone expansion and careful revisions as the practice of medicine and the educational needs of students have changed. Although the book's original mission, providing new clinical clerks with essential patient care information in an easy-to-use format, remains unchanged, our readership has expanded. Residents, practicing physicians, and allied health professionals all use the Clinician's Pocket Reference as a "manual of manuals." Even individuals considering careers in medicine have used the book in their decision-making process. An attempt is made to cover the most frequently asked basic management questions that are normally found in many different sources, such as procedure manuals, laboratory manuals, drug references, and critical care manuals, to name a few. It is not meant as a substitute for specialty-specific reference manuals. The core of information presented is a foundation for new medical students as they move through training to more advanced medical studies.

The book is designed to represent a cross section of medical practices around the country. The *Clinician's Pocket Reference* has been translated into six different languages with electronic media versions in development. I was honored to have been asked to grant permission to Warner Brothers, the producers of the TV show "ER," to have the eighth edition of the Scut Monkey book as one of the books used on their series.

I would like to express special thanks to my wife and my family for their long-term support of the Scut Monkey project. Linda Davoli, our extraordinary copy editor, had an exceptional eye for detail in helping create this final work. Janet Foltin, Harriet Lebowitz, Lester **xii** Preface

Sheinis, and the team at McGraw-Hill were instrumental in moving the book forward and in giving the ninth edition a fresh, new two-color format. They are also responsible for helping reach our long-term goal of the new companion manual, the Clinician's Pocket Drug Reference. A special thanks to my assistant Conchita Ballard, who always kept things organized and flowing smoothly. I am indebted to all of the past contributors and readers who have helped to keep the Scut Monkey book as a useful reference for students and residents worldwide. The original coeditors of this work, G. Richard Braen, MD, and Michael J. Olding, MD, are acknowledged for their early contributions.

Your comments and suggestions for improvement are always welcomed by me personally, since revisions to the book would not be possible if it were not for the ongoing interest of our readers. I hope this book will not only help you learn some of the basics of the art and science of medicine but also allow you to care for your patients in the best way possible.

> Leonard G. Gomella, MD Philadelphia, Pennsylvania Leonard.Gomella@mail.tju.edu

ABBREVIATIONS

The following are common abbreviations used in medical records and in this edition

:: divided dose

↓: decrease(d), reduce, downward

x: times for multiplication sign

1: increase(d), upward (as in titrate upward) /: per

±: with or without

+: with

<: less than, younger than

>: more than, older than

≅: approximately equal to

AAA: abdominal aortic aneurysm

AaDo2: difference in partial pressures of oxygen in mixed alveolar gas and mixed arterial blood

A-a gradient: alveolar-to-arterial gradient

AAI: ankle-arm index

AAS: acute abdominal series

AB: antibody, abortion, antibiotic

A&B: apnea and bradycardia

ABD: abdomen

ABG: arterial blood gas

A/B index: ankle-brachial index

ABMT: autologous bone marrow transplantation

ac: before eating (ante cibum), assistcontrolled

ACCP: American College of Chest Physicians

ACE: angiotensin-converting enzyme

Ach-ase: acetylcholinesterase

ACLS: Advanced Cardiac Life Support

ACS: acute coronary syndrome, American Cancer Society, American College of Surgeons

ACTH: adrenocorticotropic hormone

A.D.C. VAAN DIML: mnemonic for Admit, Diagnosis, Condition, Vitals, Activity, Allergies, Nursing procedures, Diet, Ins and outs, Medications, Labs

A.D.C. VAN DISSEL: mnemonic for

Admit, Diagnosis, Condition, Vitals, Activity, Nursing procedures, Diet, Ins and outs, Specific drugs, Symptomatic

drugs, Extras, Labs

ADH: antidiuretic hormone

ADHD: attention-deficit hyperactivity disorder

ad lib: as much as needed (ad libitum)

AEIOU TIPS: mnemonic for Alcohol. Encephalopathy, Insulin, Opiates, Uremia, Trauma, Infection, Psychi-

atric, Syncope (diagnosis of coma)

AF: afebrile, aortofemoral, atrial fibrillation

AFB: acid-fast bacilli

AFP: alpha-fetoprotein

A/G: albumin/globulin ratio

AHA: American Heart Association

AHF: antihemophilic factor

AI: aortic insufficiency

AIDS: acquired immunodeficiency syndrome

AJCC: American Joint Committee on Cancer

AKA: above-the-knee amputation

ALAT: alanine aminotransferase

ALL: acute lymphocytic leukemia

ALS: amyotrophic lateral sclerosis

ALT: alanine aminotransferase

AM: morning

amb: ambulate

AMI: acute myocardial infarction

AML: acute myelocytic leukemia, acute myelogenous leukemia

AMMoL: acute monocytic leukemia

amp: ampule

AMP: adenosine monophosphate

ANA: antinuclear antibody

XIV Abbreviations

BEE: basal energy expenditure

bid: twice a day (bis in die)

bili: bilimbin

ANC: absolute neutrophil count

BCAA: branched-chain amino acid

BCG: bacille Calmette-Guérin

BE: barium enema

body

ANCA: antineutrophil cytoplasmic anti-

ANLL: acute nonlymphoblastic leukemia BKA: below-the-knee amputation ANS: autonomic nervous system BM: bone marrow, bowel movement AOB: alcohol on breath BMR: basal metabolic rate AODM: adult-onset diabetes mellitus BMT: bone marrow transplantation AP: anteroposterior, abdominal-perineal BOM: bilateral otitis media APAP: acetaminophen BP: blood pressure APL: acute promyelocytic leukemia BPH: benign prostatic hypertrophy aPPT: activated partial thromboplastin bpm: beats per minute BR: bed rest APSAC: anisoylated plasminogen strepto-BRBPR: bright red blood per rectum kinase activator complex BRP: bathroom privileges APUD: amine precursor uptake (and) bs, BS: bowel sounds, breath sounds BSA: body surface area decarboxylation Ara-C: cytarabine BS&O: bilateral salpingo-oophorectomy ARD: antibiotic removal device BUN: blood urea nitrogen ARDS: adult respiratory distress syndrome BW: body weight ARF: acute renal failure Bx: biopsy AS: aortic stenosis c: with (cum) ASA: American Society of Anesthesiolo-Ca: calcium CA: cancer gists ASAP: as soon as possible CAA: crystalline amino acid ASAT: aspartate aminotransferase CABG: coronary artery bypass graft ASCVD: atherosclerotic cardiovascular CAD: coronary artery disease CAF: cyclophosphamide, doxorubicin disease ASD: atrial septal defect (Adriamycin), 5-fluorouracil ASHD: atherosclerotic heart disease CALGB: Cancer and Leukemia Group B ASO: antistreptolysin O cAMP: cyclic adenosine monophosphate AST: aspartate aminotransferase Cao2: arterial oxygen content ATG: antithymocyte globulin caps: capsule(s) CAT: computed axial tomography ATN: acute tubular necrosis ATP: adenosine triphosphate CBC: complete blood count AUC: area under the curve CBG: capillary blood gas AV: atrioventricular CC: chief complaint A-V: arteriovenous CCI: corrected count increment (platelets) A-Vo2: arteriovenous oxygen CCO: continuous cardiac output B I&II: Billroth I and II Cco2: capillary oxygen content BACOD: bleomycin, doxorubicin (Adri-CCU: clean-catch urine, cardiac care unit amycin), cyclophosphamide, vin-CCV: critical closing volume cristine (Oncovin), dexamethasone CD: continuous dose BACOP: bleomycin, doxorubicin (Adri-CDC: Centers for Disease Control and Preamycin), cyclophosphamide, vinvention cristine (Oncovin), prednisone CEA: carcinoembryonic antigen BBB: bundle branch block CEP/CIEP: counterimmunoelectrophore-BC: bone conduction

CF: cystic fibrosis

CFU: colony-forming unit(s)

CGL: chronic granulocytic leukemia

Abbreviations

CH50: (total serum) hemolytic complement CVAT: costovertebral angle tenderness CHD: coronary heart disease CVH: common variable hypogammaglobu-CHF: congestive heart failure CHO: carbohydrate Cvo₂: oxygen content of mixed venous CHOP: cyclophosphamide, doxorubicin, blood vincristine (Oncovin), prednisone CVP: central venous pressure CI: cardiac index CXR: chest x-ray CIE: counterimmunoelectrophoresis CIS: carcinoma in situ D₅LR: 5% dextrose in lactated Ringer's CK: creatine phosphokinase solution CKI: cyclin-dependent kinase inhibitor D₅W: 5% dextrose in water CK-MB: isoenzyme of creatine kinase DAG: diacylglycerol with muscle and brain subunits DAP: diastolic pulmonary artery pressure Cl: chlorine DAT: diet as tolerated CLL: chronic lymphocytic leukemia DAW: dispense as written DC: discontinue, discharge, direct current cm: centimeter CML: chronic myelogenous leukemia D&C: dilation and curettage CMV: cytomegalovirus ddI: dideoxvinosine CN: cranial nerve DDx: differential diagnosis CNS: central nervous system **DEA:** United States Drug Enforcement Administration CO: cardiac output C/O: complaining of **DES:** diethylstilbestrol COAD: chronic obstructive airway disease DEXA: dual-energy x-ray absorptiometer COLD: chronic obstructive lung disease DHEA: dehydroepiandrosterone DHEAS: dehydroepiandrosterone sulfate COMT: catechol-O-methyltransferase conc: concentrate DI: diabetes insipidus DIC: disseminated intravascular coagulation cont inf: continuous infusion COPD: chronic obstructive pulmonary DIP: distal interphalangeal joint disease DIT: diiodotyrosine COX-2: cyclooxygenase-2 DJD: degenerative joint disease CP: chest pain, cerebral palsy DKA: diabetic ketoacidosis CPAP: continuous positive airway pressure dL: deciliter CPK: creatinine phosphokinase DM: diabetes mellitus CPP: central precocious puberty DMSA: dimercaptosuccinic acid CPR: cardiopulmonary resuscitation DNA: deoxyribonucleic acid CR: controlled release DNP: deoxyribonucleic protein CrCl: creatine clearance DNR: do not resuscitate CREST: calcinosis cutis, Raynaud's DOA: dead on arrival disease, esophageal dysmotility, **DOCA:** deoxycorticosterone acetate syndactyly, telangiectasia DOE: dyspnea on exertion CRF: chronic renal failure DOPA: dihydroxyphenylalanine DP: dorsalis pedis CRH: corticotropin-releasing hormone 2,3-DPG: 2,3-diphosphoglycerate CRP: C-reactive protein C&S: culture and sensitivity DPL: diagnostic peritoneal lavage CSF: cerebrospinal fluid, colony-DPT: diphtheria, pertussis, tetanus stimulating factor DR: delayed release C-spine: cervical spine DRG: diagnosis-related group CT: computed tomography DS: double strength CVA: cerebrovascular accident, costoverte-DSA: digital subtraction angiography

DTPA: diethylenetriamine-pentaacetic acid

bral angle

xvi Abbreviations

DTR: deep tendon reflex Fio₂: fraction of inspired oxygen DVT: deep venous thrombosis FRC: functional residual capacity Dx: diagnosis FSH: follicle-stimulating hormone EAA: essential amino acid FSP: fibrin split product EBL: estimated blood loss ft: foot EBV: Epstein-Barr virus FTA-ABS: fluorescent treponemal EC: enteric-coated antibody-absorbed ECG: electrocardiogram FTT: failure to thrive ECOG: Eastern Cooperative Oncology FU: follow-up 5-FU: fluorouracil Group **ECT:** electroconvulsive therapy FUO: fever of unknown origin EDC: estimated date of confinement FVC: forced vital capacity EDTA: ethylenediamine tetraacetic acid Fx: fracture EDVI: end-diastolic volume index g: gram EFAD: essential fatty acid deficiency G: gravida ELISA: enzyme-linked immunosorbent GABA: gamma-aminobutyric acid GAD: glutamic acid decarboxylase assay EMD: electromechanical dissociation GC: gonorrhea (gonococcus) EMG: electromyelogram G-CSF: granulocyte colony-stimulating EMS: emergency medical system, factor eosinophilia-myalgia syndrome GDP: guanosine diphosphate EMV: eyes, motor, verbal response GERD: gastroesophageal reflux disease (Glasgow Coma Scale) GETT: general by endotracheal tube ENA: extractable nuclear antigen (anesthesia) ENT: ear, nose, and throat GFR: glomerular filtration rate eod: every other day GGT: gamma-glutamyltransferase EOM: extraocular muscle GH: growth hormone GHIH: growth hormone-inhibiting EPO: erythropoietin EPSP: excitatory postsynaptic potential hormone ER: endoplasmic reticulum, Emergency GI: gastrointestinal Room, extended release GM-CSF: granulocyte-macrophage ERCP: endoscopic retrograde cholancolony-stimulating factor GNID: gram-negative intracellular giopancreatography ERV: expiratory reserve volume diplococci ESR: erythrocyte sedimentation rate GnRH: gonadotropin-releasing hormone ESRD: end-stage renal disease GOG: Gynecologic Oncology Group ET: endotracheal G6PD: glucose-6-phosphate ETOH: ethanol dehydrogenase ETT: endotracheal tube gr: grain EUA: examination under anesthesia GSW: gunshot wound ExU: excretory urogram **gt, gtt:** drop, drops (*gutta*) Fab: antigen-binding fragment GTP: guanosine triphosphate FANA: fluorescent antinuclear antibody GTT: glucose tolerance test GU: genitourinary FBS: fasting blood sugar GVHD: graft-versus-host disease FEV₁: forced expiratory volume in 1 s GXT: graded exercise tolerance (cardiac FFP: fresh frozen plasma stress test) FHR: fetal heart rate HA: headache FIGO: Fédération Internationale de HAA: hepatitis B surface antigen

(hepatitis-associated antigen)

Gynécologie et d'Obstétrique

Abbreviations xvii

HAV: hepatitis A virus IgG1{k}: immunoglobulin G1 kappa HBcAg: hepatitis B core antigen IHSS: idiopathic hypertrophic subaortic HBeAg: hepatitis B e antigen stenosis HBP: high blood pressure IL: interleukin HBsAg: hepatitis B surface antigen IM: intramuscular HBV: hepatitis B virus IMV: intermittent mandatory ventilation HCG: human chorionic gonadotropin in.: inch HCL: hairy cell leukemia INF: intravenous nutritional fluid **HCT:** hematocrit INH: isoniazid HCTZ: hydrochlorothiazide inhal: inhalation HDL: high-density lipoprotein inj: injection HEENT: head, eyes, ears, nose, and throat INR: international normalized ratio HFV: high-frequency ventilation **I&O:** intake and output Hgb: hemoglobin IP3: inositol triphosphate [Hgb]: hemoglobin concentration IPPB: intermittent positive pressure H/H: hemoglobin/hematocrit, breathing Henderson-Hasselbalch equation IPSP: inhibitory postsynaptic potential HIAA: 5-hydroxyindoleacetic acid iPTH: parathyroid hormone by radioim-HIDA: hepatic 2,6-dimethyliminodiacetic munoassay acid IR: inversion recovery IRBBB: incomplete right bundle branch HIV: human immunodeficiency virus HJR: hepatojugular reflex HLA: histocompatibility locus antigen IRDM: insulin-resistant diabetes mellitus HO: history of IRV: inspiratory reserve volume HOB: head of bed **ISA:** intrinsic sympathomimetic activity H&P: history and physical examination IT: intrathecal hpf: high-power field ITP: idiopathic thrombocytopenic HPI: history of the present illness purpura HPLC: high-pressure liquid IV: intravenous chromatography IVC: intravenous cholangiogram HPV: human papilloma virus IVP: intravenous pyelogram HR: heart rate JODM: juvenile-onset diabetes mellitus hs: at bedtime (hora somni) JVD: jugular venous distention **HSG:** hysterosalpingogram K: potassium **HSM:** hepatosplenomegaly katal: unit of enzyme activity HSV: herpes simplex virus kg: kilogram 5-HT₃: 5-hydroxytryptamine KOR: keep open rate HTLV-III: human T-lymphotropic virus, 17-KSG: 17-ketogenic steroids KUB: kidneys, ureters, bladder type III (AIDS agent, HIV) HTN: hypertension KVO: keep vein open Hx: history L: left, liter IC: inspiratory capacity LAD: left axis deviation, left anterior ICN: Intensive Care Nursery descending ICS: intercostal space LAE: left atrial enlargement ICSH: interstitial cell-stimulating hormone LAHB: left anterior hemiblock ICU: intensive care unit LAP: left atrial pressure, leukocyte ID: identification, infectious disease alkaline phosphatase I&D: incision and drainage LBBB: left bundle branch block IDDM: insulin-dependent diabetes mellitus LDH: lactate dehydrogenase

LDL: low-density lipoprotein

Ig: immunoglobulin

XVIII Abbreviations

mg: milligram

Mg: magnesium

LE: lupus erythematosus

LH: luteinizing hormone

LHRH: luteinizing hormone releasing MHA-TP: microhemagglutination-Treponema pallidum hormone MHC: major histocompatibility complex LIH: left inguinal hernia lia: liquid MI: myocardial infarction, mitral insuffi-LLL: left lower lobe ciency LLSB: left lower sternal border MIBG: metaiodobenzyl-guanidine LMP: last menstrual period MIC: minimum inhibitory concentration LNMP: last normal menstrual period min: minute, minimum MIT: monoiodotyrosine LOC: loss of consciousness, level of consciousness mL: milliliter LP: lumbar puncture MLE: midline episiotomy lpf: low-power field mm: millimeter LPN: licensed practical nurse MMEF: maximal midexpiratory flow LSB: left sternal border mm Hg: millimeters of mercury LSD: lysergic acid diethylamide mmol: millimole LUL: left upper lobe MMR: measles, mumps, rubella LUO: left upper quadrant mo: month LV: left ventricle mol: mole MOPP: mechlorethamine, vincristine LVD: left ventricular dysfunction LVEDP: left ventricular end-diastolic pres-(Oncovin), procarbazine, prednisone 6-MP: mercaptopurine MPF: M phase-promoting factor LVH: left ventricular hypertrophy MPGN: membrane-proliferative glomerum: meter MAC: Mycobacterium avium complex lonephritis MACE: methotrexate, doxorubicin (Adri-MPTP: analog of meperidine (used by amycin), cyclophosphamide, drug addicts) epipodophyllotoxin MRI: magnetic resonance imaging MAG3: mercaptoacetyltriglycine mRNA: messenger ribonucleic acid MAMC: midarm muscle circumference MRS: magnetic resonance spectroscopy MAO: monoamine oxidase MRSA: methicillin-resistant Staphylococ-MAOI: monoamine oxidase inhibitor cus aureus MAP: mean arterial pressure MS: mitral stenosis, morphine sulfate, mul-MAST: military/medical antishock trousers tiple sclerosis MAT: multifocal atrial tachycardia MSBOS: maximal surgical blood order max: maximum schedule MBC: minimum bactericidal concentration MSH: melanocyte-stimulating hormone MBT: maternal blood type MTT: monotetrazolium MCH: mean cell hemoglobin MTX: methotrexate MUGA: multigated (image) acquisition MCHC: mean cell hemoglobin concentra-(analysis) μm: micrometer MCT: medium-chain triglycerides MCTD: mixed connective tissue disease MVA: motor vehicle accident MCV: mean cell volume MVI: multivitamin injection MEN: multiple endocrine neoplasia MVV: maximum voluntary ventilation meq: milliequivalent MyG: myasthenia gravis Na: sodium MESNA: 2-mercaptoethane sulfonate sodium NAACP: mnemonic for Neoplasm, Allergy, met-dose: metered-dose Addison's disease, Collagen-vascular

Abbreviations **xix**

disease, Parasites (causes of eosinophilia)

NAD: no active disease

Na⁺/K⁺-ATPase: sodium/potassium adenosine triphosphate

NAPA: *N*-acetylated procainamide, *N*-acetylparaaminophenol

N-acetylparaaminopneno
NAS: no added sodium

NAVEL: mnemonic for *N*erve, *A*rtery, *V*ein, *E*mpty space, *L*ymphatic

NCV: nerve conduction velocity

NE: norepinephrine **neb:** nebulizer

NED: no evidence of recurrent disease

ng: nanogram NG: nasogastric

NIDDM: non-insulin-dependent diabetes mellitus

NK: natural killer

NKA: no known allergies NKDA: no known drug allergy

nmol: nanomole

NMR: nuclear magnetic resonance

NPC: nuclear pore complex

NPO: nothing by mouth (nil per os)

NRM: no regular medicines

NS: normal saline

NSAID: nonsteroidal antiinflammatory drug

NSILA: nonsuppressible insulin-like activity

NSR: normal sinus rhythm

NT: nasotracheal NTG: nitroglycerin OB: obstetrics

OCD: obsessive-compulsive disorder

OCG: oral cholecystogram

7-OCHS: 17-hydroxycorticosteroids **OD:** overdose, right eye (*oculus dexter*)

oint: ointment

OM: otitis media OOB: out of bed ophth: ophthalmic

OPV: oral polio vaccine **OR:** operating room

OS: opening snap, left eye (*oculus sinister*) **OTC:** over-the-counter (medications)

OU: both eyes

p: para

PA: posteroanterior, pulmonary artery

PAC: premature atrial contraction

PAD: diastolic pulmonary artery pressure

PAF: paroxysmal atrial fibrillation

PAL: periarterial lymphatic (sheath)

Pao2: peripheral arterial oxygen content

PAo2: alveolar oxygen

PAOP: pulmonary artery occlusion pressure

PAP: pulmonary artery pressure, prostatic acid phosphatase

PAS: systolic pulmonary artery pressure

PASG: pneumatic antishock garment PAT: paroxysmal atrial tachycardia

PBM: pharmacy benefit manager

pc: after eating (post cibum)

PCA: patient-controlled analgesia

PCI: percutaneous coronary intervention

PCKD: polycystic kidney disease

PCN: percutaneous nephrostomy pCO₂: partial pressure of carbon dioxide

PCP: Pneumocystis carinii pneumonia, phencyclidine

PCR: polymerase chain reaction

PCWP: pulmonary capillary wedge pressure

PDA: patent ductus arteriosus

PDGF: platelet-derived growth factor

PDR: Physicians' Desk Reference

PDS: polydioxanone

PE: pulmonary embolus, physical examination, pleural effusion

PEA: pulseless electrical activity

PEEP: positive end-expiratory pressure **PEG:** polyethylene glycol, percutaneous gastrostomy

PERRLA: pupils equal, round, reactive to light and accommodation

PERRLADC: pupils equal, round, reactive to light and accommodation directly and consensually

PET: positron emission tomography

PFT: pulmonary function test

pg: picogram

PGE₁: prostaglandin E₁

PI: pulmonic insufficiency (disease)

PICC: peripherally inserted central catheter

PID: pelvic inflammatory disease

PIE: pulmonary infiltrates with eosinophilia **XX** Abbreviations

PIH: prolactin-inhibiting hormone qid: four times a day (quater in die) PKU: phenylketonuria QNS: quantity not sufficient PMDD: premenstrual dysphoric disorder qod: every other day PMH: past medical history Qs: volume of blood (portion of cardiac PMI: point of maximal impulse output) shunted past nonventilated PMNL: polymorphonuclear leukocyte alveoli (neutrophil) Os/Ot: shunt fraction PND: paroxysmal nocturnal dyspnea Qt: total cardiac output PNS: peripheral nervous system R: right PO: by mouth (per os) RA: rheumatoid arthritis, right atrium pO2: partial pressure of oxygen RAD: right axis deviation POD: postoperative day RAE: right atrial enlargement postop: postoperative, after surgery RAP: right atrial pressure PP: pulsus paradoxus, postprandial RBBB: right bundle branch block PPD: purified protein derivative RBC: red blood cell (erythrocyte) P&PD: percussion and postural drainage RBP: retinol-binding protein PPN: partial parenteral nutrition RCC: renal cell carcinoma PR: by rectum RDA: recommended dietary allowance PRA: plasma renin activity RDS: respiratory distress syndrome (of **PRBC:** packed red blood cells newborn) preop: preoperative, before surgery RDW: red cell distribution width PRG: pregnancy REF: right ventricular ejection fraction PRK: photorefractive keratectomy **REM:** rapid eye movement PRN: as often as needed (pro re nata) RER: rough endoplasmic reticulum PS: pulmonic stenosis, partial saturation %RH: percentage of relative humidity PSA: prostate-specific antigen RIA: radioimmunoassay PSV: pressure support ventilation RIH: right inguinal hernia PSVT: paroxysmal supraventricular RIND: reversible ischemic neurologic tachycardia deficit Pt: patient RL: Ringer's lactate RLL: right lower lobe PT: prothrombin time, physical therapy, RLQ: right lower quadrant posterior tibial PTCA: percutaneous transluminal RME: resting metabolic expenditure RML: right middle lobe coronary angioplasty PTH: parathyroid hormone RMSF: Rocky Mountain spotted fever PTHC: percutaneous transhepatic RNA: ribonucleic acid cholangiogram RNase: ribonuclease PTT: partial thromboplastin time R/O: rule out PTU: propylthiouracil ROM: range of motion PUD: peptic ulcer disease ROS: review of systems PVC: premature ventricular contraction RPG: retrograde pyelogram PVD: peripheral vascular disease RPR: rapid plasma reagin PVR: peripheral vascular resistance rRNA: ribosomal ribonucleic acid RRR: regular rate and rhythm PWP: pulmonary wedge pressure PZI: protamine zinc insulin RSV: respiratory syncytial virus q: every (quaque) RT: rubella titer, respiratory therapy, Q: mathematical symbol for flow radiation therapy qd: every day RTA: renal tubular acidosis qh: every hour RTC: return to clinic q{_}h: every {_} hours RTOG: Radiation Therapy Oncology

Group

qhs: every hour of sleep

Abbreviations **xxi**

RU: resin uptake SO: subcutaneous RUG: retrograde urethrogram SR: sustained release RUL: right upper lobe SRP: single recognition particle RUQ: right upper quadrant SRS-A: slow-reacting substance of ana-RV: residual volume RVEDVI: right ventricular end-diastolic SSKI: saturated solution of potassium volume index RVH: right ventricular hypertrophy SSRI: selective serotonin reuptake in-Rx: treatment s: without (sine), second stat: immediately (statim) SA: sinoatrial STD: sexually transmitted disease S&A: sugar and acetone supp: suppository SAA: synthetic amino acid susp: suspension Sao2: arterial oxygen saturation SVD: spontaneous vaginal delivery SBE: subacute bacterial endocarditis Svo2: mixed venous blood oxygen satura-SBFT: small bowel follow-through SBS: short bowel syndrome SVR: systemic vascular resistance SCr: serum creatinine SVT: supraventricular tachycardia segs: segmented cells SWOG: Southwest Oncology Group Sx: symptoms SEM: systolic ejection murmur T: one. TT: two, etc. SER: smooth endoplasmic reticulum SG: Swan-Ganz T₃: triiodothyronine T₃ RU: triiodothyronine resin uptake SGA: small for gestational age SGGT: serum gamma-glutamyl transpepti-T₄: thyroxine tabs: tablet(s) SGOT: serum glutamic-oxaloacetic TAH: total abdominal hysterectomy transaminase TB: tuberculosis SGPT: serum glutamic-pyruvic transami-TBG: thyroxine-binding globulin, total blood gas nase SI: Système International (see page 55) TBLC: term birth, living child SIADH: syndrome of inappropriate antidi-T&C: type and cross-match uretic hormone TC&DB: turn, cough, and deep sig: write on label (signa) breathe SIMV: synchronous intermittent manda-TCF: triceps skin fold tory ventilation TCP: transcutaneous pacer SIRS: systemic inflammatory response Td: tetanus-diphtheria toxoid syndrome TD: transdermal SKSD: streptokinase-streptodornase TFT: thyroid function test SL: sublingual 6-TG: 6-thioguanine SLE: systemic lupus erythematosus T&H: type and hold SMA: sequential multiple analysis TIA: transient ischemic attack SMO: slips made out TIBC: total iron-binding capacity **SMX:** sulfamethoxazole tid: three times a day (ter in die) SOAP: mnemonic for Subjective, Objec-TIG: tetanus immune globulin tive, Assessment, Plan TKO: to keep open SOB: shortness of breath TLC: total lung capacity SOC: signed on chart TMJ: temporal mandibular joint soln: solution TMP: trimethoprim TMP-SMX: trimethoprim-sulfamethoxa-SPAG: small-particle aerosol generator

TNFα: tumor necrosis factor alpha

SPECT: single-photon emission computed

tomography

xxii Abbreviations

TNM: tumor-nodes-metastases TNTC: too numerous to count

TO: telephone order

TOPV: trivalent oral polio vaccine **TORCH:** toxoplasma, rubella, cy-

tomegalovirus, herpes virus (O = other [syphilis])

TPA: tissue plasminogen activator

TPN: total peripheral resistance, total par-

enteral nutrition

TRH: thyrotropin-releasing hormone **TSH:** thyroid-stimulating hormone

TT: thrombin time

TTP: thrombotic thrombocytopenic pur-

pura

TU: tuberculin units

TUR: transurethral resection TURBT: TUR bladder tumors

TURP: TUR prostate **TV:** tidal volume

TVH: total vaginal hysterectomy **Tx:** treatment, transplant, transfer

type 2 DM: noninsulin-dependent diabetes mellitus, type 2 diabetes mellitus

UA: urinalysis
UAC: uric acid

ud: as directed (*ut dictum*)UDS: urodynamic studiesUGI: upper gastrointestinal

UPEP: urine protein electrophoresis **URI:** upper respiratory infection

US: ultrasonography

USP: United States Pharmacopeia

UTI: urinary infection

UUN: urinary urea nitrogen

V: volt

VAMP: vincristine, doxorubicin

(Adriamycin), methylprednisolone

VC: vital capacity

VCUG: voiding cystourethrogram VDRL: Venereal Disease Research

Laboratory

VF: ventricular fibrillation

VLDL: very low density lipoprotein

VMA: vanillylmandelic acid

VO: voice order

VP-16: etoposide

V/Q: ventilation-perfusion VSS: vital signs stable VT: ventricular tachycardia

W: watt

WB: whole blood

WBC: white blood cell, white blood cell

count

WD: well developed WF: white female wk: week

WM: white male WN: well nourished

wnl, WNL: within normal limits WPW: Wolff-Parkinson-White

XRT: x-ray therapy

y: year YO: years old

ZE: Zollinger-Ellison

"SO YOU WANT TO BE A SCUT MONKEY": AN INTRODUCTION TO CLINICAL MEDICINE*

The transition from the preclinical years to the clinical years of medical school is often a difficult one. Understanding the new responsibilities and a set of ground rules can ease this transition. What follows is a brief introduction to clinical medicine for the new clinical clerk

THE HIERARCHY

Most services can be expected to have at least one of each of the following physicians on the team

The Intern

In some programs, the intern is known euphemistically as the first-year resident. This person has the day-to-day responsibilities of patient care. This duty, combined with a total lack of seniority, usually serves to keep the intern in the hospital more than the other members of the team and may limit his or her teaching of medical students. Any question concerning details in the evaluation of the patient, for example, whether Mrs. Pavona gets a complete blood count this morning or this evening, is usually referred first to the intern.

The Resident

The resident is a member of the house staff who has completed at least 1 year of postgraduate medical education. The most senior resident is typically in charge of the overall conduct of the service and is the person you might ask a question such as "What might cause Mrs. Pavona's white blood cell count to be 142,000?" You might also ask your resident for an appropriate reference on the subject or perhaps to arrange a brief conference on the topic for everyone on the service. A surgical service typically has a chief resident, a doctor in the last year of residency who usually runs the service. On medical services the chief resident is

^{*} Adapted, with permission, from Epstein A, Frye T (eds.): So You Want to Be a Toad. College of Medicine, Ohio State University, Columbus, OH.

usually an appointee of the chairman of medicine and primarily has administrative responsibilities with limited ward duties.

The Attending Physician

The attending physician is also called simply "The Attending," and on nonsurgical services, "the attending." This physician has completed postgraduate education and is now a member of the teaching faculty. The attending is morally and legally responsible for the care of all patients whose charts are marked with the attending's name. All major therapeutic decisions made about the care of these patients are ultimately passed by the attending. In addition, this person is responsible for teaching and evaluating house staff and medical students. This is the member of the team you might ask, "Why are we treating Mrs. Pavona with busulfan?"

The Fellow

Fellows are physicians who have completed their postgraduate education and elected to do extra study in one special field, such as, nephrology, high-risk obstetrics, or surgical oncology. They may or may not be active members of the team and may not be obligated to teach medical students, but usually they are happy to answer any questions you may ask. You might ask this person to help you read Mrs. Pavona's bone marrow smear.

TEAMWORK

The medical student, in addition to being a member of the medical team, must interact with members of the professional team of nurses, dietitians, pharmacists, social workers, and all others who provide direct care for the patient. Good working relations with this group of professionals can make your work go more smoothly; bad relations with them can make your rotation miserable.

Nurses are generally good-tempered, but overburdened. Like most human beings, they respond very favorably to polite treatment. Leaving a mess in a patient's room after the performance of a floor procedure, standing by idly while a 98-lb licensed practical nurse struggles to move a 350-lb patient onto the chair scale, and obviously listening to three ringing telephones while room call lights flash are acts guaranteed not to please. Do not let anyone talk you into being an acting nurse's aide or ward secretary, but try to help when you can.

You will occasionally meet a staff member who is having a bad day, and you will be able to do little about it. Returning hostility is unwarranted at these times, and it is best to avoid confrontations except when necessary for the care of the patient.

When faced with ordering a diet for your first sick patient, you will no doubt be confronted with the inadequacy of your education in nutrition. Fortunately for your patient, dietitians are available. Never hesitate to call one.

In matters concerning drug interactions, side effects, individualization of dosages, alteration of drug dosages in disease, and equivalence of different brands of the same drug, it never hurts to call the pharmacist. Most medical centers have a pharmacy resident who follows every patient on a floor or service and who will gladly answer any questions you have on medications. The pharmacist or pharmacy resident can very often provide pertinent articles on a requested subject.

YOUR HEALTH AND A WORD ON "AGGRESSIVENESS"

In your months of curing disease both day and night, it becomes easy to ignore your own right to keep yourself healthy. There are numerous bad examples of medical and surgical interns who sleep 3 hours a night and get most of their meals from vending machines. Do not let anyone talk you into believing that you are not entitled to decent meals and sleep. If you offer yourself as a sacrifice, it will be a rare rotation on which you will not become one.

You may have the misfortune someday of reading an evaluation that says a student was not "aggressive enough." This is an enigmatic notion to everyone. Does it mean that the student refused to attempt to start an intravenous line after eight previous failures? Does it mean that the student was not consistently the first to shout out the answer over the mumblings of fellow students on rounds? Whatever constitutes "aggressiveness" must be a dubious virtue at best.

A more appropriate virtue might be assertiveness in obtaining your education. Ask good questions, have the house staff show you procedures and review your chartwork, read about your patient's illness, review the surgery basics before going to the OR, participate actively in your patient's care, and take an interest in other patients on the service. This approach avoids the need for victimizing your patients and comrades that the definition of aggression suggests.

ROUNDS

Rounds are meetings of all members of the service for discussing the care of the patient. These occur daily and are of three kinds.

Morning Rounds

Also known as "work rounds," these take place anywhere from 6:30 to 9:00 AM on most services and are attended by residents, interns, and students. This is the time for discussing what happened to the patient during the night, the progress of the patient's evaluation or therapy or both, the laboratory and radiologic tests to be ordered for the patient, and, last but not least, talking with and evaluating the patient. Know about your patient's most recent laboratory reports and progress—this is a chance for you to look good.

Ideally, differences of opinion and any glaring omissions in patient care are politely discussed and resolved here. Writing new orders, filling out consultations, and making any necessary telephone calls are best done right after morning rounds.

Attending Rounds

These vary greatly depending on the service and on the nature of the attending physician. The same people who gathered for morning rounds will be here, with the addition of the attending. At this meeting, the patients are often seen again (especially on the surgical services); significant new laboratory, radiographic, and physical findings are described (often by the student caring for the patient); and new patients are formally presented to the attending (again, often by the medical student).

The most important priority for the student on attending rounds is to **know the patient**. Be prepared to concisely tell the attending what has happened to the patient. Also be ready to give a brief presentation on the patient's illness, especially if it is unusual. The attending will probably not be interested in minor details that do not affect therapeutic decisions. Additionally, the attending will probably not wish to hear a litany of normal laboratory values, only the pertinent ones, such as, Mrs. Pavona's platelets are still 350,000/ μ L in spite of her bone marrow disease. You do not have to tell everything you know on rounds, but you must be prepared to do so.

Open disputes among house staff and students are bad form on attending rounds. For this reason, the unwritten rule is that any differences of opinion not previously discussed shall not be initially raised in the presence of the attending.

Check-out or Evening Rounds

Formal evening rounds on which the patients are seen by the entire team a second time are typically done only on surgical services and pediatrics. Other services, such as, medicine, often will have check-out with the resident on call for the service that evening (sometimes called "card rounds"). Expect to convene sometime between 3:00 and 7:00 PM on most days. All new data are presented by the person who collected them (usually the student). Orders are again written, laboratory work desired for early the next day is requested, and those unfortunates on call compile a "scut list" of work to be done that night and a list of patients who need close supervision.

BEDSIDE ROUNDS

Basically, these are the same as any other rounds except that tact is at a premium. The first consideration at the bedside must be for the patient. If no one else on the team says "Good morning" and asks how the patient is feeling, do it yourself; this is not a presumptuous act on your part. Keep this encounter brief and then explain that you will be talking about the patient for a while. If handled in this fashion, the patient will often feel flattered by the attention and will listen to you with interest.

Certain points in a hallway presentation are omitted in the patient's room. The patient's race and sex are usually apparent to all and do not warrant inclusion in your first sentence. The patient must *never* be called by the name of the disease, eg, Mrs. Pavona is not "a 45-year-old CML (chronic myelogenous leukemia)" but "a 45-year-old with CML." The patient's general appearance need not be reiterated. Descriptions of evidence of disease must not be prefaced by words such as *outstanding* or *beautiful*. Mrs. Pavona's massive spleen is not beautiful to her, and it should not be to the physician or student either.

At the bedside, keep both feet on the floor. A foot up on a bed or chair conveys impatience and disinterest to the patient and other members of the team. It is poor form to carry beverages or food into the patient's room.

Although you will probably never be asked to examine a patient during bedside rounds, it is still worthwhile to know how to do so considerately. Bedside examinations are often done by the attending at the time of the initial presentation or by one member of a surgical service on postoperative rounds. First, warn the patient that you are about to examine the wound or affected part. Ask the patient to uncover whatever needs to be exposed rather than boldly removing the patient's clothes yourself. If the patient is unable to do so alone, you may do it, but remember to explain what you are doing. Remove only as much clothing as is necessary and then promptly cover the patient again. In a ward room, remember to pull the curtain.

Bedside rounds in the intensive care unit call for as much consideration as they do in any other room. That still, naked soul on the bed might not be as "out of it" as the resident (or anyone else) might believe and may be hearing every word you say. Again, exercise discretion in discussing the patient's illness, plan, prognosis, and personal character as it relates to the disease.

Remember that the patient information you are entrusted with as a health care provider is confidential. There is a time and place to discuss this sensitive information and public areas such as elevators or cafeterias are not the appropriate location for these discussions.

READING

Time for reading is at a premium on many services, and it is therefore important to use that time effectively. Unless you can remember everything you learned in the first 20 months of medical school, you will probably want to review the basic facts about the disease that brought your patient into the hospital. These facts are most often found in the same core texts that got you through the preclinical years. Unless specifically directed to do so, avoid the temptation to sit down with MEDLINE/Index Medicus to find all the latest articles on a disease you have not read about for the last 7 months; you do not have the time.

The appropriate time to head for the MEDLINE/Index Medicus is when a therapeutic dilemma arises and only the most recent literature will adequately advise the team. You may wish to obtain some direction from the attending, the fellow, or the resident before plunging into

the library on your only Friday night off call this month. Ask the residents or fellow students for the pocket manuals or PDA downloads that they found most useful for a given rotation.

THE WRITTEN HISTORY AND PHYSICAL

Much has been written on how to obtain a useful medical history and perform a thorough physical examination, and there is little to add to it. Three things worth emphasizing are your own physical findings, your impression, and your own differential diagnosis.

Trust and record your own physical findings, even if other examiners have written things different from those you found. You just may be right, and, if not, you have learned something from it. Avoid the temptation to copy another examiner's findings as your own when you are unable to do the examination yourself. Still, it would be an unusually cruel resident who would make you give Mrs. Pavona her fourth rectal examination of the day, and in this circumstance you may write "rectal per resident." Do not do this routinely just to avoid performing a complete physical examination. Check with the resident first.

Although not always emphasized in physical diagnosis, your clinical impression is probably the most important part of your write-up. Reasoned interpretation of the medical history and physical examination is what separates physicians from the computers touted by the tabloids as their successors. Judgment is learned only by boldly stating your case, even if you are wrong more often than not.

The differential diagnosis, that is, your impression, should include only those entities that you consider when evaluating your patient. Avoid including every possible cause of your patient's ailments. List only those that you are seriously considering, and include in your plan what you intend to do to exclude each one. Save the exhaustive list for the time your attending asks for all the causes of a symptom, syndrome, or abnormal laboratory value.

THE PRESENTATION

The object of the presentation is to *briefly* and *concisely* (usually in a few minutes) describe your patient's reason for being in the hospital to all members of the team who do not know the patient and the story. Unlike the write-up, which contains all the data you obtained, the presentation may include only the pertinent positive and negative evidence of a disease and its course in the patient. It is hard to get a feel for what is pertinent until you have seen and done a few presentations yourself.

Practice is important. Try never to read from your write-up, as this often produces dull and lengthy presentations. Most attendings will allow you to carry note cards, but this method can also lead to trouble unless content is carefully edited. Presentations are given in the same order as a write-up: identification, chief complaint, history of the present illness, past medical history, family history, psychosocial history, review of systems, physical examination, laboratory and x-ray data, clinical impression, and plan. Only pertinent positives and negatives from the review of systems should be given. These and truly relevant items from other parts of the interview often can be added to the history of the present illness. Finally, the length and content of the presentation vary greatly according to the wishes of the attending and the resident, but you will learn quickly what they do and do not want.

RESPONSIBILITY

Your responsibilities as a student should be clearly defined on the first day of a rotation by either the attending or the resident. Ideally, this enumeration of your duties should also include a list of what you might expect concerning teaching, floor skills, presentations, and all the other things you are paying many thousand dollars a year to learn.

On some services, you may feel like a glorified unit secretary (clinical rotations are called "clerkships" for good reason!), and you will not be far from wrong. This is *not* what you are going into hock for. The scut work should be divided among the house staff.

You will frequently be expected to call for a certain piece of laboratory data or to go review an x-ray with the radiologist. You may then mutter under your breath, "Why waste my time? The report will be on the chart in a day or two!" You will feel less annoyed in this situation if you consider that every piece of data ordered is vital to the care of your patient.

Outpatient clinic experiences are incorporated into many rotations today. The same basic rules and skill set necessary for inpatient care can be easily transferred to the outpatient setting.

The student's responsibility may be summarized in three words: **know your patient.**The whole service relies to a great extent on a well-informed presentation by the student.
The better informed you are, the more time left for education and the better your evaluation will be. A major part of becoming a physician is learning responsibility.

ORDERS

Orders are the physician's instructions to the nursing and other members of the professional staff on the care of the patient. These may include the frequency of vital signs, medications, respiratory care, laboratory and x-ray studies, and nearly anything else that you can imagine.

There are many formats for writing concise admission, transfer, and postoperative orders. Some rotations may have a precisely fixed set of routine orders, but others will leave you and the intern to your own devices. It is important in each case to avoid omitting instructions critical to the care of the patient. Although you will be confronted with a variety of lists and mnemonics, ultimately it is helpful to devise your own system and commit it to memory. Why memorize? Because when you are an intern and it is 3:30 AM, you may overlook something if you try to think it out. One system for writing admission or transfer orders uses the mnemonic "A.D.C. Vaan Diml" and is discussed in Chapter 2.

The word *stat* is the abbreviation for the Latin word *statim*, which means "immediately." When added to any order, it puts the requested study in front of all the routine work waiting to be done. Ideally, this order is reserved for the truly urgent situation, but in practice it is often inappropriately used. Most of the blame for this situation rests with physicians who either fail to plan ahead or order stat lab results when routine studies would do.

Student orders usually require a co-signature from a physician, although at some institutions students are allowed to order routine laboratory studies. Do not ask a nurse or pharmacist to act on an unsigned student order; it is **illegal** for them to do so.

The intern is usually responsible for most orders. The amount of interest shown by the resident and the attending varies greatly, but ideally you will review the orders on routinely admitted patients with the intern. Have the intern show you how to write some orders on a few patients, then take the initiative and write the orders yourself and review them with the intern.

THE DAY

The events of the day and the effective use of time are two of the most distressing enigmas encountered in making the transition from preclinical to clinical education. For example, there are no typical days on surgical services, as the operating room schedule prohibits making rounds at a regularly scheduled time every day. The following are suggestions that will help on any service.

- Schedule special studies early in the day. The free time after work rounds is usually
 ideal for this. Also, call consultants early in the morning. Often, they can see your patient on the same day or at least early the next day.
- Try to take care of all your business in the radiology department in one trip unless a given problem requires viewing a film promptly. Do not make as many separate trips as you have patients.
- Make a point of knowing when certain services become unavailable, for example, electrocardiograms, contrast-study scheduling, and blood drawing. Be sure to get these procedures done while it is still possible to do so.
- 4. Make a daily work or "scut"* list, and write down laboratory results as soon as you obtain them. Few people can keep all the daily data in their heads without making errors.
- 5. Try to arrange your travels around the hospital efficiently. If you have patients to see on four different floors, try to take care of all their needs, such as, drawing blood, removing sutures, writing progress notes, and calling for consultations, in one trip.
- 6. Strive to work thoroughly but quickly. If you do not try to get work done early, you never will (this is not to say that you will succeed even if you do try). There is no sin in leaving at 5:00 PM or earlier if your obligations are *completed* and the supervising resident has dismissed you.

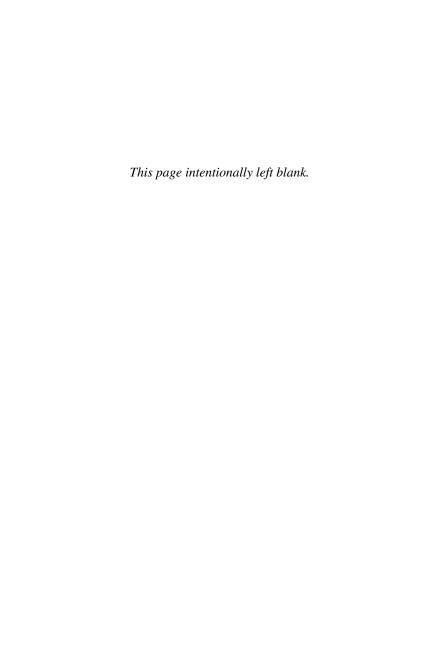
A PARTING SHOT

The clinical years are when all the years of premed study in college and the first two years of medical school suddenly come together. Trying to tell you adequately about being a clinical clerk is similar to trying to make someone into a swimmer on dry land.

The terms to describe new clinical clerks may vary at different medical centers ("scut monkey," "scut boy," "scut dog," "torpedoes"). These euphemistic expressions describing the new clinical clerk acknowledge that the transition, a sort of rite of passage, into the next phase of physician training has occurred. It is hoped that this "So You Want to Be a Scut Monkey" introduction and the information contained in this book will give you a good start as you enter the "hands on" phase of becoming a successful and respected physician.



^{*} Although the origin of the word *scut* is obscure, it probably represents an acronym for "some common unfinished task" or "some clinically useful training."



HISTORY AND PHYSICAL EXAMINATION

History and Physical Examination
Psychiatric History and Physical
Psychiatric Mental Status
Examination
Mini Mental Status Examination
Heart Murmurs and Extra Heart Sounds

Blood Pressure Guidelines

Dental Examination
Dermatologic Descriptions
Dermatome and Cutaneous Innervation
Physical Symptoms and Eponyms
Example of a Written History and
Physical Examination

HISTORY AND PHYSICAL EXAMINATION

An example of a complete H&P write-up can be found on page 28. The details provided and length of the written H&P can vary with the particular problem and with the service to which the patient is admitted.

History

Identification: Name, age, sex, referring physician, and the informant (eg, patient, relative, old chart) and the informant's reliability.

Chief Complaint: State, in patient's own words, the current problem.

History of the Present Illness (HPI): Defines the present illness by quality; quantity; setting; anatomic location and radiation; time course, including when it began; whether the complaint is progressing, regressing, or steady; of constant or intermittent frequency; and aggravating, alleviating, and associated factors. The information should be in chronologic order, including diagnostic tests done prior to admission. Related history, including previous treatment for the problem, risk factors, and pertinent negatives should be included. Any other significant ongoing problems should be included in the HPI in a separate section or paragraph. For instance, if a patient with poorly controlled diabetes mellitus comes to the emergency room because of chest pain, the HPI would first include information regarding the chest pain followed by a detailed history of the diabetes mellitus. If the diabetes mellitus was well controlled or diet-controlled, the history of the diabetes mellitus is placed in the past medical history.

Past Medical History (PMH): Current medications, including OTC medications, vitamins, and herbals; allergies (drugs and other—include how allergies are manifested); surgeries; hospitalizations; blood transfusions, include when and how many units and the type of blood product; trauma; stable current and past medical problems unrelated to the HPI. Specific illnesses to inquire about include diabetes mellitus, hypertension, MI, stroke, peptic ulcer disease, asthma, emphysema, thyroid and kidney disease, bleeding disorders, cancer,

TB, hepatitis, and STDs. Also inquire about routine health maintenance. This category depends on the age and sex of the patient but could include last Pap smear and pelvic exam, breast exam, whether the patient does self breast examination, date of last mammogram, diphtheria/tetanus immunization, pneumococcal and flu vaccine, stool samples for hemocult, sigmoidoscopy, cholesterol, HDL cholesterol, and use of seat belts. **Pediatric patients:** Include prenatal and birth history, feedings, food intolerance, and immunization history.

Family History: Age, status (alive, dead) of blood relatives and medical problems for any blood relatives (inquiry about cancer, especially breast, colon, and prostate; TB, asthma; MI; HTN; thyroid disease; kidney disease; peptic ulcer disease; diabetes mellitus; bleeding disorders; glaucoma, and macular degeneration). Can be written out or use family tree.

Psychosocial (Social) History: Stressors (financial, significant relationships, work or school, health) and support (family, friends, significant other, clergy); life-style risk factors, (alcohol, drugs, tobacco, and caffeine use; diet; and exposure to environmental agents; and sexual practices); patient profile (may include marital status and children; present and past employment; financial support and insurance; education; religion; hobbies; beliefs; living conditions); for veterans, include military service history. Pediatric patients: Include grade in school, sleep, and play habits.

Review of Systems (ROS)

General. Weight loss, weight gain, fatigue, weakness, appetite, fever, chills, night sweats *Skin.* Rashes, pruritus, bruising, dryness, skin cancer or other lesions

Head. Trauma, headache, tenderness, dizziness, syncope

Eyes. Vision, changes in the visual field, glasses, last prescription change, photophobia, blurring, diplopia, spots or floaters, inflammation, discharge, dry eyes, excessive tearing, history of cataracts or glaucoma

Ears. Hearing changes, tinnitus, pain, discharge, vertigo, history of ear infections

Nose. Sinus problems, epistaxis, obstruction, polyps, changes in or loss of sense of smell

Throat. Bleeding gums; dental history (last checkup, etc); ulcerations or other lesions on tongue, gums, buccal mucosa

Respiratory. Chest pain; dyspnea; cough; amount and color of sputum; hemoptysis; history of pneumonia, influenza, pneumococcal vaccinations, or positive PPD

Cardiovascular. Chest pain, orthopnea, dyspnea on exertion, paroxysmal nocturnal dyspnea, murmurs, claudication, peripheral edema, palpitations

Gastrointestinal. Dysphagia, heartburn, nausea, vomiting, hematemesis, indigestion, abdominal pain, diarrhea, constipation, melena (hematochezia), hemorrhoids, change in stool shape and color, jaundice, fatty food intolerance

Gynecologic. Gravida/para/abortions; age at menarche; last menstrual period (frequency, duration, flow); dysmenorrhea; spotting; menopause; contraception; sexual history, including history of venereal disease, frequency of intercourse, number of partners, sexual orientation and satisfaction, and dyspareunia

Genitourinary. Frequency, urgency, hesitancy; dysuria; hematuria; polyuria; nocturia; incontinence; venereal disease; discharge; sterility; impotence; polyuria; polydipsia; change in urinary stream; and sexual history, including frequency of intercourse, number of partners, sexual orientation and satisfaction, and history of venereal disease

Endocrine. Polyuria, polydipsia, polyphagia, temperature intolerance, glycosuria, hormone therapy, changes in hair or skin texture

Musculoskeletal. Arthralgias, arthritis, trauma, joint swelling, redness, tenderness, limitations in ROM, back pain, musculoskeletal trauma, gout

Peripheral Vascular. Varicose veins, intermittent claudication, history of thrombophlebitis Hematology. Anemia, bleeding tendency, easy bruising, lymphadenopathy

Neuropsychiatric. Syncope; seizures; weakness; coordination problems; alterations in sensations, memory, mood, sleep pattern; emotional disturbances; drug and alcohol problems

Physical Examination

General: Mood, stage of development, race, and sex. State if patient is in any distress or is assuming an unusual position, such as, sitting up leaning forward (position often seen in patients with acute exacerbation of COPD or pericarditis)

Vital Signs: Temperature (note if oral, rectal, axillary), pulse, respirations, blood pressure (may include right arm, left arm, lying, sitting, standing), height, weight. Blood pressure and heart rate supine and after standing 1 min should always be included if volume depletion is suspected, such as in GI bleeding, diarrhea, dizziness, or syncope.

Skin: Rashes, eruptions, scars, tattoos, moles, hair pattern (See page 20 for definitions of dermatologic lesions.)

Lymph Nodes: Location (head and neck, supraclavicular, epitrochlear, axillary, inguinal), size, tenderness, motility, consistency

Head, Eves, Ears, Nose, and Throat (HEENT)

Head. Size and shape, tenderness, trauma, bruits. Pediatric patients: Fontanels, suture lines Eyes. Conjunctiva; sclera; lids; position of eyes in orbits; pupil size, shape, reactivity; extraocular muscle movements; visual acuity (eg, 20/20); visual fields; fundi (disc color, size, margins, cupping, spontaneous venous pulsations, hemorrhages, exudates, A-V ratio, nicking)

Ears. Test hearing, tenderness, discharge, external canal, tympanic membrane (intact, dull or shiny, bulging, motility, fluid or blood, injected)

Nose. Symmetry; palpate over frontal, maxillary, and ethmoid sinuses; inspect for obstruction, lesions, exudate, inflammation. **Pediatric patients:** Nasal flaring, grunting

Throat. Lips, teeth, gums, tongue, pharynx (lesions, erythema, exudate, tonsillar size, presence of crypts)

Neck: ROM, tenderness, JVD, lymph nodes, thyroid examination, location of larynx, carotid bruits, HJR. JVD should be reported in relationship to the number of centimeters above or below the sternal angle, such as "1 cm above the sternal angle," rather than "no JVD."

Chest: Configuration and symmetry of movement with respiration; intercostal retractions; palpation for tenderness, fremitus, and chest wall expansion; percussion (include diaphragmatic excursion); breath sounds; adventitious sounds (rales, rhonchi, wheezes, rubs). If indicated: vocal fremitus, whispered pectoriloquy, egophony (found with consolidation)

Heart: Rate, inspection, and palpation of precordium for point of maximal impulse and thrill; auscultation at the apex, LLSB, and right and left second intercostal spaces with diaphragm and apex and LLSB with bell. Heart murmurs are reviewed on pages 16 to 18.

Breast: Inspection for nipple discharge, inversion, excoriations and fissures, and skin dimpling or flattening of the contour; palpation for masses, tenderness; gynecomastia in males

Abdomen: Note shape (scaphoid, flat, distended, obese); examine for scars; auscultate for bowel sounds and bruits; percussion for tympani and masses; measure liver size (span in midclavicular line); note costovertebral angle tenderness; palpate for tenderness (if present, check for rebound tenderness), note hepatomegaly, splenomegaly; guarding, inguinal adenopathy Male Genitalia: Inspect for penile lesions, scrotal swelling, testicles (size, tenderness, masses, varicocele), and hernia, and observe for transillumination of testicular masses

Pelvic: See Chapter 13, page 289.

Rectal: Inspect and palpate for hemorrhoids, fissures, skin tags, sphincter tone, masses, prostate (size [grade from small 1+ to massively enlarged 4+], note any nodules, tenderness); note presence or absence of stool; test stool for occult blood

Musculoskeletal: Note amputations, deformities, visible joint swelling, and ROM; also palpate joints for swelling, tenderness, and warmth

Peripheral Vascular: Note hair pattern; color change of skin; varicosities; cyanosis; clubbing; palpation of radial, ulnar, brachial, femoral, popliteal, posterior tibial, dorsalis pedis pulses; simultaneous radial pulses; calf tenderness; Homans's sign; edema; auscultate for femoral bruits

Neurologic

Mental Status Examination. (If appropriate, see sections "Psychiatric History and Physical," and "Psychiatric Mental Status Examination," page 13.)

Cranial Nerves. There are 12 cranial nerves, the functions of which are as follows:

- I Olfactory—Smell
- · II Optic-Vision, visual fields, and fundi; afferent limb of pupillary response
- III, IV, VI Oculomotor, trochlear, abducens—Efferent limb pupillary response, ptosis, volitional eye movements, pursuit eye movements
- V Trigeminal—Corneal reflex (afferent), facial sensation, masseter and temporalis
 muscle tested by biting down
- VII Facial—Raise eyebrows, close eyes tight, show teeth, smile, or whistle, corneal reflex (efferent)
- VIII Acoustic—Test hearing by watch tick, finger rub, Weber–Rinne test (see also page 27) to be done if hearing loss noted on history or by gross testing. (Air conduction lasts longer than bone conduction in a normal person.)
- IX, X Glossopharyngeal and vagus—Palate moves in midline; gag; speech
- XI Spinal accessory—Shoulder shrug, push head against resistance.
- XII Hypoglossal—Stick out tongue. Strength can be tested by having the patient
 press tongue against the buccal mucosa on each side and the examiner can press a
 finger against the patient's cheek. Also look for fasciculations.
- Motor. Strength should be tested in upper and lower extremities proximally and distally. (Grading system: 5 active motion against full resistance; 4 active motion against some resistance; 3 active motion against gravity; 2 active motion with gravity eliminated; 1 barely detectable motion; 0 no motion or muscular contraction detected)
- Cerebellum. Romberg's test (see page 27)—heel to shin (should not be with assistance from gravity), finger to nose, heel and toe walking, rapid alternating movements upper and lower extremities
- Sensory. Pain (sharp) or temperature distal and proximal upper and lower extremities, vibration using either a 128- or 256-Hz tuning fork or position sense distally upper and lower extremities, and stereognosis or graphesthesia. Identify any deficit using the dermatome and cutaneous innervation diagrams (see Figure 1–3).
- Reflexes. Brachioradialis and biceps C5-6, triceps C7-8, abdominal (upper T8-10, lower T10-12), quadriceps (knee) L3-4-5, ankle S1-2, (Grading system: 4+ Hyperactive with clonus; 3+ brisker than usual; 2+ normal or average; 1+ decreased or less than normal; 0 absent). Check for pathologic reflexes: Babinski's sign, Hoffmann's sign, snout, others (see pages 21 to 27). Pediatric patients: Moro's reflex (startle) and suck reflexes

Database

Laboratory tests, x-rays ordered as indicated by the history and physical

Problem List

(See example page 31.) Should include entry date of problem, date of problem onset, problem number. (With initial problem list, the more severe problems are numbered first. After the initial list is generated, problems are added chronologically.) List problem by status: active or inactive.

Assessment (Impression)

A discussion and evaluation of the current problems with a differential diagnosis.

Plan: Additional laboratory tests, medical treatment, consults, etc.

Note: The history and physical examination should be legibly signed and your title noted. Each entry should be dated and timed.

PSYCHIATRIC HISTORY AND PHYSICAL

The elements of the psychiatric history and physical are identical to those of the basic history and physical outlined earlier. The main difference involves attention to the past psychiatric history and more detailed mental status examination as described in the following section.

Psychiatric Mental Status Examination

The following factors are evaluated as part of the psychiatric status examination.

- · Appearance: Gestures, mannerisms, and so on
- · Speech: Coherence, flight of ideas, and so on
- · Mood and Affect: Depression, elation, anger, and so on
- · Thought Process: Blocking, evasion, and so on
- Thought Content: Worries, hypochondriasis, lack of self-confidence, delusions, hallucinations, and so on
- · Motor Activity: Slow, rapid, purposeful, and so on
- · Cognitive Functions:

Attention and concentration

Memory (immediate, recent, and remote recall)

Calculations

Abstractions

Judgment

Mini Mental Status Examination

A thorough mental status exam should be done on every geriatric patient, every patient with AIDS, and any patient suspected of having dementia. The mini mental status exam is a simple, practical test that takes only a few minutes and can be followed over time. It may show progression, improvement, or no changes in the underlying process. The mini mental status exam developed by Folstein, Folstein, and McHugh is discussed in detail in the *Journal of Psychiatric Research*, 1975, Vol. 12, pages 189–198. The test is divided into two sections: one assessing orientation, memory, and attention and the other testing the patient's ability to

write a sentence and to copy a diagram (usually two intersecting pentagons whose intersect forms a four-sided figure. Table 1–1 is the "Mini Mental State" Examination as outlined by Folstein and associates.

HEART MURMURS AND EXTRA HEART SOUNDS

Table 1-2 and Figure 1-1 describe the various types of heart murmurs and extra heart sounds.

BLOOD PRESSURE GUIDELINES

There is a clear association between hypertension and coronary artery and cerebrovascular disease.

Hypertension is defined as systolic BP >140 mm Hg or a diastolic BP >90 mm Hg in adults. Measure the BP after 5 min of rest with patient seated and arm at heart level. Use the bell of the stethoscope, the last sounds heard are the Korotkoff sounds, which are low-pitched. Take the average of two readings separated by 2 min. Elevated readings on three separate days should be obtained prior to diagnosing hypertension. Classification and follow-up recommendations for adults are shown in Table 1–3.

In children from age 1 to 10 years, systolic blood pressure can be calculated as follows:

Lower limits (5th percentile): 70 mm Hg + (child's age in years \times 2) Typical (50th percentile): 90 mm Hg + (child's age in years \times 2)

DENTAL EXAMINATION

The dental examination is an often overlooked part of the history and physical. Many times, the patient may have some intraoral problem that is contributing to the overall medical condition (ie, the inability to eat due to a toothache, abscess, or ill-fitting denture in a poorly controlled diabetic) for which a dental consult may be necessary. Loose dentures can compromise the ability to manually maintain an open airway. In addition, in an emergency situation when intubation is necessary, complications may occur if the clinician is unfamiliar with the oral structures.

The patient may be able to give some dental history, including recent toothaches, abscesses, and loose teeth or dentures. Be sure to ask if the patient is wearing a removable partial denture (partial plate), which should be removed before intubation. As lost dentures are a chief dental complaint of hospitalized patients, care must be taken not to misplace the removed prosthesis.

A brief dental examination may be performed with gloved hand, two tongue blades, and a flashlight. Look for any obvious inflammation, erythema, edema, or ulceration of the gingiva (gums) and oral mucosa. Gently tap on any natural teeth to test for sensitivity. Place each tooth between two tongue blades and push gently to check for looseness. This is especially important for the maxillary anterior teeth, which serve as the fulcrum for the laryngo-scope blade. Any abnormal dental findings should be noted and the appropriate consults obtained. Many diseases, including AIDS, STDs, pemphigus, pemphigoid, allergies, uncontrolled diabetes, leukemia, and others, may first manifest themselves in the mouth.

Hospitalized patients often have difficulty cleaning their teeth or dentures. This care should be added to the daily orders if indicated. Patients who will be receiving head and neck radiation must be examined and treated for any tooth extractions or dental infections before the initiation of the radiation therapy. Extractions after radiation to the maxilla and particularly the mandible may lead to osteoradionecrosis, a condition that may be impossible to control.

TABLE 1-1 The Mini Mental State Examination

		"I	Mini Mental	State"	
Maximum Score	Score				
5 5			the (year) (sec	ason) (date) (day)) (county) (town) (
3		patient o	objects: 1 se all 3 after you	cond to say each have said them. Then repeat until d.	Give 1 point for
5		Serial 7		c ulation for each correct. S pell "world" back	
3			the 3 objects i rrect answer.	repeated above. (Give 1 point for
9		name it. Repeat t (1 point) Follow o hand, fo Read an Close Write	a pencil, and (2 points) he following: a 3-stage com	watch and ask th "No if's, and's, o mand: "Take a po nd put it on the fl llowing:	r but's." per in your right
			Total Score		
Assess level	of cons	ciousness	along the fol	lowing continuum	
Alert	D	rowsy	Stupor	Coma	

TABLE 1-2
Heart Murmurs and Extra Heart Sounds*

Type [†]	Description
A. Aortic stenosis (AS)	Heard best at second intercostal space. Systolic (medium-pitched) crescendo-decrescendo murmur with radiation to the carotid arteries. A ₂ decreased, ejection click and S ₄ often heard at apex. Paradoxical splitting of S ₂ . Narrow pulse pressure and delayed carotid upstroke and left ventricular
B. Aortic insufficiency (AI)	hypertrophy (IVH) with lift at apex. Heard best at left lower sternal border third and fourth interspace with patient sitting up, leaning forward and fully exhaled. Diastolic (high-pitched) decrescendo murmur. Often with IVH. Widened pulse pressure, bisferious pulse, Traube's sign, Quincke's sign, and Corrigan's pulse may be seen with chronic aortic insufficiency. S ₃ and pulsus alternans often
C. Pulmonic stenosis (PS)	present with acute aortic insufficiency. Heard best at left second intercostal space. Systolic crescendo-decrescendo murmur. Louder with inspiration. Click often present. P ₂ delayed and soft weeks evere. Right ventricu
D. Pulmonic insufficiency (PI)	lar hypertrophy (RVH) with parasternal lift. Heard best at left second intercostal space. Diastolic decrescendo or crescendo— decrescendo murmur. Louder with inspiration. RVH usually present.
E. Mitral stenosis (MS)	Localized at the apex. Diastolic (low-pitched rumbling sound) murmur heard best with the bell in the left lateral decubitus position. With increased or decreased S ₁ . Opening snap (OS) heard best at apex with diaphragm. Increased P ₂ , right-sided S ₄ , left-sided S ₃ often present. RVH with parasternal lift may be
F. Mitral insufficiency (MI)	present. Heard best at apex. Holosystolic (high- pitched) murmur with radiation to axilla. Soft S ₁ , may be masked by murmur. S ₃ and LVH often present. Midsystolic click suggests mi- tral valve prolapse.
G. Tricuspid insufficiency (TI)	Heard best at left lower sternal border. Holosystolic (high-pitched) murmur. Increases with inspiration. Right-sided S ₃ often present. Large V wave in jugular venous pulsations.

TABLE 1-2 (Continued)

Type [†]	Description
H. Atrial septal defect (ASD)	Heard best at left upper sternal border. Systolic (medium-pitched) murmur. Fixed splitting of S_2 and RVH, often with left- and right-sided S_4 .
 Ventricular septal defect (VSD) 	O4. Heard best at left lower sternal border. Harsh holosystolic (high-pitched) murmur with midsystolic peak. S ₁ and S ₂ may be soft.
J. Patent ductus arteriosus (PDA)	Heard best at left first and second intercostal space. Continuous, machinery (mediumpitched) murmur. Increased P ₂ and ejection click may be present.
K. Third heard sound (S ₃)	Early diastolic sound caused by rapid ventricular filling. Heard best with bell. Left-sided S ₃ heard at apex, right-sided S ₃ heard at left lower sternal border. Left-sided S ₃ seen normally in young people, also pregnancy, thyrotoxicosis, mitral regurgitation, and congestive heart failure.
L. Fourth heart sound (S ₄)	Late diastolic sound caused by a noncompliant ventricle. Heard best with bell. Left-sided S_4 heard at apex, right-sided S_4 heard at left lower sternal border. Left-sided S_4 seen with hypertension, aortic stenosis, and myocardial infarction. Right-sided S_4 seen with pulmonic stenosis and pulmonary hypertension.

Eruption of Teeth

The eruption of teeth may be of great concern to new parents. Often, parents think something is developmentally wrong with their child if teeth have not appeared by a certain age. The timing of tooth eruption varies tremendously. Factors contributing to this variation include family history, ethnic background, vitality during fetal development, position of teeth in the arch, size and shape of the dental arch itself, and, in the case of the eruption of permanent teeth, when the primary tooth was lost. Radiographs of the maxilla and mandible can determine whether or not the teeth are present. Figure 1–2 serves as a guide to the chronology of tooth eruption. Remember that variations may be greater than 1 year in some cases.

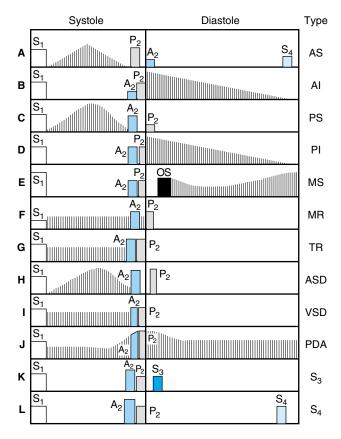


FIGURE 1-1 Graphic representation of common heart murmurs. See Table 1–2 for abbreviations and descriptions of murmurs.

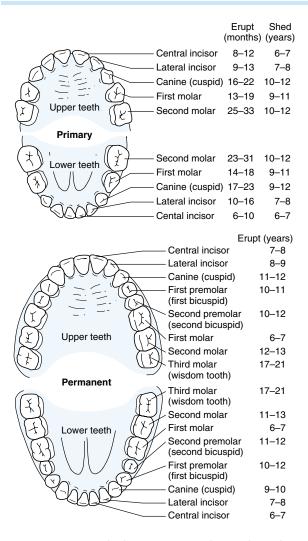


FIGURE 1-2 Dentition development sequences. The age when teeth are shed and erupt varies widely. (Based on data from: McDonald RE and Avery DR [eds]: *Dentistry for the Child and Adolescent, Mosby, St. Louis, 1994. Used with permission.)*

TABLE 1-3
Guidelines for Blood Pressure Management in Adults

Category	Systolic (mm Hg)	Diastolic (mm Hg)
Desired	<120	<80
Normal	<130	<85
High normal	130-139	85–89
Hypertension		
Stage 1	140-159	90–99
Stage 2	160-179	100-109
Stage 3	>180	>110

FOLLOW-UP RECOMMENDATIONS INITIAL SCREENING BP (MM HG)

Systolic	Diastolic	Action
<130 130–139 140–159 160–179 >180	<85 85–89 90–99 100–109 >110	Recheck in 2 years Recheck in 1 yr Confirm within 2 months Evaluate or refer within 1 month Evaluate or refer immediately or within 1 wk depending on the clinical situation

DERMATOLOGIC DESCRIPTIONS

Atrophy: Thinning of the surface of the skin with associated loss of normal markings. Examples: Aging, striae associated with obesity, scleroderma

Bulla: A superficial, well-circumscribed, raised, fluid-filled lesion greater than 1 cm in diameter. Examples: Bullous pemphigoid, pemphigus, dermatitis herpetiformis

Burrow: A subcutaneous linear track made by a parasite. Example: Scabies

Crust: A slightly raised lesion with irregular border and variable color resulting from dried blood, serum, or other exudate. Examples: Scab resulting from an abrasion, or impetigo

Ecchymoses: A flat, nonblanching, red-purple-blue lesion that results from extravasation of red blood cells into the skin. Differs from purpura in that ecchymoses are large purpura. Examples: Trauma, long-term steroid use

Erosion: A depressed lesion resulting from loss of epidermis due to rupture of vesicles or bullae. Example: Rupture of herpes simplex blister

Excoriation: A linear superficial lesion, which may be covered with dried blood. Early lesions with surrounding erythema. Often self-induced. Example: Scratching associated with pruritus from any cause

Fissure: A deep linear lesion into the dermis. Example: Cracks seen in athlete's foot

Keloid: Irregular, raised lesion resulting from scar tissue that is hypertrophied. Examples: Often seen with burns, and African-Americans are more prone to keloid formation.

Lichenification: A thickening of the skin with an increase in skin markings resulting from chronic irritation and rubbing. Example: Atopic dermatitis

Macule: A circumscribed nonpalpable discoloration of the skin less than 1 cm in diameter. Examples: Freckles, rubella, petechiae

Nodule: A solid, palpable, circumscribed lesion larger than a papule and smaller than a tumor Example: Frythems podosum gouty tophi

tumor. Examples: Erythema nodosum, gouty tophi **Papule:** A solid elevated lesion less than 1 cm. Examples: Acne, warts, insect

bites

Patch: A nonpalpable discoloration of the skin with an irregular border, greater than 1 cm in diameter. Example: Vitiligo

Petechiae: A flat pinhead-sized, nonblanching, red-purple lesion caused by hemorrhage into the skin. Example: Seen in DIC, ITP, SLE, meningococcemia (Neisseria meningitidis)

Plaque: A solid, flat, elevated lesion greater than 1 cm in diameter. Examples: Psoriasis, discoid lupus erythematosus, actinic keratosis

Purpura: A flat, nonblanching, red-purple lesion larger than petechiae caused by hemorrhage into the skin. Examples: Henoch–Schönlein purpura, TTP.

Pustule: A vesicle that is filled with purulent fluid. Examples: Acne, impetigo

Scales: Partial separation of the superficial layer of skin. Examples: Psoriasis, dandruff

Scar: Replacement of normal skin with fibrous tissue, often resulting from injury. Examples: Surgical scar, burn

Telangiectasia: Dilatation of capillaries resulting in red, irregular, clustered lines that blanch. Examples: Seen in scleroderma, Osler-Weber-Rendu disease, cirrhosis

Tumor: A solid, palpable, circumscribed lesion that is greater than 2 cm in diameter. Example: Lipoma

Ulcer: A depressed lesion resulting from loss of epidermis and part of the dermis. Examples: Decubitus ulcers, primary lesion of syphilis, venous stasis ulcer

Vesicle: A superficial, well-circumscribed, raised, fluid-filled lesion that is less than 1 cm in diameter. Examples: Herpes simplex, varicella (chickenpox)

Wheal: Slightly raised, red, irregular lesions that are transient and secondary to edema of the skin. Examples: Urticaria (hives), allergic reaction to injections or insect bites

DERMATOME AND CUTANEOUS INNERVATION

The diagrams (Figures 1–3A and B) demonstrate dermatome levels and cutaneous innervation distribution useful in the physical examination.

PHYSICAL SYMPTOMS AND EPONYMS

Allen's Test: (See Chapter 13, page 246.)

Apley's Test: Determination of meniscal tear in the knee by grinding the joint manually

Argyll-Robertson Pupil: Bilaterally small, irregular, unequal pupils that react to accommodation but not to light. Seen with tertiary syphilis

Austin Flint Murmur: Late diastolic mitral murmur; associated with aor1ic insufficiency with a normal mitral valve

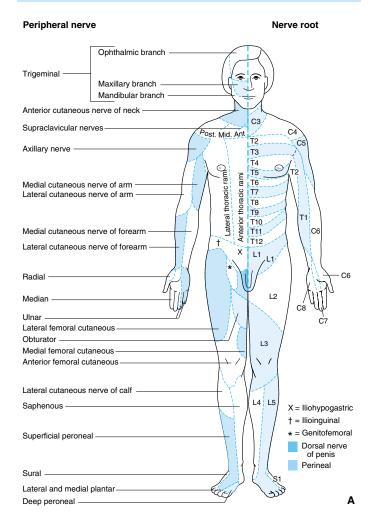


FIGURE 1-3 A: Dermatomes and cutaneous innervation patterns, anterior view. (Reprinted, with permission, from: Aminoff MJ et al [eds]: *Clinical Neurology,* 3rd ed, Appleton & Lange, Stamford CT, 1996.)

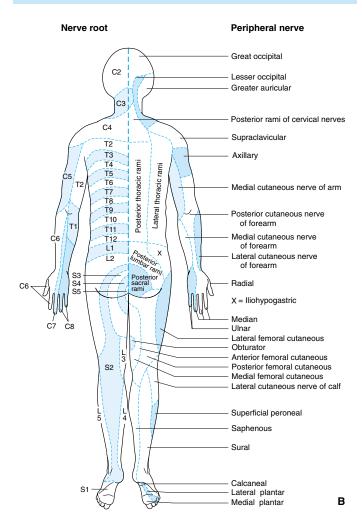


FIGURE 1-3 B: Dermatomes and cutaneous innervation patterns, posterior view. (Reprinted, with permission, from: Aminoff MJ et al [eds]: *Clinical Neurology,* 3rd ed, Appleton & Lange, Stamford CT, 1996.)

Babinski's Sign: Extension of the large toe with stimulation of the plantar surface of the foot instead of the normal flexion; indicative of upper motor neuron disease (normal in neonates)

Bainbridge's Reflex: Increased heart rate due to increased right atrial pressure

Battle's Sign: Ecchymosis behind the ear associated with basilar skull fractures.

Beau's Lines: Transverse depressions in nails due to previous systemic disease

Beck's Triad: JVD, diminished or muffled heart sounds, and decreased blood pressure associated with cardiac tamponade

Bell's Palsy: Lower motor neuron lesion of the facial nerve affecting muscles of upper and lower face. Easily distinguished from upper motor lesions, which affect predominately muscles of lower face since upper motor neurons from each side innervate muscles on both sides of the upper face

Bergman's Triad: Altered mental status, petechiae, and dyspnea associated with fat embolus syndrome

Biot's Breathing: Seen with brain injury; abruptly alternating apnea and equally deep

Bisferious Pulse: A double-peaked pulse seen in severe chronic aortic insufficiency

Bitot's Spots: Small scleral white patches suggesting vitamin A deficiency

Blumberg' Sign: Pain felt in the abdomen when steady constant pressure is quickly released. Seen with peritonitis

Blumer's Shelf: Hardness palpable on rectal examination due to metastatic cancer of the rectouterine (pouch of Douglas) or rectovesical pouch

Bouchard's Nodes: Hard, nontender, painless nodules in the dorsolateral aspects of the proximal interphalangeal joints associated with osteoarthritis. Results from hypertrophy of the bone

Branham's Sign: With large AV fistulas, abrupt slowing of the heart rate with compression of the feeding artery

Brudzinski's Sign: Flexion of the neck causing flexion of the hips in meningitis

Chadwick's Sign: Bluish color of cervix and vagina, seen with pregnancy

Chandelier's Sign: Extreme pain elicited with movement of the cervix during bimanual pelvic examination. Indicates PID

Charcot's Triad: Right upper quadrant pain, fever (chills), and jaundice associated with cholangitis

Cheyne-Stokes Respiration: Repeating cycle of a gradual increase in depth of breathing followed by a gradual decrease to apnea; seen with CNS disorders, uremia, some normal sleep patterns

Chvostek's Sign: Tapping over the facial nerve causes facial spasm in hypocalcemia (tetany). May be normal finding in some patients

Corrigan's Pulse: A palpable hard pulse immediately followed by sudden collapse, seen in aortic regurgitation

Cullen's Sign: Ecchymosis around the umbilicus associated with severe intraperitoneal bleeding. Seen with ruptured ectopic pregnancy and hemorrhagic pancreatitis

Cushing's Triad: Hypertension, bradycardia, and irregular respiration associated with increased intracranial pressure

Darier's Sign: Stroking of the skin causes erythema and edema in mastocytosis

Doll's Eyes: Conjugated movement of eyes in one direction as head is briskly turned in the other direction in comatose patients. Tests oculocephalic reflex indicating intact brain stem

Drawer Sign: Forward (or backward) movement of the tibia with pressure, indicating laxity or a tear in the anterior (or posterior) cruciate ligament Dupuytren's Contracture: Proliferation of fibrosis tissue of the palmar fascia resulting in contracture of the fourth and/or fifth digits, which is often bilateral. May be hereditary or seen in patients with chronic alcoholic liver disease or seizures

Duroziez's Sign: Found in aortic regurgitation a "to and fro" murmur when stethoscope is pressed over the femoral artery

Electrical Alternans: Beat to beat variation in the electrical axis, seen in large pericardial effusions, suggests impending hemodynamic compromise

Ewart's Sign: Dullness to percussion, increased fremitus and bronchial breathing beneath the angle of the left scapula found with pericardial effusion

Fong Lesion/Syndrome: Autosomal-dominant anomalies of the nails and patella associated with renal abnormalities

Frank's Sign: Fissure of the ear lobe; may be associated with CAD, diabetes, and hypertension

Gibbus: Angular convexity of the spine due to vertebral collapse; associated with osteoporosis or metastasis

Gregg's Triad: Cataracts, heart defects, and deafness with congenital rubella

Grey Turner's Sign: Ecchymosis in the flank associated with retroperitoneal hemorrhage

Grocco's Sign: Triangular area of paravertebral dullness, opposite side of a pleural effusion

Heberden's Nodes: Hard, nontender, painless nodules on the dorsolateral aspects of the distal interphalangeal joints associated with osteoarthritis. Results from hypertrophy of the bone

Hegar's Sign: Softening of the distal uterus. Reliable early sign of pregnancy

Hellenhorst's Plaque: A cholesterol plaque on retina seen on funduscopic examination associated with amaurosis fugax

Hill's Sign: Femoral artery pressure 20 mm Hg greater than brachial pressure seen in severe aortic regurgitation

Hoffmann's Sign/Reflex: Flicking of the volar surface of the distal phalanx causing fingers to flex; associated with pyramidal tract disease

Homans' Sign: Calf pain with forcible dorsiflexion of the foot, associated with venous

Horner's Syndrome: Unilateral miosis, ptosis, and anhidrosis (absence of sweating). From destruction of ipsilateral superior cervical ganglion often from lung carcinoma, especially squamous cell carcinoma

Janeway's Lesion: Erythematous or hemorrhagic lesion seen on the palm or sole with subacute bacterial endocarditis

Joffroy's Reflex: Inability to wrinkle the forehead when patient asked to bend head and look up, seen in hyperthyroidism

Kayser-Fleischer Ring: Brown pigment lesion due to copper deposition seen in Wilson's disease

Kehr's Sign: Left shoulder and left upper quadrant pain associated with splenic rupture

Kernig's Sign: When the thigh is flexed at a right angle, complete extension of the leg is not possible because of inflammation of the meninges; seen with meningitis

Koplik's Spots: White papules on buccal mucosa opposite molars seen in measles

Korotkoff's Sounds: Low-pitched sounds resulting from vibration of the artery, detected when obtaining a blood pressure using the bell of the stethoscope. The last Korotkoff sound may be a more accurate estimate of the true diastolic blood pressure than the diastolic blood pressure obtained using the diaphragm.

Kussmaul's Respiration: Deep, rapid respiratory pattern seen in coma or DKA

Kussmaul's Sign: Paradoxical rise in the jugular venous pressure on inspiration in constrictive pericarditis or COPD

Kyphosis: Excessive rounding of the thoracic spinal convexity, associated with aging, especially in women

Lasègue's Sign/Straight-Leg-Raising Sign: The patient is extended in the supine position and raises the leg gently. Pain in the distribution of nerve root suggests sciatica.

Levine's Sign: Clenched fist over the chest while describing chest pain; associated with angina and AMI

Lhermitte's Sign: In MS, neck flexion results in a "shock sensation."

List: Lateral tilt of the spine, frequently associated with herniated disk and muscle spasm

Lordosis: Accentuated normal concavity of the lumbar spine, normal in pregnancy

Louvel's Sign: Coughing or sneezing causes pain in the leg with DVT

Marcus-Gunn Pupil: Dilation of pupils with swinging flashlight test. Results from unilateral optic nerve disease. Normal pupillary response is elicited when light is directed from the normal eye and a subnormal response when light is quickly directed from the normal eye into the abnormal eye. When light is directed into the abnormal eye, both pupils dilate rather than maintain the previous degree of miosis.

McBurney's Point/Sign: Point located one-third of the distance from the anterior superior iliac spine to the umbilicus on the right; tenderness at the site is associated with acute appendicitis.

McMurray's Test: External rotation of the foot produces a palpable or audible click on the joint line, suggesting medial meniscal injuries

Möbius' Sign: Weakness of convergence seen in thyrotoxicosis

Moro's Reflex (Startle Reflex): Abduction of hips and arms with extension of arms when infant's head and upper body is suddenly dropped several inches while being held. Normal reflex in early infancy

Murphy's Sign: Severe pain and inspiratory arrest with palpation of the right upper quadrant during deep inspiration; associated with cholecystitis

Musset's or de Musset's Sign: Rhythmic nodding or movement of the head with each heart beat caused by blood flow back into the heart in aortic insufficiency

Obturator Sign: Flexion and internal rotation of the thigh elicits hypogastric pain in cases of inflammation of the obturator internus; positive with pelvic abscess and appendicitis

Ortolani's Test/Sign: Sign is hip click that suggests congenital hip dislocation. With the infant supine, point the legs toward you and flex the legs to 90 degrees at the hips and knees.

Osler's Node: Tender, red, raised lesions on the hands or feet seen with SBE.

Pancoast's Syndrome: Carcinoma involving apex of lung, resulting in arm and or shoulder pain from involvement of brachial plexus and Horner's syndrome from involvement of the superior cervical ganglion

Pastia's Lines: Linear striations of confluent petechiae in axillary folds are antecubital fossa seen in scarlet fever

Phalen's Test: Prolonged maximum flexion of wrists while opposing dorsum of each hand against each other. A positive test results in pain and tingling in the distribution of the median nerve, indicating carpal tunnel syndrome

Psoas Sign (Iliopsoas Test): Flexion against resistance or extension of the right hip, producing pain; seen with inflammation of the psoas muscle; positive with appendicitis.

Pulsus Alternans: Fluctuation of pulse pressure with every other beat. Seen in aortic stenosis and CHF

Queckenstedt's Test: Tests patency of the subarachnoid space; compression of the internal jugular vein during lumbar puncture; should normally immediately raise CSF pressure Quincke's Sign: Alternating blushing and blanching of the fingernail bed following light compression; seen in chronic aortic regurgitation

Radovici's Sign: A frontal release sign, scratching palm causes chin contractions

Raynaud's Phenomenon/Disease: Pain and tingling in fingers after exposure to cold with characteristic color changes of white to blue and then often red. May be seen with scleroderma. and SLE

Romberg's Test: Used to test position sense or cerebellar function. The patient stands with heels and toes together. Arms may be outstretched with palms facing upward or down or arms can be at the patient's side. The patient may be lightly tapped by the examiner with the eyes open and then closed. A positive test is a loss of balance. A loss of balance with the eyes open indicates cerebellar dysfunction. Normal balance with eyes open and loss of balance with eyes closed indicates loss of position sense.

Roth's Spots: Oval retinal hemorrhages with a pale central area occurring in patients with bacterial endocarditis

Rovsing's Sign: Pain in the right lower quadrant with deep palpation of the left lower quadrant. Seen in acute appendicitis

Schmorl's Node: Degeneration of the intervertebral disk resulting in herniation into the adjacent vertebral body

Scoliosis: Lateral curvature of the spine

Sentinel Loop: A single dilated loop of small or large bowel, usually occurs localized inflammation such as pancreatitis

Sister Mary Joseph's Sign/Node: Metastatic cancer to umbilical lymph node

Stellwag's Sign: Infrequent ocular blinking

Tinel's Sign: Radiation of an electric shock sensation in the distal distribution of the median nerve elicited by percussion of the flexor surface of the wrist when fully extended. Seen in carpal tunnel syndrome

Traube's Sign: Booming or pistol shot sounds heard over the femoral arteries in chronic aortic insufficiency

Trendelenburg's Test: Observe patient from behind while patient shifts weight from one leg to the other; a pelvis tilt to opposite side suggests hip disease and weakness of the gluteus medius muscle. If normal, pelvis will not tilt.

Trousseau's Sign: Carpal spasm produced by inflating a blood pressure cuff above the systolic pressure for 2–3 min, indicates hypocalcemia; also migratory thrombophlebitis associated with cancer

Turner's Sign: See Grey Turner's sign

Virchow's Node (Signal or Sentinel Node): A palpable, left supraclavicular lymph node; often first sign of a GI neoplasm, such as pancreatic or gastric carcinoma

von Graefe's Sign: Lid lag associated with thyrotoxicosis

Weber–Rinne Test: For the Weber test a 512- or 1024-Hz tuning fork is placed on the middle of the skull to determine if the sound lateralizes. For the Rinne test, the tuning fork is held against the mastoid process (BC) with the opposite ear covered. The patient indicates when the sound is gone. The tuning fork is then held next to the ear and the patient indicates whether the sound is present and when the sound (AC) disappears. Normally AC is better than BC. With sensorineural hearing loss, the Weber test lateralizes to the less affected ear and AC > BC; with conduction hearing loss, the Weber test lateralizes to the more affected ear and BC > AC.

Whipple's Triad: Hypoglycemia, CNS, and vasomotor symptoms (ie, diaphoresis, syncope); relief of symptoms with glucose; associated with insulinoma

EXAMPLE OF A WRITTEN HISTORY AND PHYSICAL EXAMINATION

(Adult Admitted to a Medical Service)

7/10/01 5:30 PM

Identification: Mr. Robert Jones is a 50-year-old male referred by Dr. Harry Doyle from Whitesburg, Kentucky. The informant is the patient, who seems reliable, and a photocopy of the ER records from Whitesburg Hospital accompanies the patient.

Chief Complaint: "Squeezing chest pain for 10 h, 4 d ago"

HPI: Mr. Jones awoke at 6 AM 3 d ago with squeezing substernal chest pain that felt "like a ton of bricks" sitting on his chest. The chest pain was a 9 on a 10-point scale, with 10 being pain from a kidney stone. The pain was progressively worse after its onset and decreased in intensity after going to the Whitesburg ER. The pain radiated to his left neck and elbow and was associated with dyspnea and diaphoresis. He denies experiencing any associated nausea. He notes the pain seemed to get worse with any movement, and nothing seemed to alleviate it.

He presented to the Whitesburg ER 10 h after the onset of pain and was given 3 NTG tablets SL and 2 mg morphine sulfate. ECG revealed 3 mm ST depression in leads V_1 through V_4 . He was admitted to the ICU at Whitesburg Hospital and had an uneventful course. CPK increased to 850 at 24 h. He has been on aspirin 325 mg/d PO, isosorbide dinitrate 20 mg PO q6h, and diltiazem 60 mg PO q8h. He was transferred for possible cardiac catheterization.

He notes a similar chest pain that was less intense and occurred intermittently over the last 3 mo. The pain was precipitated by exercise and relieved with rest. He denies seeking medical attention in the past. He denies a history of orthopnea, paroxysmal nocturnal dyspnea, dyspnea on exertion, or pedal edema.

He has smoked two packs of cigarettes per day for 35 years, notes a 2-y history of hypertension for which he has been taking HCTZ 25 mg/d and denies a history of hypercholesterolemia or diabetes.

The patient's father died of an MI at age 54, and his brother underwent coronary artery bypass graft surgery last year at age 48.

PMH

Medications. As above and ranitidine 300 mg PO qhs. Occasional ibuprofen 200 mg two to three tablets PO for back pain and acetaminophen 500 mg PO for headache

Vitamins. One-a-day

Herbals. None

Allergies. Penicillin, rash entire body 20 years of age

Surgeries. Appendectomy age 20, Dr. Smith, Whitesburg

Hospitalization. See above.

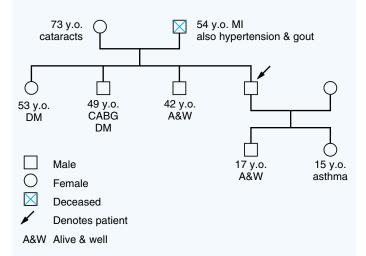
Trauma. Roof fall in mine accident 10 years ago, injured back. Notes occasional pain, which is relieved with ibuprofen 200 mg two or three tablets at a time

Transfusions. None

Illnesses. Denies asthma, emphysema, thyroid disease, kidney disease, peptic ulcer disease, cancer, bleeding disorders, tuberculosis, or hepatitis. He notes a several-year history of water brash/heartburn and has been on ranitidine for 1 year

Routine Health Maintenance. Last diphtheria/tetanus immunization 3 years ago. Stools for guaiac were negative times 3. Refused sigmoidoscopy. He has been seen by Dr. Doyle every 3–4 months for the last 2 years for hypertension.

Family History



Psychosocial History: Mr. Jones has been married for 25 years and has three children. He and his family live in a home on 3 acres about three miles from Whitesburg. He worked in a coal mine until 10 years ago when he was injured in a "roof fall." He is currently employed in a local chair factory. He graduated from high school. He is Baptist and attends church regularly. Hobbies include woodworking and gardening. He eats breakfast and supper every day and has a soft drink and crackers for lunch. He currently works 8 h/d Monday through Friday. He notes going to bed every day by 10:00 PM and awakens at 5:30 AM. He drinks one to two cups of coffee per day and denies drinking any alcohol. He denies drug use but smokes as noted earlier. He denies exposure to environmental toxins. He denies any financial problems but is concerned about how his illness will affect his income. He has "good" health insurance. He denies any other stressor in his life. His sources of support are his wife, minister, and a sister who lives near the patient.

ROS: Negative unless otherwise noted.

Eyes. Has worn reading glasses since 1995; notes blurred vision for 1 year; last eye appointment 1996. Denies loss of vision, double vision, or history of cataracts.

Respiratory. Notes cough every morning and has produced 1 teaspoon of gray sputum for years. Denies hemoptysis or pleuritic chest pain. Last chest x-ray prior to today was 3 years ago. All other ROS negative.

General: Mr. Jones is a pleasant male lying comfortably supine in bed. He appears to be the stated age.

Vital Signs: Temp 98.6°F orally. Resp 16, HR 88 and regular, BP 110/70 left arm supine *Skin:* Tattoo left arm, otherwise no lesions

 $\textit{Node: } 1 \times 1$ left axillary node, nontender and mobile. No other lymphadenopathy HEENT

Head. Normocephalic, atraumatic, nontender, no lesions

Eyes. Visual acuity 20/40 left and right corrected. External structures normal, without lesions, PERRLA. EOM intact. Visual fields intact. Funduscopic examination disks sharp bilaterally, moderate arteriolar narrowing and A-V nicking.

Ears. Hearing intact to watch tick at 3 ft bilaterally. Tympanic membranes intact with good cone of light bilaterally

Nose. Symmetrical. No lesions. Sinuses nontender

Mouth. Several dental fillings, otherwise normal dentition. No lesions

Neck. Full ROM without tenderness. No masses or lymphadenopathy. Carotids +2/4 bilaterally, no bruits. Internal jugular vein visible 2 cm above the sternal angle, patient at 30 degrees.

Chest: Symmetrical expansion. Fremitus by palpation bilaterally equal. Diaphragm moves 5.5 cm bilaterally by percussion. Lung fields clear to percussion. Breath sounds normal except end-inspiratory crackles heard at both bases that do not clear with coughing.

Breast: Normal to inspection and palpation

Heart: No cardiac impulse visible. Apical impulse palpable at the sixth intercostal space 2 cm lateral to the midclavicular line. Normal S₁, physiologically split S₂. S₄ heard at apex. No murmurs, rub, or S₃.

Abdomen: Flat, no scars. Positive bowel sounds. No bruits. Liver 10 cm midclavicular line. No CVA tenderness. No hepatomegaly or splenomegaly by palpation. No tenderness or guarding. No inguinal lymphadenopathy

Genital: Normal circumcised male, both testes descended without masses or tenderness Rectal: Normal sphincter tone. No external lesions. Prostate smooth without tenderness or nodules. No palpable masses. Stool present, stool for occult blood negative

Musculoskeletal: Lumbar spine decreased flexion to 75 degrees, extension to 5 degrees, decreased rotary and lateral movement. Otherwise full ROM of all joints, no erythema, tenderness, or swelling. No clubbing cyanosis or edema

Peripheral Vascular: Radial, ulnar, brachial, femoral, dorsalis pedis, and posterior tibial pulses +2/4 bilaterally. Popliteal pulses nonpalpable. No femoral bruits

Neurologic: Cranial nerves: I through XII intact. Motor: +5/5 upper and lower extremity, proximally and distally. Sensory intact to pinprick upper and lower extremities proximally and distally. Vibratory sense intact in great toes and thumbs bilaterally. Stereognosis intact

Reflexes. Biceps, triceps, brachioradialis, quadriceps, and ankles +2/4 bilaterally. Toes down going bilaterally

Cerebellum. Romberg's sign negative. Intact finger-to-nose and heel-to-shin bilaterally; gait normal—normal heel-and-heel, toe-and-toe, and heel-to-toe gaits. Rapid alternating movements intact upper and lower extremities bilaterally

DATABASE

ECG. HR 80, NSR inverted T waves V1 through V5

CXR. Cardiomegaly, otherwise clear

UA. Normal

Chemistry Profile. Normal. Except elevated CPK

CBC. 6700 WBC; 49 Hct; HBG 16; 40 S, 5 B, 44 L, 5 M, 6 E

ASSESSMENT AND PLAN

Coronary Artery Disease: Mr. Jones presented with a classic history for MI. The CPK and electrocardiogram support the diagnosis. The ST depression without evolving Q waves was consistent with a nontransmural MI. Mr. Jones is at risk for further MI since it was a nontransmural MI, and he will require further evaluation before discharge.

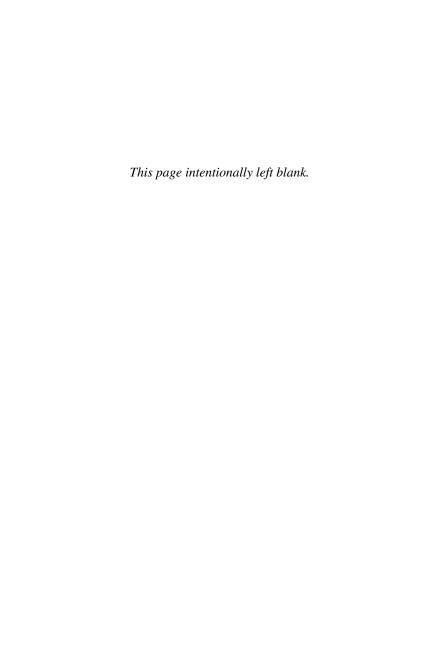
- Continue aspirin 325 mg/d PO and diltiazem 60 mg/d PO.
- · Change isosorbide to tid prior to discharge.
- Monitor by telemetry unit for next 24-48 h.
- · Stress test by modified Bruce protocol prior to discharge.
- Consider cardiac catheterization especially if any further pain or if an early positive stress test.
- · Continue cardiac rehabilitation.

Hypertension: In view of the patient's age, sex, and degree of hypertension, and the fact that there is no evidence of a secondary cause, the hypertension is most likely primary in nature. It is important that blood pressure be well controlled after this infarct. Mr. Jones' blood pressure has been well controlled on diltiazem alone.

- Continue diltiazem.
- Dietary consult to instruct patient on low-sodium as well as low-fat diet prior to discharge.
- · Continue discussion of other problems as shown earlier.

Signature:	
Title:	

Date Entered	Date of Onset	Problem	Active	Inactive	Date Inactive
<i>7</i> -10-01	4-01	1	Coronary artery	ŀ	
<i>7</i> -10-01	<i>7-7-</i> 01	la	Subendocardial MI—anterior	disease	
<i>7</i> -10-01	1998	2	Hypertension		
<i>7</i> -10-01	1997	3	Bronchitis		
<i>7</i> -10-01	1999	4	Heartburn/reflux esophagitis		
<i>7</i> -10-01	1990	5	Back injury		
<i>7</i> -10-01	<i>7</i> -10-01	6	Eosinophilia		
<i>7</i> -10-01	2000	7	Blurred vision		
<i>7</i> -10-01	1970	8		Appendicitis	1970



CHARTWORK

How to Write Orders Problem-Oriented Progress Note Discharge Summary/Note On-Service Note Off-Service Note

Bedside Procedure Note

Preoperative Note
Operative Note
Night of Surgery Note (Postop Note)
Delivery Note
Outpatient Prescription Writing
Shorthand for Laboratory Values

HOW TO WRITE ORDERS

The following format is useful for writing concise admission, transfer, and postoperative orders. It involves the mnemonic "A.D.C. VAAN DIML," which stands for Admit/Attending, Diagnosis, Condition, Vitals, Activity, Allergies, Nursing procedures, Diet, Ins and outs, Medications, and Labs.

A.D.C. Vaan Diml

Admit: Admitting team, room number

Attending: The name of the attending physician, the person legally responsible for the patient's care. Also include the resident's and intern's names.

Diagnosis: List admitting diagnosis or procedure if postop orders.

Condition: Stable, critical, etc

Vitals: Determine frequency of vital signs (temperature, pulse, blood pressure, central venous pressure, pulmonary capillary wedge pressure, weight, etc)

Activity: Specify bedrest, up ad lib, ambulate qid, bathroom privileges, etc **Allergies:** Note any drug reactions or food or environmental allergies.

Nursing Procedures

Bed Position. Elevate head of bed 30 degrees, etc

Preps. Enemas, scrubs, showers

Respiratory Care. P&PD. TC&DB, etc

Dressing Changes, Wound Care. Change dressing bid, etc

Notify House Officer If. Temperature >101°F, BP <90 mm Hg, etc

Diet: NPO, clear liquid, regular, etc

Ins and Outs: Refers to all "tubes" a patient may have.

Record Daily I&O.

IV Fluids. Specify type and rate.

Drains. NG to low wall suction, Foley to gravity, etc

Endotracheal Tubes, Arterial Lines, Pulmonary-Artery Catheters. Specify care desired.

Medications: Write orders for specific medications (eg, diuretic, antibiotics, hormones, etc) and symptomatic drugs as needed (eg, pain medications, laxatives, "sleepers"). Include dose frequency and special instructions, ie, take with food.

Labs: Indicate studies and specify times desired if applicable. This includes ECGs, x-rays, nuclear scans, consultation requests, etc.

PROBLEM-ORIENTED PROGRESS NOTE

(See Chapter 20 for a sample ICU progress note.)

- List each medical, surgical, psychiatric problem separately: pneumonia, pancreatitis, congestive heart failure, etc.
- 2. Give each problem a call number: 1, 2, 3, ... (as on page 31).
- 3. Retain the number of each problem throughout the hospitalization.
- When the problem is resolved, mark it as such and delete it from the daily progress note.
- Evaluate each problem by number in the following SOAP format. Or, you may do a separate assessment and plan for each problem

Soap

Subjective

How the patient feels, any complaints

Objective

- · How the patient looks
- · Vital signs
- · Physical examination
- · Laboratory data, etc

Assessment: (for each problem)

· Evaluation of the data and any conclusions that can be drawn

Plan: (for each problem)

- · Any new lab tests or medications
- · Changes or additions to orders
- Discharge or transfer plans

DISCHARGE SUMMARY/NOTE

A formal discharge note is usually required for any admission that is longer than 24 h at most hospitals. This note provides a framework for the complete dictated note as well as providing a reference, if needed, before the dictated note is transcribed and filed. The following skeleton includes most of the information needed for a discharge note.

Date of Admission:

Date of Discharge:

Admitting Diagnosis:

Discharge Diagnosis:

Attending Physician and Service Caring for Patient:

Referring Physician: Provide address if available.

Procedures: Include surgery and any invasive diagnostic procedures, eg, lumbar punctures, arteriograms.

Brief History, Pertinent Physical and Lab Data: Briefly review the main points of the history, physical, and admission lab tests. Do not repeat what is available in the admission note; summarize the most important points about the patient's admission.

Hospital Course: Briefly summarize the evaluation, treatment, and progress of the patient during the hospitalization.

Condition at Discharge: Note if improved, unchanged, etc.

Disposition: Where was the patient discharged to (eg, home, another hospital, nursing home)? Try to give specific address if transferred to another medical institution, and note who will be assuming responsibility for the patient.

Discharge Medications: List medications, dosing, refills.

Discharge Instructions and Follow-up: Clinic return date, diet instructions, activity restrictions, etc

Problem List: List active and past medical problems.

ON-SERVICE NOTE

Also known as a "pick-up note," the on-service note is written by a new member of the team taking over the care of a patient who has been on the service for some time. The note should be brief and summarize the hospital course to date as well as demonstrate that the new team member has reviewed the patient's care to date. The following skeleton includes most of the information needed in an on-service note.

Date of Admission:

Admitting Diagnosis:

Procedures (with Results) to Date:

Hospital Course to Date: This should be briefly summarized. **Brief Physical Examination:** Pertinent to the patient's problems.

Pertinent Lab Data: Problem List: Assessment:

Plan:

OFF-SERVICE NOTE

This is written by the team member who is rotating off the service but who was primarily responsible for the patient before the patient is ready for discharge. The components are identical to the "On-Service" note in the previous section.

BEDSIDE PROCEDURE NOTE

Procedure: (eg, LP, thoracentesis, etc)

Indications: (eg, R/O meningitis, symptomatic pleural effusion)

Permit: Note risks and benefits explained and indicate signed and on chart

Physicians: Note physicians present and responsible for procedure

Description of Procedure: Indicate type of positioning, prep, anesthesia, and amount. Briefly describe technique and instruments used.

Complications: List.

EBL: List.

Specimens/Findings Obtained: (eg, opening pressure for LP, CSF appearance, and tubes sent to lab, etc)

Disposition: Describe patient's status after procedure (eg, Patient alert and oriented with no complaints; BP stable)

PREOPERATIVE NOTE

The specific items in the preoperative note depend on institutional guidelines, the nature of the procedure, and the age and health of the patient. For example, an ECG and blood set-up may not be necessary for a 2-year-old child being treated for a hernia but essential for a 70-year-old scheduled for vascular surgery. The following list includes most of the information needed in a preoperative note.

Preop Diagnosis: Such as "acute appendicitis"

Procedure: The planned procedure, eg, "exploratory laparotomy" Labs: Results of CBC, electrolytes, PT, PTT, urinalysis, etc

CXR: Note results ECG: Note results.

Blood: T&C 2 units PRBC, blood not needed, etc History and Physical: Should be "on chart."

Orders: Note any special preop orders, such as preop colon preps, vaginal douches, prophylactic antibiotics.

Permit: If completed, write "signed and on chart"; if not, indicate plans for obtaining permit.

OPERATIVE NOTE

The operative note is written immediately after surgery to summarize the operation for those who were not present and is meant to complement the formal operative summary dictated by the surgeon. The following list includes most of what is needed in an operative note.

Preop Diagnosis: Reason for the surgery, eg, "acute appendicitis"

Procedure: Surgery performed, eg, "exploratory laparotomy"

Postop Diagnosis: Based on the operative findings, eg, "mesenteric lymphadenitis"

Surgeons: List the attending physicians, residents, and students who scrubbed on the case, including their titles (MD, CCIV, MSII, etc). It is often helpful to identify the dictating surgeon.

Findings: Briefly note operative findings, eg, "normal appendix with marked lymphadenopathy."

Anesthesia: Specify the type of anesthesia, eg, local, spinal, general, endotracheal, etc.

Fluids: Amount and type of fluid administered during case, eg, 1500 mL NS, 1 unit PRBC, 500 mL albumin. This is usually obtained from the anesthesia records.

EBL: Usually obtained from the anesthesia or nursing records.

Drains: State location and type of drain, eg, "Jackson-Pratt drain in left upper quadrant," "T-tube in midline," etc.

Specimens: State any samples sent to pathology and the results of examination of any intraoperative frozen sections.

Complications: Note any complications during or after the surgery.

Condition: Note where the patient is taken immediately after surgery and the patient's condition. Example: "Transferred to the recovery room in stable condition."

NIGHT OF SURGERY NOTE (POSTOP NOTE)

This type of progress note is written several hours after or the night of surgery.

Procedure: Indicate the operation performed.

Level of Consciousness: Note if the patient is alert, drowsy, etc.

2 Chartwork 37

Vital Signs: BP, pulse, respiration.

I&O: Calculate amount of IV fluids, blood, urine output, and other drainage, and attempt to assess fluid balance.

Physical Examination: Examine and note the findings of the chest, heart, abdomen, extremities, and any other part of the physical examination pertinent to the surgery; examine the dressing for bleeding.

Labs: Review lab results if any were obtained since surgery. **Assessment:** Evaluate the postop course thus far (stable, etc).

Plan: Note any changes in orders.

DELIVERY NOTE

- EBL:
- MBT:
- HCT (predelivery and postdelivery):
- RT-
- VDRL test:
- · Condition of mother:

OUTPATIENT PRESCRIPTION WRITING

The format for outpatient prescription writing is outlined in the following list and illustrated in Figure 2–1. Controlled substances, such as narcotics, require a DEA number on the prescription and in some states may require that the controlled substance be written on a special type of prescription paper (see Chapter 22 for controlled drugs indicated by a [C]). For security, the DEA number should never be preprinted on a prescription pad but written by hand at the time the prescription is written.

Elements of an outpatient prescription include:

Patient's Name, Address, and Age: Print clearly where indicated.

Date: State requirements vary, but most prescriptions must be filled within 6 months.

Rx: Drug name, strength, and type (usually listed as the generic name); if you specifically want a brand name you must designate "no substitution." Rx is an abbreviation from the Latin for "recipe." List the strength of the product (usually in mg) and the form (eg, tablets, capsule, suspension, transdermal, etc).

Dispense: Amount of drug (number of capsules), or time period (1 month supply, etc).

Sig: Short for the Latin "signa," which means "mark through" on patient instructions. This part can be written out or noted in shorthand. Shorthand use is generally discouraged, however, because writing out the prescription decreases the likelihood of errors. Frequently used abbreviations are noted here with a more complete listing provided at the front of the book

bid = twice a day tid = three times a day q6h = every 6 h

NICK PAVONA, MD BENJAMIN FRANKLIN UNIVERSITY MEDICAL CENTER CHADDS FORD, PA 19317			
LICENSE PA MD 685-488-194	DEA NP-3612982		
NAME NICK PAVONA, Sr.	AGE 84		
ADDRESS 34-10 75 th Street	DATE 10/24/2001		
Wilmington, DE	_		
Rx: minoxidil (Rogaine) 2% to DISP: 60 mL SIG: Apply BID to scalp Brand medically necessary	•		
REFILL X5			
SUBSTITUTION PERMISSIBLE	Nick Pavona M.D.		
TO ENSURE BRAND NAME DISPENSING, PRESCRIBER MUST SPECIFY "DISPENSE AS WRITTEN" ON THE PRESCRIPTION.*			

FIGURE 2-1 Example of an outpatient prescription. As a safety feature DEA numbers should **never** be preprinted on a prescription form. The "Dispense as Written" statement can vary by state requirements; this statement requests that the pharmacist fill the prescription as requested and not substitute a generic equivalent.

```
ad lib = freely at pleasure
PO = by mouth
PR = by rectum
OS = left eye
OD = right eye
qd = daily (this is a dangerous abbreviation and should not be used; see "Dangerous Practices," page 39)
PRN = as needed
T = one
T = two
T = three
qhs = every night at bedtime
```

^{*}This can vary by state; some require that you write "Brand Medically Necessary" to specify a brand name and not a generic.

qid = four times a day. (Note that qid and q6h are NOT the same orders: qid means that the medication is given four times a day while awake (eg, 8 AM, 12 noon, 6 PM, and 10 PM); q6h means that the medication is given four times a day but by the clock (eg, 6 AM, 12 noon, 6 PM, 12 midnight).

Refills: Indicate how many times this prescription can be refilled.

Substitution: Can a generic drug be used instead of the one prescribed?

Tips for Safe Prescription Writing

Legibility

- 1. Take time to write legibly.
- 2. Print if this would be more legible than handwriting.
- Use a typewriter or computer if necessary. In the near future, physicians will generate all prescriptions by computer to eliminate legibility problems.
- When prescribing a new or rarely used drug, carefully print the order to avoid misreading.

Dangerous Practices

1. NEVER use a trailing zero.

Correct: 1 mg

Dangerous: 1.0 mg. If the decimal is not seen, a 10-fold overdose can occur.

2. NEVER leave a decimal point "naked."

Correct: 0.5 mL

Dangerous: .5 mL. If the decimal point is not seen, a 10-fold overdose can occur.

- NEVER abbreviate a drug name because the abbreviation may be misunderstood or have multiple meanings.
- 4. NEVER abbreviate U for units as it can easily be read as a zero, thus "6 U regular insulin" can be misread as 60 units. The order should be written as "6 units regular insulin."
- NEVER use qd (abbreviation for once a day). When poorly written, the tail of the "q" can make it read qid or four times a day.

SHORTHAND FOR LABORATORY VALUES

(See Figure 2-2)

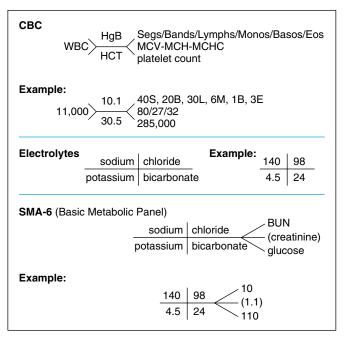


FIGURE 2-2 Shorthand notation for recording laboratory values. The basic metabolic panel is similar to the SMA-6 except that the creatinine is also listed.

DIFFERENTIAL DIAGNOSIS: SYMPTOMS, SIGNS, AND CONDITIONS

Abdominal Distention Abdominal Pain Adrenal Mass Alopecia Amenorrhea

Anorexia Anuria Arthritis Ascites Back Pain Breast Lump Chest Pain

Chills Clubbing Coma Constipation

Cough Cyanosis Delirium Dementia

Diarrhea Diplopia Dizziness Dysphagia Dyspnea Dysuria Farache

Edema **Epistaxis** Failure to Thrive

Fever of Unknown Origin (FUO)

Flatulence

Frequency Galactorrhea Gynecomastia Headache Heartburn (Pyrosis) Hematemesis and Melena

Hematochezia Hematuria Hemoptysis Hepatomegaly Hiccups (Singultus)

Hirsutism

Impotence (Erectile Dysfunction)

Incontinence (Urinary)

Jaundice

Lymphadenopathy and Splenomegaly

Melena

Nausea and Vomiting Nystagmus Oliguria and Anuria

Pleural Effusion Pruritus Seizures Splenomegaly Syncope Tremors

Vaginal Bleeding Vaginal Discharge

Vertigo Vomiting Weight Loss Wheezing

This chapter provides a general guide to commonly encountered symptoms and conditions and their frequent causes. Remember: "There are more uncommon presentations of common diseases than common presentations of uncommon diseases."

ABDOMINAL DISTENTION

Ascites, intestinal obstruction, cysts (ovarian or renal), tumors, hepatosplenomegaly, aortic aneurysm, uterine enlargement (pregnancy), bladder distention, inflammatory mass

ABDOMINAL PAIN

Diffuse: Intestinal angina, early appendicitis, colitis, diabetic ketoacidosis, hereditary angioedema, gastroenteritis, mesenteric thrombosis, mesenteric lymphadenitis, peritonitis, porphyria, sickle cell crisis, uremia, renal colic, renal infarct, pancreatitis

Right Upper Quadrant: Dissecting aneurysm, gallbladder disease (cholecystitis, cholangitis, choledocholithiasis), hepatitis, hepatomegaly, pancreatitis, peptic ulcer disease, pneumonia, PE, pyelonephritis, renal colic, renal infarct, appendicitis (retroperitoneal)

Left Upper Quadrant: Dissecting aneurysm, esophagitis, hiatal hernia, esophageal rupture, gastritis, pancreatitis, peptic ulcer disease, MI, pericarditis, pneumonia, PE, pyelonephritis, renal colic, renal infarct, splenic rupture or infarction

Lower Abdomen: Aortic aneurysm, colitis, diverticulitis including Meckel's, intestinal obstruction, hernias, perforated viscus, pregnancy, ectopic pregnancy, dysmenorrhea, endometriosis, mittelschmerz (ovulation), ovarian cyst or tumor (especially with torsion), PID, renal colic, UTI, rectal hematoma, bladder distention.

Right Lower Quadrant Specific: Appendicitis, ectopic pregnancy, ovarian cyst or tumor, salpingitis, mittelschmerz, cholecystitis, perforated duodenal ulcer, Crohn's disease

ADRENAL MASS

Adrenal adenoma, adrenal hyperplasia (unilateral or bilateral), adrenal metastasis (solid tumors, lymphoma, leukemia), adrenocortical carcinoma, pheochromocytoma, adrenal myelolipoma, adrenal cyst, Wolman's disease, adrenal varices, hemorrhage, congenital adrenal hyperplasia, ganglioneuroma, micronodular adrenal disease

ALOPECIA

Male pattern baldness (alopecia, androgenic type in both men and women), trauma and hair pulling, congenital, tinea capitis, bacterial folliculitis, telogen arrest, anagen arrest (chemotherapy/radiation therapy), alopecia areata, discoid lupus

AMENORRHEA

Pregnancy, menopause (physiologic or premature), severe illness, weight loss, stress, athletic training, "physiologically delayed puberty," anatomic (imperforate hymen, uterine agenesis, etc.), gonadal dysgenesis (Turner's syndrome, etc.), hypothalamic and pituitary tumors, virilizing syndromes (polycystic ovaries, idiopathic hirsutism, etc.). Amenorrhea is categorized as primary (never had menses) or secondary (cessation of menses).

ANOREXIA

Hepatitis, carcinoma (most types, especially advanced), anorexia nervosa, generalized debilitating diseases, digitalis toxicity, uremia, depression, CHF, pulmonary failure, radiation exposure, chemotherapy

ANURIA

See Oliguria, page 49

ARTHRITIS

Osteoarthritis, bursitis, tendonitis, connective tissue disease (RA, SLE, rheumatic fever, scleroderma, gout, pseudogout, rheumatoid variants [ankylosing spondylitis, psoriatic arthritis, Reiter's syndrome]), infection (bacterial, viral, TB, fungal Lyme disease), trauma, sarcoidosis, sickle cell anemia, hemochromatosis, amyloidosis, coagulopathy

ASCITES

(See Chapter 13, page 296, under "Peritoneal Paracentesis" for more details.) CHF, tricuspid insufficiency, constrictive pericarditis, venous occlusion (including Budd–Chiari syndrome), cirrhosis, pancreatitis, peritonitis (ruptured viscus, TB, bile leak, spontaneous bacterial), tumors (most common ovarian, gastric, uterine, unknown primary, breast, lymphoma), trauma, Meigs' syndrome (ovarian fibroma associated with hydrothorax and ascites), myxedema, anasarca (hypoalbuminemia)

BACK PAIN

Herniated disk, spinal stenosis, ankylosing spondylitis, metastatic tumor, multiple myeloma, mechanical back sprain, referred pain (visceral, vascular), vertebral body fracture, osteo-porosis induced fracture, infectious processes (diskitis, osteomyelitis, epidural abscess

BREAST LUMP

Cancer, fibroadenoma, fibrocystic breast disease, fat necrosis, gynecomastia (males, alcoholics)

CHEST PAIN

Deep, Dull, Poorly Localized: Angina, variant angina, unstable angina, AMI, aortic aneurysm, PE, tumor, gallbladder disease, pulmonary hypertension

Sharp, Well Localized: PE, pneumothorax, epidemic pleurodynia, pericarditis, atypical MI, hyperventilation, hiatal hernia, esophagitis, esophageal spasm, herpes zoster, aortic aneurysm, breast lesions, variety of bony and soft tissue abnormalities (rib fractures, costochondritis, muscle damage), perforated ulcer, acute cholecystitis, pancreatitis

CHILLS

Infection (bacterial with bacteremia, viral, TB, fungal), neoplasm (Hodgkin's disease), drug and transfusion reactions, hypothermia, malaria

CLUBBING

Pulmonary causes (bronchiectasis, lung abscesses, tuberculosis, neoplasms, fibrosis), AV malformations, cardiac (congenital cyanotic heart diseases, bacterial endocarditis), GI (ulcerative and regional enteritis, cirrhosis), hereditary, thyrotoxicosis

B

COMA

Use the mnemonic **AEIOU TIPS:** Alcohol; Encephalitis (other CNS causes—epilepsy, hemorrhage, mass), Insulin (hypoglycemia, hyperglycemia), **Op**iates (drugs), Uremia (and other metabolic conditions, such as hypernatremia, hyponatremia, hypercalcemia, hepatic failure, and thiamine deficiency), Trauma, Infection, **Ps**ychiatric causes, **Syncope** (or decreased cardiac output such as from arrhythmias).

CONSTIPATION

Dehydration, lack of exercise, bedrest, medications (narcotics, anticholinergics, antidepressants, calcium channel blockers—verapamil, diuretics, clonidine, aluminum—or calcium-containing antacids), laxative abuse, megacolon, spastic colon, chronic suppression of the urge to defecate, fecal impaction (often with paradoxical diarrhea), neoplasm, intestinal obstruction, vascular occlusion to the bowel, inflammatory lesions (diverticulitis, proctitis), hemorrhoids, anal fissures, neurological disorders, depression, porphyria, hypothyroidism, hypercalcemia

COUGH

Acute: Tracheobronchitis, pneumonia, sinusitis, pulmonary edema, foreign body, toxic inhalation, allergy, pharyngitis (viral or bacterial), asthma, GERD ACE inhibitors, impacted cerumen or foreign body in ear

Chronic: Bronchitis (smoker), chronic sinusitis, emphysema, cancer (bronchogenic, head and neck, and esophageal), TB, sarcoidosis, fungal infection, bronchiectasis, mediastinal lymphadenopathy, thoracic aneurysm, GERD, ACE inhibitors

CYANOSIS

Peripheral: Arterial occlusion and insufficiency, vasospasm/Raynaud's disease, venous stasis, venous obstruction

Central: Hypoxia, congenital heart disease (right to left shunt), PE, pseudo-cyanosis (eg, polycythemia vera), methemoglobinemia

DELIRIUM

Metabolic: Hypoglycemia, hypoxia, sodium and calcium disorders, hypercarbia, uremia

Neurologic: Stroke, subdural and epidural hematoma, subarachnoid hemorrhage, postictal, concussion and contusion, meningitis, encephalitis, brain tumor

Drug or Toxin-Induced: Lithium intoxication, ethanol, steroids, anticholinergics, sympathomimetics, poisons (eg, mushrooms, carbon monoxide), drugs of abuse

DEMENTIA

Chronic CNS disease: Alzheimer's, senile dementia, Pick's disease, Parkinson's, chronic demyelinating disease (MS), ALS, brain tumor, normal pressure hydrocephalus, Wilson's disease, Huntington's disease, lipid storage diseases (eg, Tay–Sachs)

Metabolic: Usually chronic (hypoxia, hypoglycemia, hypocalcemia), hyperammonemia, dialysis, heavy-metal intoxication, pernicious anemia (B_{12} deficiency), niacin and thiamine

deficiency (usually chronic alcoholic) posthepatic coma, medications (barbiturates, phenothiazines, lithium, benzodiazepines, many others)

Infectious: AIDS encephalopathy, brain abscess, chronic meningoencephalitis (eg, fungal neurosyphilis), encephalitis, Jakob-Creutzfeldt disease

Vascular: Vasculitis, multicerebral/cerebellar infarcts

Traumatic: Contusion, hemorrhage, subdural hematoma

Psychiatric: Sensory deprivation, depression (pseudodementia)

DIARRHEA

Acute: Infections (bacterial, viral, fungal, protozoan, parasitic), toxic (food poisoning, chemical), drugs (antibiotics, cholinergic agents, lactulose, magnesium-containing antacids, quinidine, reserpine, guanethidine, metoclopramide, bethanechol), appendicitis, diverticular disease, GI bleeding, ischemic colitis, food intolerance, fecal impaction (paradoxical diarrhea), pseudomembranous colitis

Chronic: After gastrectomy or vagotomy, ZE syndrome, regional enteritis, ulcerative colitis, malabsorption, diverticular disease, carcinoma, villous adenoma, gastrinomas, lymphoma of the bowel, functional bowel disorders (irritable colon, mucous colitis), pseudomembranous colitis, endocrine disease (carcinoid, hyperthyroidism, Addison's disease), radiation enteritis, drugs, Whipple's disease, amyloidosis, AIDS

DIPLOPIA

Problems with the third, fourth, or sixth cranial nerve, such as from vascular disturbances, meningitis, tumor, demyelination, orbital blow-out fracture, hyperthyroid ocular myopathy

DIZZINESS

Hyperventilation, depression, hypoglycemia, anemia, volume depletion, hypoxia, trauma, Ménière's disease, benign positional vertigo, aminoglycoside toxicity, vestibular neuronitis, MS, brain stem ischemia or stroke, posterior fossa lesions, cerebellar ischemia or stroke, arrhythmias, aortic stenosis, carotid sinus hypersensitivity

DYSPHAGIA

Loss of tongue function, pharyngeal dysfunction (myasthenia gravis), Zenker's diverticulum, tumors (bronchogenic, head and neck, and esophageal), stricture, esophageal web, Schatzki's ring, lower esophageal sphincter spasm, foreign body, aortic aneurysm, achalasia, scleroderma, diabetic neuropathy, amyloidosis, infection (especially candidiasis), dermatomyositis, polymyositis, MS, brain stem infarctions

DYSPNEA

Laryngeal and tracheal infections and foreign bodies, tumors (both intrinsic and extrinsic), COPD, asthma, pneumonia, lung carcinoma, atelectasis, pneumothorax, pleural effusion, hemothorax, PE, pulmonary infarction, carbon monoxide poisoning, any cause of pain from respiratory movements, cardiac and noncardiac pulmonary edema, AMI, pericardial tamponade, anemia, abdominal distention, anxiety

DYSURIA

Urethral stricture, stones, blood clot, tumor (bladder, prostate, urethral), prostatic enlargement, infection (urethritis, cystitis, vaginitis, prostatitis), trauma, bladder spasm, dehydration

EARACHE

Otitis media and externa, mastoiditis, serous otitis, otic barotrauma, foreign body, impacted cerumen. referred pain (dental or TMJ)

EDEMA

CHF, constrictive pericarditis, liver disease (cirrhosis), nephrotic syndrome, nephritic syndrome, hypoalbuminemia, malnutrition, myxedema, hemiplegia, volume overload, thrombophlebitis, lymphatic obstruction, medications (nifedipine), venous stasis

EPISTAXIS

Trauma (nose picking, blunt trauma), neoplasm, polyps, foreign body, desiccation, coagulopathy, medications (use of cocaine, nasal sprays), infections (sinusitis), uremia, hypertension (more often a result rather than a cause of epistasis)

FAILURE TO THRIVE

Environmental: Social deprivation, decreased food intake

Organic: CNS disorder, intestinal malabsorption, CF, parasites, cleft palate, heart failure, endocrine diseases, hypercalcemia, Turner's syndrome, renal disease, chronic infection, malignancies

FEVER

Based on adult population studies an AM temperature above $98.8^{\circ}F$ (37.2°C) or PM above $99.9^{\circ}F$ (37.7°C) is generally defined as a fever. Rectal temperatures are generally $1^{\circ}F$ (0.6°C) higher and reflect core temperature

Infections (viral, bacterial, mycobacterial, fungal, parasitic), neoplasm (lymphoma, leukemia, renal and hepatic carcinoma), connective tissue disease (SLE, vasculitis, RA, adult Still's disease, temporal arteritis), heat stroke, malignant hyperthermia, thyroid storm, adrenal insufficiency, PE, MI, atrial myxoma, inflammatory bowel disease, factitious, drugs (most common offenders: amphotericin, bleomycin, barbiturates, cephalosporins, methyldopa, penicillins, phenytoin, procainamide, sulfonamides, quinidine, cocaine, LSD, phencyclidine and amphetamines)

FEVER OF UNKNOWN ORIGIN (FUO)

Defined as a temperature of 101°F (38.3°C) or greater for at least 3 weeks and for which a diagnosis is not established after 1 week of hospitalization. In children, the minimum duration is 2 weeks and the temperature is at least 101.3°F (38.5°C): TB, fungal infection, endocarditis, abscess (especially hepatic), neoplasm (lymphoma, renal cell, hepatoma, preleukemia), atrial myxoma, connective tissue disease, drugs (see Fever, previous listing), PE, Crohn's disease, ulcerative colitis, hypothalamic injury, factitious; in elderly, temporal arteritis

FLATULENCE

Aerophagia, food intolerance, disturbances in bowel motility (diabetes, uremia), lactose intolerance, gallbladder disease, peptic ulcer fiber, cholestyramine

FREQUENCY

Infection (bladder, prostate), excessive fluid intake, use of diuretics (also coffee, tea, or colas), diabetes mellitus, diabetes insipidus, prostatic obstruction, bladder stones, bladder tumors, pregnancy, psychogenic bladder syndrome, neurogenic bladder, interstitial cystitis

GALACTORRHEA

Hyperprolactinemia, prolonged breast feeding, major stress, pituitary tumors, breast lesions (benign, cancer, inflammatory), idiopathic with menses and after oral contraceptive use

GYNECOMASTIA

Normal (Physiologic): Newborn, adolescence, aging

Pathologic: Medications or drug use(cimetidine, spironolactone, estrogens, gonadotropins, antiandrogens, marijuana), decreased testosterone (Klinefelter's syndrome, testicular failure or absence), increased estrogen production (hermaphroditism, testicular or lung cancers, adrenal and liver diseases)

HEADACHE

Includes cluster, tension, and migraine (classic or simple), benign exertional, headache associated with sexual activity, benign cough headache, ice-pick (idiopathic stabbing), vascular (menstruation, hypertension), eye strain, acute glaucoma, sinusitis, dental problems, TMJ dysfunction, trauma, subarachnoid hemorrhage, intracranial mass, fever, meningitis, pseudo-tumor cerebri, trigeminal neuralgia, temporal arteritis (especially in elderly), hypoglycemia, toxin exposure (carbon monoxide poisoning), drugs (vasodilators—nifedipine [Procardia]), vasculitis

HEARTBURN (PYROSIS)

GERD, esophagitis, hiatal hernia, peptic ulcer, gallbladder disease, medications, tumors, scleroderma, food intolerance. Myocardial ischemia maybe mistaken for heartburn.

HEMATEMESIS AND MELENA

Melena generally means that the bleeding site is in the upper GI tract (ie, proximal to the ligament of Treitz), but occasionally can be as distal as the right colon.) Swallowed blood (eg, epistaxis), esophageal varices, esophagitis, Mallory-Weiss syndrome, hiatal hernia, gastritis, peptic ulcer, duodenitis, carcinoma of the stomach, tumors (both small and large bowel), ischemic colitis, aortoenteric fistula, bleeding diathesis, anticoagulation (may unmask GI tract pathology)

HEMATOCHEZIA

Massive upper GI bleeding, hemorrhoids, diverticular disease, angiodysplasia, polyps, carcinoma, inflammatory bowel disease, ischemic colitis

3

HEMATURIA (see also page 111)

First rule out false-positives: myoglobinuria, hemoglobinuria, porphyria. GU neoplasms (malignant and benign), polycystic kidneys, trauma, infection (urethral, bladder, prostate, etc), stones, glomerulonephritis, renal infarction, renal vein thrombosis, anticoagulation (may unmask GU tract pathology), bleeding diathesis, enterovesical fistula, sickle cell anemia, vigorous exercise ("runners' hematuria"), accelerated hypertension, factitious, and vaginal and rectal bleeding

HEMOPTYSIS

Infection (pneumonia, bronchitis, fungal, TB), bronchiectasis, cancer (usually bronchogenic), PE, arteriovenous malformations, Wegener's granulomatosis, Goodpasture's syndrome, SLE, pulmonary hemosiderosis, foreign body, trauma, bleeding diatheses, excessive anticoagulation (may unmask respiratory tract pathology), pulmonary edema, mitral stenosis

HEPATOMEGALY

CHF, hepatitis (viral, alcoholic, drug-induced, autoimmune), cirrhosis (alcoholic, etc), tumors (primary and metastatic), amyloid, biliary obstruction, hemochromatosis, chronic granulomatous disease, infections (schistosomiasis, liver abscess). Riedel's lobe is a normal variant, elongated right lobe of the liver with normal liver volume.

HICCUPS (SINGULTUS)

Uremia, electrolyte disorders, diabetes, medications (benzodiazepines, barbiturates, others), emotionally induced (excitement, fright), gastric distention, CNS disorders, psychogenic, thoracic and diaphragmatic disorders (pneumonia, MI, diaphragmatic irritation), alcohol ingestion

HIRSUTISM

Idiopathic, familial, adrenal causes (Cushing's disease, congenital adrenal hyperplasia, virilizing adenoma or carcinoma), polycystic ovaries, medications (minoxidil, androgens)

IMPOTENCE (ERECTILE DYSFUNCTION)

Psychogenic, vascular, neurologic (cord injury, radical prostatectomy, rectal surgery, aortic bypass), pelvic radiation, medications (some common drugs: antihypertensives, thiazide diuretics, beta-blockers, methyldopa; antidepressants especially the SSRIs, anticholinergics; addictive medications: alcohol, narcotics; antipsychotics; antiandrogens: histamine H₂ blockers, finasteride, LHRH analogues, spironolactone, others; history of priapism, Peyronie's disease, testicular failure, hyperprolactinemia

INCONTINENCE (URINARY)

Cystitis, dementia and delirium, stroke, prostatic hypertrophy, fecal impaction, peripheral or autonomic neuropathy, medications (diuretics, sedatives, alpha blockers), diabetes, spinal cord trauma or lesions, MS, childbirth, surgery (prostate, rectal), aging, acute and chronic medical conditions, estrogen deficiency

JAUNDICE

Hepatitis (alcoholic, viral, drug-induced, autoimmune), Gilbert's disease, Crigler-Najjar syndrome, Dubin-Johnson syndrome, Wilson's disease, drug-induced cholestasis (phenothiazines and estrogen), gallbladder and biliary tract disease (including inflammation, infection, obstruction, and tumors—primary hepatic and metastatic), hemolysis, neonatal jaundice, cholestatic jaundice of pregnancy, total parenteral nutrition

LYMPHADENOPATHY AND SPLENOMEGALY

Infection (bacterial, fungal, viral, parasitic), benign neoplasm (histiocytosis), malignant neoplasm (primary lymphoma, metastatic), sarcoid, connective tissue disease, drugs (phenytoin, etc), AIDS, splenomegaly without lymphadenopathy (cirrhosis, hereditary spherocytosis, hemoglobinopathies, ITP, hairy cell leukemia, and amyloidosis)

MELENA

(See Hematemesis, page 47.)

NAUSEA AND VOMITING

Appendicitis, acute cholecystitis, chronic gallbladder disease, peptic ulcer disease, gastritis (especially alcoholic), pancreatitis, gastric distention (diabetic atony, pyloric obstruction), intestinal obstruction, peritonitis, food intolerance, intestinal infection (bacterial, viral, parasitic), acute systemic infections (especially in children), hepatitis, toxins (food poisoning), CNS disorders ([increased intracranial pressure often cause vomiting without headache], tumor, hemorrhagic stroke, hydrocephalus, meningitis, labyrinthitis, Ménière's disease, migraine headaches) AMI, CHF, endocrine disorders (DKA, adrenal crisis), hypercalcemia, hyperkalemia, hypokalemia, pyelonephritis, nephrolithiasis, uremia, hepatic failure, pregnancy, PID, drugs (opiates, digitalis, chemotherapeutic agents, L-dopa, NSAIDs), psychogenic vomiting, porphyria, radiation therapy

NYSTAGMUS

Congenital, vision loss early in life, MS, neoplasms, infarction, toxic or metabolic encephalopathy, alcoholic cerebellar degeneration, medications (anticonvulsants, barbiturates, phenothiazines, lithium, others), encephalitis, vascular brainstem lesions, Arnold– Chiari malformation, nonpathologic (extreme lateral gaze), opticokinetic nystagmus (attempt to fix gaze on rapidly moving object, eg, train)

OLIGURIA AND ANURIA

(See also Urinary Indices, page 119.)

Oliguria is <500 mL urine/24 h; anuria is <100 mL urine/24 h in adults.

Prerenal: Volume depletion, shock, heart failure, fluids in the third space, renal artery compromise

Renal: Glomerular disease, acute tubular necrosis, bilateral cortical necrosis, interstitial disease (acute and chronic interstitial nephritis, urate or hypercalcemic nephropathy), trans-

fusion reaction, myoglobulinuria, radiographic contrast media (especially in diabetics, dehydration, multiple myeloma and elderly), ESRD, drugs (aminoglycosides, amphotericin B, vancomycin, NSAIDs, cephalosporins, penicillins, and sulfonamides), emboli, thrombosis, and DIC

Postrenal: Bilateral ureteral obstruction, prostatic obstruction, neurogenic bladder

PLEURAL EFFUSION

(See Chapter 13, page 304, Thoracentesis, for more details.)

Transudate: (Pleural to serum protein ratio <0.5, and pleural to serum LDH ratio <0.6 and pleural LDH $<\frac{2}{3}$ the upper limits of normal for serum LDH), CHF, cirrhosis, nephrotic syndrome, peritoneal dialysis

Exudate: (Pleural to serum protein ratio >0.5, or pleural to serum LDH ratio >0.6, or pleural LDH > 273 the upper limits of normal for serum LDH), bacterial or viral pneumonia, pulmonary infarction, TB, RA, SLE, malignancy (most common, breast, lung lymphoma, leukemia, ovarian, unknown primary, GI, mesothelioma, others), pancreatitis, pneumothorax, chest trauma, uremia

Chylothorax: Traumatic or postoperative complication

Empyema: Bacteria, fungi, TB, trauma, surgery

Hydrothorax: Usually iatrogenic (central venous catheter complication)

PRURITUS

Skin lesions (papulosquamous, vesicobullous, contact dermatitis, infestations [scabies, etc], infections), dry skin (especially in winter), liver disease, uremia, diabetes, gout, Hodgkin's disease, leukemias, polycythemia vera, intestinal parasites, drug reactions, pregnancy, psychosomatic, neurologic, or circulatory disturbances

SEIZURES

Types

Generalized: Grand mal and petit mal (absence), febrile

Partial Seizures: Partial motor, partial sensory, partial complex (psychomotor or temporal lobe, déjà vu, automatisms)

Causes: Primary, CNS tumors (primary, metastatic), trauma, metabolic (hypoglycemia, hyponatremia, hypornatremia, acidosis, alkalosis, porphyria, uremia, etc), fever (especially in children), infection (meningitis, encephalitis, and abscess), anoxia (arrhythmias, stroke, carbon monoxide poisoning), drugs (alcohol or barbiturate withdrawal, cocaine, amphetamines), collagen-vascular disease (SLE), chronic renal failure, trauma, hypertensive encephalopathy, toxemia of pregnancy, psychogenic

SPLENOMEGALY

(See Lymphadenopathy and Splenomegaly, page 49)

SYNCOPE

Includes vasovagal (simple faint), orthostatic (volume depletion, sympathectomy [either functional or surgical], diabetes, Shy–Drager [idiopathic], tricyclic antidepressants and diuretics) and hysterical. Cardiac syncope (Adams–Stokes attack), paroxysmal atrial tachycardia, atrial fibrillation, ventricular tachycardia, atrial or atrioventricular block, pacemaker malfunction, aortic stenosis, IHSS, primary pulmonary hypertension, atrial myxoma, cough syncope, hypoglycemia, seizure disorder, subclavian steal syndrome, cerebrovascular accident. AMI, alcohol-related

TREMORS

Resting (decrease with movement): Parkinson's disease, Wilson's disease, brain tumors (rare), medications (SSRI antidepressants, metoclopramide, phenothiazines [tardive dyskinesia])

Action (present with movement): Benign essential tremor (familial and senile), cerebellar diseases, withdrawal syndromes (alcohol, benzodiazepines, opiates), normal/physiologic (induced by anxiety, fatigue)

Ataxic (worse at end of voluntary movement): MS, cerebellar diseases

Others: Medication-induced (caffeines [coffee, tea], steroids, valproic acid, bronchodilators) febrile, hypoglycemic, hyperthyroidism, pheochromocytoma

VAGINAL BLEEDING

Normal menstrual period, dysfunctional uterine bleeding (premenopausal bleeding, oral contraceptives, luteal phase defect), anovulatory abnormal uterine bleeding (hypothalamic/pituitary disorders, stress, thyroid and adrenal disease, endometriosis), pregnancy-related (ectopic pregnancy, threatened/spontaneous abortion, retained products of gestation), neoplasia (uterine fibroids; cervical polyps; and endometrial, cervical, ovarian, and vulvar carcinoma)

VAGINAL DISCHARGE

Vaginitis due to Candida albicans, Trichomonas vaginalis, Gardnerella vaginalis, Neisseria gonorrhoeae, Chlamydia trachomatis, Mycoplasma, herpesvirus, chronic cervicitis, tumors, irritants, foreign bodies, estrogen deficiency

VERTIGO

Ménière's disease (recurrent vertigo, deafness and tinnitus), labyrinthitis, aminoglycoside toxicity, benign positional vertigo, vestibular neuronitis, brainstem ischemia and infarction, basilar artery migraine, cerebellar infarction, acoustic neuroma motion sickness, excess of ethanol, quinine, and salicylic acid

VOMITING

(See Nausea and Vomiting page 49)

WEIGHT LOSS

Normal or Increased Appetite: Diabetes, hyperthyroidism, anxiety, drugs (thyroid), carcinoid, sprue, pancreatic deficiency, parasites

Decreased Appetite: Depression, anorexia nervosa, GI obstruction, neoplasm, liver disease, severe infection, severe cardiopulmonary disease, uremia, adrenal insufficiency, hypercalcemia, hypokalemia, intoxication (alcohol, lead), old age, drugs (amphetamines, digitalis, SSRIs, such as fluoxetine [Prozac]), AIDS

WHEEZING

Large airway difficulty (laryngeal stridor, tracheal stenosis, foreign body), endobronchial tumor, asthma, bronchitis, emphysema, pulmonary edema, PE, anaphylactic reactions, myocardial ischemia

LABORATORY DIAGNOSIS: CHEMISTRY, IMMUNOLOGY, AND **EROLOGY**

Acetoacetate

Acid Phosphatase **ACTH**

ACTH Stimulation Test

Albumin

Albumin/Globulin Ratio

Aldosterone

Alkaline Phosphatase

Alpha-fetoprotein (AFP)

ALT

Ammonia

Amylase

ASO Titer

AST

Autoantibodies

Base Excess/Deficit

Bicarbonate

Bilirubin

Blood Urea Nitrogen (BUN)

BUN/Creatinine Ratio

C-Peptide

C-Reactive Protein

CA 15-3

CA 19-9

CA-125

Calcitonin

Calcium, Serum

Captopril Test

Carbon Dioxide

Carboxyhemoglobin

Carcinoembryonic Antigen (CEA)

Catecholamines, Fractionated Serum

Chloride, Serum

Cholesterol

Clostridium difficile Toxin Assay, Fecal

Cold Agalutinins

Complement (C3, C4, CH₅₀)

Cortisol, Serum

Counterimmunoelectrophoresis

Creatine Phosphokinase

Creatinine, Serum

Cryoglobulins, Serum

Cytomegalovirus Antibodies

Dehydroepiandrosterone

Dehydroepiandrosterone Sulfate

Dexamethasone Suppression Test

Erythropoietin

Estradiol, Serum

Estrogen/Progesterone Receptors

Ethanol

Fecal Fat

Ferritin

Folic Acid

Follicle-Stimulating Hormone (FSH)

FTA-ABS

Fungal Serologies

Gastrin, Serum

GGT

Glucose

Glucose Tolerance Test, Oral

Glycohemoglobin

Haptoglobin

Helicobacter pylori Antibody Titers

Hepatitis Testina

High-Density Lipoprotein Cholesterol

HLA

Homocysteine, Serum

Human Chorionic Gonadotropin (HCG)

Human Immunodeficiency Antibody

Testing (HIV)

Immunoalobulins, Quantitative

Iron-Binding Capacity, Total

Lactate Dehydrogenase (LDH)

Lactic Acid LAP Score LE Preparation Lead, Blood *Legionella* Antibody

Lipase Lipid Profile

Low-Density Lipoprotein-

Cholesterol

Luteinizing Hormone Lyme Disease Serology Maanesium

Metyrapone Test
MHA-TP
β₂-Microglobulin
Monospot
Myoglobin
5'-Nucleotidase

Oligoclonal Banding, CSF Osmolality, Serum

Oxygen

P-24 Antigen (HIV Antigen) Parathyroid Hormone

Phosphorus Potassium, Serum

Progesterone, Serum Prolactin

Prostate-Specific Antigen (PSA) Protein Electrophoresis, Serum

and Urine Protein, Serum Renin Plasma Renal Vein

Retinol-Binding Protein Rheumatoid Factor

Rocky Mountain Spotted Fever

Antibodies Semen Analysis

SGGT SGOT SGPT

Sodium, Serum Stool for Occult Blood Sweat Chloride T₂ RU

Testosterone Thyroglobulin

Thyroid-Stimulating Hormone

Thyroxine

Thyroxine-Binding Globulin Thyroxine Index, Free TORCH Battery Transferrin

Triglycerides Triiodothyronine

Troponin, Cardiac-Specific

Uric Acid VDRL Test Vitamin B₁₂ Zinc

This chapter outlines commonly ordered blood chemistry, immunology, and serology tests with normal values and a guide to the diagnosis of common abnormalities. Other laboratory tests can be found in the following chapters: Hematology, Chapter 5; Urine Studies, Chapter 6; Microbiology, Chapter 7; and Blood Gases, Chapter 8.

With the institution of DRGs, it becomes imperative to understand appropriate, as well as economical, laboratory testing patterns. Laboratory testing should be guided by, but not a substitute for, an effective history, physical, and careful clinical assessment.

Most laboratories offer AMA recommended "panel" tests, whereby multiple determinations are performed on a single sample. Although your lab may vary, some common chemistry panels include:

Basic Metabolic Panel: BUN, calcium, creatinine, electrolytes (Na, K, Cl, CO₂), glucose Cardiac Enzymes: CK-MB (if total CK >150 IU/L), troponin Chem-7 Panel/SMA-7: BUN, creatinine, electrolytes (Na, K, Cl, CO₂), glucose

ļ

Comprehensive Metabolic Panel: Albumin, alkaline phosphatase, ALT (SGPT), AST (SGOT), bilirubin (total), BUN, calcium, creatinine, electrolytes (Na, K, Cl, CO₂), glucose, protein (total)

Electrolytes: Sodium, potassium, chloride, CO₂, (Na, K, Cl, CO₂)

Health Screen-12/SMA-12: Albumin, alkaline phosphatase, AST (SGOT), bilirubin (total), calcium, cholesterol, creatinine, glucose, LDH, phosphate, protein (total), uric acid

Hepatic Function Panel: Albumin, alkaline phosphatase, ALT (SGPT), AST (SGOT), bilirubin (total & direct), protein

Lipid Panel: Cholesterol, HDL cholesterol, LDL cholesterol (calculated), triglycerides

The Système International (SI) is a metric-based laboratory data-reporting system that is used internationally. The mole is the unit used most extensively in the system. The SI unit for expressing enzymatic activity is the "katal"; however, most countries have adopted units per liter (U/L) as an alternative measure of enzymatic activity. For most lab values, representative SI units have been included; however, each individual laboratory should be consulted for its "normal" values.

If an increased or decreased value is not clinically useful, it is usually not listed. Because each laboratory has its own set of normal reference values, the normals given should only be used as a guide. The range for common normal values is given in parentheses. Unless specified, values reflect normal adult levels. This section includes the method of collection since laboratories have attempted to standardize collection methods; however, be aware that some labs may have alternative collection methods. Blood specimen tubes are listed in Chapter 13, page 311.

ACETOACETATE (KETONE BODIES, ACETONE)

• Normal = negative • Collection: Red top tube

Positive: DKA, starvation, emesis, stress, alcoholism, infantile organic acidemias, iso-propanol ingestion

ACID PHOSPHATASE (PROSTATIC ACID PHOSPHATASE, PAP)

<3.0 ng/mL by RIA, or <0.8 IU/L by enzymatic
 Collection: Tiger top tube
 Not a useful screening test for cancer; most useful as a marker of response to therapy or
in confirming metastatic disease. PSA is more sensitive in diagnosis of cancer.

Increased: Carcinoma of the prostate (usually outside of prostate), prostatic surgery or trauma (including prostatic massage), rarely in infiltrative bone disease (Gaucher's disease, myeloid leukemia), prostatitis, or BPH

ACTH (ADRENOCORTICOTROPIC HORMONE)

• 8 AM 20–140 pg/mL (SI: 20–140 ng/L), midnight, approximately 50% of AM value • Collection: Tiger top tube

Increased: Addison's disease (primary adrenal hypofunction), ectopic ACTH production (small [oat] cell lung carcinoma, pancreatic islet cell tumors, thymic tumors, renal cell carcinoma, bronchial carcinoid), Cushing's disease (pituitary adenoma), congenital adrenal hyperplasia (adrenogenital syndrome)

Decreased: Adrenal adenoma or carcinoma, nodular adrenal hyperplasia, pituitary insufficiency, corticosteroid use

ACTH STIMULATION TEST (CORTROSYN STIMULATION TEST)

· Collection: Tiger top tube

Used to help diagnose adrenal insufficiency. Cortrosyn (an ACTH analogue) is given at a dose of 0.25 mg IM or IV in adults or 0.125 mg in children <2 years. Collect blood at time 0.30, and 60 min for cortisol and aldosterone.

Normal Response: Three criteria are required: basal cortisol of at least 5 mg/dL, an incremental increase after cosyntropin (Cortrosyn) injection of at least 7 mg/dL, and a final serum cortisol of at least 16 mg/dL at 30 or 18 mg/dL at 60 min or cortisol increase of >10 mg/dL. Aldosterone increases >5 ng/dL over baseline.

Addison's Disease (Primary Adrenal Insufficiency): Neither cortisol nor aldosterone increase over baseline.

Secondary Adrenal Insufficiency: Caused by pituitary insufficiency or suppression by exogenous steroids, cortisol does not increase, but aldosterone does.

ALBUMIN

 • Adult 3.5–5.0 g/dL (SI: 35–50 g/L), child 3.8–5.4 g/dL (SI: 38–54 g/L) • Collection: Tiger top tube; part of SMA-12

Decreased: Malnutrition (see page 211), overhydration, nephrotic syndrome, CF, multiple myeloma, Hodgkin's disease, leukemia, metastatic cancer, protein-losing enteropathies, chronic glomerulonephritis, alcoholic cirrhosis, inflammatory bowel disease, collagen-vascular diseases, hyperthyroidism

ALBUMIN/GLOBULIN RATIO (A/G RATIO)

• Normal >1

A calculated value (Total protein minus albumin = globulins. Albumin divided by globulins = A/G ratio). Serum protein electrophoresis is a more informative test (see page 85).

Decreased: Cirrhosis, liver diseases, nephrotic syndrome, chronic glomerulonephritis, cachexia, burns, chronic infections and inflammatory states, myeloma

ALDOSTERONE

• Serum: Supine 3–10 ng/dL (SI: 0.083–0.28 nmol/L) early AM, normal sodium intake [3 g sodium/d] • Upright 5–30 ng/dL (SI: 0.138–0.83 nmol/L); urinary 2–16 mg/24 h (SI: 5.4–44.3 nmol/d) • Collection: Green or lavender top tube

Discontinue antihypertensives and diuretics 2 wk prior to test. Upright samples should be drawn after 2 h. Primarily used to screen hypertensive patients for possible Conn's syndrome (adrenal adenoma producing excess aldosterone).

Increased: Primary hyperaldosteronism, secondary hyperaldosteronism (CHF, sodium depletion, nephrotic syndrome, cirrhosis with ascites, others), upright posture

Decreased: Adrenal insufficiency, panhypopituitarism, supine posture

ALKALINE PHOSPHATASE

Adult 20–70 U/L, child 20–150 U/L
 Collection: Tiger top tube; part of SMA-12
 A fractionated alkaline phosphatase was formerly used to differentiate the origin of the enzyme in the bone from that in the liver. Replaced by the GGT and 5'-nucleotidase determinations

Increased: Increased calcium deposition in bone (hyperparathyroidism), Paget's disease, osteoblastic bone tumors (metastatic or osteogenic sarcoma), osteomalacia, rickets, pregnancy, childhood, healing fracture, liver disease such as biliary obstruction (masses, drug therapy), hyperthyroidism

Decreased: Malnutrition, excess vitamin D ingestion

ALPHA-FETOPROTEIN (AFP)

• (<16 ng/mL (SI: <16 mL) • third trimester of pregnancy maximum 550 ng/mL (SI: 550 mL) • Collection: Tiger top tube

Increased: Hepatoma (hepatocellular carcinoma), testicular tumor (embryonal carcinoma, malignant teratoma), neural tube defects (in mother's serum [spina bifida, anencephaly, myelomeningocele]), fetal death, multiple gestations, ataxia–telangiectasia, some cases of benign hepatic diseases (alcoholic cirrhosis, hepatitis, necrosis)

Decreased: Trisomy 21 (Down syndrome) in maternal serum

ALT (ALANINE AMINOTRANSFERASE, ALAT) OR SGPT

• 0–35 U/L (SI: 0–0.58 mkat/L), higher in newborns • Collection: Tiger top tube

Increased: Liver disease, liver metastasis, biliary obstruction, pancreatitis, liver congestion (ALT is more elevated than AST in viral hepatitis; AST elevated more than ALT in alcoholic hepatitis.)

AMMONIA

• Adult 10–80 mg/dL (SI: 5–50 mmol/L) • To convert mg/dL to mmol/L, multiply by 0.5872 • Collection: Green top tube, on ice, analyze immediately

Increased: Liver failure, Reye's syndrome, inborn errors of metabolism, normal neonates (normalizes within 48 h of birth)

AMYLASE

• 50-150 Somogyi units/dL (SI: 100-300 U/L) • Collection: Tiger top tube

Increased: Acute pancreatitis, pancreatic duct obstruction (stones, stricture, tumor, sphincter spasm secondary to drugs), pancreatic pseudocyst or abscess, alcohol ingestion, mumps, parotiditis, renal disease, macroamylasemia, cholecystitis, peptic ulcers, intestinal obstruction, mesenteric thrombosis, after surgery

Decreased: Pancreatic destruction (pancreatitis, cystic fibrosis), liver damage (hepatitis, cirrhosis), normal newborns in the first year of life

ASO (ANTISTREPTOLYSIN O/ANTISTREPTOCOCCAL O) TITER (STREPTOZYME)

- <200 IU/mL (Todd units) school-age children <100 IU/mL preschool and adults
- · varies with lab · Collection: Tiger top tube

Increased: Streptococcal infections (pharyngitis, scarlet fever, rheumatic fever, post-streptococcal glomerulonephritis), RA, and other collagen diseases

Е

AST (ASPARTATE AMINOTRANSFERASE, ASAT) OR SGOT

 8–20 U/L (SI: 0–0.58 mkat/L)
 Collection: Tiger top tube; part of SMA-12 Generally parallels changes in ALT in liver disease.

Increased: AMI, liver disease, Reye's syndrome, muscle trauma and injection, pancreatitis, intestinal injury or surgery, factitious increase (erythromycin, opiates), burns, cardiac catheterization, brain damage, renal infarction

Decreased: Beriberi (vitamin B₆ deficiency), severe diabetes with ketoacidosis, liver disease, chronic hemodialysis

AUTOANTIBODIES

• Normal = negative • Collection: Tiger top tube

Antinuclear Antibody (ANA, FANA)

A useful screening test in patients with symptoms suggesting collagen–vascular disease, especially if titer is >1:160.

Positive: SLE, drug-induced lupus-like syndromes (procainamide, hydralazine, isoniazid, etc), scleroderma, MCTD, RA, polymyositis, juvenile RA (5–20%). Low titers are also seen in non-collagen–vascular disease.

Specific Immunofluorescent ANA Patterns

Homogenous. Nonspecific, from antibodies to DNP and native double-stranded DNA. Seen in SLE and a variety of other diseases. Antihistone is consistent with drug-induced lupus.

Speckled. Pattern seen in many connective tissue disorders. From antibodies to ENA, including anti-RNP, anti-Sm, anti-PM-1, and anti-SS. Anti-RNP is positive in MCTD and SLE. Anti-Sm is very sensitive for SLE. Anti-SS-A and anti-SS-B are seen in Sjögren's syndrome and subacute cutaneous lupus. The speckled pattern is also seen with sclero-derma.

Peripheral Rim Pattern. From antibodies to native double-stranded DNA and DNP. Seen in SLE

Nucleolar Pattern. From antibodies to nucleolar RNA. Positive in Sjögren's syndrome and scleroderma

Anticentromere: Scleroderma, Raynaud's disease, CREST syndrome

Anti-DNA (Antidouble-stranded DNA): SLE (but negative in drug-induced lupus), chronic active hepatitis, mononucleosis

Antimitochondrial: Primary biliary cirrhosis, autoimmune diseases such as SLE

Antineutrophil Cytoplasmic: Wegener's granulomatosis, polyarteritis nodosa, and other vasculitides

Anti-SCL 70: Scleroderma

Antismooth Muscle: Low titers are seen in a variety of illnesses; high titers (>1:100) are suggestive of chronic active hepatitis.

Sjögren Syndrome Antibody (SS-A): Sjögren syndrome, SLE, RA

Antimicrosomal: Hashimoto's thyroiditis

BASE EXCESS/DEFICIT

• -2 to +2 • See Chapter 8, page 162

BICARBONATE (OR "TOTAL CO₂")

• 23-29 mmol/L • See CARBON DIOXIDE, page 61

BILIRUBIN

- Total, 0.3–1.0 mg/dL (SI: 3.4–17.1 mmol/L) direct, <0.2 mg/dL (SI: <3.4 mmol/L)
 indirect, <0.8 mg/dL (SI: <3.4 mmol/L) To convert mg/dL to mmol/L, multiply by
 17.10 Collection: Tiger top tube
- Increased Total: Hepatic damage (hepatitis, toxins, cirrhosis), biliary obstruction (stone or tumor), hemolysis, fasting.

Increased Direct (Conjugated): Note: Determination of the direct bilirubin is usually unnecessary with total bilirubin levels <1.2 mg/dL (SI: 21 mmol/L) Biliary obstruction/cholestasis (gallstone, tumor, stricture), drug-induced cholestasis, Dubin–Johnson and Rotor's syndromes

Increased Indirect (Unconjugated): Note: This is calculated as total minus direct bilirubin. So-called hemolytic jaundice caused by any type of hemolytic anemia (transfusion reaction, sickle cell, etc), Gilbert's disease, physiologic jaundice of the newborn, Crigler–Najjar syndrome

Bilirubin, Neonatal("Baby Bilirubin")

• Normal levels dependent on prematurity and age in days • "panic levels" usually >15-20 mg/dL (SI: >257-342 mmol/L in full-term infants) • Collection: Capillary tube

Increased: Erythroblastosis fetalis, physiologic jaundice (may be due to breast-feeding), resorption of hematoma or hemorrhage, obstructive jaundice, others

BLOOD UREA NITROGEN (BUN)

• Birth–1 year: 4–16 mg/dL (SI: 1.4–5.7 mmol/L) • 1–40 years 5–20 mg/dL (SI: 1.8–7.1 mmol/L)]] • Gradual slight increase with age • To convert mg/dL to mmol/L, multiply by 0.3570 • Collection: Tiger top tube

Less useful measure of GFR than creatinine because BUN is also related to protein metabolism

Increased: Renal failure (including drug-induced from aminoglycosides, NSAIDs), prerenal azotemia (decreased renal perfusion secondary to CHF, shock, volume depletion), postrenal (obstruction), GI bleeding, stress, drugs (especially aminoglycosides)

Decreased: Starvation, liver failure (hepatitis, drugs), pregnancy, infancy, nephrotic syndrome, overhydration

BUN/CREATININE RATIO (BUN/CR)

Mean 10, range 6–20
 Calculated based on serum levels

4

Increased: Prerenal azotemia (renal hypoperfusion), GI bleeding, high-protein diet, ileal conduit, drugs (steroids, tetracycline)

Decreased: Malnutrition, pregnancy, low-protein diet, ketoacidosis, hemodialysis, SIADH, drugs (cimetidine)

C-PEPTIDE, INSULIN ("CONNECTING PEPTIDE")

• Fasting, <4.0 ng/mL (SI: <4.0 mg/L) • Male >60 years, 1.5–5.0 ng/mL (SI: 1.5–5.0 mg/L) • Female 1.4–5.5 ng/mL (SI: 1.4–5.5 mg/L) • Collection: Tiger top tube

Differentiates between exogenous and endogenous insulin production/administration. Liberated when proinsulin is split to insulin; levels suggest endogenous production of insulin

Decreased: Diabetes (decreased endogenous insulin), insulin administration (factitious or therapeutic), hypoglycemia

C-REACTIVE PROTEIN (CRP)

• Normal = none detected • Collection: Tiger top tube

A nonspecific screen for infectious and inflammatory diseases, correlates well with ESR. In the first 24 h, however, ESR may be normal and CRP elevated.

Increased: Bacterial infections, inflammatory conditions (acute rheumatic fever, acute RA, MI, transplant rejection, embolus, inflammatory bowel disease), last half of pregnancy, oral contraceptives, some malignancies

CA 15-3

Used to detect breast cancer recurrence in asymptomatic patients and monitor therapy. Levels related to stage of disease

Increased: Progressive breast cancer, benign breast disease and liver disease

Decreased: Response to therapy (25% change considered significant)

CA 19-9

• <37 U/ml (SI:<37 kU/L) • Collection: Tiger top tube

Primary used to determine resectability of pancreatic cancers (ie, >1000 U/mL 95% unresectable)

Increased: GI cancers such as pancreas, stomach, liver, colorectal, hepatobiliary, some cases of lung and prostate, pancreatitis

CA-125

• <35 U/mL (SI: <35 kU/L) • Collection: Tiger top tube

Not a useful screening test for ovarian cancer when used alone; best used in conjunction with ultrasound and physical examination. Rising levels after resection predictive for recurrence

Increased: Ovarian, endometrial, and colon cancer; endometriosis; inflammatory bowel disease; PID; pregnancy; breast lesions; and benign abdominal masses (teratomas)

CALCITONIN (THYROCALCITONIN)

• <19 pg/mL (SI: <19 ng/L) • Collection: Tiger top tube

Increased: Medullary carcinoma of the thyroid, C-cell hyperplasia (precursor of medullary carcinoma), small (oat) cell carcinoma of the lung, newborns, pregnancy, chronic renal insufficiency, Zollinger–Ellison syndrome, pernicious anemia.

CALCIUM, SERUM

• Infants to 1 month: 7–11.5 mg/dL (SI: 1.75–2.87 mmol/L) • 1 month to 1 year: 8.6–11.2 mg/dL (SI: 2.15–2.79 mmol/L) • >1 year and adults: 8.2–10.2 mg/dL (SI: 2.05–2.54 mmol/L) • Ionized: 4.75–5.2 mg/dL (SI: 1.19–1.30 mmol/L) • To convert mg/dL to mmol/L, multiply by 0.2495 • Collection: Tiger top tube; ionized requires green or red tube

When interpreting a total calcium value, albumin must be known. If it is not within normal limits, a corrected calcium can be roughly calculated by the following formula. Values for ionized calcium need no special corrections.

Corrected total Ca = 0.8 (Normal albumin - Measured albumin) + Reported Ca

Increased: (Note: Levels >12 mg/dL [2.99 mmol/L] may lead to coma and death) Primary hyperparathyroidism, PTH-secreting tumors, vitamin D excess, metastatic bone tumors, osteoporosis, immobilization, milk-alkali syndrome, Paget's disease, idiopathic hypercalcemia of infants, infantile hypophosphatasia, thiazide diuretics, chronic renal failure, sarcoidosis, multiple myeloma

Decreased: (Note: Levels <7 mg/dL [<1.75 mmol/L] may lead to tetany and death.) Hypoparathyroidism (surgical, idiopathic), pseudo-hypoparathyroidism, insufficient vitamin D, calcium and phosphorus ingestion (pregnancy, osteomalacia, rickets), hypomagnesemia, renal tubular acidosis, hypoalbuminemia (cachexia, nephrotic syndrome, CF), chronic renal failure (phosphate retention), acute pancreatitis, factitious decrease because of low protein and albumin

CAPTOPRIL TEST

• See Aldosterone, page 56, and renin (plasma renin), page 88, for normal values

Used in the evaluation of renovascular hypotension, the drug is an ACE inhibitor that blocks angiotensin II. Captopril is administered (25 mg IV at 8AM). Aldosterone decreases 2 h later from baseline in normals or essential hypertension, but does not suppress in patients with aldosteronism. For renovascular hypertension, the PRA increases >12 ng/mL/h and an absolute increase of 10 ng/mL/h plus a 400% increase in PRA if pretest level <3 ng/mL/h and >150% over baseline if the pretest PRA was >3 ng/mL/h. Test now also combined with nuclear renal scan to identify renal artery stenosis

CARBON DIOXIDE ("TOTAL CO2" OR BICARBONATE)

• Adult 23–29 mmol/L, child 20–28 mmol/L • (See Chapter 8 for pco_2 values • Collection: Tiger top tube, do not expose sample to air

Increased: Compensation for respiratory acidosis (emphysema) and metabolic alkalosis (severe vomiting, primary aldosteronism, volume contraction, Bartter's syndrome)

Н

Decreased: Compensation for respiratory alkalosis, and metabolic acidosis (starvation, diabetic ketoacidosis, lactic acidosis, alcoholic ketoacidosis, toxins [methanol, ethylene glycol, paraldehyde], severe diarrhea, renal failure, drugs [salicylates, acetazolamide], dehydration, adrenal insufficiency)

CARBOXYHEMOGLOBIN (CARBON MONOXIDE)

• Nonsmoker <2%; smoker <9%; toxic >15% • Collection: Gray or lavender top tube; confirm with lab

Increased: Smokers, smoke inhalation, automobile exhaust inhalation, normal new-

CARCINOEMBRYONIC ANTIGEN (CEA)

 • Nonsmoker <3.0 ng/mL (SI: <3.0 $\mu g/L)$ • smoker <5.0 ng/mL (SI: <5.0 $\mu g/L)$ • Collection: Tiger top tube

Not a screening test; useful for monitoring response to treatment and tumor recurrence of adenocarcinomas of the GI tract

Increased: Carcinoma (colon, pancreas, lung, stomach), smokers, nonneoplastic liver disease, Crohn's disease, and ulcerative colitis

CATECHOLAMINES, FRACTIONATED SERUM

· Collection: Green or lavender tube; check with lab

Values vary and depend on the lab and method of assay used. Normal levels shown here are based on a HPLC technique. Patient must be supine in a nonstimulating environment with IV access to obtain sample.

Catecholamine Plasma (Supine) Levels

 Norepinephrine
 70–750 pg/mL (SI: 414–4435 pmol/L)

 Epinephrine
 0–100 pg/mL (SI: 0–546 pmol/L)

 Dopamine
 <30 pg/mL (SI: 196 pmol/L)</td>

Increased: Pheochromocytoma, neural CREST tumors (neuroblastoma), with extraadrenal pheochromocytoma, norepinephrine may be markedly elevated compared with epinephrine.

CHLORIDE, SERUM

• 97–107 mEq/L (SI: 97–107 mmol/L) • Collection: Tiger top tube

Increased: Diarrhea, renal tubular acidosis, mineralocorticoid deficiency, hyperalimentation, medications (acetazolamide, ammonium chloride)

Decreased: Vomiting, diabetes mellitus with ketoacidosis, mineralocorticoid excess, renal disease with sodium loss

CHOLESTEROL

• Total • Normal, see Table 4–1; see also LIPID PROFILE/CHOLESTEROL SCREEN-ING, page 79, and Figure 4–4, see page 80.• To convert mg/dL to mmol/L, multiply by 0.02586 • Collection: Tiger top tube

TABLE 4–1 Normal Total Cholesterol Levels by Age

Age	Standard Units (mg/dL)	SI Units (mmol/L)	
<29	<200	<5.20	
30–39	<225	<5.85	
40–49	<245	<6.35	

Increased: Idiopathic hypercholesterolemia, biliary obstruction, nephrosis, hypothyroidism, pancreatic disease (diabetes), pregnancy, oral contraceptives, hyperlipoproteinemia (types IIb, III, V)

Decreased: Liver disease (hepatitis, etc), hyperthyroidism, malnutrition (cancer, starvation), chronic anemias, steroid therapy, lipoproteinemias, AMI

High-Density Lipoprotein Cholesterol (HDL, HDL-C)

Fasting 30–70 mg/dL (SI: 0.8–1.80 mmol/L)
 Female 30–90 mg/dL (SI: 0.80–2.35)
 HDL-C has the best correlation with the development of CAD; decreased HDL-C in males leads to an increased risk. Levels <45 mg/dL associated with increased risk of CAD

Increased: Estrogen (females), regular exercise, small ethanol intake, medications (nicotinic acid, gemfibrozil, others)

Decreased: Males, smoking, uremia, obesity, diabetes, liver disease, Tangier disease

Low-Density Lipoprotein Cholesterol (LDL, LDL-C)

• 50-190 mg/dL (SI: 1.30-4.90 mmol/L)

Increased: Excess dietary saturated fats, MI, hyperlipoproteinemia, biliary cirrhosis, endocrine disease (diabetes, hypothyroidism)

Decreased: Malabsorption, severe liver disease, abetalipoproteinemia

CLOSTRIDIUM DIFFICILE TOXIN ASSAY, FECAL

· Normal negative

Majority of patients with pseudomembranous colitis have positive *C. difficile* assay. Often positive in antibiotic associated diarrhea and colitis. Can be seen in some normals and neonates

COLD AGGLUTININS

<1:32 • Collection: Lavender or blue top tube
 Most frequently used to screen for atypical pneumonias.

Increased: Atypical pneumonia (mycoplasmal pneumonia), other viral infections (especially mononucleosis, measles, mumps), cirrhosis, parasitic infections, Waldenström's macroglobulinemia, lymphomas and leukemias, multiple myeloma

COMPLEMENT

· Collection: Tiger or lavender top tube

Complement describes a series of sequentially reacting serum proteins that participate in pathogenic processes and lead to inflammatory injury.

Complement C3

• 85–155 mg/dL, (SI: 800–1500 ng/L)

Decreased levels suggest activation of the classical or alternative pathway, or both.

Increased: RA (variable finding), rheumatic fever, various neoplasms (gastrointestinal, prostate, others), acute viral hepatitic, MI, pregnancy, amyloidosis

Decreased: SLE, glomerulonephritis (poststreptococcal and membranoproliferative), sepsis, SBE, chronic active hepatitis, malnutrition, DIC, gram-negative sepsis

Complement C4

• 20-50 mg/dL (SI: 200-500 ng/L)

Increased: RA (variable finding), neoplasia (gastrointestinal, lung, others)

Decreased: SLE, chronic active hepatitis, cirrhosis, glomerulonephritis, hereditary angioedema (test of choice).

Complement CH50 (Total)

33–61 mg/mL (SI: 330–610 ng/L)
 Tests for complement deficiency in the classical pathway.

Increased: Acute-phase reactants (tissue injury, infections, etc)

Decreased: Hereditary complement deficiencies

CORTISOL, SERUM

8 AM, 5.0-23.0 mg/dL (SI: 138-365 nmol/L)
 4 PM, 3.0-15.0 mg/dL (SI: 83-414 nmol/L)
 Collection: Green or red top tube

Increased: Adrenal adenoma, adrenal carcinoma, Cushing's disease, nonpituitary ACTH-producing tumor, steroid therapy, oral contraceptives

Decreased: Primary adrenal insufficiency (Addison's disease), congenital adrenal hyperplasia, Waterhouse-Friderichsen syndrome, ACTH deficiency

COUNTERIMMUNOELECTROPHORESIS (CIEP, CEP)

Normal = negative

An immunologic technique that allows for rapid identification of infecting organisms from fluids, including serum, urine, CSF, and other body fluids. Organisms identified include Neisseria meningitidis, Streptococcus pneumoniae, Haemophilus influenzae, and group B Streptococcus.

CREATINE PHOSPHOKINASE (KINASE) (CP, CPK)

• 25–145 mU/mL (SI: 25–145 U/L) • Collection: Tiger top tube

Used in suspected MI or muscle diseases. Heart, skeletal muscle, and brain have high levels

Increased: Muscle damage (AMI, myocarditis, muscular dystrophy, muscle trauma [including injections], after surgery), brain infarction, defibrillation, cardiac catheterization and surgery, rhabdomyolysis, polymyositis, hypothyroidism

CPK Isoenzymes

MB: (Normal <6%, heart origin) increased in AMI (begins in 2–12 h, peaks at 12–40 h, returns to normal in 24–72 h), pericarditis with myocarditis, rhabdomyolysis, crush injury, Duchenne's muscular dystrophy, polymyositis, malignant hyperthermia, and cardiac surgery

MM: (Normal 94–100%, skeletal muscle origin) increased in crush injury, malignant hyperthermia, seizures, IM injections

BB: (Normal 0%, brain origin) brain injury (CVA, trauma), metastatic neoplasms (prostate), malignant hyperthermia, colonic infarction

CREATININE, SERUM

- Adult male <1.2 mg/dL (SI: 106 mmol/L) Adult female <1.1 mg/dL (SI: 97 mmol/L)
- • Child 0.5–0.8 mg/dL (SI: 44–71 mmol/L) • To convert mg/dL to μ mol/L, multiply by 88.40 • Collection: Tiger top tube

A clinically useful estimate of GFR. As a rule of thumb, serum creatinine doubles with each 50% reduction in the GFR. Creatine clearance is discussed in Chapter 6.

Increased: Renal failure (prerenal, renal, or postrenal obstruction or medication-induced [aminoglycosides, NSAIDs, others]), gigantism, acromegaly, ingestion of roasted meat, false-positive with DKA

Decreased: Pregnancy, decreased muscle mass, severe liver disease

CRYOGLOBULINS (CRYOCRIT)

<0.4% (or negative if qualitative) $\{\cdot\}$

Collection: Tiger top tube, process immediately

These abnormal proteins precipitate out of serum at low temperatures. Cryocrit, a quantitative measure, is preferred over the qualitative method. Should be collected in nonanticoagulated tubes and transported at body temperature. Positive samples can be analyzed for immunoglobulin class, and light-chain type on request.

Monoclonal: Multiple myeloma, Waldenström's macroglobulinemia, lymphoma, CLL

Mixed Polyclonal or Mixed Monoclonal: Infectious diseases (viral, bacterial, parasitic), such as SBE or malaria; SLE; RA; essential cryoglobulinemia; lymphoproliferative diseases; sarcoidosis; chronic liver disease (cirrhosis)

4

CYTOMEGALOVIRUS (CMV) ANTIBODIES

IgM <1:8, IgG <1:16 • Collection: Tiger top tube
 Used in neonates (CMV is the most common intrauterine infection), posttransfusion
 CMV infection, and organ donors and recipients. Most of adults will have detectable titers.

Increased: Serial measurements 10–14 days apart with a 4× increase in titers or a single IgM >1:8 is suspicious for acute infection. Universally increased titers in AIDS. IgM most useful in neonatal infections

DEHYDROEPIANDROSTERONE (DHEA)

• Male 2.0–3.4 ng/mL (SI: 5.2–8.7 mmol/L) • Female, premenopausal 0.8–3.4 ng/mL (SI: 2.1–8.8 mmol/L) • Postmenopausal 0.1–0.6 ng/mL (SI: 0.3–1.6 mmol/L) • Collection: Tiger top tube

Increased: Anovulation, polycystic ovaries, adrenal hyperplasia, adrenal tumors

Decreased: Menopause

DEHYDROEPIANDROSTERONE SULFATE (DHEAS)

- Male 1.7-4.2 ng/mL (SI: 6-15 mmol/L) Female 2.0-5.2 ng/mL (SI: 7-18 mmol/L)
- · Collection: Tiger top tube

Increased: Hyperprolactinemia, adrenal hyperplasia, adrenal tumor, polycystic ovaries, lipoid ovarian tumors

Decreased: Menopause

DEXAMETHASONE SUPPRESSION TEST

Used in the differential diagnosis of Cushing's syndrome (elevated cortisol)

Overnight Test: In the "rapid" version of this test, a patient takes 1 mg of dexamethasone PO at 11 PM and a fasting 8 AM plasma cortisol is obtained. Normally the cortisol level should be <5.0 mg/dL [138 nmol/L]. A value that is >5 mg/dL [138 nmol/L] usually confirms the diagnosis of Cushing's syndrome; however, obesity, alcoholism, or depression may occasionally show the same result. In these patients, the best screening test is a 24-h urine for free cortisol.

Low-Dose Test: After collection of baseline serum cortisol and 24-h urine-free cortisol levels, dexamethasone 0.5 mg is administered PO every 6 h for eight doses. Serum and urine cortisol are repeated on the second day. Failure to suppress to a serum cortisol of <5.0 mg/dL [138 nmol/L] and a urine-free cortisol of <30 μg/dL (82 nmol/L) confirms Cushing's syndrome.

High-Dose Test: After the low-dose test, dexamethasone, 2 mg PO every 6 h for eight doses will cause a fall in urinary-free cortisol to 50% of the baseline value in bilateral adrenal hyperplasia (Cushing's disease) but not in adrenal tumors or ectopic ACTH production.

ERYTHROPOIETIN (EPO)

 5–36 mU/L (5–36 IU/L)
 Collection: Tiger top tube EPO is a renal hormone that stimulates RBC production. Increased: Pregnancy, secondary polycythemia (high altitude, COPD, etc), tumors (renal cell carcinoma, cerebellar hemangioblastoma, hepatoma, others), PCKD, anemias with bone marrow unresponsiveness (aplastic anemia, iron deficiency, etc)

Decreased: Bilateral nephrectomy, anemia of chronic disease (ie, renal failure, nephrotic syndrome), primary polycythemia (*Note:* The determination of EPO levels before administration of recombinant EPO for renal failure is not usually necessary.)

ESTRADIOL, SERUM

· Collection: Tiger top tube

Serial measurements useful in assessing fetal well-being, especially in high-risk pregnancy. Also useful in evaluation of amenorrhea and gynecomastia in males.

Female	Normal Value
Follicular phase	25-75 pg/mL
Midcycle peak	200-600 pg/mL
Luteal phase	100-300 pg/mL
Pregnancy 1st trimester	1-5 ng/mL
2nd trimester	5-15 ng/mL
3rd trimester	10-40 ng/mL
Postmenopause	5-25 pg/mL
Oral contraceptives	<50 pg/mL
Male	
Prepubertal	2-8 pg/mL
Adult	10-60 pg/mL

ESTROGEN/PROGESTERONE RECEPTORS

These are typically determined on fresh surgical (breast cancer) specimens. The presence of the receptors is associated with a longer disease-free interval, survival from breast cancer, and increased likelihood of responding to endocrine therapy. Fifty to seventy-five percent of breast cancers are estrogen-receptor-positive.

ETHANOL (BLOOD ALCOHOL)

 \bullet 0 mg/dL (0 mmol/L) \bullet Collection: Tiger top tube; do not use alcohol to clean venipuncture site, use povidone-iodine

Physiologic changes can vary with degree of alcohol tolerance of an individual.

- <50 mg/dL [<10.85 mmol/L]: Limited muscular incoordination
- 50–100 [10.85–21.71]: Pronounced incoordination
- 100–150 [21.71–32.57]: Mood and personality changes; legally intoxicated in most states
- 150–400 [32.57–87]: Nausea, vomiting, marked ataxia, amnesia, dysarthria
- · ≥400: Coma, respiratory insufficiency and death

FECAL FAT

 • 2–6 g/d on an 80–100 g/d fat diet • 72-h collection time • Sudan III stain, random <60 droplets fat/hpf

Increased: CF, pancreatic insufficiency, Crohn's disease, chronic pancreatitis, sprue

9

FERRITIN

- Male 15-200 ng/mL (SI: 15-200 mg/L) Female 12-150 ng/mL (SI: 12-150 mg/L)
- · Collection: Tiger top tube

Increased: Hemochromatosis, hemosiderosis, sideroblastic anemia

Decreased: Iron deficiency (earliest and most sensitive test before red cells show any morphologic change), severe liver disease

FOLIC ACID

Serum Folate

• >2.0 ng/mL (SI: >5 nmol/L)

RBC

 • 125–600 ng/mL (283–1360 nmol/L) • Collection: Lavender top tube

Serum folate can fluctuate with diet. RBC levels are more indicative of tissue stores. Vitamin B_{12} deficiency can result in the RBC unable to take up folate in spite of normal serum folate levels.

Increased: Folic acid administration

Decreased: Malnutrition/malabsorption (folic acid deficiency), massive cellular growth (cancer) or cell turnover, ongoing hemolysis, medications (trimethoprim, some anticonvulsants, oral contraceptives), vitamin B₁₂ deficiency (low RBC levels), pregnancy

FOLLICLE-STIMULATING HORMONE (FSH)

• Males: <22~IU/L • Females: nonmidcycle <20~IU/L, midcycle surge <40~IU/L (Midcycle peak should be two times basal level • Postmenopausal 40–160~IU/L • Collection: Tiger top tube

Used in the workup of impotence, infertility in men, and amenorrhea in women

Increased: (Hypergonadotropic >40 IU/L) postmenopausal, surgical castration, gonadal failure, gonadotropin-secreting pituitary adenoma

Decreased: (Hypogonadotropic <5 IU/L) prepubertal, hypothalamic and pituitary dysfunction, pregnancy

FTA-ABS (FLUORESCENT TREPONEMAL ANTIBODY ABSORBED)

• Normal = nonreactive • Collection: Tiger top tube

FTA-ABS may be negative in early primary syphilis and remain positive in spite of adequate treatment.

Positive: Syphilis (test of choice to confirm diagnosis after a reactive VDRL test), other treponemal infections can cause false-positive (Lyme disease, leprosy, malaria)

FUNGAL SEROLOGIES

• Negative <1:8 • Collection: Tiger top tube

This is a screening technique for complement-fixed fungal antibodies, which usually detects antibodies to *Histoplasma capsulatum*, *Blastomyces dermatitidis*, *Cryptococcus neoformans*, *Aspergillus* species, *Candida* species, and *Coccidioides immitis*.

7

GASTRIN, SERUM

Fasting <100 pg/mL (SI: 47.7 pmol/L)
 Postprandial 95–140 pg/mL (SI: 45.3–66.7 pmol/L)
 Collection: Tiger top tube, freeze immediately
 Make sure patient is not on H₂ blockers or antacids.

Increased: Zollinger-Ellison syndrome, medications (antacids, cimetidine, others) pyloric stenosis, pernicious anemia, atrophic gastritis, ulcerative colitis, renal insufficiency, and steroid and calcium administration

Decreased: Vagotomy and antrectomy

GGT (SERUM GAMMA-GLUTAMYL TRANSPEPTIDASE, SGGT)

Male 9–50 U/L • Female 8–40 U/L • Collection: Tiger top tube
 Generally parallels changes in serum alkaline phosphatase and 5'-nucleotidase in liver
disease. Sensitive indicator of alcoholic liver disease

Increased: Liver disease (hepatitis, cirrhosis, obstructive jaundice), pancreatitis.

GLUCOSE

Fasting, 70–105 mg/dL (SI: 3.89–5.83 nmol/L)
 2 h postprandial <140 mg/dL (SI: <7.8 nmol/L)
 To convert mg/dL to nmol/L, multiply by 0.05551
 Collection: Tiger top tube American Diabetes Association Diagnostic Criterion for Diabetes: normal fasting <110, localized for the Language of the Collection of the Language o

Impaired fasting 110–126, diabetes >126 or any random level >200 when associated with other symptoms. Confirm with repeat testing.

Increased: Diabetes mellitus, Cushing's syndrome, acromegaly, increased epinephrine (injection, pheochromocytoma, stress, burns, etc), acute pancreatitis, ACTH administration, spurious increase caused by drawing blood from a site above an IV line containing dextrose, elderly patients, pancreatic glucagonoma, drugs (glucocorticoids, some diuretics)

Decreased: Pancreatic disorders (pancreatitis, islet cell tumors), extrapancreatic tumors (carcinoma of the adrenals, stomach), hepatic disease (hepatitis, cirrhosis, tumors), endocrine disorders (early diabetes, hypothyroidism, hypopituitarism), functional disorders (after gastrectomy), pediatric problems (prematurity, infant of a diabetic mother, ketotic hypoglycemia, enzyme diseases), exogenous insulin, oral hypoglycemic agents, malnutrition, sepsis

GLUCOSE TOLERANCE TEST (GTT), ORAL (OGTT)

A fasting plasma glucose level >126 mg/dl (7.0 mmol/L) or a casual plasma glucose –200 mg/dL (11.1 mmol/L) meets the threshold for the diagnosis of diabetes, if confirmed on a subsequent day, and precludes the need for any glucose challenge. GTT is usually unnecessary to diagnose asymptomatic diabetes mellitus; it may be useful in gestational diabetes. The GTT is unreliable in the presence of severe infection, prolonged fasting, or after the injection of insulin. After an overnight fast, a fasting blood glucose is drawn, and the patient is given a 75-g oral glucose load (100 g for gestational diabetes screening, 1.75 mg/kg ideal body weight in children up to a dose of 75 g). Plasma glucose is then drawn at 30, 60, 120, and 180 min.

ч

Interpretation of GTT

Adult-Onset Diabetes: Any fasting blood sugar >126, or >200 at both 120 min and one other time interval measured

Gestational Diabetes: Any fasting blood sugar >126, 60 min >180, 120 min >155, 180 min >140

GLYCOHEMOGLOBIN (GHB, GLYCATED HEMOGLOBIN, GLYCOHEMOGLOBIN, HBA_{1C}, HBA₁ HEMOGLOBIN A_{1C}, GLYCOSYLATED HEMOGLOBIN)

• 4.6–7.1% or new standard: Nondiabetic <6, near normal 6–7 • Excellent glucose control 7–8 • Good control 8–9 • Fair control 9–10 • Poor control >10 • Collection: Lavender top tube

Useful in long-term monitoring control of blood sugar in diabetics; reflects levels over preceding 3-4 months. Glycated serum protein (GSP) under study and may reflect serum glucose over the preceding 1-2 weeks

Increased: Diabetes mellitus (uncontrolled), lead intoxication

Decreased: Chronic renal failure, hemolytic anemia, pregnancy, chronic blood loss

HAPTOGLOBIN

• 40-180 mg/dL (SI: 0.4-1.8 g/L) • Collection: Tiger top tube

Increased: Obstructive liver disease, any cause of increased ESR (inflammation, collagen-vascular diseases)

Decreased: Any type of hemolysis (transfusion reaction, etc), liver disease, anemia, oral contraceptives, children and infants

HELICOBACTER PYLORI ANTIBODY TITERS

• IgG <0.17 = negative

Most patients with gastritis and ulcer disease (gastric or duodenal) have chronic *H. pylori* infection that should be treated. Positive in 35–50% asymptomatic patients (increases with age). Use in dyspepsia controversial. Four diagnostic methods are available to test for *H. pylori*, the organism associated with gastritis and ulcers. These include noninvasive (serology and a ¹³C breath test) and invasive (gastric mucosal biopsy and the *Campylobacter*-like organism test). The IgG subclass is found in all patient populations; occasionally only IgA antibodies can be detected. Serology is most useful in the evaluation of newly diagnosed *H. pylori* infection or in monitoring response to therapy. IgG levels decrease slowly after treatment, but can remain elevated after clearing infection.

Positive: Active or recent *H. pylori* infection, some asymptomatic carriers

HEPATITIS TESTING

Recommended hepatitis panel tests based on clinical settings is shown in Table 4–2. Interpretation of testing patterns is shown in Table 4–3. Profile patterns of hepatitis A and B are shown in Figures 4–1 and 4–2, respectively.

Hepatitis Tests (Collection: Tiger top tube)

TABLE 4–2 Hepatitis Panel Testing to Guide the Ordering of Hepatitis Profiles for Given Clinical Settings

Clinical Setting	Test	Purpose
SCREENING TESTS		
Pregnancy	HBsAg*	All expectant mothers should be screened during third trimester
High-risk patients on admission (homosexuals, dialysis patients)	HBsAg	To screen for chronic or active infection
Percutaneous inoculation		
Donor	HBsAg Anti-HBc IgM Anti-Hep C	To test patient's blood (esp. dialysis and HIV patients) for infectivity with hepatitis B and C if a health care worker is exposed
Victim	HBsAg Anti-HBc Anti-Hep C	To test exposed health care worker for immunity or chronic infection
Pre-HBV vaccine	Anti-HBc Anti-HBs	To determine if an individual is infected or has antibodies to HBV
Screening blood donors	HBsAg Anti-HBc Anti-Hep C	Used by blood banks to screen donors for hepatitis B and C
DIAGNOSTIC TESTS		
Differential diagnosis of acute jaundice, hepatitis, or fulminant liver failure	HBsAg Anti-HBc IgM Anti-HAV IgM Anti-Hep C	To differentiate between HBV, HAV, and hepatitis C in an acutely jaundiced patient with hepatitis or fulminant liver failure
Chronic hepatitis	HBsAg HBeAg Anti-HBe Anti-HDV (total + IgM)	To diagnose HBV infection: if positive for HBsAg to determine infectivity If HBsAg patient worsens or
MONITORING		
Infant follow-up	HBsAg Anti-HBc	To monitor the success of vaccination and passive

TABLE 4-2 (Continued)

Test	Purpose
Anti-HBs	immunization for perinatal transmission of HBV 12–15 mo after birth
Anti-HBs	To ensure immunity has been achieved after vaccination (CDC recommends "titer" determination, but usually qualitative assay is adequate)
HBsAg Anti-HBc Anti-Hep C	To monitor sexual partners of a patient with chronic HBV or hepatitis C
	Anti-HBs Anti-HBs HBsAg Anti-HBc

TABLE 4–3
Interpretation of Viral Hepatitis Serologic Testing Patterns

Anti-HAV (IgM)	HBsAg		Anti-HBc (Total)	Anti-C (ELISA)	Interpretation
+	_	_	_	_	Acute hepatitis A
+	+	-	+	-	Acute hepatitis A in hepatitis B carrier
_	+	_	+	_	Chronic hepatitis B*
_	_	+	+	_	Acute hepatitis B
_	+	+	+	_	Acute hepatitis B
-	-	-	+	-	Past hepatitis B infection
_	_	_	_	+	Hepatitis C [†]
_	_	-	-	_	Early hepatitis C or other cause (other virus, toxin)

^{*}Patients with chronic hepatitis B (either active hepatitis or carrier state) should have HBeAg and anti-HBe checked to determine activity of infection and relative infectivity. Anti-HBs is used to determine response to hepatitis B vaccination.

[†]Anti-C often takes 3–6 mo before being positive. PCR may allow earlier detection.

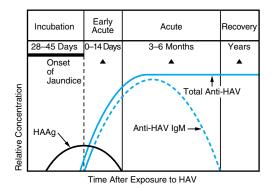


FIGURE 4-1 Hepatitis A diagnostic profile. (Courtesy of Abbott Laboratories, Diagnostic Division, North Chicago, Illinois.)

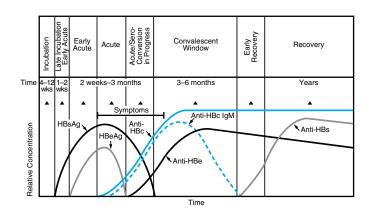


FIGURE 4-2 Hepatitis B diagnostic profile. (Courtesy of Abbott Laboratories, Diagnostic Division, North Chicago, Illinois.)

Hepatitis A

Anti-HAV Ab: Total antibody to hepatitis A virus; confirms previous exposure to hepatitis A virus, elevated for life.

Anti-HAV IgM: IgM antibody to hepatitis A virus; indicative of recent infection with hepatitis A virus; declines typically 1–6 months after symptoms

Hepatitis B

HBsAg: Hepatitis B surface antigen. Earliest marker of HBV infection. Indicates either chronic or acute infection with hepatitis B virus. Used by blood banks to screen donors; vaccination does not affect this test

Anti-HBc-Total: IgG and IgM antibody to hepatitis B core antigen; confirms either previous exposure to hepatitis B virus (HBV) or ongoing infection. Used by blood banks to screen donors

Anti-HBc IgM: IgM antibody to hepatitis B core antigen. Early and best indicator of acute infection with hepatitis B

HBeAg: Hepatitis Be antigen; when present, indicates high degree of infectivity. Order only when evaluating for chronic HBV infection

HBV-DNA: Most sensitive and specific for early evaluation of hepatitis B and may be detected when all other markers are negative

Anti-HBe: Antibody to hepatitis Be antigen; associated with resolution of active inflammation

Anti-HBs: Antibody to hepatitis B surface antigen; when present, typically indicates immunity associated with clinical recovery from HBV infection or previous immunization with hepatitis B vaccine. Order only to assess effectiveness of vaccine and request titer levels

Anti-HDV: Total antibody to delta hepatitis; confirms previous exposure. Order only in patients with known acute or chronic HBV infection.

Anti-HDV IgM: IgM antibody to delta hepatitis; indicates recent infection. Order only in cases of known acute or chronic HBV infection

Hepatitis C

Anti-HCV: Antibody against hepatitis C. Indicative of active viral replication and infectivity. Used by blood banks to screen donors. Many false-positives

HCV-RNA: Nucleic acid probe detection of current HCV infection

HIGH-DENSITY LIPOPROTEIN CHOLESTEROL

· See CHOLESTEROL, page 62.

HLA (HUMAN LEUKOCYTE ANTIGENS; HLA TYPING)

· Collection: Green top tube

This test identified a group of antigens on the cell surface that are the primary determinants of histocompatibility and useful in assessing transplantation compatibility. Some are associated with specific diseases but are not diagnostic of these diseases.

HLA-B27: Ankylosing spondylitis, psoriatic arthritis, Reiter's syndrome, juvenile RA

HLA-DR4/HLA DR2: Chronic Lyme disease arthritis

HLA-DRw2: MS

HLA-B8: Addison's disease, juvenile-onset diabetes, Grave's disease, gluten-sensitive enteropathy

HOMOCYSTEINE, SERUM

- Normal fasting 5 and 15 $\mu mol/L$ - Fasting target <10 $\mu mol/L$

Under investigation as a risk factor for CAD and atherosclerosis. Moderate, intermediate, and severe hyperhomocystinemia refer to concentrations between 16 and 30, between 31 and 100, and >100 μ mol/L, respectively. May be useful to screen high-risk patients and recommend strategies to obtain target of <10 (ie, dietary, lifestyle changes, vitamin supplementation)

Increased: Vitamin B₁₂, B₆ and folate deficiency, kidney and renal failure, medications (nicotinic acid, theophylline, methotrexate, L-dopa, anticonvulsants) advanced age, hypothyroidism, impaired kidney function, SLE, and certain medications

HUMAN CHORIONIC GONADOTROPIN, SERUM (HCG, BETA SUBUNIT)

- Normal, <3.0 mIU/mL 10 days after conception, >3 mIU/mL 30 days, 100–5000 mIU/mL 10 weeks, 50,000–140,000 mIU/mL >16 weeks, 10,000–50,000 mIU/mL
- \bullet Thereafter, levels slowly decline (SI units IU/L equivalent to mIU/mL) \bullet Collection: Tiger top tube

Increased: Pregnancy, some testicular tumors (nonseminomatous germ cell tumors, but not seminoma), trophoblastic disease (hydatidiform mole, choriocarcinoma levels usually >100,000 mIU/mL)

HUMAN IMMUNODEFICIENCY VIRUS (HIV) TESTING

See Figure 4–3 CDC guidelines. Any HIV-positive person over 13 years of age with a CD4⁺ T-cell level <200/mL or an HIV-positive patient with a series of CDC-defined indicator conditions (eg, pulmonary candidiasis, disseminated histoplasmosis, HIV wasting, Kaposi's sarcoma, TB, various lymphomas, PCP, and others) is considered to have AIDS.

HIV Antibody

• Normal = negative • Collection: Tiger top tube

Assay kits recognize both HIV-1 and HIV-2 antibodies. Used in the diagnosis of AIDS and to screen blood for use in transfusion. Antibodies appear in blood 1–4 mo after infection in most cases.

HIV Antibody, ELISA

· Normal = negative

4

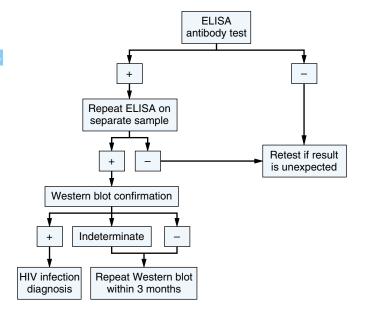


FIGURE 4-3 Diagnostic algorithm for HIV infection. (Courtesy of Burroughs-Wellcome Company, Research Triangle Park, North Carolina.)

Initial screen to detect HIV antibody; a positive test is often repeated or confirmed by Western blot.

Positive: AIDS, asymptomatic HIV infection

False-Positive: Flu vaccine within 3 months, hemophilia, rheumatoid factor, alcoholic hepatitis, dialysis patients

HIV Western Blot

Normal = negative

The technique is used as the reference procedure for confirming the presence or absence of HIV antibody, usually after a positive

HIV Antibody by ELISA Determination

Positive: AIDS, asymptomatic HIV infection (if indeterminate, repeat in 1 mo or perform PCR for HIV-1 DNA or RNA)

False-Positive: Autoimmune or connective tissue diseases, hyperbilirubinemia, HLA antibodies, others

HIV DNA PCR

· Normal = negative

Performed on peripheral blood mononuclear cells. Preferred test to diagnose HIV infection in children <18 months of age

HIV RNA PCR

• Normal = <400 copies/mL

Used to quantify plasma "viral load." Establishes the diagnosis before antibody production begins or when HIV antibody test is indeterminate. Obtained at baseline diagnosis, serves as an important parameter to initiate or modify HIV therapy (see the following details of viral load). Not recommended for routine testing of children <18 months

HIV VIRAL LOAD

• Normal <50 copies/mL

Single best predictor of progression to AIDS and death among HIV-infected individuals. Also used as a baseline and for initiation and modification of HIV therapy, but not for diagnosis. For example, antiretroviral therapy is uniformly initiated when the viral load is >20,000 copies/mL RNA or RT PCR.

HIV Antigen (P-24 antigen)

• Normal = negative

Detects early HIV infection before antibody conversion, used along with PCR testing

IMMUNOGLOBULINS, QUANTITATIVE

• IgG: 65–1500 mg/dL or 6.5–15 g/L • IgM: 40–345 mg/dL or 0.4–3.45 mg/L • IgA: 76–390 mg/dL or 0.76–3.90 g/L • IgE: 0–380 IU/mL or KIU/L • IgD: 0–8 mg/dL or 0.80 mg/L • Collection: Tiger top tube

Levels are determined in the evaluation of immunodeficiency diseases, during replacement therapy, and to evaluate humoral immunity.

Increased: Multiple myeloma (myeloma immunoglobulin increased, other immunoglobulins decreased); Waldenström's macroglobulinemia (IgM increased, others decreased); lymphoma; carcinoma; bacterial infection; liver disease; sarcoidosis; myeloproliferative disorders

Decreased: Hereditary immunodeficiency, leukemia, lymphoma, nephrotic syndrome, protein-losing enteropathy, malnutrition

IRON

 \bullet Males 65–175 mg/dL (SI: 11.64–31.33 mmol/L) \bullet Females 50–170 mg/dL (SI: 8.95–30.43 mmol/L) \bullet To convert mg/dL to mmol/L, multiply by 0.1791 \bullet Collection: Tiger top tube

Increased: Hemochromatosis, hemosiderosis caused by excessive iron intake, excess destruction or decreased production of erythrocytes, liver necrosis

Decreased: Iron deficiency anemia, nephrosis (loss of iron-binding proteins), normochromic anemia of chronic diseases and infections

ь

IRON-BINDING CAPACITY, TOTAL (TIBC)

• 250–450 mg/dL (SI: 44.75–80.55 mmol/L) • Collection: Tiger top tube
The normal iron/TIBC ratio is 20–50%. Decreased ratio (<10%) is almost diagnostic of iron deficiency anemia. Increased ratio is seen with hemochromatosis.

Increased: Acute and chronic blood loss, iron deficiency anemia, hepatitis, oral contraceptives

Decreased: Anemia of chronic diseases, cirrhosis, nephrosis/uremia, hemochromatosis, iron therapy overload, hemolytic anemia, aplastic anemia, thalassemia, megaloblastic anemia

LACTATE DEHYDROGENASE (LD, LDH)

• Adults <230 U/L, (<3.82 mkat/L) • Higher levels in childhood • Collection: Tiger top tube; carefully avoid hemolysis because this can increase LDH levels

Increased: AMI, cardiac surgery, prosthetic valve, hepatitis, pernicious anemia, malignant tumors, pulmonary embolus, hemolysis (anemias or factitious), renal infarction, muscle injury, megaloblastic anemia, liver disease

LDH Isoenzymes (LDH 1 to LDH 5)

Normally, the ratio LDH 1/LDH 2 is <0.6–0.7. If the ratio becomes >1 (also termed "flipped"), suspect a recent MI (change in ratio can also be seen in pernicious or hemolytic anemia). With an AMI, the LDH will begin to rise at 12–48 h, peak at 3–6 days, and return to normal at 8–14 days. LDH 5 is >LDH 4 in liver diseases. (Largely replaced by troponin.)

LACTIC ACID (LACTATE)

 4.5–19.8 mg/dL (SI: 0.5–2.2 mmol/L)
 Collection: Gray top tube on ice Suspect lactic acidosis with elevated anion gap in the absence of other causes (renal failure, ethanol or methanol ingestion)

Increased: Lactic acidosis due to hypoxia, hemorrhage, shock, sepsis, cirrhosis, exercise, ethanol, DKA, regional ischemia (extremity, bowel) spurious (prolonged use of a tourniquet)

LAP SCORE (LEUKOCYTE ALKALINE PHOSPHATASE SCORE/STAIN)

 50–150 • Collection: Finger stick blood sample directly on slide; air dry Used to differentiate among various hematologic conditions

Increased: Leukemoid reaction, acute inflammation, Hodgkin's disease, pregnancy, liver disease

Decreased: Chronic myelogenous leukemia, nephrotic syndrome

LE (LUPUS ERYTHEMATOSUS) PREPARATION

Normal = no cells seen

Positive: SLE, scleroderma, RA, drug-induced lupus (procainamide, others)

LEAD, BLOOD

Adult <40 mg/dL (1.93 mmol/L)
 Child <25 mg/dL (1.21 mmol/L)
 Collection: Lavender, navy, or green top tube; lab-specific

Neurologic findings can be detected at 15 mg/dL in children and 30 mg/dL in adults; severe symptoms (lethargy, ataxia, coma) are present >60 mg/dL.

Increased: Lead poisoning, occupational exposure

LEGIONELLA ANTIBODY

<1:32 titers

Obtain two sera, acute (within 2 wk of onset) and convalescent (at least 3 wk after onset of fever). A fourfold rise in titers or a single titer of 1:256 is diagnostic.

Increased: Legionella infection; false-positives with Bacteroides fragilis, Francisella tularensis, Mycoplasma pneumoniae.

LIPASE

• 0-1.5 U/mL (SI: 10-150 U/L) by turbidimetric method • Collection: Tiger top tube

Increased: Acute or chronic pancreatitis, pseudo-cyst, pancreatic duct obstruction (stone, stricture, tumor, drug-induced spasm), fat embolus syndrome, renal failure, dialysis (usually normal in mumps) gastric malignancy, intestinal perforation, diabetes (usually in DKA only)

LIPID PROFILE/LIPOPROTEIN PROFILE/LIPOPROTEIN ANALYSIS

• See also CHOLESTEROL, page 62, and TRIGLYCERIDES, page 91.

Usually includes cholesterol, HDL cholesterol, LDL cholesterol (calculated), trigly-cerides. Useful in the evaluation of CAD and allows classification of dyslipoproteinemias to direct treatment. Initial screening for cardiac risk includes total cholesterol and HDL as outlined in Figure 4–4 (page 80). The main lipids in the blood are cholesterol and triglycerides. These lipids are carried by lipoproteins. Lipoproteins are further classified by density (least dense to most dense):

- Chylomicrons (least dense, rise to surface of unspun serum) and are normally found
 only after a fatty meal is eaten (a "lipemic specimen" on a lab report usually refers to
 these chylomicrons).
- VLDL consist mainly of triglycerides.
- LDL in the fasting state; the LDL carry most cholesterol.
- HDL are the densest and consist of mostly apoproteins and cholesterol.

Table 4-4 (see page 81) indicates the dyslipoproteinemias based on the lipid profile.

LOW-DENSITY LIPOPROTEIN-CHOLESTEROL (LDL, LDL-C)

• See CHOLESTEROL, page 62.

LUTEINIZING HORMONE, SERUM (LH)

• Male 7–24 IU/L • Female 6–30 IU/L, midcycle peak increase two- to threefold over baseline, postmenopausal >35 IU/L • Collection: Tiger top tube

-

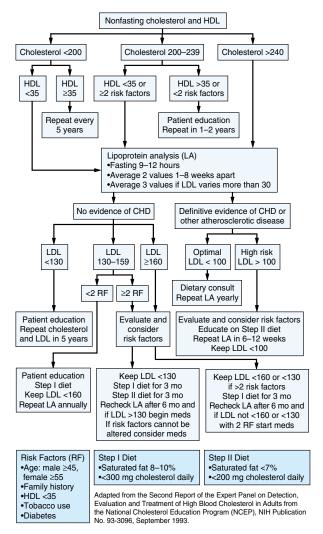


FIGURE 4-4 Cholesterol and lipoprotein screening. (Reprinted, with permission, from: Gordon JD [ed]: *Obstetrics, Gynecology, and Infertility,* 4th ed. Scub Hill Press, Menlo Park CA, 1995.)

TABLE 4-4 Lipoproteins

Fredrickson Classification System	Type I (Rare)	Type Ila (Common)	Type IIb (Common)	Type III (Uncommon)	Type IV (Uncommon)	Type V (Uncommon)
Cholesterol LDL	N or slightly ↑ N	Very ↑ ↑	Very ↑ ↑	Very ↑ ↑	N or slightly ↑ N	↑ N
HDL	N or ↓	N or ↓	N or ↓	N or ↓	N or ↓	N or ↓
Triglycerides	Very ↑	Ν	1	Very ↑	Very ↑	↑
Increased lipoproteins	Chylomicrons	LDL	LDL, VLDL	IDL	VLĎL	VLDL and chylomicrons
Atherogenesis risk	No increase	Very ↑	\uparrow	Î	No increase	No increase



Increased: (Hypergonadotropic >40 IU/L) postmenopausal, surgical or radiation castration, ovarian or testicular failure, polycystic ovaries

Decreased: (Hypogonadotropic <40 IU/L prepubertal) hypothalamic, and pituitary dysfunction, Kallmann's syndrome, LHRH analogue therapy

4

LYME DISEASE SEROLOGY

• Normal varies with assay, ELISA <1:8 • Western blot nonreactive

Most useful when comparing acute and convalescent serum levels for relative titers. Normal values differ among labs. IgM antibody becomes detectable 2–4 weeks after onset of rash; IgG rises in 4–6 weeks and peaks up to 6 mo after infection and may stay elevated for months to years.

Positive: Infection with Borrelia burgdorferi, syphilis, and other rickettsial diseases

Negative: After antibiotic therapy or during first few weeks of disease

MAGNESIUM

• 1.6-2.6 mg/dL (SI: 0.80-1.20 mmol/L) • Collection: Tiger top tube

Increased: Renal failure, hypothyroidism, magnesium-containing antacids, Addison's disease, diabetic coma, severe dehydration, lithium intoxication

Decreased: Malabsorption, steatorrhea, alcoholism and cirrhosis, hyperthyroidism, aldosteronism, diuretics, acute pancreatitis, hyperparathyroidism, hyperalimentation, NG suctioning, chronic dialysis, renal tubular acidosis, drugs (cisplatin, amphotericin B, aminoglycosides), hungry bone syndrome, hypophosphatemia, intracellular shifts with respiratory or metabolic acidosis

METYRAPONE TEST

• See Chapter 22, page 570

MHA-TP (MICROHEMAGGLUTINATION, TREPONEMA PALLIDUM)

• Normal <1:160 • Collection: Tiger top tube

Confirmatory test for syphilis, similar to FTA-ABS. Once positive, remains so, therefore cannot be used to judge effect of treatment. False-positives with other treponemal infections (pinta, yaws, etc), mononucleosis, and SLE

B₂-MICROGLOBULIN

+ 0.1–0.26 mg/dL)1–2.6 mg/L) + Collection: Tiger top tube

A portion of the class I MHC antigen. A useful marker to follow the progression of HIV infections

Increased: HIV infection, especially during periods of exacerbation, lymphoid malignancies, renal diseases (diabetic nephropathy, pyelonephritis, ATN, nephrotoxicity from medications), transplant rejection, inflammatory conditions

Decreased: Treatment of HIV with AZT (zidovudine)

MONOSPOT

• Normal = negative • Collection: Tiger top tube

Positive: Mononucleosis, rarely in leukemia, serum sickness, Burkitt's lymphoma, viral hepatitis, RA

MYOGLOBIN

• 30-90 ng/mL • Collection: Tiger top tube

Increased: Skeletal muscle injury (crush, injection, surgical procedures), delirium tremens, rhabdomyolysis (burns, seizures, sepsis, hypokalemia, others)

5'-NUCLEOTIDASE

• 2-15 U/L

Used in the workup of increased alkaline phosphatase and biliary obstruction

Increased: Obstructive or cholestatic liver disease, liver metastasis, biliary cirrhosis

OLIGOCLONAL BANDING, CSF

• Normal = negative • Collection: Serum tiger top tube and simultaneous CSF sample collected in a plain tube by LP

This is performed simultaneously on CSF and serum samples when MS is clinically suspected. Agarose gel electrophoresis will reveal multiple bands in the IgG region not seen in the serum. Oligoclonal banding is present in up to 90% of patients with MS. Occasionally seen in other CNS inflammatory conditions and CNS syphilis

OSMOLALITY, SERUM

• 278-298 mOsm/kg (SI: 278-298 mmol/kg) • Collection: Tiger top tube

A rough estimation of osmolality is [2(Na) + BUN/2.8 + glucose/18]. Measured value is usually less than calculated value. If measured value is 15 mOsm/kg less than calculated, consider methanol, ethanol, or ethylene glycol ingestion.

Increased: Hyperglycemia; ethanol, methanol, mannitol, or ethylene glycol ingestion; increased sodium because of water loss (diabetes, hypercalcemia, diuresis)

Decreased: Low serum sodium, diuretics, Addison's disease, SIADH (seen in bronchogenic carcinoma, hypothyroidism), iatrogenic causes (poor fluid balance)

OXYGEN

• See Chapter 8, Table 8-1, page 162

P-24 ANTIGEN (HIV CORE ANTIGEN)

• Normal = negative • Collection: Tiger top tube • See also Human Immunodeficiency Virus Testing, page 75

Used to diagnose recent acute HIV infection; becomes positive earlier than HIV antibodies. Decreases "window" period. Can be positive as early as 2–4 weeks but becomes undetectable during antibody seroconversion (periods of latency). With progression of disease, P-24 usually becomes evident again. Used to screen blood donors 7

PARATHYROID HORMONE (PTH)

- · Normal based on relationship to serum calcium, usually provided on the lab report
- Also, reference values vary depending on the laboratory and whether the N-terminal, C-terminal or midmolecule is measured.
 PTH midmolecule: 0.29--0.85 ng/mL (SI: 29-85 pmol/L)
 With calcium: 8.4-10.2 mg/dL (SI: 2.1-2.55 mmol/L)
 Collection: Tiger top tube

Increased: Primary hyperparathyroidism, secondary hyperparathyroidism (hypocalcemic states, such as chronic renal failure, others)

Decreased: Hypercalcemia not due to hyperparathyroidism, hypoparathyroidism

PHOSPHORUS

Adult 2.5–4.5 mg/dL (SI: 0.81–1.45 mmol/L)
 Child 4.0–6.0 mg/dL (SI: 1.29–1.95 mmol/L)
 To convert mg/dL to mmol/L, multiply by 0.3229
 Collection: Tiger top tube

Increased: Hypoparathyroidism (surgical, pseudo-hypoparathyroidism), excess vitamin D, secondary hyperparathyroidism, renal failure, bone disease (healing fractures), Addison's disease, childhood, factitious increase (hemolysis of specimen)

Decreased: Hyperparathyroidism, alcoholism, diabetes, hyperalimentation, acidosis, alkalosis, gout, salicylate poisoning, IV steroid, glucose or insulin administration, hypokalemia, hypomagnesemia, diuretics, vitamin D deficiency, phosphate-binding antacids

POTASSIUM, SERUM

• 3.5-5 mEq/L (SI: 3.5-5 mmol/L) • Collection: Tiger top tube

Increased: Factitious increase (hemolysis of specimen, thrombocytosis), renal failure, Addison's disease, acidosis, spironolactone, triamterene, ACE inhibitors, dehydration, hemolysis, massive tissue damage, excess intake (oral or IV), potassium-containing medications, acidosis

Decreased: Diuretics, decreased intake, vomiting, nasogastric suctioning, villous adenoma, diarrhea, Zollinger–Ellison syndrome, chronic pyelonephritis, renal tubular acidosis, metabolic alkalosis (primary aldosteronism, Cushing's syndrome)

PREALBUMIN

See Chapter 11, page 211

PROGESTERONE

· Collection: Tiger top tube

Used to confirm ovulation and corpus luteum function

 Sample Collection
 Normal Values (female)

 Follicular phase
 <1 ng/mL</td>

 Luteal phase
 5-20 ng/mL

 Pregnancy
 10-30 ng/mL

 2nd trimester
 50-100 ng/mL

 3rd trimester
 100-400 ng/mL

Postmenopause -1 ng/mL

PROLACTIN

 • Males 1–20 ng/mL (SI: 1–20 mg/L) • Females 1–25 ng/mL (SI: 1–25 mg/L) • Collection: Tiger top tube

Used in the workup of infertility, impotence, hirsutism, amenorrhea, and pituitary neo-plasm

Increased: Pregnancy, nursing after pregnancy, prolactinoma, hypothalamic tumors, sarcoidosis or granulomatous disease of the hypothalamus, hypothyroidism, renal failure, Addison's disease, phenothiazines, haloperidol

PROSTATE-SPECIFIC ANTIGEN (PSA)

• <4 ng/dL by monoclonal, eg, Hybritech assay

Most useful as a measure of response to therapy of prostate cancer; approved for screening for prostate cancer. Although any elevation increases suspicion of prostate cancer, levels >10.0 ng/dL are frequently associated with carcinoma. Age corrected levels gaining popularity (40–50 y 2.5 ng/dL; 50–60 y 3.5 ng/dL; 60–70 years 4.5 ng/dL; >70 years 6.5 ng/dL.)

Increased: Prostate cancer, acute prostatitis, some cases of BPH, prostatic infarction, prostate surgery (biopsy, resection), vigorous prostatic massage (routine rectal exam does not elevate levels), rarely postejaculation

Decreased: Radical prostatectomy, response to therapy of prostatic carcinoma (radiation or hormonal therapy)

PSA Velocity

A rate of rise in PSA of 0.75 ng/mL or greater per year is suspicious for prostate cancer based on at least three separate assays 6 mo apart.

PSA Free and Total

Patients with prostate cancer tend to have lower free PSA levels in proportion to total PSA. Measurement of the free/total PSA can improve the specificity of PSA in the range of total PSA from 2.0–10.0 ng/mL. Some recommend prostate biopsy only if the free PSA percentage is low. Threshold for biopsy is controversial, ranging from a ratio of less than 15% to less than 25%, with a higher threshold having improved sensitivity and lower threshold having improved specificity.

PROTEIN ELECTROPHORESIS, SERUM AND URINE (SERUM PROTEIN ELECTROPHORESIS, SPEP) (URINE PROTEIN ELECTROPHORESIS, UPEP)

Qualitative analysis of the serum proteins is often used in the workup of hypoglobulinemia, macroglobulinemia, α_1 -antitrypsin deficiency, collagen disease, liver disease, myeloma, and occasionally in nutritional assessment. Serum electrophoresis yields five different bands (Figure 4–5 and Table 4–5, pages 86 and 87). If a monoclonal gammopathy or a low globulin fraction is detected, quantitative immunoglobulins should be ordered.

Urine protein electrophoresis can be used to evaluate proteinuria and can detect Bence Jones protein (light chain) that is associated with myeloma, Waldenström's macroglobulinemia, and Fanconi's syndrome.

4

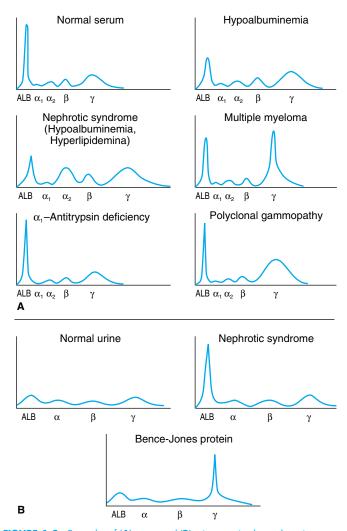


FIGURE 4–5 Examples of **(A)** serum and **(B)** urine protein electrophoresis patterns. See also Table 4–5. (Courtesy of Dr. Steven Haist.)

TABLE 4-5 Normal Serum Protein Components and Fractions as Determined by Electrophoresis, Along with Associated Conditions*

Protein Fraction	of Total Protein	Constituents	Increased	Decreased
Albumin	52–68	Albumin	Dehydration (only known cause)	Nephrosis, malnutri- tion, chronic liver disease
Alpha-1 (α ₁) globulin	2.4–4.4	Thyroxine- binding globulin, antitrypsin, lipoproteins, glycoprotein, transcortin	Inflammation, neoplasia	Nephrosis, α_1 -anti- trypsin deficiency (emphy- sema related)
Alpha-2 (α ₂) globulin	6.1–10.1	Haptoglobin, glycoprotein, macroglobulin, ceruloplasmin	Inflammation, infection, neoplasia, cirrhosis	Severe liver disease, acute hemolytic anemia
Beta (β) globulin	8.5–14.5	Transferrin, glycoprotein, lipoprotein	Cirrhosis, obstructive jaundice	Nephrosis
Gamma (y) globulins (immuno- globulins)	10–21	IgA, IgG, IgM, IgD, IgE	Infections, collagen vascular diseases, leukemia, myeloma	Agammaglob- ulinemia, hypo- gamma- globuline- mia,neph- rosis

PROTEIN, SERUM

• 6.0-8.0 g/dL • See also Serum Protein Electrophoresis, page 85. • Collection: Tiger top tube

Increased: Multiple myeloma, Waldenström's macroglobulinemia, benign monoclonal gammopathy, lymphoma, chronic inflammatory disease, sarcoidosis, viral illnesses

Decreased: Malnutrition, inflammatory bowel disease, Hodgkin's disease, leukemias, any cause of decreased albumin

RENIN

Plasma (Plasma Renin Activity [PRA])

• Adults, Normal sodium diet, upright 1–6 ng/mL/h (SI: 0.77–4.6 nmol/L/h) • Renal vein renin: L & R should be equal)

Useful in the diagnosis of hypertension associated with hypokalemia. Values highly dependent on salt intake and position. Stop diuretics, estrogens for 2–4 wk before testing.

Increased: Medications (ACE inhibitors, diuretics, oral contraceptives, estrogens), pregnancy, dehydration, renal artery stenosis, adrenal insufficiency, chronic hypokalemia, upright posture, salt-restricted diet, edematous conditions (CHF, nephrotic syndrome), secondary hyperaldosteronism

Decreased: Primary aldosteronism (renin will not increase with relative volume depletion, upright posture)

Renal Vein

Normal L & R should be equal
 A ratio of >1.5 (affected/nonaffected) suggestive of renovascular hypertension

RETINOL-BINDING PROTEIN (RBP)

• Adults 3-6 mg/dL • Children 1.5-3.0 mg/dL • Collection: Tiger top tube

Decreased: Malnutrition, vitamin A deficiency, intestinal malabsorption of fats, chronic liver disease

RHEUMATOID FACTOR (RA LATEX TEST)

• <15 IU by Microscan kit or <1:40 • Collection: Tiger top tube

Increased: Collagen-vascular diseases (RA, SLE, scleroderma, polyarteritis nodosa, others), infections (TB, syphilis, viral hepatitis), chronic inflammation, SBE, some lung diseases, MI

ROCKY MOUNTAIN SPOTTED FEVER ANTIBODIES (RMSF)

- • Normal: <4(times) increase in paired acute and convalescent sera • IgG <1:64 • IgM <1:8 • Collection: Tiger top tube acute and convalescent
- The diagnosis of RMSF is made by acute and convalescent titers that demonstrate a $4\times$ rise or a single convalescent titer >1:64 in the clinical setting of RMSF. Occasional false-positives in late pregnancy

SEMEN ANALYSIS

 • Volume 2–5 mL • Sperm count >20-40 \times $10^6/mL$ • Motility >60% • Forward migration • Morphology >60% normal

Specimen must be collected after 48–72 h abstinence and analyzed within 1–2 h. Test may not be valid after a recent illness or high fever. Verify abnormal analysis by serial tests.

Decreased: After vasectomy (should be 0 sperm after 3 mo), varicocele, primary testicular failure (ie, Klinefelter's syndrome), secondary testicular failure (chemotherapy, radiation, infections), varicocele, after recent illness, congenital obstruction of the vas, retrograde ejaculation, endocrine causes (hyperprolactinemia, low testosterone, others)

SGGT (SERUM GAMMA-GLUTAMYL TRANSPEPTIDASE)

· See GGT, page 69.

SGOT (SERUM GLUTAMIC-OXALOACETIC TRANSAMINASE)

· See AST, page 58.

SGPT SERUM (GLUTAMIC-PYRUVIC TRANSAMINASE)

• See ALT, page 57.

SODIUM, SERUM

• 136-145 mmol/L • Collection: Tiger top tube

In factitious hyponatremia due to hyperglycemia, for every 100 mmol/L blood glucose above normal, serum sodium decreases 1.6. For example, a blood glucose of 800 and a sodium of 129 would factitiously lower the sodium value by about 7×1.6 , or 11.6. Corrected serum sodium would therefore be 129 + 11 = 140.

Increased: Associated with low total body sodium (glycosuria, mannitol, or lactulose use urea, excess sweating), normal total body sodium (diabetes insipidus [central and nephrogenic], respiratory losses, and sweating), and increased total body sodium (administration of hypertonic sodium bicarbonate, Cushing's syndrome, hyperaldosteronism)

Decreased: Associated with excess total body sodium and water (nephrotic syndrome, CHF, cirrhosis, renal failure), excess body water (SIADH, hypothyroidism, adrenal insufficiency), decreased total body water and sodium (diuretic use, renal tubular acidosis, use of mannitol or urea, mineralocorticoid deficiency, vomiting, diarrhea, pancreatitis), and pseudo-hyponatremia (hyperlipidemia, hyperglycemia, and multiple myeloma)

STOOL FOR OCCULT BLOOD (HEMOCCULT TEST)

Normal-Negative: Apply small amount of stool to test site on Hemoccult card and close. Open test panel on other side of card and apply 2–3 drops developer to the test and the positive control panels; read in 30 s. Blue color is positive. Detects >5 mg hemoglobin/g feces. Repeat three times for maximum yield. (A positive test more informative than a negative test)

Positive: Any GI tract ulcerated lesion (ulcer, carcinoma, polyp, diverticulosis, inflammatory bowel disease), hemorrhoids, telangiectasias, drugs that cause GI irritation (eg, NSAIDs) swallowed blood, ingestion of rare red meat, certain foods (horseradish, turnips) (vitamin C [>500 mg/d], antacids may result in false-negative test)

SWEAT CHLORIDE

• 5-40 mEq/L (SI: 5-40 mmol/L) • Collection: 100-200 mg sweat on filter paper after electrical stimulation of sweating by pilocarpine iontophoresis on an extremity

-

Increased: CF (not valid on children <3 wk); Addison's disease, meconium ileus, and renal failure can occasionally raise levels.

T₃ RU (RESIN UPTAKE; THYROXINE-BINDING GLOBULIN RATIO)

• 30-40%

This test is used in conjunction with a T_4 to yield the Free T_4 Index [FTI]), an estimate of the free T_4 .

Increased: Hyperthyroidism, medications (phenytoin [Dilantin], steroids, heparin, aspirin, others), nephrotic syndrome

Decreased: Hypothyroidism, medications (iodine, propylthiouracil, others), any cause of increased TBG, such as oral estrogen or pregnancy

TESTOSTERONE

• Male free: 9-30 ng/dL, total 300-1200 ng/dL • Female, see following table

Sample Collection	Normal Values
Follicular phase	20-80 ng/dL
Midcycle peak	20-80 ng/dL
Luteal phase	20-80 ng/dL
Postmenopause	10-40 ng/dL

Increased: Adrenogenital syndrome, ovarian stromal hyperthecosis, polycystic ovaries, menopause, ovarian tumors.

(female)

Decreased: Some cases of impotence, hypogonadism, hypopituitarism, Klinefelter's syndrome

THYROGLOBULIN

1–20 ng/mL (mg/L) • Collection: Tiger top tube
 Useful for following patients with nonmedullary thyroid carcinomas

Increased: Differentiated thyroid carcinomas (papillary, follicular), Graves' disease, nontoxic goiter

Decreased: Hypothyroidism, testosterone, steroids, phenytoin

THYROID-STIMULATING HORMONE (TSH)

• 0.7-5.3 mU/mL • Collection: Tiger top tube

Excellent screening test for hyperthyroidism as well as hypothyroidism. Differentiates between a low normal and a decreased TSH

Increased: Hypothyroidism

Decreased: Hyperthyroidism. Less than 1% of hypothyroidism is from pituitary or hypothalamic disease resulting in a decreased TSH.

THYROXINE (T₄ TOTAL)

- 5-12 mg/dL (SI: 65-155 nmol/L) Males: >60 years, 5-10 mg/dL (SI: 65-129 nmol)
- Females: 5.5–10.5 μg/dL (SI: 71–135 nmol/L)
 Collection: Tiger top tube

Good screening test for hyperthyroidism. Measures both bound and free T_4 , therefore, can be affected by TBG levels.

Increased: Hyperthyroidism, exogenous thyroid hormone, estrogens, pregnancy, severe illness, euthyroid sick syndrome

Decreased: Hypothyroidism, euthyroid sick syndrome, any cause of decreased TBG

THYROXINE-BINDING GLOBULIN (TBG)

• 21-52 mg/dL (270-669 nmol/L) • Collection: Tiger top tube

Increased: Hypothyroidism, pregnancy, oral contraceptives, estrogens, hepatic disease, acute porphyria

Decreased: Hyperthyroidism, androgens, anabolic steroids, prednisone, nephrotic syndrome, severe illness, surgical stress, phenytoin, hepatic disease

THYROXINE INDEX, FREE (FTI)

• 6.5-1.25

Practically speaking, the FTI is equivalent to the free thyroxine. Useful in patients with clinically suspected hyper- or hypothyroidism. Determined as follows:

Thyroxine (Total T_4) $\times T_3$ RU

Increased: Hyperthyroidism, high-dose beta-blockers, psychiatric illnesses

Decreased: Hypothyroidism, phenytoin (Dilantin)

TORCH BATTERY

Normal = negative • Collection: Tiger top tube
 Serial determinations best (acute and convalescent titers).

Test is based on serologic evidence of exposure to toxoplasmosis, rubella, cytomegalovirus, and herpesviruses.

TRANSFERRIN

• 220–400 mg/dL (SI: 2.20–4.0 g/L) • Collection: Tiger top tube, avoid hemolysis Used in the workup of anemias; transferrin levels can also be assessed by the total ironbinding capacity.

Increased: Acute and chronic blood loss, iron deficiency, hemolysis, oral contraceptives, pregnancy, viral hepatitis

Decreased: Anemia of chronic disease, cirrhosis, nephrosis, hemochromatosis, malignancy

TRIGLYCERIDES

Recommended values: • Males: 40–160 mg/dL (SI: 0.45–1.81 mmol/L) • Females:
 35–135 mg/dL (SI: 0.40–1.53 mmol/L) • Can vary with age. • Collection: Tiger top tube
 Fasting preferred • See also LIPID PROFILE page 79

Increased: Nonfasting specimen, hyperlipoproteinemias (types I, IIb, III, IV, V), hypothyroidism, liver diseases, poorly controlled diabetes mellitus, alcoholism, pancreatitis,

Ė

AMI, nephrotic syndrome, familial, medications (oral contraceptives, estrogens, betablockers, cholestyramine)

Decreased: Malnutrition, malabsorption, hyperthyroidism, Tangier disease, medications (nicotinic acid, clofibrate, gemfibrozil) congenital abetalipoproteinemia

TRIIODOTHYRONINE (T₃ RIA)

• 120-195 ng/dL (SI: 1.85-3.00 nmol/L) • Collection: Tiger top tube

Useful when hyperthyroidism is suspected, but T_4 is normal; not useful in the diagnosis of hypothyroidism

Increased: Hyperthyroidism, T₃ thyrotoxicosis, pregnancy, exogenous T₄, any cause of increased TBG, such as oral estrogen or pregnancy

Decreased: Hypothyroidism and euthyroid sick state, any cause of decreased TBG

TROPONIN, CARDIAC-SPECIFIC

Troponin 1 (cTn1) <0.35 ng/mL
 Troponin T cTnT <0.2 μg/L

Used to diagnose AMI; increases rapidly 3–12 h, peak at 24 h and may stay elevated for several days (cTn1 5–7 days, cTnT up to 14 days). More cardiac-specific than CK-MB

Positive: Myocardial damage, including MI, myocarditis (false-positive: renal failure)

URIC ACID (URATE)

Males: 3.4–7 mg/dL (SI: 202–416 mmol/L)
 Females: 2.4–6 mg/dL (SI: 143–357 mmol/L)
 To convert mg/dL to mmol/L, multiply by 59.48
 Collection: Tiger top tube Increased uric acid is associated with increased catabolism, nucleoprotein synthesis, or decreased renal clearing of uric acid (ie, thiazide diuretics or renal failure).

Increased: Gout, renal failure, destruction of massive amounts of nucleoproteins (leukemia, anemia, chemotherapy, toxemia of pregnancy), drugs (especially diuretics), lactic acidosis, hypothyroidism, PCKD, parathyroid diseases

Decreased: Uricosuric drugs (salicylates, probenecid, allopurinol), Wilson's disease, Fanconi's syndrome

VDRL TEST (VENEREAL DISEASE RESEARCH LABORATORY) OR RAPID PLASMA REAGIN (RPR)

• Normal = nonreactive • Collection: Tiger top tube

Good screening for syphilis. Almost always positive in secondary syphilis, but frequently becomes negative in late syphilis. Also, in some patients with HIV infection, the VDRL can be negative in primary and secondary syphilis.

Positive (Reactive): Syphilis, SLE, pregnancy and drug addiction. If reactive, confirm with FTA-ABS (false-positives with bacterial or viral illnesses).

VITAMIN B₁₂ (EXTRINSIC FACTOR, CYANOCOBALAMIN)

• >100–700 pg/mL (SI: 74–516 pmol/L) • Collection: Tiger top tube

Increased: Excessive intake, myeloproliferative disorders

Decreased: Inadequate intake (especially strict vegetarians), malabsorption, hyperthyroidism, pregnancy

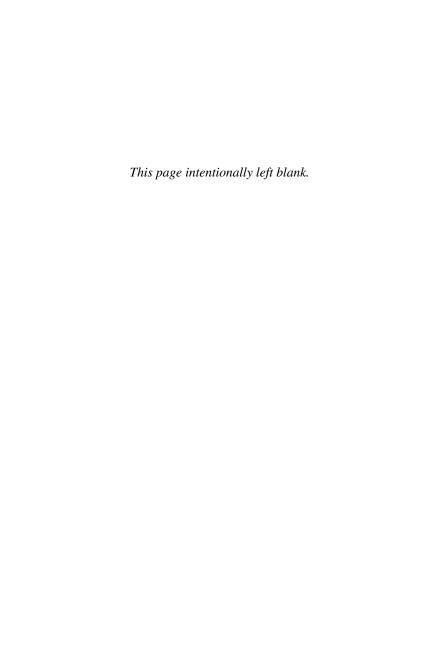
ZINC

 • 60–130 mg/dL (SI: 9–20 mmol/L) • Collection: Check with lab; special collection to limit contamination

Increased: Atherosclerosis, CAD

Decreased: Inadequate dietary intake (parenteral nutrition, alcoholism); malabsorption; increased needs, such as pregnancy or wound healing; acrodermatitis enteropathica; dwarfism

Θ



LABORATORY DIAGNOSIS: CLINICAL HEMATOLOGY

Blood Collection Blood Smears: Wright's Stain Normal CBC Values Normal CBC Variations Hematocrit Three-Cell Differential Count The "Left Shift" CBC Differential Diagnosis Lymphocyte Subsets RBC Morphology Differential Diagnosis WBC Morphology Differential Diagnosis Coagulation and Other Hematologic

BLOOD COLLECTION

Reticulocyte Count

Venipuncture is discussed in detail in Chapter 13, page 39. The best CBC sample is venous blood drawn with at least a 22-gauge or larger needle. For a routine CBC, venous blood needs to be placed in a special hematology lab tube, usually a purple top tube, that has an anticoagulant (EDTA) and that is mixed gently. Blood for a CBC should be fresh, less than 3 h old. Most coagulation studies are submitted in a blue top (citrate) tube. (See page 311 for detailed description of blood collection tubes.)

If a **capillary fingerstick** or **heelstick** (see page 274) is used, the hematocrit may be falsely low. If the finger needs to be "milked," sludging of the RBCs can create a falsely high hematocrit. In practice, you can draw the blood up in a capillary tube, seal an end with clay, and spin a tube on the hematocrit centrifuge for 2–3 min and rapidly determine a hematocrit. Wright's staining can also be done and viewed as outlined in the next section.

BLOOD SMEARS: WRIGHT'S STAIN Making the Blood Smear

In some clinical situations a quick interpretation of a smear can be useful.

- Place a small drop of blood from the anticoagulated lab sample tube (usually purple top) in the center of a clean glass slide, about 1–2 cm from the end.
- 2. Place the spreading slide (a glass slide with a perfectly smooth edge) at a 45-degree angle on the slide with the blood sample and slowly move it back to make contact with the drop. The drop should spread out quickly along the line of contact between the two slides. The moment this occurs, spread the film by a rapid, smooth forward movement of the spreader (Figure 5–1).
- 3. The drop of blood should result in a film about 3 cm long. The faster a film is spread, the more even it is and the better the slide it produces. The ideal thickness shows some overlap by the RBCs throughout much of the film's length with separation and lack of distortion toward the feathered edge of the film. Leukocytes should be easily recognizable throughout the length of the film.

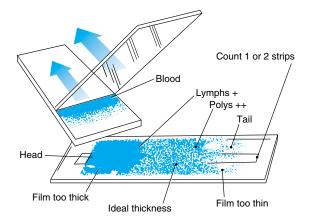


FIGURE 5-1 The technique of preparing a blood smear for staining and the distribution of white blood cells on the standard smear.

Staining the Blood Smear (Wright's stain)

Make sure that all reagents are fresh, or the slide may not turn out properly.

- Let the slide air dry, and mark the patient's name and date in pencil on the blood film itself. It will not be removed by staining. An alternative method is to bring the slide to the hematology lab where instruments can automatically stain the slides.
- 2. Fix the slide in methanol for 1 min.
- 3. Shake off excess methanol from the slide, but do not rinse or dry it.
- Flood the slide with Wright's stain, and allow the slide to stand for 3–5 min. (This time can vary with the batch of stain.)
- 5. Flood the slide with Wright's buffer (pH 6.4) until about 50% of the Wright's stain is washed off. Blow air gently over the top of the slide to mix the fluids, and look for a greenish copper sheen that appears on the surface. Let the slide stand for about 8 min.
- 6. Rinse the slide with tap water, wipe the back of the slide with methanol, and air dry it.

Viewing the Film: The Differential WBC

- The film should not be so thick that the leukocytes in the body of the film shrink. Examine the smear in an area where the red cells approximate but do not overlap.
- 2. If the film is too thin or if a rough-edged spreader is used, up to 50% of the WBCs may accumulate in the edges and tail (See Fig. 5–1).
- 3. WBCs are NOT randomly dispersed even in a well-made smear. Polys and monos predominate at the margins and tail, and lymphs are prevalent in the middle of the film. To overcome this problem, use the "high dry" or oil immersion objective, and count cells in a strip running the whole length of the film. Avoid the lateral edges of the film.

TABLE 5–1
Estimated WBC Based on Cells Counted in a Blood Smear

WBC/hpf (high dry or 40×)	Estimated WBC (per mm ³)
2–4 4–6 6–10	4000–7000 7000–10,000
6–10 10–20	10,000–13,000 13,000–18,000
Abbreviations: WBC = white blood cell; hp	of = high-power field.

- 4. If fewer than 200 cells are counted in a strip, count another strip until at least 200 are seen. The special white cell counter found in most labs is ideal for this purpose. In patients receiving chemotherapy, the total count may be so small that only a 25–50 cell differential is possible.
- 5. In smears of blood from patients with very high white counts, such as those with leukemia, count the cells in any well-spread area where the different cell types are easy to identify. Table 5–1 shows the correlation between the number of cells in a smear and the estimated white cell count. A platelet count can be estimated by averaging the number of platelets seen in 10 hpf (oil immersion) and multiplying by 20,000.

NORMAL CBC VALUES

A CBC panel generally includes WBC count, RBC count, hemoglobin, hematocrit, MCH, MCHC, MCV, and the RDW and platelets. The differential is usually ordered separately. Normal CBC, differential, and platelet values are outlined in Tables 5–2 and 5–3.

NORMAL CBC VARIATIONS

Hemoglobin and hematocrit are highest at birth (20 g/100 mL and 60%, respectively). The values fall steeply to a minimum at 3 mo (9.5 g/100 mL and 32%). Then they slowly rise to near adult levels at puberty, and thereafter both values are higher in males. A normal decrease occurs in pregnancy. The number of WBCs is highest at birth (mean of 25,000/mm³) and slowly falls to adult levels by puberty. Lymphs predominate (up to 60% from the second week of life until age 5–7 y when polys begin to predominate.

HEMATOCRIT

The hematocrit is a simple screening test and can be performed on the medical floor as described previously (page 95). Always remember that because an equal amount of plasma and red cells are lost in acute blood loss, the hematocrit will not reflect the loss until sometime later (sometimes 2–3 h). If an anemia is suspected, the red cell indices and reticulocyte count should be checked.

THREE-CELL DIFFERENTIAL COUNT

Instead of a manual differential count of WBCs, many labs now rely on a **three-cell differential count** that is automatically performed by newer instruments. White cells are separated on the basis of three sizes: **small cells** (mostly normal lymphocytes), **middle cells**

TABLE 5-2 Normal CBC for Selected Age Ranges

Age	WBC Count (cells/mm³) [SI: 10°/L]	RBC Count (10 ⁶ /µL) [SI: 10 ¹² /L]	Hemoglobin (g/dL) [Sl: g/L]	Hematocrit (%)	MCH (pg) [SI: pg]	MCHC (g/dL) [SI: g/L]*	MCV (µm³) [SI: fL]	RDW
Adult ?	4500–11,000 [4.5–11.0]	4.73–5.49 [4.73–5.49]	14.40–16.60 [144–166]	42.9–49.1	27 – 31	33–37	76–100	11.5–14.5
Adult /	As above	4.15–4.87	12.2–14.7	37.9–43.9	As above	As above	As above	As above
		[4.15–5.49]	[122–1 <i>47</i>]					
11-15 years	4500–13,500	4.8	13.4	39	28	34	82	
6–10 years	5000-14,500	4.7	12.9	37.5	27	34	80	
4–6 years	5500-15,500	4.6	12.6	37.0	27	34	80	
2-4 years	6000-17,000	4.5	12.5	35.5	25	32	77	
4 mo-2 y	6000-17,500	4.6	11.2	35.0	25	33	77	
1 wk-4 mo	5500-18,000	4.7±0.9	14.0±3.3	42.0±7.0	30	33	90	
24 hr-1 wk	5000-21,000	5.1	18.3±4.0	52.5	36	35	103	
First day	9400-34,000	5.1±1.0	19.5±5.0	54.0±10.0	38	36	106	

^{*}To convert standard reference value to SI units, multiply by 10.

Abbreviations: WBC = white blood cell; MCH = mean cell hemoglobin; MCHC = mean cell hemoglobin concentration; MCV = mean cell volume; RDW = red cell distribution width.

TABLE 5-3 Normal CBC for Selected Age Ranges

Age	Platelet Count (10³/µL) [SI: 10°/L]	Lymphocytes, Total (% WBC count)	Neutrophils, Band (% WBC count)	Neutrophils, Segmented (% WBC count)	Eosinophils (% WBC count)	Basophils (% WBC count)	Monocytes (% WBC count)
Adult ?	238±49	34	3.0	56	2.7	0.5	4.0
Adult /	270±58	As above	As above	As above	As above	As above	As above
11-15 years	282±63	38	3.0	51	2.4	0.5	4.3
6–10 years	351±85	39	3.0	50	2.4	0.6	4.2
4–6 years	357±70	42	3.0	39	2.8	0.6	5.0
2–4 years	357±70	59	3.0	30	2.6	0.5	5.0
4 mo-2 y	As above	61	3.1	28	2.6	0.4	4.8
1 wk-4 mo	As above	56	4.5	30	2.8	0.5	6.5
24 hr-1 wk	240-380	24-41	6.8-9.2	39-52	2.4-4.1	0.5	5.8-9.1
First day	As above	24	10.2	58	2.0	0.6	5.8

(monocytes, eosinophils, large lymphocyte variants), and large cells (neutrophils [stabs and band cells]). Each lab sets its own reference ranges based on "normal" populations. If one of the three cell populations falls outside the reference range, the sample is made into a slide, and a microscopic differential count is performed. With the anticipated shortage of health care workers and the expense of manual counting, these types of determinations will become more widely used.

As an example of the three-cell count, a patient with sepsis may have a large-cell count of 95% and a small-cell count of 5% with no middle cells. On manual examination of the slide, there may be 70% segmented neutrophils and 25% stabs, for a total of 95%.

THE "LEFT SHIFT"

The degree of nuclear lobulation of PMNs is thought to give some indication of cell age. A predominance of immature cells with only one or two nuclear lobes separated by a thick chromatin band is called a "shift to the left." Conversely, a predominance of cells with four nuclear lobes is called a "shift to the right." (For historical information, left and right designations come from the formerly used manual lab counters, in which the keys for entering the stabs were located on the left of the keyboard.)

As a general rule, 40–50% of PMNs have three lobes, approximately 5% have two lobes, and 15–25% have four lobes. More than 20 five-lobed cells/100 WBCs suggest incipient megaloblastic anemia, and a six-lobed or seven-lobed poly is virtually diagnostic.

"Bands" or "stabs," the more immature forms of PMNs (the more mature are called "segs"), are identified by the fact that the connections between ends or lobes of a nucleus are greater than one-half the width of the hypothetical round nucleus. In bands or stabs, the connection between the lobes of the nucleus is by a thick band; in segs, by a thin filament. A band is defined as a connecting strip wide enough to reveal two distinct margins with nuclear material in between. A filament is so narrow that no intervening nuclear material is present. When in doubt if a cell is a band or seg, call it a seg.

For practical purposes, a left shift is present in the CBC when more than 10–12% bands are seen or when the total PMN count (segs plus bands) is greater than 80.

Left Shift: Bacterial infection, toxemia, hemorrhage

Right Shift: Liver disease, megaloblastic anemia, iron deficiency anemia

RETICULOCYTE COUNT

· Collection: Lavender top tube

The reticulocyte count is not a part of the routine CBC. The count is used in the initial workup of anemia (especially unexplained) and in monitoring the effect of hematinic or erythropoietin therapy, monitoring the recovery from myelosuppression or monitoring engraftment following bone marrow transplant. Reticulocytes are juvenile RBCs with remnants of cytoplasmic basophilic RNA. These are suggested by **basophilia** of the RBC cytoplasm on Wright's stain; however, confirmation requires a special reticulocyte stain. The result is reported as a percentage, and you should calculate the **corrected reticulocyte count** for interpretation of the results

$$Corrected reticulocyte count = \frac{Reported count \times Patient' s HCT}{Normal HCT}$$

This corrected count is an excellent indicator of erythropoietic activity. The **normal** corrected reticulocyte count is <1.5.

Normal bone marrow responds to a decrease in erythrocytes (shown by a decreased hematocrit) with an increase in the production of reticulocytes. Lack of increase in a reticulocyte count with an anemia suggests a chronic disease, a deficiency disease, marrow replacement, or marrow failure.

CBC DIFFERENTIAL DIAGNOSIS

See Tables 5–2 and 5–3 for normal age and sex-specific ranges.

Basophils

0-1%

Increased: Chronic myeloid leukemia, after splenectomy, polycythemia, Hodgkin's disease, and, rarely, in recovery from infection and from hypothyroidism

Decreased: Acute rheumatic fever, pregnancy, after radiation, steroid therapy, thyrotoxicosis, stress

Eosinophils

• 1-3%

Increased: Allergy, parasites, skin diseases, malignancy, drugs, asthma, Addison's disease, collagen-vascular diseases (handy mnemonic NAACP: Neoplasm, Allergy, Addison's disease, Collagen-vascular diseases, Parasites), pulmonary diseases including Löffler's syndrome and PIE

Decreased: Steroids, ACTH, after stress (infection, trauma, burns), Cushing's syndrome

Hematocrit (Male 40-54%; Female 37-47%)

Decreased: Megaloblastic anemia (folate or B₁₂ deficiency); iron deficiency anemia; sickle cell anemia; acute or chronic blood loss; hemolysis; anemia due to chronic disease, dilution, alcohol, or drugs

Increased: Primary polycythemia (polycythemia vera), secondary polycythemia (reduced fluid intake or excess fluid loss, congenital and acquired heart disease, lung disease, high altitudes, heavy smoking, tumors [renal cell carcinoma, hepatoma], renal cysts)

Lymphocytes

• 24-44% • See also Lymphocyte Subsets, page 103

Increased: Virtually any viral infection (AIDS, measles, rubella, mumps, whooping cough, smallpox, chickenpox, influenza, hepatitis, infectious mononucleosis), acute infectious lymphocytosis in children, acute and chronic lymphocytic leukemias

Decreased: (Normal finding in 22% of population) Stress, burns, trauma, uremia, some viral infections, AIDS, AIDS-related complex, bone marrow suppression after chemotherapy, steroids, MS

Atypical Lymphocytes

>20%: Infectious mononucleosis, CMV infection, infectious hepatitis, toxoplasmosis

<20%: Viral infections (mumps, rubeola, varicella), rickettsial infections, TB

MCH (Mean Cellular [Corpuscular] Hemoglobin)

• 27-31 pg (SI: pg)

The weight of hemoglobin of the average red cell. Calculated by

$$MCH = \frac{Hemoglobin (g / L)}{RBC (10^6 / \mu L)}$$

Increased: Macrocytosis (megaloblastic anemias, high reticulocyte counts)

Decreased: Microcytosis (iron deficiency, sideroblastic anemia, thalassemia)

MCHC (Mean Cellular [Corpuscular] Hemoglobin Concentration)

• 33-37 g/dL (SI:330-370 g/L)

The average concentration of hemoglobin in a given volume of red cells. Calculated by the formula

$$MCHC = \frac{Hemoglobin (g / dL)}{Hematocrit}$$

Increased: Very severe, prolonged dehydration; spherocytosis

Decreased: Iron deficiency anemia, overhydration, thalassemia, sideroblastic anemia

MCV (Mean Cell [Corpuscular] Volume)

• 76-100 cu um (SI: fL)

The average volume of red blood cells. Calculated by the formula

$$MCV = \frac{Hematocrit \times 1000}{RBC (10^6 / \mu L)}$$

 $\label{localization} \emph{Increased/Macrocytosis:} \quad \text{Megaloblastic anemia (B$_{12}$, folate deficiency), macrocytic (normoblastic) anemia, reticulocytosis, myelodysplasias, Down syndrome, chronic liver disease, treatment of AIDS with AZT, chronic alcoholism, cytotoxic chemotherapy, radiation therapy, Dilantin use, hypothyroidism, newborns$

Decreased/Microcytosis: Iron deficiency, thalassemia, some cases of lead poisoning or polycythemia

Monocytes

3–7%

Increased: Bacterial infection (TB, SBE, brucellosis, typhoid, recovery from an acute infection), protozoal infections, infectious mononucleosis, leukemia, Hodgkin's disease, ulcerative colitis, regional enteritis

Decreased: Lymphocytic leukemia, aplastic anemia, steroid use

Platelets

• 150-450,000 μL

Platelet counts may be normal in number, but abnormal in function as occurs in aspirin therapy. Abnormalities of platelet function are assessed by bleeding time.

Increased: Sudden exercise, after trauma, bone fracture, after asphyxia, after surgery (especially splenectomy), acute hemorrhage, polycythemia vera, primary thrombocytosis, leukemias, after childbirth, carcinoma, cirrhosis, myeloproliferative disorders, iron deficiency

Decreased: DIC, ITP, TTP, congenital disease, marrow suppressants (chemotherapy, alcohol, radiation), burns, snake and insect bites, leukemias, aplastic anemias, hypersplenism, infectious mononucleosis, viral infections, cirrhosis, massive transfusions, eclampsia and preeclampsia, prosthetic heart valve, more than 30 different drugs (NSAIDs, cimetidine, aspirins, thiazides, others)

PMNs (Polymorphonuclear Neutrophils) (Neutrophils)

• 40-76% • See also the "Left Shift" page 100.

Increased

Physiologic (Normal). Severe exercise, last months of pregnancy, labor, surgery, newborns, steroid therapy

Pathologic. Bacterial infections, noninfective tissue damage (MI, pulmonary infarction, pancreatitis, crush injury, burn injury), metabolic disorders (eclampsia, DKA, uremia, acute gout), leukemias

Decreased: Pancytopenia, aplastic anemia, PMN depression (a mild decrease is referred to as **neutropenia**, severe is called **agranulocytosis**), marrow damage (x-rays, poisoning with benzene or antitumor drugs), severe overwhelming infections (disseminated TB, septicemia), acute malaria, severe osteomyelitis, infectious mononucleosis, atypical pneumonias, some viral infections, marrow obliteration (osteosclerosis, myelofibrosis, malignant infiltrate), drugs (more than 70, including chloramphenicol, phenylbutazone, chlorpromazine, quinine), B₁₂ and folate deficiencies, hypoadrenalism, hypopituitarism, dialysis, familial decrease, idiopathic causes

RDW (Red Cell Distribution Width)

• 11 5-14 5

RDW is a measure of the degree of anisocytosis (variation in RBC size) and measured by the automated hematology counters.

Increased: Many anemias (iron deficiency, pernicious, folate deficiency, thalassemias), liver disease

LYMPHOCYTE SUBSETS

Specific monoclonal antibodies are used to identify specific T and B cells. Lymphocyte subsets (also called lymphocyte marker assays, or T- and B-cell assay) are useful in the diagnosis of AIDS and various leukemias and lymphomas. The designation **CD** ("clusters of differentiation") has largely replaced the older antibody designations (eg. Leu 3a or OKT3). Results are most reliable when reported as an absolute number of cells/µL rather

than a percentage of cells. A CD4/CD8 ratio < 1 is seen in patients with AIDS. Absolute CD4 count is used to initiate therapy with antiretrovirals or prophylaxis for PCP (see page 75). The CDC includes in the category of AIDS any patient with a CD4 count < 200 who is HIV-positive.

Normal Lymphocyte Subsets

- Total lymphocytes 0.66–4.60 thousand/μL
- T cell 644–2201 μL (60–88%)
- B cell 82–392 μL (3–20%)
- T helper/inducer cell (CD4, Leu 3a, OKT4) 493–1191 μL (34–67%)
- Suppressor/cytotoxic T cell (CD8, Leu 2, OKT8) 182–785 μL (10–42%)
- CD4/CD8 ratio > 1

RBC MORPHOLOGY DIFFERENTIAL DIAGNOSIS

The following lists some erythrocyte abnormalities and the associated conditions. General terms include **poikilocytosis** (irregular RBC shape such as sickle or burr) and **anisocytosis** (irregular RBC size such as microcytes and macrocytes).

Basophilic Stippling: Lead or heavy-metal poisoning, thalassemia, severe anemia

Burr Cells (Acanthocytes): Severe liver disease; high levels of bile, fatty acids, or toxins

Helmet Cells (Schistocytes): Microangiopathic hemolysis, hemolytic transfusion reaction, transplant rejection, other severe anemias, TTP

Howell-Jolly Bodies: After splenectomy, some severe hemolytic anemias, pernicious anemia, leukemia, thalassemia

Nucleated RBCs: Severe bone marrow stress (hemorrhage, hemolysis, etc), marrow replacement by tumor, extramedullary hematopoiesis

Polychromasia (Basophilia): The appearance of a bluish gray red cell on routine Wright's stain suggests reticulocytes.

Sickling: Sickle cell disease and trait

Spherocytes: Hereditary spherocytosis, immune or microangiopathic hemolysis, severe burns. ABO transfusion reactions

Target Cells (Leptocytes): Thalassemia, hemoglobinopathies, obstructive jaundice, any hypochromic anemia, after splenectomy

WBC MORPHOLOGY DIFFERENTIAL DIAGNOSIS

The following gives conditions associated with certain changes in the normal morphology of WBCs.

Auer Rods: AML

Döhle's Inclusion Bodies: Severe infection, burns, malignancy, pregnancy

Hypersegmentation: Megaloblastic anemias

Toxic Granulation: Severe illness (sepsis, burn, high temperature)

COAGULATION AND OTHER HEMATOLOGIC TESTS

The coagulation cascade is shown in Figure 5–2. A variety of coagulation-related and other blood tests follow.

Activated Clotting Time (ACT)

114–186 s
 Collection: Black top tube from instrument manufacturer
 This is a bedside test used in the operating room, dialysis unit, or other facility to document neutralization of heparin (ie, after coronary artery bypass, heparin is reversed.)

Increased: Heparin, some platelet disorders, severe clotting factor deficiency

Antithrombin-III (AT-III)

 • 17–30 mg/dL or 80–120% of control • Collection: Blue top tube, patient must be off heparin for 6 h

Used in the evaluation of thrombosis. Heparin must interact with AT-III to produce anti-coagulation effect.

Decreased: Autosomal-dominant familial AT-III deficiency, PE, severe liver disease, late pregnancy, oral contraceptives, nephrotic syndrome, heparin therapy (>3 days)

Increased: Coumadin, after MI

Bleeding Time

• Duke, Ivy <6 min; Template <10 min • Collection: Specialized bedside test performed by technicians. A small incision is made, and the wound is wicked with filter paper every 30 s until the fluid is clear.

In vivo test of hemostasis that tests platelet function, local tissue factors, and clotting factors. Nonsteroidal medications should be stopped 5–7 d before the test because these agents can affect platelet function.

Increased: Thrombocytopenia (DIC, TTP, ITP), von Willebrand's disease, defective platelet function (NSAIDs such as aspirin)

Coombs' Test, Direct (Direct Antiglobulin Test)

• Normal = negative • Collection: Purple top tube

Uses patient's erythrocytes; tests for the presence of antibody on the patient's cells and used in the screening for autoimmune hemolytic anemia.

Positive: Autoimmune hemolytic anemia (leukemia, lymphoma, collagen-vascular diseases), hemolytic transfusion reaction, some drug sensitizations (methyldopa, levodopa, cephalosporins, penicillin, quinidine), hemolytic disease of the newborn (erythroblastosis fetalis)

Coombs' Test, Indirect (Indirect Antiglobulin Test/Autoantibody Test)

• Normal = negative • Collection: Purple top tube

Uses serum that contains antibody, usually from the patient. Used to check cross-match prior to blood transfusion in the blood bank.

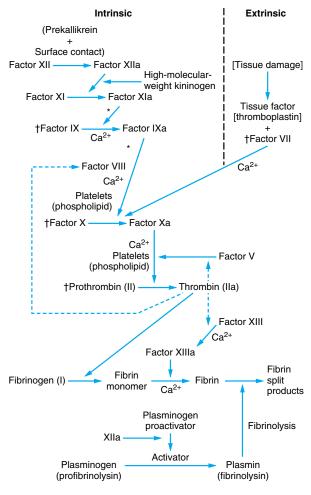


FIGURE 5-2 Blood coagulation cascade. Nearly all of the coagulation factors apparently exist as inactive proenzymes (Roman numeral) that, when activated (Roman numeral + a), serve to activate the next proenzyme in the sequence. Symbol key: * = Heparin acts to inhibit. ^Ü = Plasma content decreased by Coumadin. (Reprinted, with permission, from: Krupp MA [ed]: The Physician's Handbook. Lange Medical Publications, Los Angeles CA, 1985.)

-5

Positive: Isoimmunization from previous transfusion, incompatible blood due to improper cross-matching or medications such as methyldopa.

Fibrin p-Dimers

 Negative or <0.5 μg/mL
 Collection: Blue, green, or purple top tube Fibrin broken into various D-dimer fragments by plasmin.

Increased: DIC, thromboembolic diseases (PE, arterial or venous thrombosis)

Fibrin Degradation Products (FDP), Fibrin Split Products (FSP)

<10 μg/mL
 Collection: Blue top tube
 Generally replaced by the fibrin p-dimer as a screen for DIC

 $\it Increased: DIC$ (usually >40 $\mu g/mL),$ any thromboembolic condition (DVT, MI, PE), hepatic dysfunction

Fibrinogen

 200–400 mg/dL (SI:2.0–4.0 g/L)
 Collection: Blue top tube

Most useful in the diagnosis of DIC and congenital hypofibrinogenemia. Fibrinogen is cleaved by thrombin to form insoluble fragments that polymerize to form a stable clot.

Increased: Inflammatory reactions, oral contraceptives, pregnancy, cancer (kidney, stomach, breast)

Decreased: DIC (sepsis, amniotic fluid embolism, abruptio placentae), surgery (prostate, open heart), neoplastic and hematological conditions, acute severe bleeding, burns, venomous snake bite, congenital

Lee-White Clotting Time

• 5-15 min • Collection: Draw into plain plastic syringe; clotting time measured in separate tube

Increased: Heparin therapy, plasma–clotting factor deficiency (except Factors VII and XIII). (*Note:* This is not a sensitive test and so is therefore not considered a good screening test.)

Partial Thromboplastin Time (Activated Partial Thromboplastin Time, PTT, APTT)

• 27-38 s • Collection: Blue top tube

Evaluates the intrinsic coagulation system (See Figure 5–2). Most commonly used to monitor heparin therapy

Increased: Heparin and any defect in the intrinsic coagulation system (includes Factors I, II, V, VIII, IX, X, XI, and XII), prolonged use of a tourniquet before drawing a blood sample, hemophilia A and B

Prothrombin Time (PT)

• 11.5–13.5 s • Figure 5–2, page 106 • Collection: Blue top tube

PT evaluates the **extrinsic coagulation system** that includes Factors I, II, V, VII, and X. The use of **INR** instead of the Patient/Control ratio to guide anticoagulant (Coumadin) therapy is becoming standard. **INR provides a more universal and standardized result because it measures the control against a WHO standard reference reagent.** Therapeutic INR levels are 2–3 for DVT, PE, TIAs, and atrial fibrillation. Recurrent DVT on adequate treatment requires an INR of 3–4.5. Mechanical heart valves require an INR of 3–4.5 (See also Chapter 22, Table 22–10 [page 637].)

Increased: Drugs (sodium warfarin [Coumadin]), vitamin K deficiency, fat malabsorption, liver disease, prolonged use of a tourniquet before drawing a blood sample, DIC

Sedimentation Rate (Erythrocyte Sedimentation Rate, ESR)

· Collection: Lavender top tube

The ESR is a very nonspecific test with a high sensitivity and a low specificity. Most useful in serial measurement to follow the course of disease (eg, polymyalgia rheumatica or temporal arteritis). ZETA rate is not affected by anemia. ESR correlates well with C-reactive protein levels.

Wintrobe Scale: Males, 0-9 mm/h, females, 0-20 mm/h

ZETA Scale: 40–54% normal, 55–59% mildly elevated, 60–64% moderately elevated, >65% markedly elevated

Westergren Scale: Males <50 years 15 mm/h, >50 years 20 mm/h; female <50 years 20 mm/h, >50 years 30 mm/h

Increased: Any type of infection, inflammation, rheumatic fever, endocarditis, neo-plasm, AMI

Thrombin Time

• 10-14 s • Collection: Blue top tube

A measure of the rate of conversion of fibrinogen to fibrin and fibrin polymerization. Used to detect the presence of heparin and hypofibrinogenemia and as an aid in the evaluation of prolonged PTT

Increased: Systemic heparin, DIC, fibrinogen deficiency, congenitally abnormal fibrinogen molecules

LABORATORY DIAGNOSIS: URINE STUDIES

Urinalysis Procedure Urinalysis, Normal Values Differential Diagnosis for Routine Urinalysis Urine Sediment

Urinalysis
Urine Sediment
Spot or Random Urine Studies
Creatinine and Creatinine Clearance

24-Hour Urine Studies Other Urine Studies Urinary Indices in Renal Failure Urine Output Urine Protein Electrophoresis

URINALYSIS PROCEDURE

For a routine screening urinalysis, a fresh (less than 1-h old), clean-catch urine is acceptable. If it cannot be interpreted immediately, it should be refrigerated (urine standing at room temperature for long periods causes lysis of casts and red cells and becomes alkalinized.) See Chapter 13 under Urinary Tract Procedures, page 306, for the different ways to collect the sample.

- Pour about 5-10 mL of well-mixed urine into a centrifuge tube. Check the specific gravity with a urinometer or optic refractory urinometer (refractometer) on the remaining sample.
- 2. Check for appearance (color, turbidity, odor).
- 3. Spin the capped sample at 3000 rpm (450 g) for 3 min.
- 4. While the sample is in the centrifuge and using the dipstick (Chemstrip, etc) supplied by your lab, perform the dipstick evaluation on the remaining portion of the sample. Read the results according to the color chart and instructions on the bottle. Make sure to allow the time noted before reading the test because reading before the time (up to 60 s) may yield false results. Record glucose, ketones, blood, protein, pH, nitrite, and leukocyte esterase if available. Be sure to recap the bottle tightly after use. Agents that color the urine (phenazopyridine [Pyridium]) may interfere with the results of the dipstick.
- 5. Decant and discard the supernatant. Mix the remaining sediment by flicking it with your finger and pour or pipette one or two drops on a microscope slide. Cover with a coverslip. If a urine sample looks very grossly cloudy, it is sometimes advisable to examine an unspun sample. If an unspun sample is used, note this on the report. In general, for routine urinalysis, a spun sample is more desirable.
- Examine 10 lpf (10x objective) for epithelial cells, casts, crystals, and mucus. Casts are
 usually reported per low-power field. Casts tend to collect around the periphery of the
 coverslip.
- Examine several high-power fields (40x objective) for epithelial cells, crystals, RBCs, WBCs, bacteria, and parasites (trichomonads). RBCs, WBCs, and bacteria are usually reported per high-power field. Two reporting systems are commonly used:

System OneSystem TwoRare = <2 per field</td>Trace = <</td>Occasional = 3-5 per field $1 + = \frac{1}{4}$ of fieldFrequent = 5-9 per field $2 + = \frac{1}{2}$ of fieldMany = "large number" per field $3 + = \frac{3}{4}$ of field

TNTC = too numerous to count 4+= field is full

URINALYSIS, NORMAL VALUES

1. Appearance: "Yellow, clear," or "straw-colored, clear"

2. Specific Gravity

a. Neonate: 1.012b. Infant: 1.002–1.006

c. Child and Adult: 1.001–1.035 (with normal fluid intake 1.016–1.022)

3. pH

a. Newborn/Neonate: 5–7b. Child and Adult: 4.6–8.0

Negative for: Bilirubin, blood, acetone, glucose, protein, nitrite, leukocyte esterase, reducing substances

5. Trace: Urobilinogen

6. RBC: Male 0-3/hpf, female 0-5/hpf

7. WBC: 0-4/hpf

8. Epithelial Cells: Occasional

9. Hyaline Casts: Occasional

10. Bacteria: None

11. Crystals: Some limited crystals based on urine pH (see below)

DIFFERENTIAL DIAGNOSIS FOR ROUTINE URINALYSIS

Appearance

Colorless: Diabetes insipidus, diuretics, excess fluid intake

Dark: Acute intermittent porphyria, malignant melanoma

Cloudy: UTI (pyuria), amorphous phosphate salts (normal in alkaline urine), blood, mucus, bilirubin

Pink/Red:

Heme-positive. Blood, hemoglobin, sepsis, dialysis, myoglobin

Heme-negative. Food coloring, beets, sulfa drugs, nitrofurantoin, salicylates

Orange/Yellow: Dehydration, phenazopyridine (Pyridium), rifampin, bile pigments

Brown/Black: Myoglobin, bile pigments, melanin, cascara, iron, nitrofurantoin, alkap-

tonuria

Green: Urinary bile pigments, indigo carmine, methylene blue

Foamy: Proteinuria, bile salts

рΗ

Acidic: High-protein (meat) diet, ammonium chloride, mandelic acid and other medications, acidosis, (due to ketoacidosis [starvation, diabetic], COPD)

6

٢

Basic: UTI, renal tubular acidosis, diet (high-vegetable, milk, immediately after meals), sodium bicarbonate therapy, vomiting, metabolic alkalosis

Specific Gravity

Usually corresponds with osmolarity except with osmotic diuresis. Value >1.023 indicates normal renal concentrating ability. Random value 1.003–1.030

Increased: Volume depletion; CHF; adrenal insufficiency; diabetes mellitus; SIADH; increased proteins (nephrosis); if markedly increased (1.040–1.050), suspect artifact or excretion of radiographic contrast media

Decreased: Diabetes insipidus, pyelonephritis, glomerulonephritis, water load with normal renal function

Bilirubin

Positive: Obstructive jaundice (intrahepatic and extrahepatic), hepatitis. (*Note:* False-positives occur with stool contamination.)

Blood

Note: If the dipstick is positive for blood, but no red cells are seen, free hemoglobin from trauma may be present; a transfusion reaction may have occurred, from lysis of RBCs (RBCs will lyse if the pH is <5 or >8); or myoglobin may be present because of a crush injury, burn, or tissue ischemia.

Positive: Stones, trauma, tumors (benign and malignant, anywhere in the urinary tract), urethral strictures, coagulopathy, infection, menses (contamination), polycystic kidneys, interstitial nephritis, hemolytic anemia, transfusion reaction, instrumentation (Foley catheter, etc)

Glucose

Positive: Diabetes mellitus, pancreatitis, pancreatic carcinoma, pheochromocytoma, Cushing's disease, shock, burns, pain, steroids, hyperthyroidism, renal tubular disease, iatrogenic causes. (*Note:* Glucose oxidase technique in many kits is specific for glucose and will not react with lactose, fructose, or galactose.)

Ketones

Detects primarily acetone and acetoacetic acid and not β -hydroxybutyric acid.

Positive: Starvation, high-fat diet, DKA, vomiting, diarrhea, hyperthyroidism, pregnancy, febrile states (especially in children)

Nitrite

Many bacteria will convert nitrates to nitrite. (See also the section on Leukocyte Esterase, page 112.)

Positive: Infection (A negative test does not rule out infection because some organisms, such as *Streptococcus faecalis* and other gram-positive cocci, do not produce nitrite, and the urine must also be retained in the bladder for several hours to allow the reaction to take place.)

Indication by dipstick of persistent proteinuria should be quantified by 24-h urine studies.

Positive: Pyelonephritis, glomerulonephritis, Kimmelstiel-Wilson syndrome (diabetes), nephrotic syndrome, myeloma, postural causes, preeclampsia, inflammation and malignancies of the lower tract, functional causes (fever, stress, heavy exercise), malignant hypertension, CHF

Leukocyte Esterase

Test detects \geq 5 WBC/hpf or lysed WBCs. When combined with the nitrite test, it has a predictive value of 74% for UTI if both tests are positive and a value of >97% if both tests are negative.

Positive: UTI (false-positive with vaginal contamination)

Reducing Substances

Positive: Glucose, fructose, galactose, false-positives (vitamin C, salicylates, antibiotics, etc.)

Urobilinogen

Positive: Cirrhosis, CHF with hepatic congestion, hepatitis, hyperthyroidism, suppression of gut flora with antibiotics

URINE SEDIMENT

Many labs no longer do microscopic examinations unless specifically requested or if evidence exists for an abnormal finding on dipstick test (such as positive leukocyte esterase). Figure 6–1 is a pictorial representation of materials found in urine sediments.

Red Blood Cells (RBCs): Trauma, pyelonephritis, genitourinary TB, cystitis, prostatitis, stones, tumors (malignant and benign), coagulopathy, and any cause of blood on dipstick test (See previous section on blood pH, page 111.)

White Blood Cells (WBCs): Infection anywhere in the urinary tract, TB, renal tumors, acute glomerulonephritis, radiation, interstitial nephritis (analgesic abuse)

Epithelial Cells: ATN, necrotizing papillitis. (Most epithelial cells are from an otherwise unremarkable urethra.)

Parasites: Trichomonas vaginalis, Schistosoma haematobium infection

Yeast: Candida albicans infection (especially in diabetics, immunosuppressed patients, or if a vaginal yeast infection is present)

Spermatozoa: Normal in males immediately after intercourse or nocturnal emission

Crystals

Abnormal. Cystine, sulfonamide, leucine, tyrosine, cholesterol

Normal. Acid urine: Oxalate (small square crystals with a central cross), uric acid. Alkaline urine: Calcium carbonate, triple phosphate (resemble coffin lids)

Contaminants: Cotton threads, hair, wood fibers, amorphous substances (all usually unimportant)

Urine Sediment

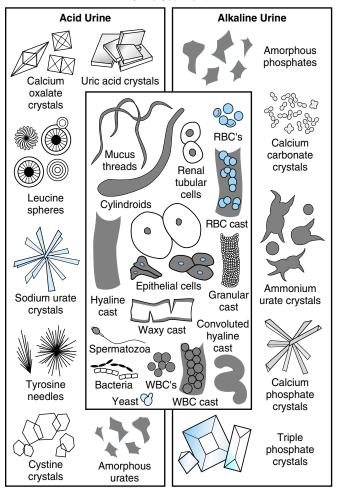


FIGURE 6-1 Urine sediment as seen under the microscope. (Reprinted, with permission, from: Greene MG [ed]: *The Harriet Lane Handbook: A Manual for Pediatric House Officers,* 12th ed,. Yearbook Medical Publishers, Chicago IL, 1991.)

Mucus: Large amounts suggest urethral disease (normal from ileal conduit or other forms of urinary diversion)

Glitter Cells: WBCs lysed in hypotonic solution

Casts: The presence of casts in a urine localizes some or all of the disease process to the kidney itself.

Hyaline Casts. (Acceptable unless they are "numerous"), benign hypertension, nephrotic syndrome, after exercise

RBC Casts. Acute glomerulonephritis, lupus nephritis, SBE, Goodpasture's disease, after a streptococcal infection, vasculitis, malignant hypertension

WBC Casts. Pyelonephritis

Epithelial (Tubular) Casts. Tubular damage, nephrotoxin, virus

Granular Casts. Breakdown of cellular casts, leads to waxy casts; "dirty brown granular casts" typical for ATN

Waxy Casts. (End stage of granular cast). Severe chronic renal disease, amyloidosis

Fatty Casts. Nephrotic syndrome, diabetes mellitus, damaged renal tubular epithelial cells

Broad Casts. Chronic renal disease

SPOT OR RANDOM URINE STUDIES

The so-called spot urine, which is often ordered to aid in diagnosing various conditions, relies on only a small sample (10–20 mL) of urine.

Spot Urine for β₂-microglobulin

• <0.3 mg/L

A marker for renal tubular injury

Increased: Diseases of the proximal tubule (ATN, interstitial nephritis, pyelonephritis), drug-induced nephropathy (aminoglycosides), diabetes, trauma, sepsis, HIV, lymphoproliferative and lymphodestructive diseases

Spot Urine for Electrolytes

The usefulness of this assay is limited because of large variations in daily fluid and salt intake, and the results are usually indeterminate if a diuretic has been given.

- Sodium <10 mEq/L (mmol/L): Volume depletion, hyponatremic states, prerenal azotemia (CHF, shock, etc.), hepatorenal syndrome, glucocorticoid excess
- Sodium >20 mEq/L (mmol/L): SIADH, ATN (usually >40 mEq/L), postobstructive diuresis, high salt intake, Addison's disease, hypothyroidism, interstitial nephritis
- Chloride <10 mEq/L (mmol/L): Chloride-sensitive metabolic alkalosis (vomiting, excessive diuretic use), volume depletion
- 4. Potassium <10 mEq/L (mmol/L): Hypokalemia, potassium depletion, extrarenal loss

Spot Urine for Erythrocyte Morphology

The morphology of red blood cells in a sample of urine that tests positive for blood may give some indication of the nature of the hematuria. **Eumorphic red cells** are typically seen in cases of postrenal, nonglomerular bleeding. **Dysmorphic red cells** are more likely associated with glomerular causes of bleeding. Each reference lab has standards, but as a general rule, the

presence of >90% dysmorphic erythrocytes in patients with asymptomatic hematuria indicates a renal glomerular source of bleeding, especially if associated with proteinuria and or casts (ie, IgA nephropathy, poststreptococcal glomerular, sickle cell disease or trait, etc). If ≥90% eumorphic erythrocytes or even "mixed" results (10–90% eumorphic erythrocytes) indicates a postrenal cause of hematuria requiring a complete urologic evaluation (ie, hypercalciuria, urolithiasis, cystitis, trauma, tumors, hemangioma, exercise induced, BPH, etc).

Spot Urine for Microalbumin

Normal <30 μg albumin/mg creatinine

Used to determine which patients with diabetes are at risk for nephropathy. Clinical albuminuria occurs at $>300 \mu g$ albumin/mg creatinine. Base test on two or three separate determinations over 6 mo. Diabetic patients with levels between $30-300 \mu g$ have microalbuminuria and are usually initiated on ACE inhibitor or angiotensin receptor blocker.

Spot Urine for Myoglobin

· Qualitative negative

Positive: Skeletal muscle conditions (crush injury, electrical burns, carbon monoxide poisoning, delirium tremens, surgical procedures, malignant hyperthermia), polymyositis.

Spot Urine for Osmolality

• 75-300 mOsm/kg (mmol/kg) • Varies with water intake

Patients with normal renal function should concentrate >800 mOsm/kg (mmol/kg) after a 14-h fluid restriction; <400 mOsm/kg (mmol/kg) is a sign of renal impairment.

Increased: Dehydration, SIADH, adrenal insufficiency, glycosuria, high-protein diet

Decreased: Excessive fluid intake, diabetes insipidus, acute renal failure, medications (acetohexamide, glyburide, lithium)

Spot Urine for Protein

 Normal <10 mg/dL (0.1 g/L) or <20 mg/dL (0.2 g/L) for a sample taken in the early AM See page 112 for the differential diagnosis of protein in the urine.

CREATININE AND CREATININE CLEARANCE

Normal

Adult Male. Total creatinine 1–2 g/24 h (8.8–17.7 mmol/d); clearance 85–125 mL/min/1.73 m 2

Adult Female. Total creatinine 0.8–1.8 g/24 h (7.1–15.9 mmol/d); clearance 75–115 mL/min 1.73 m² (1.25–1.92 mL/s/1.73 m²)

Child. Total creatinine (>3 years) 12–30 mg/kg/24 h; clearance 70–140 mL/min/1.73 $m^2(1.17-2.33~mL/s/1.73~m^2)$

Decreased: A decreased creatinine clearance results in an increase in serum creatinine usually secondary to renal insufficiency. See Chapter 4, page 65, for differential diagnosis of increased serum creatinine.

Increased: Early diabetes mellitus, pregnancy

Creatinine Clearance Determination

Creatinine clearance is one of the most sensitive indicators of early renal insufficiency. Clearances are ordered for patients with suspected renal disease and are useful for following patients who are taking nephrotoxic medications, (eg, gentamicin). Clearance normally decreases with age. A creatinine clearance of 10–20 mL/min indicates severe renal failure, and a clearance of <10 mL/min usually indicates the need for dialysis.

To determine a creatinine clearance, order a concurrent serum creatinine and a 24-h urine creatinine. A shorter time interval can be used, for example, 12 h, but remember that the formula must be corrected for this change and that a 24-h sample is less prone to collection error.

Example: (A quick formula is also found under "Aminoglycoside Dosing," page 620.) The following are calculations of (a) the creatinine clearance from a 24-h urine sample with a volume of 1000 mL, (b) a urine creatinine of 108 mg/100 mL, and (c) a serum creatinine of 1 mg/100 mL (1 mg/dL).

$$Clearance = \frac{Urine\ creatinine \times Total\ urine\ volume}{Plasma\ creatinine \times Time}$$

where time = 1440 min if 24-h collection.

Clearance =
$$\frac{(108 \text{ mg} / 100 \text{ mL}) (1000 \text{ mL})}{(1 \text{ mg} / 100 \text{ mL}) (1440 \text{ min})} = 75 \text{ mL} / \text{min}$$

To see if the urine sample is valid, some clinicians advocate a preliminary evaluation by determining first if the sample contains at least 18–25 mg/kg/24 h of creatinine for adult males or 12–20 mg/kg/24 h for adult females. This preliminary test is not a requirement, but can confirm if a 24–h sample was collected or if some of the sample was lost.

If the patient is an adult $(150 \text{ lb} = \text{body surface area of } 1.73 \text{ m}^2)$, adjustment of the clearance for body size is not routinely done. Adjustment for pediatric patients is a necessity. If the values in the previous example were for a 10-year-old boy who weighed 70 lb (1.1 m^2) , the clearance would be:

75 mL / min
$$\times \frac{1.73 \text{ m}^2}{1.1 \text{ m}^2} = 118 \text{ mL / min}$$

24-HOUR URINE STUDIES

A wide variety of diseases, most of them endocrine, can be diagnosed by assays of 24-h urine samples. The following information gives the normal values for certain agents and the conditions associated with changes in these values.

Calcium, Urine

Normal: On a calcium-free diet <150 mg/24 h (3.7 mmol/d), average calcium diet (600–800 mg/24 h) 100–250 mg/24 h (2.5–6.2 mmol/d)

Increased: Hyperparathyroidism, hyperthyroidism, hypervitaminosis D, distal renal tubular acidosis (type I), sarcoidosis, immobilization, osteolytic lesions (bony metastasis, multiple myeloma), Paget's disease, glucocorticoid excess, immobilization, furosemide

Decreased: Medications (thiazide diuretics, estrogens, oral contraceptives), hypothyroidism, renal failure, steatorrhea, rickets, osteomalacia

Used to evaluate neuroendocrine tumors, including pheochromocytoma and neuroblastoma. Avoid caffeine and methyldopa (Aldomet) prior to test

Normal: Values are variable and depend on the assay method used. Norepinephrine 15–80 mg/24 h [SI: 89–473 nmol/24 h], epinephrine 0–20 mg/24 h [0–118 nmol/24 h], dopamine 65–400 mg/24 h [SI: 384–2364 nmol/24 h].

Increased: Pheochromocytoma, neuroblastoma, epinephrine administration, presence of drugs (methyldopa, tetracyclines cause false increases)

Cortisol, Free

Used to evaluate adrenal cortical hyperfunction, screening test of choice for Cushing's syndrome

Normal: 10-110 mg/24 h [SI: 30-300 nmol]

Increased: Cushing's syndrome (adrenal hyperfunction), stress during collection, oral contraceptives, pregnancy

Creatinine

· See pages 65 and 115

Cysteine

Used to detect cystinuria, homocystinuria, monitor response to therapy

Normal: 40-60 mg/g creatinine

Increased: Heterozygotes < 300 mg/g creatinine/day; homozygotes > 250 mg/g creatinine

5-HIAA (5-Hydroxyindoleacetic Acid)

5-HIAA is a serotonin metabolite useful in diagnosing carcinoid syndrome.

Normal: (2–8 mg [SI: 10.4–41.6] mmol/24–h urine collection)

Increased: Carcinoid tumors (except rectal), certain foods (banana, pineapple, tomato, walnuts, avocado), phenothiazine derivatives

Metanephrines

Detects metabolic products of epinephrine and norepinephrine, a primary screening test for pheochromocytoma

Normal: <1.3 mg/24 h (7.1 mmol/L) for adults, but variable in children

Increased: Pheochromocytoma, neuroblastoma (neural crest tumors), false-positive with drugs (phenobarbital, guanethidine, hydrocortisone, MAO inhibitors)

Protein

• See also Urine Protein Electrophoresis, pages 85 and 112.

6

Normal: <150 mg/24 h (<0.15 g/d)

Increased: Nephrotic syndrome usually associated with >4 g/24 h

17-Ketogenic Steroids (17-KGS, Corticosteroids)

Overall adrenal function test, largely replaced by serum or urine cortisol levels

Normal: Males 5–24 mg/24 h (17–83 mmol/24 h); females 4–15 mg/24 h (14–52 mmol/24 h)

Increased: Adrenal hyperplasia (Cushing's syndrome), adrenogenital syndrome

Decreased: Panhypopituitarism, Addison's disease, acute steroid withdrawal

17-Ketosteroids, Total (17-KS)

Measures DHEA, androstenedione (adrenal androgens); largely replaced by assay of individual elements

Normal: Adult males 8–20 mg/24 h (28–69 mmol/L); adult female 6–15 mg/dL (21–52 mmol/L). *Note:* Low values in prepubertal children

Increased: Adrenal cortex abnormalities (hyperplasia [Cushing's disease], adenoma, carcinoma, adrenogenital syndrome), severe stress, ACTH or pituitary tumor, testicular interstitial tumor and arrhenoblastoma (both produce testosterone)

Decreased: Panhypopituitarism, Addison's disease, castration in men

VanillyImandelic Acid

VMA is the urinary product of both epinephrine and norepinephrine; good screening test for pheochromocytoma, also used to diagnose and follow up neuroblastoma and ganglioneuroma

Normal: <7–9 mg/24 h (35–45 mmol/L)

Increased: Pheochromocytoma, other neural crest tumors (ganglioneuroma, neuroblastoma), factitious (chocolate, coffee, tea, methyldopa)

OTHER URINE STUDIES

Drug Abuse Screen

• Normal = negative

Tests urine for common drugs of abuse, often used for employment screening for critical jobs. Assay will vary by facility and may include tests for amphetamines, barbiturates, benzodiazepines, marijuana (cannabinoid metabolites), cocaine metabolites, opiates, phencyclidine.

Xylose Tolerance Test (D-Xylose Absorption Test)

- 5 g xylose in 5-h urine specimen after 25 g oral dose of xylose or 1.2 g after 5-g oral dose
- Collection: Patient is NPO after midnight except for water.
 After voiding at 8 AM, 25 g of p-xylose (or 5 g if GI irritation is a concern) is dissolved in 250 mL water.
 An additional 750 mL water is drunk and the urine collected for the next 5 h.

- 6

TABLE 6-1 Urinary Indices Useful in the Differential Diagnosis of Oliguria

Index Prerenal Renal (ATN)* Urine osmolality >500 <350 Urinary sodium <20 >40
,
Urinary sodium <20 >40
Urine/serum creatinine >40 <20
Urine/serum osmolarity >1.2 <1.2
Fractional excreted sodium [†] <1 >1
Renal failure index (RFI) [‡] <1 >1

Used to assess proximal bowel function; differentiates between malabsorption due to pancreatic insufficiency or intestinal problems.

Urine creatinine

Decreased: Celiac disease (nontropical sprue, gluten-sensitive enteropathy), false decreas0e with renal disease

URINARY INDICES IN RENAL FAILURE

Use Table 6-1 to help differentiate the causes (renal or prerenal) of oliguria. (See also Oliguria and Anuria, page 49.)

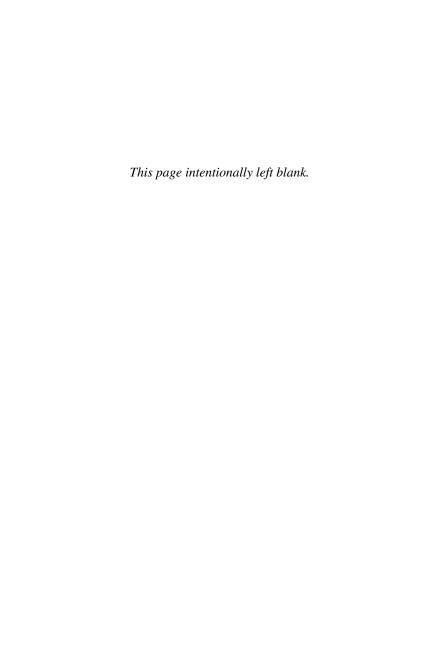
URINE OUTPUT

‡Renal failure index =

Although clinical situations vary greatly, the usual, minimal acceptable urine output for an adult is 0.5-1.0 mL/kg/h (daily volume normally 1000-1600 mL/d).

URINE PROTEIN ELECTROPHORESIS

See Protein Electrophoresis, Serum and Urine, page 85, and Figure 4–5, page 86.



CLINICAL MICROBIOLOGY

Staining Techniques Acid-Fast Stain

Darkfield Examination

Giemsa Stain

Gonorrhea Smear Gram Stain

Gram Stain Characteristics

of Common Pathogens

India Ink Preparation

KOH Preparation

Stool Leukocyte Stain

Tzanck Smear

Vaginal Wet Preparation

Wayson Stain

Gonorrhea (GC) Cultures and Smear

Nasopharyngeal Cultures

Blood Cultures Sputum Cultures

Stool Cultures

Throat Cultures

Urine Cultures

Viral Cultures and Serology

Scotch Tape Test

Molecular Microbiology

Susceptibility Testing (MIC, MBC,

Schlichter Test)

Differential Diagnosis of Common Infections and Empiric Therapy

SBE Prophylaxis

Isolation Protocols

STAINING TECHNIQUES

Acid-Fast Stain (AFB Smear, Kinyoun Stain)

Clinical microbiology labs can also perform a "modified" acid-fast stain for organisms that are weakly acid-fast-staining (eg, *Nocardia* species).

- 1. Spread the smear on a slide, allow it to air dry, and then gently heat fix it.
- 2. Stain the smear for 3–5 min with terpinol in carbol-fuchsin red solution.
- 3. Rinse the slide with tap water.
- 4. Decolorize with acid-alcohol solution for no longer than 30 s.
- 5. Rinse with tap water.
- 6. Counterstain with methylene blue for 1 min.
- 7. Rinse the slide with tap water and allow it to air dry.
- 8. Examine the smear with high dry and oil immersion lenses; search for the acid-fast bacilli that stain red to bright pink against the light blue background (Mycobacterium tuberculosis [TB], M. scrofulaceum, M. avium-intracellulare, others). These organisms have a beaded rod appearance under oil immersion.
- 9. These organisms must be cultured on specialized media. Rapid-growing AFB include M. abscessus, M. chelonae, M. fortuitum and can usually be cultured in fewer than 7 days. Most other AFB (M. tuberculosis, M. avium complex, M. kansasii, M. marinum) require at least 7–10 d to grow. M. gordonae is thought to be nonpathogenic.

Darkfield Examination

Darkfield examination is used to identify *Treponema pallidum*, the organism responsible for syphilis. Rectal and oral lesions cannot be examined by this technique due to the presence of nonpathogenic spirochetes.

Procedure

- The chancre is cleansed with a saline-moistened swab and a slide is touched on the lesion and examined under darkfield illumination within 15 min of applying the specimen to the slide.
- The organisms resemble tight corkscrews and are 1-1½ times the diameter of an RBC in length.

Giemsa Stain

Used to identify intracellular organisms such as chlamydiae, *Plasmodium* spp. (malaria), and other parasites.

Gonorrhea Smear (See the following section on Gonorrhea [GC] Cultures)

Gram Stain

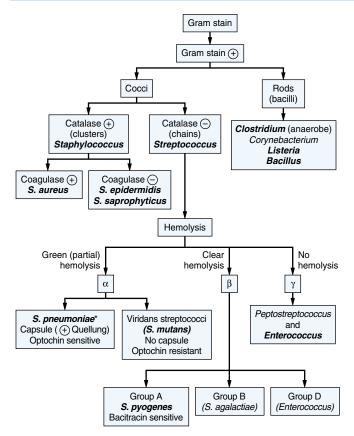
The Gram stain is used to determine whether an organism can be decolorized with alcohol after being stained with crystal violet. This determination is based on the organism's cell wall characteristics. Gram staining is performed on bacteria from a variety of body fluids, including exudates, abscesses, sputum, and others as clinically indicated.

Procedure

- 1. Smear the specimen (sputum, peritoneal fluid, etc) on a glass slide in a fairly thin coat. If time permits, allow the specimen to air dry. The smear may also be fixed under very low heat (excessive heat can cause artifacts). If a Bunsen burner is not available, other possible methods for heating the sample include using a hot light bulb or setting an alcohol swab on fire. Heat the slide until it is warm, but not hot, when touched to the back of the hand.
- 2. Timing for the stain is not critical, but allow at least 10 s for each set of reagents.
- Apply the crystal violet (Gram stain), rinse the slide with tap water, apply iodine solution, and rinse with water.
- 4. Decolorize the slide carefully with the acetone–alcohol solution until the blue color is barely visible in the runoff. (Be careful; this is the step where most Gram stains are ruined.)
- Counterstain with a few drops of safranin, rinse the slide with water, and blot it dry with lint-free bibulous or filter paper.
- 6. Use the high dry (100×) and oil immersion lenses on the microscope to examine the slide. If the Gram stain is satisfactory, any polys on the slide should be pink with light blue nuclei. On a Gram stain of sputum, an excessive number of epithelial cells (>25/hpf) means the sample contained more saliva than sputum. Gram-positive organisms stain dark blue to purple; gram-negative ones stain red.

Gram Stain Characteristics of Common Pathogens:

Initial lab reports identify the Gram stain characteristics of the organisms. Complete identification usually requires culturing the organism. The lab algorithm for gram-positive and



^{*}Important pathogens are in bold type.

Note: Enterococcus is Group D but it is not β -hemolytic; it is α - or γ -hemolytic.

FIGURE 7–1 Lab algorithm for the identification of gram-positive organisms. (Reprinted, with permission, from: Bhushan V [ed]: *First Aid for the USMLE, Step 1,* Appleton & Lange, Norwalk, CT, 1999.)

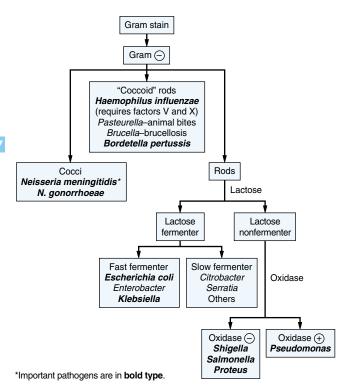


FIGURE 7-2 Lab algorithm for the identification of gram-negative organisms. (Reprinted, with permission, from: Bhushan V [ed]: *First Aid for the USMLE, Step 1*, Appleton & Lange, Norwalk, CT, 1999.)

TABLE 7–1 Gram Stain Characteristics and Key Features of Common Organisms*

negative; beta-hemolytic; yellow pigment Clusters; catalase-positive; coagulase positive; skin flora Clusters; catalase-positive; coagulase positive; skin flora Clusters; catalase-positive; coagulase positive; skin flora Clusters; catalase-positive; coagulase positive Streptococcus spp. Streptococcus agalactiae (group B) Streptococcus bovis (group D Enterococcus) Streptococcus faecalis (group D Enterococcus) Streptococcus pneumoniae (Pneumococcus, group B) Streptococcus pyogenes (group A) Streptococcus viridans Pairs, chains; catalase-negative Pairs, chains; catala		
Enterococcus spp. (E. faecalis) (Note: These are equivalent group D Streptococcus) Peptostreptococcus spp. Staphylococcus aureus Staphylococcus epidermidis Staphylococcus saprophyticus Streptococcus saprophyticus Streptococcus agalactiae (group B) Streptococcus bovis (group D Enterococcus) Streptococcus faecalis (group D Enterococcus yogenes (group B) Streptococcus yogenes (group B) Streptococcus viridans Streptococcus yogenes (group A) Str	Gram Staining Pattern and Organisms	Identifying Key Features
(Note: These are equivalent group D Streptococcus) Peptostreptococcus spp. Staphylococcus spp. Staphylococcus aureus Staphylococcus epidermidis Staphylococcus epidermidis Staphylococcus saprophyticus Streptococcus spp. Streptococcus spp. Streptococcus spp. Streptococcus agalactiae (group B) Streptococcus bovis (group D Enterococcus) Streptococcus faecalis (group D Enterococcus) Streptococcus pneumoniae (Pneumococcus, group B) Streptococcus viridans Streptococcus viridans Streptococcus viridans GRAM-NEGATIVE COCCI Acinetobacter spp. Moraxella (Branhamella) catarrhalis Neisseria gonorrhoeae (gonococcus) Veillonella spp. GRAM-POSITIVE BACILLI Actinomyces Anaerobic Clusters; catalase-positive; coagulase positive; skin flora Clusters; catalase-positive; coagulase positive Pairs, chains; catalase-negative Pairs,	GRAM-POSITIVE COCCI	
Peptostreptococcus spp. Staphylococcus spp. Staphylococcus aureus Staphylococcus epidermidis Staphylococcus saprophyticus Streptococcus saprophyticus Streptococcus bovis (group D Enterococcus) Streptococcus pneumoniae (Pneumococcus, group B) Streptococcus propens (group A) Streptococcus viridans Streptococcus yogenes (group A) Streptococcus yogene	(Note: These are equivalent	Pairs, chains; catalase-negative
Staphylococcus spp. Staphylococcus aureus Staphylococcus epidermidis Staphylococcus epidermidis Staphylococcus saprophyticus Streptococcus spp. Streptococcus agalactiae (group B) Streptococcus bovis (group D Enterococcus) Streptococcus pneumoniae (Pneumococcus, group B) Streptococcus pyogenes (group A) Streptococcus pyogenes (group A) Streptococcus viridans GRAM-NEGATIVE COCCI Acinetobacter spp. Moraxella (Branhamella) catarrhalis Neisseria gonorrhoeae (gonococcus) Neisseria meningitidis (meningococcus) GRAM-POSITIVE BACILLI Actinomyces Clusters; catalase-positive; coagulase positive; skin flora Clusters; catalase-positive; coagulase positive; coagulase positive; skin flora Clusters; catalase-positive; coagulase positive; skin flora Clusters; catalase-positive; coagulase positive; scalase-logative; pairs, chains; catalase-negative; pairs, chains; catalase-negative; pairs, chains; catalase-negative; pairs, chains; catalase-negative; pairs, chains;		Angerobic
Staphylococcus aureus Staphylococcus epidermidis Staphylococcus saprophyticus Streptococcus saprophyticus Streptococcus bovis (group D Enterococcus) Streptococcus pneumoniae (Pneumococcus propup B) Streptococcus viridans GRAM-NEGATIVE COCCI Acinetobacter spp. Moraxella (Branhamella) catarrhalis Neisseria gonorrhoeae (gonopoccus) Veillonella spp. GRAM-POSITIVE BACILLI Staphylococcus epidermidis Clusters; catalase-positive; coagulase positive; skin flora Clusters; catalase-positive; coagulase positive positive. Pairs, chains; catalase-negative Pairs, lancet-shaped; alpha-hemolytic Optochin-resistant Optochin-resistant Optochin-resistant Pairs, chains; catalase-negative Pairs, lancet-shaped; alpha-hemolytic		
Staphylococcus epidermidis Staphylococcus saprophyticus Streptococcus spp. Streptococcus agalactiae (group B) Streptococcus bovis (group D Enterococcus) Streptococcus faecalis (group D Enterococcus) Streptococcus pneumoniae (Pneumococcus, group B) Streptococcus pyogenes (group A) Streptococcus yiridans GRAM-NEGATIVE COCCI Acinetobacter spp. Moraxella (Branhamella) catarrhalis Neisseria gonorrhoeae (gonococcus) Neisseria meningitidis (meningococcus) Veillonella spp. GRAM-POSITIVE BACILLI Clusters; catalase-positive; coagulase positive; skin flora Clusters; catalase-positive; coagulase positive Pairs, chains; catalase-negative Optochin-sensitive Beta-hemolytic Optochin-resistant Optochin-resistant Diplococci in pairs, often intracellula ferments glucose but not maltose Anaerobic RAM-POSITIVE BACILLI Actinomyces Branching, beaded, rods; anaerobic		Clusters; catalase-positive; coagulase- negative; beta-hemolytic; yellow
Streptococcus saprophyticus Streptococcus sap. Streptococcus agalactiae (group B) Streptococcus bovis (group D Enterococcus) Streptococcus faecalis (group D Enterococcus) Streptococcus faecalis (group D Enterococcus) Streptococcus pneumoniae (Pneumococcus, group B) Streptococcus piedinas Streptococcus viridans Streptococcus viridans Streptococcus pogenes (group A) Streptococcus viridans Streptococcus pogenes (group A) Streptococcus pogenes (group A) Streptococcus viridans Streptococcus viridans Streptococcus proup B) Pairs, chains; catalase-negative Pairs, chains; catalase-negative Optochin-sensitive Beta-hemolytic Optochin-sensitive Diplococci in pairs Optochin-sensitive Diplococci in	Staphylococcus epidermidis	Clusters; catalase-positive; coagulase-
Streptococcus spp. Streptococcus agalactiae (group B) Streptococcus bovis (group D Enterococcus) Streptococcus faecalis (group D Enterococcus) Streptococcus pneumoniae (Pneumococcus, group B) Streptococcus viridans Streptococcus	Staphylococcus saprophyticus	Clusters; catalase-positive; coagulase-
Streptococcus agalactiae (group B) Streptococcus bovis (group D Enterococcus) Streptococcus faecalis (group D Enterococcus) Streptococcus faecalis (group D Enterococcus) Streptococcus pneumoniae (Pneumococcus, group B) Streptococcus pyogenes (group A) Streptococcus viridans Streptococcus viridans Streptococcus progenes (group A) Streptococcus progenes (group B) Streptococcus progenes (group A) Streptococcus progenes (group B) Beta-hemolytic Optochin-sensitive Beta-hemolytic Pairs, chains; catalase-negative		•
Enterococcus Streptococcus faecalis (group D Enterococcus) Streptococcus peumoniae (Pneumococcus, group B) Streptococcus pyogenes (group A) Streptococcus viridans Streptococcus virida	Streptococcus agalactiae (group B)	
Enterococcus Streptococcus pneumoniae (Pneumococcus, group B) Streptococcus pyogenes (group A) Streptococcus viridans GRAM-NEGATIVE COCCI Acinetobacter spp. Moraxella (Branhamella) catarrhalis Neisseria gonorrhoeae (gonococcus) Neisseria meningitidis (meningococcus) Veillonella spp. GRAM-POSITIVE BACILLI Pairs, lancet-shaped; alpha-hemolytic Optochin-sensitive Beta-hemolytic Pairs, chains; catalase-negative; alpha-hemolytic, Optochin-resistant Diplococci in pairs, often intracellula ferments glucose but not maltose Diplococci in pairs; ferments glucose and maltose Anaerobic Branching, beaded, rods; anaerobic		Pairs, chains; catalase-negative
(Pneumococcus, group B) Streptococcus pyogenes (group A) Streptococcus viridans GRAM-NEGATIVE COCCI Acinetobacter spp. Moraxella (Branhamella) catarrhalis Neisseria gonorrhoeae (gonococcus) Neisseria meningitidis (meningococcus) Veillonella spp. GRAM-POSITIVE BACILLI Actinomyces Optochin-sensitive Beta-hemolytic Pairs, chains; catalase-negative; alphohemolytic, Optochin-resistant Beta-hemolytic Pairs, chains; catalase-negative; alphohemolytic, Optochin-resistant Diplococci in pairs ferments glucose but not maltose Diplococci in pairs, often intracellula ferments glucose and maltose Anaerobic Branching, beaded, rods; anaerobic		Pairs, chains; catalase-negative
Streptococcus viridans Pairs, chains; catalase-negative; alpha hemolytic, Optochin-resistant GRAM-NEGATIVE COCCI Acinetobacter spp. Moraxella (Branhamella) catarrhalis Neisseria gonorrhoeae (gonococcus) Neisseria meningitidis (meningococcus) Veillonella spp. GRAM-POSITIVE BACILLI Actinomyces Pairs, chains; catalase-negative; alpha hemolytic, Optochin-resistant Filamentous, branching pattern Diplococci in pairs, often intracellula ferments glucose but not maltose Diplococci in pairs; ferments glucose and maltose Anaerobic Branching, beaded, rods; anaerobic		Pairs, lancet-shaped; alpha-hemolytic; Optochin-sensitive
Acinetobacter spp. Moraxella (Branhamella) catarrhalis Neisseria gonorrhoeae (gonococcus) Neisseria meningitidis (meningococcus) Veillonella spp. GRAM-POSITIVE BACILLI Actinomyces Filamentous, branching pattern Diplococci in pairs, often intracellula ferments glucose but not maltose Diplococci in pairs; ferments glucose and maltose Anaerobic Branching, beaded, rods; anaerobic		Pairs, chains; catalase-negative; alpha
Moraxella (Branhamella) catarrhalis Neisseria gonorrhoeae (gonococcus) Neisseria meningitidis (meningococcus) Veillonella spp. GRAM-POSITIVE BACILLI Actinomyces Diplococci in pairs, often intracellula ferments glucose but not maltose Diplococci in pairs; ferments glucose and maltose Anaerobic Branching, beaded, rods; anaerobic	GRAM-NEGATIVE COCCI	
Neisseria gonorrhoeae (gonococcus) Neisseria meningitidis (meningococcus) Veillonella spp. CRAM-POSITIVE BACILLI Actinomyces Diplococci in pairs, often intracellula ferments glucose but not maltose Diplococci in pairs; ferments glucose and maltose Anaerobic Branching, beaded, rods; anaerobic	Moraxella (Branhamella)	
Neisseria meningitidis (meningococcus) Veillonella spp. GRAM-POSITIVE BACILLI Actinomyces Diplococci in pairs; ferments glucose and maltose Anaerobic Branching, beaded, rods; anaerobic	Neisseria gonorrhoeae	Diplococci in pairs, often intracellular
(meningococcus) and maltose Veillonella spp. Anaerobic GRAM-POSITIVE BACILLI Actinomyces Branching, beaded, rods; anaerobic		
Veillonella spp. Anaerobic GRAM-POSITIVE BACILLI Actinomyces Branching, beaded, rods; anaerobic		
GRAM-POSITIVE BACILLI Actinomyces Branching, beaded, rods; anaerobic		
	• •	
Pacilli anthrasia lanthray		Branching, beaded, rods; anaerobic
bacili alliliacis (alliliax) Spore forming roa	Bacilli anthracis (anthrax)	Spore forming rod

TABLE 7-1 (Continued)

Gram Staining Pattern and Organisms GRAM-POSITIVE BACILLI Clostridium spp. (C. difficile, C. botulinum, C. tetani) Corynebacterium spp. (C. diphtheriae) Eubacterium spp. Lactobacillus spp. Lactobacillus spp. Listeria monocytogenes Mycobacterium spp. (limited staining) Nocardia Nocardia Roman Staining Propionibacterium acne GRAM-NEGATIVE BACILLI Acinetobacter spp. Aeromonas hydrophilia Bacteroides fragilis Bordetella pertussis Bordetella pertussis Citrobacter spp. Lactose-positive Stains poorly, use silver stain and special media Lactose-negative, oxidase-negative, indole-positive Lactose-negative, oxidase-negative, indole-positive Lactose-negative, oxidase-negative, indole-positive Lactose-negative, oxidase-negative, indole-positive	ontinued)	
Clostridium spp. (C. difficile, C. botulinum, C. tetani) Corynebacterium spp. (C. diphtheriae) Eubacterium spp. (C. diphtheriae) Eubacterium spp. (C. diphtheriae) Listeria monocytogenes Mycobacterium spp. (limited staining) Nocardia Propionibacterium acne CRAM-NEGATIVE BACILUI Acinetobacter spp. (Acinetobacter spp.		Identifying Key Features
C. botulinum, C. tetani) Corynebacterium spp. (C. diphtheriae) Eubacterium spp. Lactobacillus spp. Listeria monocytogenes Mycobacterium spp. (limited staining) Nocardia Propionibacterium acne GRAM-NEGATIVE BACILLI Acinetobacter spp. Aeromonas hydrophilia Bacteroides fragilis Bordetella pertussis Brucella (brucellosis) Citrobacter spp. Escherichia coli Fusobacterium spp. Haemophilus ducreyi (chancroid) Haemophilus influenzae Morganella morganii Proteus mirabilis Raaerobic Small, pleomorphic diphtheroid; skin flora Anaerobic Only rapidly growing species gram stain (M. abscessus, M. chelonae, M. fortuitum) Beaded, branched rods; partially acid-fast-staining Small, pleomorphic diphtheroid; only growing species gram stain (M. abscessus, M. chelonae, M. fortuitum) Beaded, branched rods; partially acid-fast-staining Small, pleomorphic diphtheroid; only growing species gram stain (M. abscessus, M. chelonae, M. fortuitum) Beaded, branched rods; partially acid-fast-staining Small, pleomorphic diphtheroid; skin flora Lactose-negative, oxidase-negative Lactose-negative, oxidase-negative, oxidase-ne	GRAM-POSITIVE BACILLI	
Corynebacterium spp. (C. diphtheriae) Eubacterium spp. Lactobacillus spp. Listeria monocytogenes Mycobacterium spp. (limited staining) Nocardia Nocardia Propionibacterium acne GRAM-NEGATIVE BACILLI Acinetobacter spp. Aeromonas hydrophilia Bacteroides fragilis Bordetella pertussis Brucella (brucellosis) Citrobacter spp. Etscherichia coli Fusobacterium spp. Haemophilus ducreyi (chancroid) Haemophilus influenzae Morganella morganii Proteus mirabilis Manaerobic Small, pleomorphic diphtheroid; skin flora Anaerobic Only rapidly growing species gram stain (M. abscessus, M. chelonae, M. fortuitum) Beaded, branched rods; partially acid-fast-staining Small, pleomorphic diphtheroid; anaerobic Only rapidly growing species gram stain (M. abscessus, M. chelonae, M. fortuitum) Beaded, branched rods; partially acid-fast-staining Small, pleomorphic diphtheroid; Only rapidly growing species gram stain (M. abscessus, M. chelonae, M. fortuitum) Beaded, branched rods; partially acid-fast-staining Small, pleomorphic diphtheroid; Only rapidly growing species gram stain (M. abscessus, M. chelonae, M. fortuitum) Beaded, branched rods; partially acid-fast-staining Small, pleomorphic diphtheroid; Only rapidly growing species gram stain (M. abscessus, M. chelonae, M. fortuitum) Beaded, branched rods; partially acid-fast-staining Small, pleomorphic diphtheroid; Only rapidly growing species gram stain (M. abscessus, M. chelonae, M. fortuitum) Beaded, branched rods; partially acid-fast-staining Small, pleomorphic diphtheroid; Only rapidly growing species gram stain (M. abscessus, M. chelonae, M. fortuitum) Beaded, branched rods; partially acid-fast-staining Small, pleomorphic diphtheroid; Only rapidly growing species gram stain (M. abscessus, M. chelonae, M. fortuitum) Beaded, branched rods; partially acid-fast-staining Small, pleomorphic diphtheroid; Only rapidly growing species gram stain (M. abscessus, M. chelonae, M. fortuitum) Beaded, branched rods; partially acid-fast-staining Small, pleomorphic diphtheroid; Only rapidly growing s		Large, with spores; anaerobic
C. diphtheriae Eubacterium spp. Lactobacillus spp. Anaerobic Listeria monocytogenes Mycobacterium spp. (limited staining) Staining) Beaded, branched rods; partially acid-fast-staining Propionibacterium acne Small, pleomorphic diphtheroid; anaerobic GRAM-NEGATIVE BACILU Acinetobacter spp. Lactose-negative, oxidase-negative Lactose-positive Stains poorly, use silver stain and special media Lactose-negative, oxidase-negative, indole-negative, oxidase-negative, oxida		c II I I I I I I I I I I I I I I I I I
Eubacterium spp. Lactobacillus spp. Listeria monocytogenes Mycobacterium spp. (limited staining) Nocardia Propionibacterium acne Acinetobacter spp. Aeromonas hydrophilia Bacteroides fragilis Bordetella pertussis Brucella (brucellosis) Citrobacter spp. Lactose-positive Lactose-positive (usually) Enterobacter spp. Lactose-positive (usually) Lactose-positive (usually		
Listeria monocytogenes Mycobacterium spp. (limited staining) Nocardia Propionibacterium acne Acinetobacter spp. Aeromonas hydrophilia Bacteroides fragilis Bordetella pertussis Brucella (brucellosis) Citrobacter spp. Lactose-positive Lactose-positive (usually) Enterobacter spp. Lactose-positive (usually) Lactose-posi		
anaerobic Beta-hemolytic Only rapidly growing species gram staining) Nocardia Propionibacterium acne GRAM-NEGATIVE BACILLI Acinetobacter spp. Aeromonas hydrophilia Bacteroides fragilis Bordetella pertussis Bordetella (brucellosis) Citrobacter spp. Lactose-negative (usually) Enterobacter spp. Lactose-positive (usually) Enterobacter spp. Lactose-positive (usually) Escherichia coli Fusobacterium spp. Haemophilus ducreyi (chancroid) Haemophilus influenzae Morganella morganii Proteus mirabilis Anaerobic Coccoid rod Coccoid rod Coccoid rod Lactose-positive (usually) Lactose-positive (usually) Lactose-positive (usually) Lactose-positive Long, pointed shape; anaerobic Gram-negative bacilli Coccoid rod, requires chocolate agar to support growth Lactose-positive Stains poorly, use silver stain and special media Lactose-negative, oxidase-negative, indole-negative, oxidase-negative, indole-negative, oxidase-negative, indole-negative, oxidase-negative,		
Mycobacterium spp. (limited staining) Nocardia Nocardia Propionibacterium acne GRAM-NEGATIVE BACILLI Acinetobacter spp. Aeromonas hydrophilia Bacteroides fragilis Bordetella pertussis Brucella (brucellosis) Citrobacter spp. Lactose-negative (usually), oxidase-positive Enterobacter spp. Lactose-positive (usually)		
Mycobacterium spp. (limited staining) Nocardia Nocardia Propionibacterium acne Ram-NEGATIVE BACILLI Acinetobacter spp. Aeromonas hydrophilia Bacteroides fragilis Bacteroides fragilis Brucella (brucellosis) Citrobacter spp. Lactose-negative (usually), oxidase-positive Brucella (brucellosis) Citrobacter spp. Lactose-positive (usually) Enterobacter spp. Lactose-positive (usually) Lactose-positi	Listeria monocytogenes	Beta-hemolytic
Acinetobacter spp. Aeromonas hydrophilia Bacteroides fragilis Bordetella pertussis Brucella (brucellosis) Citrobacter spp. Lactose-negative (usually), oxidase-positive Bacteroides fragilis Brucella (brucellosis) Coccoid rod Brucella (brucellosis) Coccoid rod Citrobacter spp. Lactose-positive (usually) Enterobacter spp. Lactose-positive (usually) Lactose-positive (usually) Lactose-positive (usually) Lactose-positive (usually) Lactose-positive (usually) Lactose-positive (usually) Lactose-positive Long, pointed shape; anaerobic Gram-negative bacilli Coccoid rod, requires chocolate agar to support growth Lactose-positive Lactose-positive Stains poorly, use silver stain and special media Lactose-negative, oxidase-negative, indole-negative Proteus vulgaris Lactose-negative, oxidase-negative,	Mycobacterium spp. (limited	stain (M. abscessus, M. chelonae,
Propionibacterium acne GRAM-NEGATIVE BACILUI Acinetobacter spp. Aeromonas hydrophilia Bacteroides fragilis Bordetella pertussis Brucella (brucellosis) Citrobacter spp. Lactose-negative (usually), oxidase-positive Anaerobic Coccoid rod Coccoid rod Coccoid rod Lactose-positive (usually) Enterobacter spp. Lactose-positive (usually) Escherichia coli Fusobacterium spp. Haemophilus ducreyi (chancroid) Haemophilus influenzae Klebsiella spp. Legionella pneumophila Morganella morganii Proteus mirabilis Proteus vulgaris Lactose-negative, oxidase-negative, oxidase-negative, indole-negative, oxidase-negative,	Nocardia	
Acinetobacter spp. Aeromonas hydrophilia Bacteroides fragilis Bordetella pertussis Brucella (brucellosis) Citrobacter spp. Enterobacter spp. Enterobacter spp. Escherichia coli Fusobacterium spp. Haemophilus ducreyi (chancroid) Haemophilus influenzae Klebsiella spp. Legionella pneumophila Morganella morganii Proteus mirabilis Lactose-negative, oxidase-negative Lactose-negative (usually) Lactose-positive (usually) Lactos	Propionibacterium acne	Small, pleomorphic diphtheroid;
Aeromonas hydrophilia Bacteroides fragilis Bordetella pertussis Bordetella pertussis Brucella (brucellosis) Citrobacter spp. Enterobacter spp. Enterobacter spp. Escherichia coli Fusobacterium spp. Haemophilus ducreyi (chancroid) Haemophilus influenzae Klebsiella spp. Legionella pneumophila Morganella morganii Proteus mirabilis Lactose-negative (usually) Lactose-positive (usually) Lactose-positi	GRAM-NEGATIVE BACILLI	
Bacteroides fragilis Bordetella pertussis Coccoid rod Brucella (brucellosis) Citrobacter spp. Lactose-positive (usually) Enterobacter spp. Lactose-positive (usually) Escherichia coli Fusobacterium spp. Haemophilus ducreyi (chancroid) Haemophilus influenzae Klebsiella spp. Legionella pneumophila Morganella morganii Proteus mirabilis Proteus vulgaris Proteus vulgaris Coccoid rod Coccoid rod Coram-negative bacilli Gram-negative bacilli Coccoid rod, requires chocolate agar to support growth Lactose-positive Stains poorly, use silver stain and special media Lactose-negative, oxidase-negative, indole-negative Lactose-negative, oxidase-negative,		
Bordetella pertussis Brucella (brucellosis) Coccoid rod Coccoid rod Citrobacter spp. Lactose-positive (usually) Escherichia coli Fusobacterium spp. Haemophilus ducreyi (chancroid) Haemophilus influenzae Coccoid rod Lactose-positive (usually) Lactose-positive Long, pointed shape; anaerobic Gram-negative bacilli Coccoid rod, requires chocolate agar to support growth Lactose-positive Stains poorly, use silver stain and special media Morganella morganii Proteus mirabilis Lactose-negative, oxidase-negative, indole-negative Proteus vulgaris Lactose-negative, oxidase-negative,	Aeromonas hydrophilia	
Brucella (brucellosis) Citrobacter spp. Enterobacter spp. Escherichia coli Fusobacterium spp. Haemophilus ducreyi (chancroid) Haemophilus influenzae Klebsiella spp. Legionella pneumophila Morganella morganii Proteus mirabilis Coccoid rod Lactose-positive (usually) Lactose-positive Lactose-positive Gram-negative bacilli Coccoid rod, requires chocolate agar to support growth Lactose-positive Stains poorly, use silver stain and special media Lactose-negative, oxidase-negative, indole-negative Lactose-negative, oxidase-negative, oxidase-negative,		
Citrobacter spp. Enterobacter spp. Escherichia coli Fusobacterium spp. Haemophilus ducreyi (chancroid) Haemophilus influenzae Klebsiella spp. Legionella pneumophila Morganella morganii Proteus mirabilis Lactose-positive (usually) Croccoid rod, requires chocolate agar to support growth Lactose-positive Stains poorly, use silver stain and special media Lactose-negative, oxidase-negative, indole-negative Lactose-negative, oxidase-negative,		
Enterobacter spp. Escherichia coli Fusobacterium spp. Haemophilus ducreyi (chancroid) Haemophilus influenzae Klebsiella spp. Legionella pneumophila Morganella morganii Proteus mirabilis Enterobacter spp. Lactose-positive Lactose-positive Stains poorly, use silver stain and special media Lactose-negative, oxidase-negative, indole-negative, oxidase-negative, oxidase-negative, oxidase-negative, oxidase-negative,		
Escherichia coli Fusobacterium spp. Haemophilus ducreyi (chancroid) Haemophilus influenzae Klebsiella spp. Legionella pneumophila Morganella morganii Proteus mirabilis Froteus vulgaris Lactose-positive Lactose-positive Stains poorly, use silver stain and special media Lactose-negative, oxidase-negative, indole-negative, oxidase-negative, oxidase-negative, oxidase-negative, oxidase-negative,		
Fusobacterium spp. Haemophilus ducreyi (chancroid) Haemophilus influenzae Klebsiella spp. Legionella pneumophila Morganella morganii Proteus mirabilis Froteus vulgaris Long, pointed shape; anaerobic Gram-negative bacilli Coccoid rod, requires chocolate agar to support growth Lactose-positive Stains poorly, use silver stain and special media Lactose-negative, oxidase-negative, indole-negative Lactose-negative, oxidase-negative,		
Haemophilus ducreyi (chancroid) Haemophilus influenzae Klebsiella spp. Legionella pneumophila Morganella morganii Proteus mirabilis Proteus vulgaris Gram-negative bacilli Coccoid rod, requires chocolate agar to support growth Lactose-positive Stains poorly, use silver stain and special media Lactose-negative, oxidase-negative, indole-negative Lactose-negative, oxidase-negative,		
Haemophilus influenzae Klebsiella spp. Legionella pneumophila Morganella morganii Proteus mirabilis Proteus vulgaris Coccoid rod, requires chocolate agar to support growth Lactose-positive Stains poorly, use silver stain and special media Lactose-negative, oxidase-negative Lactose-negative, oxidase-negative, indole-negative Lactose-negative, oxidase-negative,		
to support growth Klebsiella spp. Lactose-positive Stains poorly, use silver stain and special media Morganella morganii Proteus mirabilis Lactose-negative, oxidase-negative, indole-negative Proteus vulgaris Lactose-negative, oxidase-negative,		
Legionella pneumophila Stains poorly, use silver stain and special media Morganella morganii Proteus mirabilis Lactose-negative, oxidase-negative, indole-negative Proteus vulgaris Lactose-negative, oxidase-negative,		to support growth
special media Morganella morganii Proteus mirabilis Lactose-negative, oxidase-negative, indole-negative Proteus vulgaris Lactose-negative, oxidase-negative, oxidase-negative,		
Proteus mirabilis Lactose-negative, oxidase-negative, indole-negative Proteus vulgaris Lactose-negative, oxidase-negative,	Legionella pneumophila	
indole-negative Proteus vulgaris Lactose-negative, oxidase-negative,		
Proteus vulgaris Lactose-negative, oxidase-negative,	Proteus mirabilis	
	Proteus vulgaris	Lactose-negative, oxidase-negative,

TABLE 7-1 (Continued)

and Organisms	Identifying Key Features
GRAM-NEGATIVE BACILLI	
Providencia spp.	Lactose-negative, oxidase-negative
Pseudomonas aeruginosa	Lactose-negative, oxidase-positive blue-green pigment
Salmonella spp.	Lactose-negative, oxidase-negative
Serratia spp.	Lactose-negative, oxidase-negative
Serratia marcescens	Lactose-negative, oxidative-negative, red pigment
Shigella spp.	Lactose-negative, oxidase-negative
Stenotrophomonas (Xanthomonas) maltophilia	Lactose-negative, oxidase-negative
Vibrio cholerae (cholera)	Gram-negative bacilli
Yersinia enterocolitica	Gram-negative bacilli
Yersinia pestis (bubonic plague)	Gram-negative bacilli

gram-negative organisms is shown in Figures 7–1 and 7–2. Gram stain characteristics of clinically important bacteria are shown in Table 7–1.

India Ink Preparation

India ink is used primarily on CSF to identify fungal organisms (especially cryptococci).

KOH Preparation

KOH (potassium hydroxide) preps are used to diagnose fungal infections. Vaginal KOH preps are discussed in detail in Chapter 13, page 291.

- Apply the specimen (vaginal secretion, sputum, hair, skin scrapings) to a slide. Skin scrapings of a lesion are usually obtained by gentle scraping with a #15 scalpel blade (see page 242 for description).
- Add 1–2 drops of 10% KOH solution and mix. Gentle heating (optional) may accelerate dissolution of the keratin. A fishy odor from a vaginal prep suggests the presence of Gardnerella vaginalis (see page 291)
- 3. Put a coverslip over the specimen, and examine the slide for the branching hyphae and blastospores that indicate the presence of a fungus. KOH should destroy most elements other than fungus. If dense keratin and debris are present, allow the slide to sit for several hours and then repeat the microscopic examination. Lowering the substage condenser provides better contrast between organisms and the background.

Stool Leukocyte Stain (Fecal Leukocytes, Löeffler Methylene Blue Stain)

Used to differentiate treatable diarrhea (ie, bacterial) from other causes. This method detects causes from Crohn's disease, ulcerative colitis, TB, and amebic infection as well, but it should be remembered that many causes of severe diarrhea are viral. The positive predictive value of the bacterial pathogen as a cause for the diarrhea is 70%.

Procedure

- Mix a small amount of stool or mucus on a slide with 2 drops of Löeffler (methylene blue) stain. Mucus is preferred; if no mucus is present, use a small amount of stool from the outside of a formed stool.
- 2. Examine the smear after 2–3 min to allow the white cells to take up the stain; then place a coverslip. The presence of many leukocytes suggests a bacterial cause. Increased white cells (usually polys) are seen in Shigella, Salmonella, Campylobacter, Clostridium difficile, and enteropathogenic Escherichia coli infections, as well as ulcerative colitis and pseudo-membranous colitis-related diarrhea. White cells are absent or normal in cholera and in Giardia and viral (rotavirus, Norwalk virus, etc) infections.

Tzanck Smear

This technique (named after Arnault Tzanck) is used in the diagnosis of herpesvirus infections (ie, herpes zoster or simplex).

Procedure

- Clean a vesicle (not a pustule or crusted lesion) with alcohol, allow it to air dry, and gently unroof it with a #15 scalpel blade. Scrape the base with the blade, and place the material on a glass slide.
- Allow the sample to air dry, and stain with Wright's stain as used for peripheral blood. Giemsa stain can also be used, however, the sample must be fixed for 10 min with methyl alcohol before the Giemsa is applied.
- Scan the slide under low power, and identify cellular areas. Then use high-power oil immersion to identify multinucleated giant cells (epithelial cells infected with herpes viruses). This strongly suggests viral infection; culture is necessary to identify the specific virus.

Vaginal Wet Preparation

· See Chapter 13, page 291

Wayson Stain

Wayson stain is a good quick scout stain that colors most bacteria.

- 1. Spread the smear on a slide, and air or heat dry it.
- Pour freshly filtered Wayson stain onto the slide, and allow it to stand for 10-20 s (timing is not critical).
- 3. Rinse the slide gently with tap water, and dry it with filter paper.
- 4. Use the high dry and oil immersion lenses to examine the slide.

GONORRHEA (GC) CULTURES AND SMEAR

Neisseria gonorrhea can be cultured from many different sites, including female genital tract (endocervix is the preferred site), male urethra, urine, anorectum, throat, and synovial fluid, and the specimen is plated on selective (Thayer-Martin or Transgrow) media. Due to the high incidence of coinfection with Chlamydia and T. pallidum (syphilis), Chlamydia cultures and syphilis serology should also be performed, especially in females with genital infections with GC. Anorectal stains may contain nonpathogenic Neisseria species; avoid fecal contact; apply swab to anal crypts. In males with a urethral discharge, insert a calcium alginate swab (Calgiswab) into the urethra to collect the specimen and then plate.

The GC smear (see Chapter 13, page 291) has a low sensitivity (<50% in female endocervical smear, but is fairly reliable (>95%) in males with urethral discharge. A rapid enzyme immunoassay (gonococcal antigen assay [Gonozyme]) is available to diagnose cervical or urethral GC (not throat or anus) infections in less than 1 h. DNA probe testing is becoming widespread for rapid diagnosis.

NASOPHARYNGEAL CULTURES

Ideally, the specimen for culture should be obtained from deep in the nasopharynx and not the anterior nares, and the swab should not touch the skin. Cultures of nasopharyngeal specimens are useful in identifying Staphylococcus aureus and N. meningitidis infections. Normal nasal flora include Staphylococcus epidermidis and S. aureus, Streptococcus pneumoniae, Haemophilus influenzae, and several others.

BLOOD CULTURES

Blood cultures are not usually indicated for the routine workup of fever. The best use is for

- Fever of unknown origin, especially in adults with white blood counts of > 15,000/mm³ and no localizing signs or symptoms to suggest the source.
- Clinical situations in which the diagnosis is established by a positive blood culture (eg, acute and SBE).
- 3. Febrile elderly, neutropenic, or immunocompromised patients.

Chills and fever usually ensue from ½-2 h after sudden entry of bacteria into the circulation (bacteremia). If bacteremia is suspected, several sets of cultures are usually needed to improve the chances of culturing the offending organism. Ideally, more than one set of cultures should be done at least 1 h apart; drawing more than three sets of specimens a day does not usually increase the yield. Obtain the blood through venipuncture, and avoid sampling through venous lines. Each "set" of specimens for blood culture consists of both an aerobic and anaerobic culture bottle. If possible, culture the specimens before antibiotics are initiated; if the patient is already on antibiotics, use ARD culture bottles, which absorb the antibiotic that may otherwise destroy any bacteria. Legionella, Mycobacterium, Bordetella, and Histoplasma may require special blood collection devices.

- 1. Review the section on the technique of venipuncture (Chapter 13 page 309). Apply a tourniquet above the chosen vein.
- Paint the venipuncture site with a povidone-iodine solution. Repeat this procedure three times with a different pad. Then wipe the area around the vein with alcohol and allow the alcohol to dry.
- 3. Use an 18–22-gauge needle (or smaller if needed) and a 10–20-mL syringe. Enter the skin over the prepped vein, and aspirate a sufficient volume of blood (10–20 mL in adults,

1–5 mL in children); adequate volume will increase the detection rate. **Be careful not to touch the needle or the prepped skin site.** Draw about 10 mL of blood. Remove the tourniquet, and compress the venipuncture site and apply an adhesive bandage.

4. Discard the needle used in the puncture and replace it with a new, sterile 20–22-gauge needle. Place the blood in each of the bottles by allowing the vacuum to draw in the appropriate volume, usually specified on the collection device. Submit the samples to the lab promptly with the appropriate lab slips completed including current antibiotics being given.

Interpretation

Preliminary results are usually available in 12–48 h; cultures should not be formally reported as negative before 4 d. A single blood culture that is positive for one of the following organisms usually suggests contamination; however, on rare occasions these agents are the causative pathogen: Staphylococcus epidermidis, Bacillus sp., Corynebacterium diphtheriae (and other diphtheroids), Streptococcus viridans. Negative results do not rule out bacteremia, and false-positives can result for the contaminants noted. Gram-negative organisms, fungi, and anaerobes are considered to be pathogenic until proven otherwise.

SPUTUM CULTURES

Cultures of sputum remain controversial. Many clinicians do not even order them and treat only based on the Gram stain and clinical findings. One problem is that "sputum" samples often contain only saliva. If you do a Gram stain on the specimen and see only a few squamous cells, with many polys and histiocytes, the sample is good, and the culture will probably be reliable. Excessive numbers of squamous cells (see previous section on Gram stain) suggests that the sample is more saliva than sputum. An early morning sample is most likely to be from deep within the bronchial tree.

Steps to improve the quality of the sputum collection

- 1. Careful instructions to the patient.
- If the patient cannot mobilize the secretions, P&PD along with nebulizer treatments may help.
- 3 Careful nasotracheal suctioning using a specimen trap.

In general most labs will not accept anaerobic sputum cultures (critical in the diagnosis of aspiration pneumonia and lung abscesses) unless obtained by **transtracheal aspirate** or **endobronchial endoscopic collection** and submitted in special anaerobic transport media. Viral, *Legionella, Mycoplasma*, and TB cultures require special culture materials available at most labs. **PCP** can be diagnosed by sputum culture only about 10% of the time; therefore open-lung biopsy, endobronchial lavage, or other invasive techniques must be used to demonstrate the organisms. Specialized staining techniques for identifying *Pneumocystis carinii* include the methenamine silver, Giemsa, and toluidine blue stains.

STOOL CULTURES

Stool cultures are most often done to diagnose the cause of diarrhea or to identify disease carriers. A fresh sample is essential to isolate the organisms. Most common pathogens (Salmonella, Shigella, enteropathogenic E. coli, etc) can be grown on standard media. Yersinia and Campylobacter, however, usually require a special culture medium, and a special lab request is usually necessary.

A quick bedside test for bacterial causes of diarrhea is to check the stool for white cells (fecal leukocyte smear) see page 128.

Clostridium difficile Assay

Clostridium difficile is usually best diagnosed by determining the presence of *C. difficile* enterotoxin on the stool and not by culture. A positive *C. difficile* assay is found in the following cases: >90% of pseudo-membranous colitis; 30–40% antibiotic associated colitis, and 6–10% cases of antibiotic-associated diarrhea.

Stool for Ova and Parasites

With toxic diarrhea, the possibility of parasitic disease must be considered and stool for "ova and parasites" should be ordered. Protozoa (ameba [Entamoeba histolytica, others], Blastocystis, Giardia) cannot be cultured and are identified by seeing mature, mobile organisms or cysts on microscopic examination of freshly passed feces. Immunosuppressed (eg., HIV-positive) individuals may demonstrate Cryptosporidium, Microsporidia, and Strongyloides. The ova are most frequently identified in the stool of parasites such as nematodes (Ascaris, Strongyloides), cestodes (Taenia, Hymenolepsis), and trematodes (Schistosoma).

THROAT CULTURES

Used to differentiate viral from bacterial (usually group A beta-hemolytic streptococci, eg, Streptococcus pyogenes) pharyngitis.

Procedure

- 1. The best culture is obtained with the help of a tongue blade and a good light source.
- If epiglottitis (croup) is suspected (stridor, drooling), a culture should not be attempted.
- The goal is to use the culture swab and try not to touch the oral mucosa or tongue, but only the involved area. In the uncooperative patient, an arch-like swath touching both the tonsillar areas and posterior pharynx should be attempted.

Many labs perform a specific "strep screen" to rapidly identify group A beta-hemolytic streptococci. Normal flora on routine culture can include alpha-hemolytic strep, non-hemolytic staph, saprophytic Neisseria species, Haemophilus, Klebsiella, Candida, and diphtheroids.

Other pathogens can cause pharyngitis. If *Neisseria gonorrhoeae* is suspected, use the Thayer–Martin medium. Diphtheria (*C. diphtheriae*) with its characteristic pseudo-membrane, should be cultured on special media and the lab notified.

URINE CULTURES

As is true for sputum cultures, culturing for urinary tract pathogens is often controversial. Some clinicians base their decision to treat only when the culture is positive, whereas others rely on the presence of white blood cells or bacteria in the urinalysis, using cultures only for sensitivities in refractory infections. The introduction of urine dipsticks to detect leukocytes (by the detection of leukocyte esterase) aids in the decision making when cultures are not obtained or are confusing. Routine cultures fail to diagnose other urinary tract pathogens such as *N. gonorrhea* or *Chlamydia*.

A clean-catch urine (see Chapter 13, page 306) is about 85% accurate in women and uncircumcised males. In general, a positive culture is a colony count of >100,000 bacteria/mL of urine or a count from 10,000–100,000 bacteria/mL of urine in the presence of pyuria. If the culture is critical for diagnosis, obtain an in-and-out catheterized urine (page

308) or suprapubic aspiration in children (page 309). Any growth of bacteria on an in-andout catheterized or suprapubic specimen is considered to represent a true infection.

If a urine specimen cannot be taken to the lab within 60 min, refrigerate it. The lab assumes that more than three organisms growing on a culture represents a contaminant and the specimen collection should be repeated. The exception occurs in patients with a chronic indwelling Foley catheter that may be colonized with multiple bacterial or fungal organisms; the lab should be told to "culture all organisms" in such cases.

VIRAL CULTURES AND SEROLOGY

The laboratory provides the proper collection container for the specific virus. Common pathogenic viruses cultured include **herpes simplex** (from genital vesicles, throat), **CMV** (from urine or throat), **varicella-zoster** (from skin vesicles in children with chickenpox and adults with shingles), and enterovirus (rectal swab, throat).

For serologic testing, obtain an **acute specimen (titer)** as early as possible in the course of the illness, and take a **convalescent specimen (titer)** 2–4 wk later. A fourfold or greater rise in the convalescent titer compared with the acute titer indicates an active infection (see Chapter 4 for selected viral antibody titers). With the development of PCR techniques, biopsies performed on older lesions may yield useful information when cultures might be negative.

SCOTCH TAPE TEST

Also known as a "pinworm preparation," this method is used to identify infestation with *Enterobius vermicularis*. A 3-in. piece of CLEAR Scotch tape is attached around a glass slide (sticky side out). The slide is applied to the perianal skin in four quadrants and examined under the microscope for pinworm eggs. The best sample is collected either in the early morning prior to bathing or several hours after retiring.

MOLECULAR MICROBIOLOGY

Molecular techniques can now identify many bacterial and viral organisms without culturing. Many tests rely on DNA probes to identify the pathogens. The following includes some microbes commonly identified from clinical specimens (ie, swab, serum, tissue). Availability varies with each clinical facility.

Common Microorganisms Identifiable by PCR/DNA Probe

- · Chlamydia trachomatis
- · Borrelia burgdorferi (Lyme disease)
- HIV
- · Mycoplasma pneumoniae
- · Mycobacterium tuberculosis
- Neisseria gonorrhoeae
- Hepatitis B
- HPV
- · Many others under development

SUSCEPTIBILITY TESTING

To more effectively treat a specific infection by choosing the right antibiotic, many labs routinely provide the MIC or MBC. For more complex infections (endocarditis), Schlichter testing is sometimes used.

MIC (Minimum Inhibitory Concentration)

This is the lowest concentration of antibiotic that prevents an in vitro growth of bacteria. The organism is tested against a battery of antimicrobials in concentrations normally achieved in vivo and reported as

Susceptible (S): The organism is inhibited by the agent in the usual dose and route, and the drug should be effective.

Intermediate (I): Sometimes also reported as "indeterminate," this implies that high doses of the drug, such as those achieved with parenteral therapy (IM, IV), most likely inhibit the organism.

Resistant (R): The organism is resistant to the usual levels achieved by the drug.

MBC (Minimum Bactericidal Concentration)

Similar to the MIC, but indicates the lowest antibiotic concentration that will kill 99.9% of the organisms. The MBC results in killing the organisms, and the MIC prevents growth but may not kill the organism.

Schlichter Test (Serum Bacteriocidal Level)

Used to determine the antibacterial level of the serum or CSF of patients who are receiving antibiotic therapy. The test uses eight serial dilutions of the patient's serum (1:1 through 1:128) to determine what dilution is bactericidal to the infecting organism. The test is usually coordinated by the departments of infectious disease and microbiology. One set of blood or CSF cultures must be negative for the infecting organism before the test is performed. Opinion varies greatly as to interpretation of the results. Optimal killing of the organism occurs at dilutions of blood (and CSF) ranging anywhere from a trough of 1:4 to a peak of 1:8. That is, a result such as "S. aureus bactericidal level = 1:8" means the infecting organism was killed at a serum dilution of 1:8. Some data suggest higher titers (1:32) are needed to treat bacterial endocarditis. For the test to be performed, the organisms responsible for the infection must be isolated from a patient specimen.

DIFFERENTIAL DIAGNOSIS OF COMMON INFECTIONS AND EMPIRIC THERAPY

The pathogens causing common infectious diseases are outlined in Table 7–2 along with some empiric therapeutic recommendations. The antimicrobial drug of choice for the treatment of infection is usually the most active drug against the pathogenic organism or the least toxic alternative among several effective agents. The choice of drugs is modified by the site of infection, clinical status (allergy, renal disease, pregnancy, etc), and susceptibility testing.

Tables 7–3 through 7–7 provide empiric treatment guidelines for some common infectious diseases, including bacterial, fungal, viral, HIV, parasitic, and tick-borne diseases.

TABLE 7–2
Organisms Responsible for Common Infectious Diseases with Recommended Empiric Therapy*

Site/Condition	Common Uncommon but Important	Common Empiric Therapy (Modify based on clinic factors such as Gram stain)
BONES AND JOINTS		
Osteomyelitis	Staphylococcus aureus Enterobacteriaceae If nail puncture: Pseudomonas spp.	Oxacillin, nafcillin
Joint, septic arthritis	S. aureus Group A strep Enterobacteriaceae Gonococci	Oxacillin; ceftriaxone if gonococci
Joint, prosthetic	S. aureus, S. epididymis, Streptococcus spp.	Vancomycin plus ciprofloxacin
BREAST		
Mastitis, postpartum	S. aureus	Cefazolin, nafcillin, oxacillin
BRONCHITIS	In adolescent/young patient: Mycoplasma pneumoniae Respiratory viruses In chronic adult infection: Streptococcus pneumoniae Haemophilus influenzae M. catarrhalis Chlamydia pneumoniae	Treatment controversial because most infections are viral; treat if febrile, or associated with sinusitis, positive sputum culture in patients with COPD or if duration >7 days; doxycycline, erythromycin, azithromycin, clarithromycin

TABLE 7-2 (Continued)

Site/Condition	Common Uncommon but Important	Common Empiric Therapy (Modify based on clinic factors such as Gram stain)
CERVICITIS nongonococcal)	Chlamydia, M. hominis, Ureaplasma, others	Azithromycin single dose, doxycycline (evaluate and treat partner)
CHANCHROID CHLAMYDIA	Haemophilus ducreyi	Ceftriaxone or azithromycin as single dose
Urethritis, cervicitis, conjunctivitis, proctitis Neonatal ophthalmia, pneumonia	Chlamydia trachomatis	Azithromycin, doxycycline (amoxicillin if pregnant) Erythromycin
Lymphogranuloma venereum	C. trachomatis (specific serotypes, L1, L2, L3)	Doxycycline
DIVERTICULITIS (no perforation or peritonitis)	Enterobacteriaceae, enterococci, bacteroids	TMP-SMX, ciprofloxacin plus metronidazole
EAR		
Acute mastoiditis	S. pneumoniae Group A strep S. aureus	Amoxicillin, ampicillin/clavulanic acid, cefuroxime
Chronic mastoiditis	Polymicrobial: Anaerobes Enterobacteriaceae Rarely: M. tuberculosis	Ticarcillin/clavulanic acid, imipenem
Otitis externa (swimmer's ear)	Pseudomonas spp. Enterobacteriaceae	Topical agents such as Cortisporin otic, TobraDex

TABLE 7-2 (Continued)

Site/Condition	Common Uncommon but Important	Common Empiric Therapy (Modify based on clinic factors such as Gram stain)
EAR		
Otitis externa (continued)	In diabetic or malignant otitis: Pseudomonas spp.	Malignant otitis externa: acutely aminoglycoside, plus ceftazidime, imipenem or piperacillin
Otitis media	S. pneumoniae, H. influenzae, M. catarrhalis, viral causes S. aureus, group A strep In nasal intubation: Enterobacteriaceae, Pseudomonas spp.	Amoxicillin, ampicillin/clavulanic acid, cefuroxime
EMPYEMA ENDOCARDITIS	S. pneumoniae, S. aureus	Cefotaxime, ceftriaxone
Native valve	S. viridans S. pneumoniae Enterococci S. bovis	Parenteral: penicillin or ampicillin plus oxacillin or nafcillin plus gentamicin; vancomycin plus gentamicin
IV drug user	S. aureus Pseudomonas spp.	Nafcillin plus gentamicin
Prosthetic valve	If early (<6 mo after implant) S. epidermidis S. aureus Enterobacteriaceae	Vancomycin plus rifampin plus gentamicin

TABLE 7-2 (Continued)

Site/Condition	Common Uncommon but Important	Common Empiric Therapy (Modify based on clinic factors such as Gram stain)
Prosthetic valve (continued)	If late (>6 mo after implant) S. viridans Enterococci S. epidermidis S. aureus	
EPIGLOTTITIS	H. influenzae S. pneumoniae S. aureus Group A strep	Chloramphenicol plus ceftriaxone, cefotaxime or ampicillin
GALL BLADDER Cholecystitis Cholangitis	Acute: E. Coli, Klebsiella, Enterococcus Chronic obstruction: anaerobes, coliforms, Clostridium E. coli, Klebsiella, Enterococcus	Ampicillin plus gentamicin w/wo metronidazole, imipenem
GASTROENTERITIS Afebrile, no gross blood or no WBC in stool	Virus, mild bacterial infection	Supportive care only
Febrile, gross blood, and WBC in stool	Enteropathogenic E. coli Shigella Salmonella	Empiric treatment pending cultures: ciprofloxacin, norfloxacin

TABLE 7-2 (Continued)

Common Uncommon but Important	Common Empiric Therapy (Modify based on clinic factor such as Gram stain)
Campylobacter Vibrio C. difficile L. monocytogenes	
Calymmatobacterium granulomatis N. gonorrhea	Doxycycline, trimethoprim/sulfamethoxazole Cefixime, ciprofloxacin, ofloxacin, ceftriaxone all as single dose; (treat also for <i>Chlamydia</i>)
Group B strep, E. coli, Listeria monocytogenes	Ampicillin plus cefotaxime
S. pneumoniae N. meningitidis	
S. pneumoniae	Vancomycin plus ceftriaxone
S. epidermitis, S. aureus,	Vancomycin plus ceftazidime
Gram-negative bacilli, <i>L. monocytogenes</i> S. pneumoniae N. meningitidis, gram-negative bacilli	Ampicillin plus ceftazidime Ampicillin plus ceftriaxone or cefotaxime
	Campylobacter Vibrio C. difficile L. monocytogenes Calymmatobacterium granulomatis N. gonorrhea Group B strep, E. coli, Listeria monocytogenes S. pneumoniae N. meningitidis S. pneumoniae N. meningitidis, H. influenzae S. epidermitis, S. aureus, S. pneumoniae, Pseudomonas Gram-negative bacilli, L. monocytogenes S. pneumoniae

TABLE 7-2 (Continued)

Site/Condition	Common Uncommon but Important	Common Empiric Therapy (Modify based on clinic factors such as Gram stain)
Meningitis (continued)	Pseudomonas spp. H. influenzae	
HIV infection	Cryptococcus	Amphotericin B (acutely), fluconazole
NOCARDIOSIS	Nocardia asteroides	Sulfisoxazole, TMP–SMX
PELVIC INFLAMMATORY DISEASE	Gonococci Enterobacteriaceae Bacteroides spp. Chlamydia Enterococci M. hominis	Ofloxacin and metronidazole or ceftriaxone (single dose) plus doxycycline; parenteral cefotetan or cefoxitin plus doxycycline
PERITONITIS		
Primary (spontaneous)	S. pneumoniae Enterobacteriaceae	Cefotaxime or ceftriaxone
Secondary to (bowel perforation, etc)	Enterobacteriaceae, <i>Bacteroides</i> spp. Enterococci <i>Pseudomonas</i> spp.	Suspect small bowel: piperacillin, mezlocillin, meropenem, cefoxitin Suspect large bowel: clindamycin plus aminoglycoside
Peritoneal dialysis-related	S. epidermidis S. aureus Enterobacteriaceae Candida	Based on culture

TABLE 7-2 (Continued)

Site/Condition	Common Uncommon but Important	Common Empiric Therapy (Modify based on clinic factors such as Gram stain)
PHARYNGITIS	Respiratory virus Group A strep Gonococci C. diphtheria Epstein–Barr virus (infectious mono); spirochetes, anaerobes	Exudative (group A strep): benzathine penicilllin G, erythromycin, loracarbef, azithromycin
PNEUMONIA		
Neonate	Viral (CMV, herpes), bacterial (group B strep, L. monocytogenes, coliforms, S. aureus, Chlamydia)	Ampicillin or nafcillin plus gentamicin
Infant (1-24 mo)	Most viral such as RSV; S. pneumonia, Chlamydia, Mycoplasma	Cefuroxime; if critically ill, cefotaxime, ceftriaxone plus cloxacillin
Child (3 mo- 5 y)	As above	Erythromycin, clarithromycin; if critically ill, cefuroxime plus erythromycin
Child (5–18 y)	Mycoplasma, respiratory viruses, S. pneumoniae, C. pneumoniae	Clarithromycin, azithromycin; erythromycin
Adult community-acquired	M. pneumoniae, C. pneumoniae,	Clarithromycin, azithromycin
, ,	S. pneumoniae Smokers: As above plus M. catarrhalis, H. influenzae	If hospitalized, third-generation cephalosporin plus erythromycin or azithromycin

TABLE 7-2 (Continued)

Site/Condition	Common Uncommon but Important	Common Empiric Therapy (Modify based on clinic factors such as Gram stain)
Adult, community-acquired aspiration	S. pneumoniae oral flora, including anaerobes (eg, Fusobacterium, Bacteroides sp.) Enterobacteriaceae	Clindamycin
Adult hospital-acquired or ventilator-associated	S. pneumonia, coliforms, Pseudomonas, Legionella	Imipenem, meropenem
HIV-associated	Pneumocystis Others as above TB, fungi	Pneumocystis: TMP–SMX; may require steroids
SINUSITIS	S. pneumoniae H. influenzae M. catarrhalis Anaerobes In nosocomial, nasal intubations, etc: S. aureus Pseudomonas spp. Enterobacteriaceae	Acute: TMP-SMX ampicillin, amoxicillin/ clavulanic acid, ciprofloxacin, clarithromycin
SKIN/SOFT TISSUE Acne Acne rosacea Burns	Propionibacterium acne Possible skin mite S. aureus, Enterobacteriaceae,	Tetracycline, minocycline, topical clindamycin Topical: metronidazole, doxycycline Topical: silver sulfadiazine

TABLE 7-2 (Continued)

te/Condition	Common Uncommon but Important	Common Empiric Therapy (Modify based on clinic factors such as Gram stain)
Burns (continued)	Pseudomonas, Proteus Herpes simplex virus, Providencia, Serratia, Candida	Sepsis: Aztreonam or tobramycin plus cefoperazone, ceftazidime or piperacillin
Bite (human and animal)	Anaerobes P. multiloculada	Ampicillin/sulbactam IV or amoxicillin/ clavulanic acid PO
Cellulitis	Streptococcus spp. (group, A. B. C, G) S. aureus Anaerobic	Diabetic: nafcillin, oxacillin with or without penicillin; if anaerobic, high-dose penicillin G, cefoxitin, cefotetan
Decubitus	Group A strep (<i>S. pyogenes</i>) Anaerobes, <i>S. aureus,</i> Enterobacteria Polymicrobial anaerobic	If acutely ill: imipenem, meropenem, ticarcillin/clavulanic acid
Erysipelas	Group A strep (S. pyogenes)	Nafcillin, oxacillin, dicloxacillin, cefazolin
Impetigo	Group A strep S. arueus	Penicillin, erythromycin; oxacillin or nafcillin if S. aureus
Tinea capitis (scalp) "ringworm"	Fungus: Trichophyton spp., Microsporum spp.	Terbinafine, itraconazole, fluconazole,
Tinea corporis (body)	Fungus: Trichophyton spp., Epidermophyton	Topical: ciclopirox, clotrimazole, econazole, ketoconazole, miconazole, terconazole, others
Tinea unguium	Various fungi	Itraconazole, fluconazole, terbinafine

TABLE 7-2 (Continued)

Site/Condition	Common Uncommon but Important	Common Empiric Therapy (Modify based on clinic factors such as Gram stain)
SYPHILIS (less than 1 y duration)	Treponema pallidum	Benzathine penicillin G one dose; doxycycline, tetracycline, ceftriaxone
TUBERCULOSIS Pulmonary, HIV (–) TB exposure, PPD (–) Prophylaxis in high-risk patients (diabetics, IV drug users, immunosuppressed, etc)	Mycobacterium tuberculosis	INH, rifampin ethambutol plus pyrazinamide at least 6 mo (+/- pyridoxine) Children <5 INH X3 mo (+/- pyridoxine), others observe INH 6-12 mo (+/- pyridoxine)
PPD + conversion		INH 6-12 mo (+/- pyridoxine)
URINARY TRACT INFECTIONS Cystitis	Enterobacteriaceae (E. coli most common) S. saprophyticus (young female)	Quinolone, TMP–SMX
Urethritis	Candida Gonococci, C. trachomatis, Trichomonas	Candida: fluconazole or amphotericin B bladder irrigation Ceftriaxone, cefixime, ciprofloxacin, ofloxacin (all one dose) plus

TABLE 7-2 (Continued)

Site/Condition	Common Uncommon but Important	Common Empiric Therapy (Modify based on clinic factors such as Gram stain)
Urethritis (continued)	Herpesvirus	azithromycin (single dose) or doxycycline
Prostatitis, acute <35 y	Ureaplasma urealyticum C. trachomatis Gonococci Coliforms	(treat partner) Ofloxacin
Prostatitis, acute >35 y	Cryptococcus (AIDS) Coliforms	Quinolone, TMP-SMX; if acutely ill gentamicin/ampicillin IV
Prostatitis, chronic bacterial	Coliforms, enterococci, Pseudomonas	Long-term ciprofloxacin or ofloxacin
Pyelonephritis	Enterobacteriaceae (E. coli) Enterococci <i>Pseudomonas</i> spp.	If acutely ill, gentamicin/ampicillin IV; quinolone, TMP–SMX
ILCER DISEASE (duodenal or gastric, not NSAID related)	Helicobacter pylori	Omeprazole plus amoxicillin plus clarithromycin
AGINA Candidiasis	C. albicans C. glabrata, C. tropicalis	Fluconazole, itraconazole

TABLE 7-2 (Continued)

Site/Condition	Common Uncommon but Important	Common Empiric Therapy (Modify based on clinic factors such as Gram stain)	
Trichomonas Vaginosis, bacterial	Trichomonas vaginalis Polymicrobial (Gardnerella vaginalis, Bacteroides, M. hominis	Metronidazole (treat partner) Metronidazole (PO or vaginal gel); clindamycin, PO or intravaginally	

^{*}All antimichrobial therapy should be based on complete clinical data, including results of Gram's stains and cultures. See also Tables 7–3 (Viral), 7–4 (HIV), 7–5 (Fungal), and 7–6 (Parasitic) 7–7 (Tick-Borne).

Abbreviations: AIDS = acquired immunodeficiency syndrome; COPD = chronic obstructive pulmonary disease; HIV = human immunodeficiency virus; INH = isoniazid; IV = intravenous; NSAID = nonsteroidal antiinflammatory drug; PO = by mouth; PPD = purified protein derivative; TB = tuberculosis; TMP-SMX = trimethoprim-sulfamethoxazole.

Note: These guidelines are based on agents commonly involved in adult infections. Actual microbial treatment should be guided by microbiologic studies interpreted in the clinical setting.

TABLE 7–3
Pathogens and Drugs of Choice for Treating Common Viral Infections*

Viral Infection	Drug of Choice	Adult Dosage
CMV		
Retinitis, colitis, esophagitis	Ganciclovir (Cytovene)†	5 mg/kg IV q12h × 14–21d, 5 mg/kg/d IV or 6 mg/kg IV 5×/wk or 1 g PO tid
	(Vitrasert) implants	4.5 mg intraocularly q 5-8 mo
	or Foscarnet (<i>Foscavir</i>)	60 mg/kg IV q8h or 90 mg/kg IV q1–2 h x 14–21 d followed by 90–120 mg/kg/d IV
	or Cidofovir (<i>Vistide</i>) or Fomivirsen (<i>Vitravene</i>)	5 mg/kg/wk IV × 2 wk, then 5 mg/kg IV q2 wk 330 μg intravitreally q2 wk × 2 then 1/mo
EBV		
Infectious mononucleosis	None	
HAV	None, but gamma globulin within 2 wk of exposure may limit infection	0.2 mL/kg IM \times 1
HBV		
Chronic hepatitis	Lamivudine (<i>Epivir HBV</i>) Interferon alfa-2b (<i>Intron A</i>)	100 mg PO $1\times/d\times 1-3$ y 5 million units/d or 10 million units $3\times/wk$ SC or $IM\times 4$ mo
HCV		
Chronic hepatitis	Interferon alfa-2b plus Ribavirin (Rebetron)	3 million units 3×/wk SC plus ribavirin 1000–1200 mg/d PO × 12 mo 3 million units SC or IM 3 y/wk × 13, 24 mg
	Interferon alfa-2b (<i>Intron A</i>) Interferon alfa-2a (<i>Roferon-A</i>)	3 million units SC or IM $3x/wk \times 12-24$ mo 3 million units SC or IM $3x/wk \times 12-24$ mo

TABLE 7-3 (Continued)

Viral Infection	Drug of Choice	Adult Dosage
Chronic hepatitis (continued)	Interferon alfacon-1 (Infergen)	9 µg 3×/wk × 6 mo
HSV		
Orolabial herpes in the immunocompetent with multiple recurrences	Penciclovir (<i>Denavir</i>)	1% cream applied q2h while awake × 4 d
Genital herpes		
first episode	Acyclovir (<i>Zovirax</i>)	400 mg PO tid or 200 mg PO $5\times/d\times7-10$ d
	or Famciclovir (<i>Famvir</i>)	250 mg PO tid × 5–10 d
	or Valacyclovir (<i>Valtrex</i>)	1 g PO bid × 7–10 d
recurrence	Acyclovir (<i>Zovirax</i>)	400 mg PO tid × 5 d
	or Famciclovir (<i>Famvir</i>)	125 mg PO bid × 5 d 17
	or Valacyclovir (Valtrex)	500 mg PO bid × 5 d
chronic suppression	Acyclovir (Zovirax)	400 mg PO bid
	or Valacyclovir (Valtrex)	500–1000 mg PO 1×/d
Mucocutaneous in the	or Famciclovir (<i>Famvir</i>) Acyclovir (<i>Zovirax</i>)	250 mg PO bid 5 mg/kg IV q8h × 7–14 d
immunocompromised	or Acyclovir (<i>Zovirax</i>)	400 mg PO $5x/d \times 7-14 d$
Encephalitis	Acyclovii (Zovirax)	10–15 mg/kg IV q8h × 14–21 d
Neonatal	Acyclovii (<i>Zovirax</i>)	20 mg/kg IV q8h \times 14–21 d
Acyclovir-resistant	Foscarnet (Foscavir)	40 mg/kg IV q8h × 14–21 d
Keratoconjunctivitis	Trifluridine (Viroptic)	1 drop 1% solution topically, q2h, up to 9 gtt/d × 10 d
•	illionanie (*Nopiic)	1 diop 170 solution topically, 4211, up to 7 gil/ a × 10 a
HIV (See Table 7–4)		
INFLUENZA A AND B VIRUS	Zanamivir (<i>Relenza</i>)	10 mg bid × 5d by inhaler
	Oseltamivir (Tamiflu)	75 mg PO bid \times 5 d

TABLE 7-3 (Continued)

Viral Infection	Drug of Choice	Adult Dosage
INFLUENZA A VIRUS	Rimantadine (<i>Flumadine</i>) Amantadine (<i>Symmetrel</i>)	200 mg PO 1×/d or 100 mg PO bid \times 5 d 100 mg PO bid \times 5 d
MEASLES	N	
Children Adults	None (immunize, See Table 22–9) None or ribavirin	20-35 mg/kg/d×7 d
PAPILLOMA VIRUS (HPV)		
Anogenital warts	Podofilox or podophyllin Interferon alfa-2b <i>(Intron A</i>) Imiquimod, 5% cream (<i>Aldara</i>)	Topical application (see Chapter 22) 1 million units intralesional 3×/wk × 3 wk Apply 3/wk hs, remove 6–10 h later up to 16 wk
RSV		
(bronchiolitis)	Ribavirin (<i>Virazole</i>)	Aerosol treatment 12–18 h/d \times 3–7 d
VZV		
Exposure prophylaxis in the immunocompromised (HIV, steroids, etc)	VZIG, Varicella Zoster Immune Globulin	See package insert
Varicella (>12 y old)	Acyclovir (Zovirax)	20 mg/kg (800 mg max) PO qid \times 5 d
Herpes zoster	Valacyclovir (<i>Valtrex</i>) or Famciclovir (<i>Famvir</i>) or Acyclovir (<i>Zovirax</i>)	1 g PO tid \times 7 d 500 mg PO tid \times 7 d 800 mg PO $5x/d \times 7-10$ d

TABLE 7-3 (Continued)

Viral Infection	Drug of Choice	Adult Dosage
Varicella or zoster in the immunocompromised	Acyclovir (Zovirax)	10 mg/kg IV q8h × 7 d
Acyclovir-resistant	Foscarnet (Foscavir)	40 mg/kg IV q8h \times 10 d

^{*}Based on Guidelines from the CDC published in MMWR and the Medical Letter Vol. 41 December 3, 1999.

[†]The generic drug name appears in regular type; the trade name appears in parentheses afterward in *italics*.

Abbreviations: CMV = cytomegalovirus; EBV = Epstein-Barr virus; HAV = hepatitis A virus; HBV = hepatitis B virus; HCV = hepatitis C virus; HIV = human immunodeficiency virus; HPV = human papilloma virus; HSV = herpes simplex virus; RSV = respiratory syncytial virus; VZV = varicella zoster virus.

TABLE 7-4 Drugs of Choice for Treating HIV Infection in Adults

DRUGS OF CHOICE

2 nucleosides1 + 1 protease inhibitor2

2 nucleosides¹ + 1 nonnucleoside³

2 nucleosides¹ + ritonavir⁴ + another protease inhibitor⁵

ALTERNATIVES

1 protease inhibitor² + 1 nucleoside + 1 nonnucleoside³

2 protease inhibitors (each in low dose)⁵ + 1 nucleoside + 1 nonnucleoside³

abacavir + 2 other nucleosides1

2 protease inhibitors (each full dose)

- One of the following: zidovudine + lamivudine; zidovudine + didanosine; stavudine + lamivudine; stavudine + didanosine; zidovudine + zalcitabine.
- Nelfinavir, indinavir, saquinavir soft gel capsules, amprenavir or ritonavir. Ritonavir is used less frequently because of troublesome adverse effects. The Invirase formulation of saquinavir generally should not be used.
- 3. Efavirenz is often preferred. Nevirapine causes more adverse effects. Nevirapine and delavirdine require more doses, and have had shorter follow-up in reported studies. Combinations of Efavirenz and nevirapine with protease inhibitors require increasing the dosage of the protease inhibitor.
- Ritonavir is usually given in dosage of 100-400 mg bid when used with another protease inhibitor.
- Protease inhibitors that have been combined with ritonavir 100–400 mg bid include indinavir 400–800 mg bid, amprenavir 600–800 mg bid, saquinavir 400–600 mg bid and nelfinavir 500–750 mg bid.

Source: Reproduced, with permission, from The Medical Letter Vol 42, Issue 1089, January 10, 2000.

TABLE 7–5
Systemic Drugs for Treating Fungal Infections

nfection	Drug of Choice	Alternatives
ASPERGILLOSIS	Amphotericin B or itraconazole	Amphotericin B lipid complex, amphotericin cholesteryl complex liposomal amphotericin B
BLASTOMYCOSIS	Itraconazole or amphotericin B	Fluconazole
CANDIDIASIS Dral (thrush) Stomatitis, eosphagitis, vaginitis in AIDS Systemic Cystitis/vaginitis COCCIDIOIDOMYCOSIS Pulmonary (normal individual) Pulmonary (high risk)	Fluconazole or itraconazole Fluconazole or itraconazole Amphotericin B or fluconazole See Table 7–2 No drug usually recommended Itraconazole or fluconazole	Nystatin lozenge or swish and swallow Parenteral or oral amphotericin B Amphotericin B
In non-AIDS patient Meningitis (HIV/AIDS) HISTOPLASMOSIS Pulmonary, disseminated Normal individual	Amphotericin B or fluconazole Amphotericin B plus 5-flucytosine; then long-term suppression with fluconazole Moderate disease: itraconazole	Amphotericin B fluconazole Amphotericin B lipid complex Severe: amphotericin B
HIV/AIDS	Amphotericin B, followed by itraconazole suppression	ltraconazole

TABLE 7-5 (Continued)

Infection	Drug of Choice	Alternatives
MUCORMYCOSIS	Amphotericin B	No dependable alternative
PARACOCCIDIOIDOMYCOSIS	Itraconazole	Amphotericin B
SPOROTRICHOSIS Cutaneous Systemic	Itraconazole Itraconazole	Potassium iodide 1–5 mL tid Amphotericin B

TABLE 7–6
Drugs for Treating Selected Parasitic Infections

Infection	Drug
Amebiasis (Entamoeba histolytica) Asymptomatic Mild to moderate intestinal disease Severe intestinal disease, hepatic	lodoquinol or paramomycin Metronidazole or tinidazole Metronidazole or tinidazole
abscess Ascariasis (Ascaris lumbricoides, roundworm) Cryptosporidiosis (Cryptosporidium) Cutaneous larva migrans (creeping eruption, dog and cat hookworm Cyclospora infection Enterobius vermicularis (pinworm)	Albendazole, mebendazole or pyrantel pamoate Paromomycin Albendazole, thiabendazole or ivermectin Trimethoprim–sulfamethoxazole Pyrantel pamoate, mebendazole or albendazole
Filariasis (Wuchereria bancrofti,	Diethylcarbamazine
Brugia malayi, Loa loa) Giardiasis (Giardia lamblia) Hookworm infection (Ancylostoma duodenale, Necator americanus) Isosporiasis (Isospora belli) Lice (Pediculus humanus, P. capitis, Phthirus pubis) Malaria (Plasmodium falciparum, P. ovale, P. vivax, and P. malariae)	Metronidazole Albendazole, mebendazole, or pyrantel pamoate Trimethoprim–sulfamethoxazole 1% permethrin (topical) or 0.5% malathion
Chloroquine-resistant P. falciparum	Quinine sulfate plus doxycycline, tetracycline, clindamycin or pyrimethamine–sulfadoxine (oral)
Chloroquine-resistant P. vivax	Quinine sulfate plus doxycycline, or pyrimethamine–sulfadoxine (oral)
All Plasmodium except chloroquine- resistant P. falciparum	Chloroquine phosphate (oral)
All Plasmodium (parenteral)	Quinine gluconate or quinine dihydrochloride
Prevention of relapses: P. vivax, and P. ovale only	Primaquine phosphate
Malaria, prevention	
Chloroquine-sensitive areas Chloroquine-resistant areas Mites, see Scabies Pinworm, see Enterobius	Chloroquine phosphate Mefloquine or doxycycline
Pneumocystis carinii pneumonia	Trimethoprim-sulfamethoxazole
Primary and secondary prophylaxis	Alternative: pentamidine Trimethoprim–sulfamethoxazole

TABLE 7-6 (Continued)

Roundworm, see Ascariasis	
Scabies (Sarcoptes scabiei)	5% Permethrin topically Alternatives: ivermectin, 10% crotamiton
Strongyloidiasis (Strongyloides stercoralis)	Ivermectin
Tapeworm infection	
-Adult (intestinal stage)	
Diphyllobothrium latum (fish), Taenia saginata (beef), Taenia solium (pork), Dipylidium caninum (dog), Hymenolepis nana (dwarf tapeworm) —Larval (tissue stage)	Praziquantel
Echinococcus granulosus (hydatid cyst)	Albendazole
Cysticercus cellulosae (cysticercosis) Toxoplasmosis (Toxoplasma gondii) Trichinosis (Trichinella spiralis)	Albendazole or praziquantel Pyrimethamine plus sulfadiazine Steroids for severe symptoms plus mehendazole
Trichomoniasis (Trichomonas vaginalis)	Metronidazole or tinidazole
Hairworm infection (Trichostrongylus colubriformis)	Pyrantel pamoate
Trypanosomiasis (<i>Trypanosoma cruzi,</i> Chagas' disease)	Benznidazole
Trichuriasis (Trichuris trichiuria, whipworm)	Mebendazole or albendazole
Visceral larva migrans, toxocariasis (Toxocara canis)	Albendazole or mebendazole

TABLE 7–7 Guide to Common Tick-borne Diseases

Disease	Causative Agent	Season	Vector Habits
Rocky Mountain spotted fever	Rickettsia rickettsii (bacterium)	Mostly spring, summer	American Dog Tick Found in high grass and low shrubs, fields Lone Star Tick Found in woodlands, forest edge, and old fields
Human granulocytic ehrlichiosis	Ehrlichia spp. (bacterium)	Under study	Deer (black-legged) Tick found in woodlands, old fields, landscaping with significant ground cover vegetation
Lyme disease	Borrelia burgdorferi (bacterium)	Mostly spring, but year- around	Same as for the deer tick
Babesiosis	Babesia microti (protozoan)	Mostly spring/summer	Same as for the deer tick

TABLE 7-7 (Continued)

Classic Clinical Presentation	Incubation Period	Diagnosis	Treatment
Sudden moderate to high fever, severe headache, maculopapular rash (with planer/palmer presentation)	2–14 d	Clinical serology	Adults—doxycycline Children/pregnant women—chloram- phenicol
Fever, headache, constitutional symptoms	1–30 d	Clinical serology	Adults—tetracyclines Children/pregnant women— consult specialist
EM rash, constitutional symptoms, arthritis, cardiovascular- and nervous system in- volvement	3–30 d	Clinical serology, culture	Doxycycline, amoxicillin, cefuroxime for 14–21 d
Fever, hemolytic anemia, con- stitutional symptoms	1–52 wk	Thick and thin blood smears	Clindamycin/quinine

Secretion/Discharge Precautions: (Handwashing and gloves with direct patient contact) Conjunctivitis, minor skin wounds, decubiti, colonization (but not infection that requires Wound and Skin Precautions) with MRSA, herpes, mucocutaneous candidiasis, ulcerative STDs, coccidioidomycosis, others

Pregnancy Precautions: (Handwashing) CMV, rubella, parvovirus

SBE PROPHYLAXIS

The following recommendations are based on guidelines published by the American Heart Association. (JAMA 1997;277:1794–1801). The guidelines now specify which patients are at high, moderate, or low risk of bacteremia and provide general guidelines for procedures that are more likely to be associated with bacterial endocarditis. SBE prophylaxis is recommended only for patients who are at high or moderate risk. See Tables 7–8 and 7–9 for regimens.

High-risk: Prosthetic cardiac valves, history of bacterial endocarditis, complex cyanotic congenital heart disease, surgically constructed systemic pulmonary shunts

Moderate-risk: Most other congenital cardiac malformations (other than those in the previous or following lists), acquired valvular disease (eg, rheumatic heart disease), hypertrophic cardiomyopathy, mitral valve prolapse with regurgitation or thickened leaflets

Low-risk: Isolated ASD secundum; repair of atrial/ventricular septal defect, or PDA; prior CABG; mitral valve prolapse without regurgitation; innocent heart murmurs; previous Kawasaki disease or rheumatic fever without valve dysfunction; pacemakers or implanted defibrillator

ISOLATION PROTOCOLS

To prevent the spread of infectious diseases from patient to patient, visitors, and hospital personnel, isolation procedures are recommended for various pathogens and clinical settings by various agencies such as the CDC in Atlanta, Georgia. Local hospital procedures may vary slightly from these recommendations.

Strict Isolation: (Single room, controlled airflow, handwashing, gown, gloves, mask) Varicella, herpes (localized, disseminated, neonatal), wound or burns infected with S. aureus or group A Streptococcus, S. aureus or group A Streptococcus pneumoniae, congenital rubella, rabies, smallpox, others

Contact Isolation: (Single room, controlled airflow, handwashing, gown, gloves, mask) All acute respiratory infections in infants and children (cough, cold, pneumonia, croup, pharyngitis, etc), extensive impetigo, gonococcal conjunctivitis in the newborn, others

Respiratory Isolation: (Single room, controlled airflow, handwashing, mask) TB (known or suspected), measles, mumps, rubella, pertussis, meningitis (suspected *N. meningitidis* or *H. influenzae* infection), pneumonia due to *H. influenzae*, epiglottitis, others

Wound and Skin Precautions: (Single room; handwashing; for direct contact with patient secretions: gown, gloves, mask) Major wound and skin infections, group A streptococcal endometritis, gas gangrene. Scabies and lice require only 24 h after effective therapy.

Enteric Precautions: (Single room; handwashing; for direct contact with patient secretions: gown, gloves) Known or suspected infectious gastroenteritis, including from rotavirus, enterovirus, Salmonella, Shigella, E. coli, Giardia, and C. difficile enterocolitis, acute hepatitis (all types)

Blood and Body Fluid Precautions: (Handwashing; for direct contact with patient secretions: gown, gloves) Known or suspected HIV infection, hepatitis (in acute and chronic carriers), syphilis, malaria, Lyme disease, all rickettsial infections, others

TABLE 7–8
SBE Prophylaxis for Oral, Respiratory or Esophageal Procedures*

Prophylaxis	Agent	Regimen [†]
Standard prophylaxis	Amoxicillin	Adults: 2.0 g; children: 50 mg/kg PO 1 h before procedure
Unable to take oral medications	Ampicillin	Adults: 2.0 g IM or IV; children: 50 mg/kg or IV 30 min before procedure
Allergic to penicillin	Clindamycin	Adults: 600 mg; children: 20 mg/kg PO 1 h before procedure
	Cephalexin or cefa- droxil	Adults: 2.0 g; children; 50 mg/kg PO 1 h before procedure
	Azithromycin or clarith-	Adults: 500 mg; children: 15 mg/kg PO 1 h before procedure
	romycin	Adults: 600 mg; children: 20 mg/kg IV 30 min before procedure
Penicillin allergic and unable to take oral medications	Clindamycin or cefa- zolin	Adults: 1.0 g; children: 25 mg/kg IN or IV 30 min before procedure

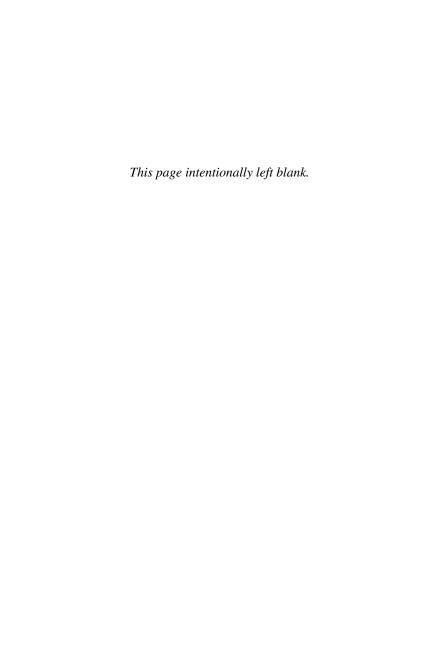
^{*}See text page 157 for recommended risk groups.

[†]Total children's dose should not exceed adult dose.

TABLE 7–9
SBE Prophylaxis for GU/GI (Excluding Esophageal)
Procedures*

Patient	Agents	Regimen
High-risk	Ampicillin + gentamicin	Adults: ampicillin 2.0 g IM/IV + gentamicin 1.5 mg/kg (max 120 mg) within 30 min of procedure; 6 h later, ampicillin 1 g IM/IV or amoxicillin 1 g PO Children: ampicillin 50 mg/kg IM or IV (2.0 g max) + gentamicin 1.5 mg/kg within 30 min of procedure; 6 h later, ampicillin 25 mg/kg IM/IV or amoxicillin 25 mg/kg PO
High-risk allergic to ampicillin/ amoxicillin	Vancomycin + gentamicin	Adults: vancomycin 1.0 g IV over 1–2 h + gentamicin 1.5 mg/kg IV/IM (120 mg max); dose within 30 min of starting procedure Children: vancomycin 20 mg/kg IV over 1–2 h + gentamicin 1.5 mg/kg IV/IM; complete dose within 30 min of starting procedure
Moderate-risk	Amoxicillin or ampicillin	Adults: amoxicillin 2.0 g PO 1 h before procedure, or ampicillin 2.0 g IM/IV within 30 min of starting procedure Children: amoxicillin 50 mg/kg PO 1 h before procedure, or ampi- cillin 50 mg/kg IM/IV within 30 min of starting procedure
Moderate-risk allergic to ampicillin/ amoxicillin	Vancomycin	Adults: vancomycin 1.0 g IV over 1–2 h complete infusion within 30 min of starting procedure Children: vancomycin 20 mg/kg IV over 1–2 h; complete infusion within 30 min of starting procedure

^{*}See text page 157 for recommended risk groups. Total children's dose should not exceed adult dose.



R

BLOOD GASES AND ACID-BASE DISORDERS

Venous Blood Gases Capillary Blood Gases General Principles of Blood Gas Determinations Acid-Base Disorders: Definition Mixed Acid-Base Disorders

Normal Blood Gas Values

Interpretation of Blood Gases Metabolic Acidosis: Diagnosis and Treatment Metabolic Alkalosis: Diagnosis and Treatment Respiratory Acidosis: Diagnosis and Treatment Respiratory Alkalosis: Diagnosis and Treatment Hypoxia

Sample Acid-Base Problems

NORMAL BLOOD GAS VALUES

The results of testing ABG are usually given as pH, pO₂, pCO₂, [HCO₃ $^-$], base excess/deficit (difference), and oxygen saturation. This test gives information on acid–base homeostasis (pH, pCO₂, [HCO₃ $^-$], and base difference) and on blood oxygenation (pO₂, O₂ saturation). Less frequently, venous blood gases and mixed venous blood gases are measured. Normal values for blood gas analysis are given in Table 8–1, page 162, and capillary blood gases are discussed in a following section. Note that the HCO₃ $^-$ from the blood gas is a calculated value and should not be used in the interpretation of the blood gas levels, instead the HCO₃ $^-$ from a chemistry panel should be used. The ABG and the chemistry panel [HCO₃ $^-$] should be obtained at the same time.

VENOUS BLOOD GASES

There is little difference between arterial and venous pH and bicarbonate (except in cases of CHF and shock); therefore, the venous blood gas level may occasionally be used to assess acid-base status. Venous oxygen levels, however, are significantly less than arterial levels (see Table 8–1).

CAPILLARY BLOOD GASES

A CBG is obtained from a highly vascularized capillary bed. (The heel is the most commonly used site.) The CBG is often used for pediatric patients because it is easier to obtain than the ABG and is less traumatic (no risk of arterial thrombosis, hemorrhage). The procedure is fully described in Chapter 13, page 274, under Heelstick.

When interpreting a CBG, apply the following rules:

- pH: Same as arterial or slightly lower (Normal = 7.35–7.40)
- pCO₂: Same as arterial or slightly higher (Normal = 40–45)
- **pO₂:** Lower than arterial (Normal = 45–60)
- O₂ Saturation: >70% is acceptable. Saturation is probably more useful than the pO₂ itself when interpreting a CBG.

TABLE 8–1 Normal Blood Gas Values

Measurement	Arterial Blood	Mixed Venous*	Venous
рН	7.40	7.36	7.36
(range)	(7.37-7.44)	(7.31-7.41)	(7.31-7.41)
pO ₂ (mm Hg) (decreases with age)	80–100	35–40	30–50
pCO ₂ (mm Hg)	36-44	41–51	40-52
O ₂ saturation (decreases with age)	>95	60–80	60–85
HCO ₃ -(mEq/L) [SI: mmol/L]	22–26	22–26	22–28
Base difference (deficit/excess)	-2 to +2	-2 to +2	-2 to +2

^{*}Obtained from the right atrium, usually through a pulmonary artery catheter.

GENERAL PRINCIPLES OF BLOOD GAS DETERMINATIONS

(Oxygen values are discussed on page 171.)

The blood gas machines in most labs actually measure the pH and the pCO₂ (as well as
the pO₂). The [HCO₃⁻] and the base difference are calculated values using the Henderson-Hasselbalch equation:

$$pH = pK_a + \frac{\log[HCO_3^-] \text{ in mEq } / L}{0.03 \times pCO_2 \text{ in mmHg}}$$

or the Henderson equation:

[H⁺] in mEq / L =
$$\frac{24 \times pCO_2 \text{ in mmHg}}{[HCO_3^-] \text{ in mEq / L}}$$

- 2. For a rough estimate of [H *], [H *] = (7.80 pH) × 100. This is accurate from a pH 7.25 7.48; 40 mEq/L = [H *] at the normal pH of 7.40. Also pH is a log scale, and for every change of 0.3 in pH from 7.40 the [H *] doubles or halves. For pH 7.10 the [H *] = 2 × 40, or 80 nmol/L, and for pH 7.70 the [H *] = $\frac{1}{2}$ × 40, or 20 nmol/L.
- 3. The calculated [HCO₃⁻] should be within 2 mEq/L of the bicarbonate concentration from a venous chemistry determination (eg, BMP) drawn at the same time. If not, an error has been made in the collection or the determination of the values, and the blood gas and serum bicarbonate should be recollected.
- 4. Two additional relationships that are derived from the Henderson-Hasselbalch equation should be committed to memory. These two rules are helpful in interpreting blood gas results, particularly in defining a simple versus a mixed blood gas disorder:

Rule 1: A change in pCO₂ up or down 10 mm Hg is associated with an increase or decrease in pH of 0.08 units. As the pCO₂ decreases, the pH increases; as the pCO₂ increases, the pH decreases.

Rule II: A pH change of 0.15 is equivalent to a base change of 10 mEq/L. A decrease in base (ie, [HCO₃⁻]) is termed a **base deficit**, and an increase in base is termed a **base excess**.

ACID-BASE DISORDERS: DEFINITION

- 1. Acid-base disorders are very common clinical problems. Acidemia is a pH <7.37, and alkalemia is a pH >7.44. Acidosis and alkalosis are used to describe how the pH changes. The primary causes of acid-base disturbances are abnormalities in the respiratory system and in the metabolic or renal system. As from the Henderson-Hasselbalch equation, a respiratory disturbance leading to an abnormal pCO₂ alters the pH, and similarly a metabolic disturbance altering the [HCO₃⁻]changes the pH.
- 2. Any primary disturbance in acid-base homeostasis invokes a normal compensatory response. A primary metabolic disorder leads to respiratory compensation, and a primary respiratory disorder leads to an acute metabolic response due to the buffering capacity of body fluids, and a more chronic compensation (1–2 days) due to alterations in renal function.
- 3. The degree of compensation is well known and can be expressed in terms of the degree of the primary acid-base disturbance. Table 8–2, page 164, lists the major categories of primary acid-base disorders, the primary ahonormality, the secondary compensatory response, and the expected degree of compensation in terms of the magnitude of the primary ahonormality. These changes are defined graphically in Figure 8–1, page 165. The types of simple acid-base disorders are discussed in the following sections.

MIXED ACID-BASE DISORDERS

- 1. Most acid-base disorders result from a single primary disturbance with the normal physiologic compensatory response and are called simple acid-base disorders. In certain cases, however, particularly in seriously ill patients, two or more different primary disorders may occur simultaneously, resulting in a mixed acid-base disorder. The net effect of mixed disorders may be additive (eg, metabolic acidosis and respiratory acidosis) and result in extreme alteration of pH; or they may be opposite (eg, metabolic acidosis and respiratory alkalosis) and nullify each other's effects on the pH.
- 2. To determine a mixed acid—base disorder from a blood gas value, follow the six steps in the Interpretation of Blood Gases (in the following section). Alterations in either [HCO₃⁻] or pCO₂ that differ from expected compensation levels indicate a second process. Two of the examples given in the following section illustrate the strategies employed in identifying a mixed acid—base disorder.

INTERPRETATION OF BLOOD GASES

Use a uniform, stepwise approach to the interpretation of blood gases. (See also Figure 8-1.)

Step 1: Determine if the numbers fit.

$$[H^+] = \frac{24 \times pCO_2}{[HCO_3^-]}$$

TABLE 8-2 Simple Acid-Base Disturbances

Acid–Base Disorder	Primary Abnormality	Expected Compensation	Expected Degree of Compensation
Metabolic acidosis Metabolic alkalosis Acute respiratory acidosis	$\begin{array}{c} \downarrow \downarrow \downarrow [\text{HCO}_3^-] \\ \uparrow \uparrow \uparrow \uparrow [\text{HCO}_3^-] \\ \uparrow \uparrow \uparrow p \text{CO}_2 \end{array}$	$\downarrow \downarrow_{p}CO_{2}$ $\uparrow \uparrow_{p}CO_{2}$ $\uparrow [HCO_{3}^{-}]$	$pCO_2 = (1.5 \times [HCO_3]) + 8$ ↑ in $pCO_2 = \Delta [HCO_3^-] \times 0.6$ ↑ in $[HCO_3^-] = \Delta pCO_2/10$
Chronic respiratory acidosis	$\uparrow\uparrow\uparrow_{p}CO_{2}$	↑↑[HCO ₃ -]	$\uparrow \text{ in [HCO}_3^-] = 4 \times \Delta \text{pCO}_2/10$
Acute respiratory alkalosis	$\downarrow\downarrow\downarrow$ pCO ₂	↓[HCO₃⁻]	$\downarrow \text{in [HCO}_3^-] = 2 \times \Delta \text{pCO}_2/10$
Chronic respiratory alkalosis	↓↓↓pCO ₂	↓↓[HCO₃ ⁻]	$\downarrow in [HCO_3^-] = 5 \times \Delta pCO_2/10$

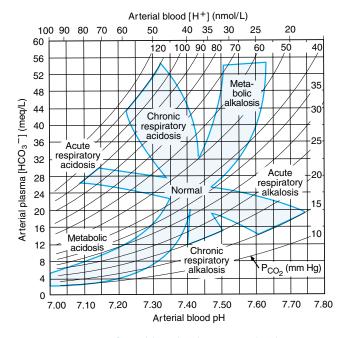


FIGURE 8-1 Nomogram for acid-base disorders. (Reprinted, with permission, from: Cogan MG: Fluid and Electrolytes, Appleton & Lange, Norwalk CT, 1991.)

The right side of the equation should be within about 10% of the left side. If the numbers do not fit, you need to obtain another ABG and chemistry panel for HCO_3^- .

Example. pH 7.25, pCO₂ 48, HCO₃⁻ 29 mmol/L

$$56 = 24 \times \frac{48}{29}$$
$$56 \neq 40$$

The blood gas is uninterpretable, and the ABG and HCO₃⁻ need to be recollected. The most common reason for the numbers not fitting is that the ABG and the chemistry panel [HCO₃⁻] were obtained at different times.

Step 2: Next, determine if an acidemia (pH <7.37) or an alkalemia (pH >7.44) is present.

- Step 3: Identify the primary disturbance as metabolic or respiratory. For example, if acidemia is present, is the pCO₂ >44 mm Hg (respiratory acidosis), or is the [HCO₃ $^-$] <22 mmol/L (metabolic acidosis). In other words, identify which component, respiratory or metabolic, is altered in the same direction as the pH abnormality. If both components act in the same direction (eg, both respiratory [pCO₂ > 44 mm Hg] and metabolic [HCO₃ $^-$ <22 mmol/L] acidosis are present), then this is a **mixed acid–base problem**, discussed later in this section. The primary disturbance will be the one that varies from normal the greatest, that is, with a [HCO₃ $^-$] = 6 mmol/L and pCO₂ = 50 mm Hg, the primary disturbance would be a metabolic acidosis, the [HCO₃ $^-$] is about one-quarter normal, whereas the increase in pCO₂ is only 25%.
- **Step 4:** After identifying the primary disturbance, use the equations in Table 8–2, page 164, to calculate the expected compensatory response. If the difference between the actual value and the calculated value is significant, then a mixed acid—base disturbance is present.
- **Step 5:** Calculate the anion gap. Anion gap = Na⁺ (Cl⁻ + HCO₃⁻). Normal anion gap is 8–12 mmol. If the anion gap is increased, proceed to step 6.
- **Step 6:** If the anion gap is elevated, then compare the changes from normal between the anion gap and [HCO₃-]. If the change in the anion gap is greater than the change in the [HCO₃-] from normal, then a metabolic alkalosis is present in addition to a gap metabolic acidosis. If the change in the anion gap is less than the change in the [HCO₃-] from normal, then a nongap metabolic acidosis is present in addition to a gap metabolic acidosis. See Examples 5, 6, and 7, page 174.

Finally, be sure the interpretation of the blood gas is consistent with the clinical setting.

METABOLIC ACIDOSIS: DIAGNOSIS AND TREATMENT

Metabolic acidosis represents an increase in acid in body fluids reflected by a decrease in $[HCO_3^-]$ and a compensatory decrease in pCO_2 .

Differential Diagnosis

The diagnosis of metabolic acidosis (Figure 8–2) can be classified as an anion gap or a nonanion gap acidosis. The **anion gap** (Normal range, 8–12 mmol/L) is calculated as:

Anion gap =
$$[Na^+] - ([C1^-] + [HCO_3^-])$$

Anion Gap Acidosis: Anion gap >12 mmol/L; caused by a decrease in [HCO₃⁻] balanced by an increase in an unmeasured acid ion from either endogenous production or exogenous ingestion (**normochloremic acidosis**).

Nonanion Gap Acidosis: Anion gap = 8–12 mmol/L; caused by a decrease in [HCO₃⁻] balanced by an increase in chloride (**hyperchloremic acidosis**). Renal tubular acidosis is a type of nongap acidosis that can be associated with a variety of pathologic conditions (Table 8–3 page 168). The anion gap is helpful in identifying metabolic gap acidosis, nongap acidosis, mixed metabolic gap and nongap acidosis. If an elevated anion gap is present, a closer look at the anion gap and the bicarbonate helps differentiate among (a) a pure metabolic gap acidosis, (b) a metabolic nongap acidosis, (c) mixed metabolic gap and nongap acidosis, and (d) a metabolic gap acidosis and metabolic alkalosis.

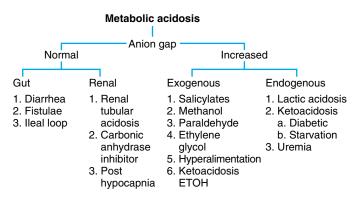


FIGURE 8-2 Differential diagnosis of metabolic acidosis.

Treatment of Metabolic Acidosis

- 1. Correct any underlying disorder (control diarrhea, etc).
- Treatment with bicarbonate should be reserved for severe metabolic gap acidosis. If the pH <7.20, correct with sodium bicarbonate. The total replacement dose of [HCO₃⁻] can be calculated as follows:

$$[HCO_3^-]$$
 needed in mEq = $\frac{Base\ deficit\ (mEq) \times Patient'\ s\ weight\ (kg)}{4}$

3. Replace with one-half the total amount of bicarbonate over 8–12 h and reevaluate. Be aware of sodium and volume overload during replacement. Normal or isotonic bicarbonate drip is made with 3 ampules NaHCO₃ (50 mmol NaHCO₃/ampule) in 1 L D₃W.

METABOLIC ALKALOSIS: DIAGNOSIS AND TREATMENT

Metabolic alkalosis represents an increase in [HCO₃⁻] with a compensatory rise in pCO₂.

Differential Diagnosis

In two basic categories of diseases the kidneys retain $[HCO_3^-]$ (Figure 8–3). They can be differentiated in terms of response to treatment with sodium chloride and also by the level of urinary $[Cl^-]$ as determined by ordering a "spot," or "random" urinalysis for chloride (U_{Cl}) .

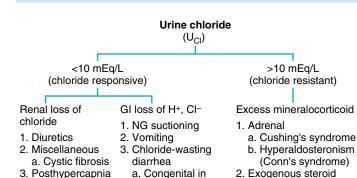
Chloride-Sensitive (Responsive) Metabolic Alkalosis: The initial problem is a sustained loss of chloride out of proportion to the loss of sodium (either by renal or GI

TABLE 8–3 Renal Tubular Acidosis: Diagnosis and Management

Clinical Condition	Renal Defect	GFR	Serum [HCO ₃ ⁻] (meq/L)	Serum [K+] (mEq/L)	Minimal Urine pH	Associated Disease States	Treatment
Normal Proximal RTA (type II RTA)	None Proximal H ⁺ secretion	N N	24–28 15–18	3.5–5 ↓	4.8–5.2 <5.5	None Drugs, Fanconi's syndrome, various genetic disorders, dysproteinemic states, secondary hyperparathy- roidism, toxins (heavy metals), tub- ulointerstitial diseases, nephrotic syndrome, paroxysmal nocturnal hemoglobinuria	N/A NaHCO $_3$ or KHCO $_3$ (10–15 mEq/kg/d), thiazides
Classic distal RTA (type I RTA)	Distal H ⁺ secretion	Ν	20–30	\	>5.5	Various genetic disorders, autoim- mune diseases, nephrocalcinosis, drugs, toxins, tubulointerstitial dis- eases, hepatic cirrhosis, empty sella syndrome	NaHCO ₃ (1–3 meq/kg/d)
Buffer deficiency (type III RTA)	Distal NH ₃ delivery	\downarrow	15–18	Ν	<5.5	Chronic renal insufficiency, renal osteodystrophy, severe hypophosphatemia	NaHCO ₃ (1–3 mEq/kg/d)
Generalized distal RTA (type IV RTA)	Distal Na+ reabsorption, K+ secretion, and H+ secretion	\downarrow	24–28	↑	<5.5	Primary mineralocorticoid deficiency (eg, Addison's Disease), hyporenin- emic hypoaldosteronism, diabetes mellitus, tubulointerstitial diseases, nephrosclerosis, drugs), salt-wasting mineralocorticoid-resistant hyper- kalemia	Fludrocortisone (0.1–0.5 mg/d) dietary K* restriction, NaHCO ₃ (1–3 meq/kg/d) furosemide (40–160 mg/d)

administration

3. Bartter's syndrome



children

b. Villous adenoma

FIGURE 8-3 Differential diagnosis of metabolic alkalosis.

losses). This chloride depletion results in renal sodium conservation leading to a corresponding reabsorption of $[HCO_3^-]$ by the kidney. In this category of metabolic alkalosis, the urinary $[Cl^-]$ is <10 mEq/L, and the disorders respond to treatment with intravenous NaCl.

Chloride-Insensitive (Resistant) Metabolic Alkalosis: The pathogenesis in this category is direct stimulation of the kidneys to retain bicarbonate irrespective of electrolyte intake and losses. The urinary [Cl⁻] >10 mEq/L, and these disorders do not respond to NaCl administration

Treatment of Metabolic Alkalosis

Correct the underlying disorder.

- 1. Chloride-responsive
 - a. Replace volume with NaCl if depleted.
 - **b.** Correct hypokalemia if present.
 - c. NH₄Cl and HCl should be reserved for extreme cases.
- 2. Chloride-resistant
 - a. Treat underlying problem, such as stopping exogenous steroids.

RESPIRATORY ACIDOSIS: DIAGNOSIS AND TREATMENT

Respiratory acidosis is a primary rise in pCO₂ with a compensatory rise in plasma [HCO₃]. Increased pCO₂ occurs in clinical situations in which decreased alveolar ventilation occurs.

Differential Diagnosis

- 1. Neuromuscular Abnormalities with Ventilatory Failure
 - Muscular dystrophy, myasthenia gravis, Guillain–Barré syndrome, hypophosphatemia

2. Central Nervous System

- a. Drugs: Sedatives, analgesics, tranquilizers, ethanol
- b. CVA
- c. Central sleep apnea
- d. Spinal cord injury (cervical)

3. Airway Obstruction

- a. Chronic (COPD)
- **b.** Acute (asthma)
- c. Upper airway obstruction
- d. Obstructive sleep apnea

4. Thoracic-Pulmonary Disorders

- a. Bony thoracic cage: Flail chest, kyphoscoliosis
- b. Parenchymal lesions: Pneumothorax, severe pulmonary edema, severe pneumonia
- c. Large pleural effusions
- d. Scleroderma
- e. Marked obesity (Pickwickian syndrome)

Treatment of Respiratory Acidosis

Improve Ventilation: Intubate patient and place on ventilator, increase ventilator rate, reverse narcotic sedation with naloxone (Narcan), etc

RESPIRATORY ALKALOSIS: DIAGNOSIS AND TREATMENT

Respiratory alkalosis is a primary fall in pCO₂ with a compensatory decrease in plasma [HCO₃⁻]. Respiratory alkalosis occurs with increased alveolar ventilation.

Differential Diagnosis

1. Central stimulation

- a. Anxiety, hyperventilation syndrome, pain
- b. Head trauma or CVA with central neurogenic hyperventilation
- c. Tumors
- d. Salicylate overdose
- e. Fever, early sepsis

2. Peripheral stimulation

- a. PE
- b. CHF (mild)
- c. Interstitial lung disease
- d. Pneumonia
- e. Altitude
- f. Hypoxemia: Any cause (See the section on Hypoxia, page 171.)

3. Miscellaneous

- a. Hepatic insufficiency
- b. Pregnancy
- c. Progesterone
- d. Hyperthyroidism
- e. Iatrogenic mechanical overventilation

Treatment of Respiratory Alkalosis

Correct the underlying disorder.

Hyperventilation Syndrome: Best treated by having the patient rebreathe into a paper bag to increase pCO₂, decrease ventilator rate, increase amount of dead space with ventilator, or treat underlying cause.

HYPOXIA

- The second type of information gained from a blood gas level, in addition to acid-base results, pertains to the level of oxygenation. Usually, results are given as pO₂ and oxygen saturation (See Table 8–1 for normal values in page 162). These two parameters are related to each other.
- Oxygen saturation at any given pO₂ is influenced by temperature, pH, and the level of 2,3-DPG as shown in Figure 8-4.

Differential Diagnosis

- 1. V/Q abnormalities
 - a. COPD: Emphysema, chronic bronchitis
 - b. Asthma
 - c. Atelectasis
 - d. Pneumonia
 - e. PE
 - f. ARDS
 - g. Pneumothorax

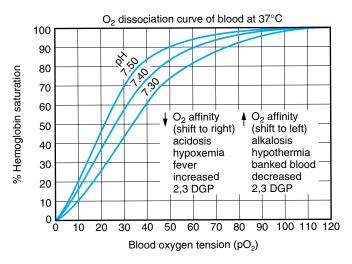


FIGURE 8-4 Oxyhemoglobin dissociation curve.

- h. Pneumoconiosis
- i. CF
- j. Obstructed airway

2. Alveolar hypoventilation

- a. Skeletal abnormalities
- b. Neuromuscular disorders
- c. Pickwickian syndromed. Sleep apnea
- 3. Decreased pulmonary diffusing capacity
 - a. Pneumoconiosis
 - b. Pulmonary edema
 - c. Drug-induced pulmonary fibrosis (Bleomycin)
 - d. Collagen–vascular diseases
- 4. Right-to-left shunt
 - a. Congenital heart disease: Tetralogy of Fallot, transposition, etc

SAMPLE ACID-BASE PROBLEMS

In each of the following examples, use the technique for blood gas interpretation on page 163 in this chapter to identify the acid-base disorder.

Example 1

A patient with COPD has a blood gas of pH 7.34, pCO₂ 55, and [HCO₃⁻] of 29.

Step 1:

$$46 = 24 \times \frac{55}{29}$$

$$46 \approx 45$$

The numbers fit because the difference between the calculated and observed is <10%.

- **Step 2:** pH < 7.37, the problem is an acidemia.
- **Step 3:** $pCO_2 > 44$ and $[HCO_3^-]$ is **not** < 22, so it represents a respiratory acidosis.
- Step 4: Normal compensation for chronic (COPD) respiratory acidosis (from Table 8–2).

$$\Delta[HCO_3^-] = 4 \times \Delta (pCO_2 / 10) = 4 \times \frac{15}{10} = 6$$

Expected [HCO₃⁻] is 24 mEq/L + 6 = 30, which is reasonably close to the measured [HCO₃⁻] of 29, therefore this is a simple respiratory acidosis. This patient has a chronic respiratory acidosis due to hypoventilation (simple acid–base disorder).

Example 2

Immediately after a cardiac arrest a patient has a pH 7.25, pCO₂ 28, and [HCO₃⁻] 12.

Step 1:

$$56 = 24 \times \frac{28}{12}$$
$$56 = 56$$

The numbers fit.

E

Step 2: pH < 7.37, so the problem is an acidemia.

Step 3: $[HCO_3^-]$ is < 22 mEq/L and pCO₂ is **not** > 44, so this is a metabolic acidosis.

Step 4: (See Table 8–2, page 164)

$$pCO_2 = (1.5 \times [HCO_3] + 8) = (1.5 \times 12) + 8 = 26$$

The expected pCO₂ of 26 mm Hg is very similar to the actual measured value of 28 mm HG, so this is a simple metabolic acidosis. This patient has a lactic acidosis following a cardiopulmonary arrest (simple acid-base disorder).

Example 3

A young man with a fever of $103.2^{\circ}F$ and a fruity odor on his breath has a blood gas with pH = 7.36, $pCO_2 = 9$, and $[HCO_3^-] = 5$.

Step 1:

$$45 = \frac{24}{5} \times 9$$
$$43 \approx 45$$

The numbers fit.

Step 2: The pH < 7.37 indicates an acidemia.

Step 3: $[HCO_3^-] < 22$ and pCO_2 is **not** >44, thus a metabolic acidosis is present.

Step 4: The expected compensation in pCO₂ can be calculated as follows (formula from Table 8–2):

$$pCO_2 = (1.5 \times [HCO_3^-]) + 8$$

= $(1.5 \times 9) + 8$
= 21.5

The expected pCO_2 is 15.5, but the actual result is 9 mm Hg, indicating a second process, which is a respiratory alkalosis. This patient had a metabolic acidosis due to diabetic ketoacidosis and a concomitant respiratory alkalosis due to early sepsis and fever (mixed acid-base disorder).

Example 4

A 30-y-old 30-wk pregnant female presents with nausea and vomiting. Blood gas reveals a pH 7.55, pCO₂ = 25 and [HCO₃ $^-$] = 22.

Step 1:

$$28 = 24 \times \frac{25}{22}$$
$$28 \approx 27$$

The numbers fit.

Step 2: pH < 7.44 indicates alkalemia.

Step 3: $pCO_2 < 36$ and the [HCO₃] is **not** >26, thus a respiratory alkalosis is present.

Step 4: The expected compensation for a chronic (pregnancy) respiratory alkalosis is calculated from Table 8–2, page 164:

$$\Delta[\text{HCO}_{\bar{3}}^{-}] = 5 \times \Delta \text{pCO}_2 / 10$$

= $5 \times \frac{15}{10} = 7.5$

The calculated $[HCO_3^-]$ is then 24 - 7.5, or 16-17 mmol, but the actual bicarbonate level is 22, indicating a relative secondary metabolic alkalosis ($[HCO_3^-]$ is higher than expected).

This patient has a respiratory acidosis due to pregnancy and a relative secondary metabolic alkalosis due to vomiting.

Example 5

A 19-y-old diabetic has an anion gap of 29 and a [HCO₃⁻] of 6.

Step 1:

- 29 mmol/L actual gap
- –10 mmol/L normal gap

19 mmol/L expected change in [HCO₃⁻]

Step 2:

- 24 mmol/L normal [HCO₃]
- -19 mmol/L expected change in [HCO₃⁻]

5 mmol/L expected change in [HCO₃⁻]

Actual bicarbonate is 6 mmol/L, which is very close to the expected of 5 mmol/L. Thus, a pure metabolic gap acidosis is present from DKA.

Example 6

A 21-y-old diabetic presents with nausea, vomiting, and abdominal pain. The anion gap was 23, and the [HCO₃] was 18.

Step 1:

- 23 mmol/L actual gap
- -10 mmol/L normal gap

13 mmol/L expected change in [HCO₃⁻] from normal

Step 2:

- 24 mmol/L normal [HCO₃⁻]
- -13 mmol/L expected change in [HCO₃⁻]
 - 11 mmol/L expected change in [HCO₃⁻]

Actual bicarbonate is 18 mmol and not the 11 mmol/L expected from a pure metabolic gap acidosis. Because the actual bicarbonate was higher than expected, this must be a mixed metabolic gap acidosis and metabolic alkalosis. The patient has a metabolic gap acidosis from DKA and a metabolic alkalosis from the vomiting.

Example 7

A 55-y-old alcoholic with a 2-wk history of diarrhea. The anion gap was 17, and [HCO₃⁻] was 10.

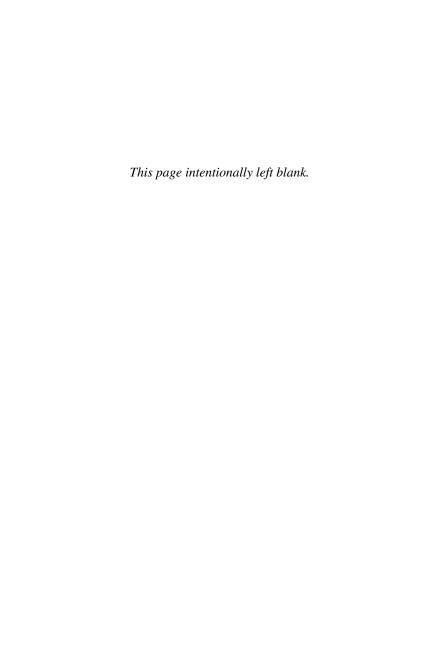
Step 1:

- 17 mmol/L actual gap
- -10 mmol/L normal gap
 - 7 mmol/L expected change in [HCO₃⁻] from normal

Step 2:

- 24 mmol/L normal [HCO₃]
- -7 mmol/L expected change in [HCO₃-]
- 17 mmol/L expected change in [HCO₃⁻]

Actual bicarbonate is 10 mmol/L and not the expected 17 mmol/L if there was a pure metabolic gap acidosis. Since the actual bicarbonate is lower than expected, there must be a mixed metabolic gap acidosis and metabolic nongap acidosis. The patient has a metabolic nongap acidosis from diarrhea and a metabolic gap acidosis from the alcoholic ketoacidosis.



FLUIDS AND ELECTROLYTES

Principles of Fluids and Electrolytes Composition of Parenteral Fluids Composition of Body Fluids Ordering IV Fluids Determining an IV Rate Electrolyte Abnormalities: Diagnosis and Treatment

PRINCIPLES OF FLUIDS AND ELECTROLYTES

Fluid Compartments

Example: 70-kg male

Total Body Water: 42,000 mL (60% of BW)

Intracellular: 28,000 mL (40% of BW)
 Extracellular: 14,000 mL (20% of BW)

Plasma: 3500 mL (5% of BW)
 Interstitial: 10,500 mL (15% of BW)

Total Blood Volume

Total blood volume = 5600 mL (8% of BW)

Red Blood Cell Mass

Male, 20-36 mL/kg (1.15-1.21 L/m²); female, 19-31 mL/kg (0.95-1.0 L/m²)

Water Balance

• 70-kg male

The minimum obligate water requirement to maintain homeostasis (assuming normal temperature and renal concentrating ability and minimal solute [urea, salt] excretion) is about 800 mL/d, which would yield 500 mL of urine.

"Normal" Intake: 2500 mL/d (about 35 mL/kg/d baseline)

Oral liquids: 1500 mL
Oral solids: 700 mL

· Metabolic (endogenous): 300 mL

"Normal" Output: 1400-2300 mL/d

Urine: 800–1500 mL
 Stool: 250 mL

 Insensible loss: 600–900 mL (lungs and skin). (With fever, each degree above 98.6°F adds 2.5 mL/kg/d to insensible loss; insensible losses are decreased if a patient is on a ventilator; free water gain may occur from humidified ventilation.)

Baseline Fluid Requirement

Afebrile 70-kg Adult: 35 mL/kg/24 h

If not a 70-kg Adult: Calculate the water requirement according to the following "kg Method":

· For the first 10 kg of body weight: 100 mL/kg/d plus

For the second 10 kg of body weight: 50 mL/kg/d plus

· For the weight above 20 kg: 20 mL/kg/d

Electrolyte Requirements

· 70-kg adult, unless otherwise specified

Sodium (as NaCl): 80-120 mEq (mmol)/d (Pediatric patients, 3-4 mEq/kg/ 24 h [mmol/kg/24 h])

Chloride: 80-120 mEq (mmol)/d, as NaCl

Potassium: 50–100 mEq/d (mmol/d) (Pediatric patients, 2–3 mEq/kg/24 h [mmol/kg/24 h]). In the absence of hypokalemia and with normal renal function, most of this is excreted in the urine. Of the total amount of potassium, 98% is intracellular, and 2% is extracellular. Thus, assuming the serum potassium level is normal, about 4.5 mEq/L (mmol/L), the total extracellular pool of $K^* = 4.5 \times 14 L = 63$ mEq (mmol). Potassium is easily interchanged between intracellular and extracellular stores under conditions such as acidosis. Potassium demands increase with diuresis and building of new body tissues (anabolic states).

Calcium: 1–3 gm/d, most of which is secreted by the GI tract. Routine administration is not needed in the absence of specific indications.

Magnesium: 20 mEq/d (mmol/d). Routine administration is not needed in the absence of specific indications, such as parenteral hyperalimentation, massive diuresis, ethanol abuse (frequently needed) or preeclampsia.

Glucose Requirements

100–200 g/d (65–75 g/d/m²). During starvation, caloric needs are supplied by body fat and protein; the majority of protein comes from the skeletal muscles. Every gram of nitrogen in the urine represents 6.25 g of protein broken down. The **protein-sparing effect** is one of the goals of basic IV therapy. The administration of at least 100 g of glucose/d reduces protein loss by more than one-half. Virtually all IV fluid solutions supply glucose as dextrose (pure dextrorotatory glucose). Pediatric patients require about 100–200 mg/kg/h.

COMPOSITION OF PARENTERAL FLUIDS

Parenteral fluids are generally classified based on molecular weight and oncotic pressure. Colloids have a molecular weight of >8000 and have high oncotic pressure; crystalloids have a molecular weight of <8000 and have low oncotic pressure.

Colloids

- Albumin (see page 200)
- Blood products (RBCs, single-donor plasma, etc) (Chapter 10, page 197)
- Plasma protein fraction (Plasmanate) (See Chapter 22)
- Synthetic colloids (hetastarch [Hespan], dextran) (Chapter 22)

Crystalloids

Table 9-1 describes common crystalloid parenteral fluids.

COMPOSITION OF BODY FLUIDS

Table 9–2 gives the average daily production and the amount of some major electrolytes present in various body fluids.

ORDERING IV FLUIDS

One of the most difficult tasks to master is choosing appropriate IV therapy for a patient. The patient's underlying illness, vital signs, serum electrolytes, and a host of other variables all must be considered. The following are general guidelines for IV therapy. Specific requirements for each patient can vary tremendously from these guidelines.

Maintenance Fluids

These amounts provide the minimum requirements for routine daily needs:

- 70-kg Male: Five% dextrose in one-quarter concentration normal saline (D5¼NS) with 20 mEq KCl/L (20 mmol/L) at 125 mL/h. (This will deliver about 3 L of free water/day.)
- Other Adult Patients: Also use D5¼ NS with 20 mEq KCl/L. Determine their 24-h
 water requirement by the "kg method" (page 178) and divide by 24 h to determine the
 hourly rate.
- 3. Pediatric Patients: Use the same solution, but determine the daily fluid requirements by either of the following methods:
 - a. kg Method: (page 181)
 - b. Meter Squared Method: Maintenance fluids are 1500 mL/m²/d. Divide by 24 to get the flow rate per hour. To calculate the surface area, use Table 9–3, page 181 "rule of sixes nomogram." Formal body surface area charts are in the Appendix.

Specific Replacement Fluids

These fluids are used to replace excessive, nonphysiologic losses.

Gastric Loss (Nasogastric Tube, Emesis): $D_51/2$ NS with 20 mEq/L (mmol/L) potassium chloride (KCl)

Diarrhea: D₃LR with 15 mEq/L (mmol/L) KCl. Use body weight as a replacement guide (about 1 L for each 1 kg, or 2.2 lb, lost)

Bile Loss: D₅LR with 25 mEq/L (½ ampule) of sodium bicarbonate mL for mL

Pancreatic Loss: D₅LR with 50 mEq/liter (1 amp) HCO₃ mL for mL.

Burn Patients: Use the Parkland or "Rule of Nines" Formulas:

TABLE 9–1 Composition of Commonly Used Crystalloids

				1	Electrolyte	es (mEq/L)			
Fluid	Glucose (g/L)	Na ⁺	Cl ⁻	K ⁺	Ca ²⁺	HCO ₃ -*	Mg ²⁺	HPO ₄ ⁻²	kcal/L
D ₅ W (5% dextrose	50	_	_	_	_	_	_	_	170
in water) D ₁₀ W (10% dextrose in water)	100	_	_	_	_	_	_	_	340
D ₂₀ W (20% dextrose in water)	200	_	-	_	_	_	_	-	680
D ₅₀ W (50% dextrose in water)	500	_	_	_	_	_	_	-	1700
½ NS (0.45% NaCl)	_	77	77	_	_	_	_	_	_
3% NS	_	513	513	_	_	_	_	_	_
NS (0.9% NaCl)	_	154	154	_	_	_	_	_	_
D ₅ 1/4NS	50	38	38	_	_	_	_	_	170
D ₅ 14NS (0.45% NaCl)	50	77	77	_	_	_	_	_	170
D ₅ ½NS (0.9% NaCl)	50	154	154	_	_	_	_	_	170
D ₅ LR (5% dextrose in lactated Ringer's)	50	130	110	4	3	27	_	-	180
Lactated Ringer's	_	130	110	4	3	27	_	_	<10
Ionosol MB	50	25	22	20	_	23	3	3	1 <i>7</i> 0
Normosol M	50	40	40	13	_	16	3	_	1 <i>7</i> 0

 $^{^{\}star}\text{HCO}_3$ is administered in these solutions as lactate that is converted to bicarbonate.

TABLE 9–2
Composition and Daily Production of Body Fluids

Fluid	Na⁺	Cl-	K ⁺	HCO ₃ ⁻	Average Daily Production* (mL)
Sweat	50	40	5	0	Varies
Saliva	60	15	26	50	1500
Gastric juice	60-100	100	10	0	1500-2500
Duodenum	130	90	5	0–10	300-2000
Bile	145	100	5	15	100-800
Pancreatic juice	140	75	5	115	100-800
lleum '	140	100	2-8	30	100-9000
Diarrhea	120	90	25	45	_

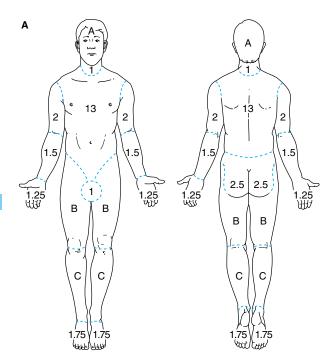
^{*}In adults.

TABLE 9-3
"Rule of Sixes" Nomogram for Calculating Fluids in Children*

Weight (lb)	Body Surface Area (m²)	
3	0.1	
6	0.2	
12	0.3	
18	0.4	
24	0.5	
30	0.6	
36	0.7	
24 30 36 42	0.8	
48	0.9	
48 60 [†]	1.0	

^{*}Over 100 lb, treat as an adult.

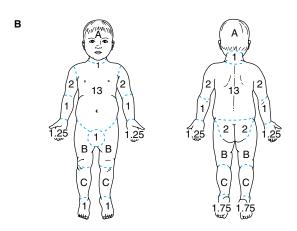
[†]After 60 lb, add 0.1 for each additional 10 lb.



Relative Percentages of Areas Affected by Growth

Area		Age	
Alea	10	15	Adult
A = half of head	5.5	4.5	3.5
B = half of one thigh	4.25	4.5	4.75
C = half of one leg	3	3.25	3.5

FIGURE 9-1 Tables for estimating the extent of burns in adults and children. In adults, a reasonable system for calculating the percentage of the body surface burned is the "rule of nines": Each arm equals 9%, the head equals 9%, the anterior and posterior each equal 18%, and the perineum equals 1%. (Reprinted, with permission, from: Way LW [ed]: Current Surgical Diagnosis and Treatment, 10th ed,. Appleton & Lange, Norwalk CT, 1994.)



Relative Percentages of Areas Affected by Growth

Area		Age	
Alea	0	1	5
A = half of head	9.5	8.5	6.5
B = half of one thigh	2.75	3.25	4
C = half of one leg	2.5	2.5	2.75

FIGURE 9-1 Continued.

Parkland Formula.

Total fluid required during the first 24 h = (% body burn) \times (body weight in kg) \times 4 mL

Replace with lactated Ringer's solution over 24 h. Use

- One-half the total over first 8 h (from time of burn)
- · One-quarter of the total over second 8 h. One-quarter of the total over third 8 h
- Rule of Nines. Used for estimating percentage of body burned in adults. See Figure 9–1 for the exact calculation for the body burn in adults and children. This is also useful for determining ongoing fluid losses from a burn until it is healed or grafted. Fluid losses can be estimated as

Loss in mL = $(25 \times \% \text{ Body burn}) \times \text{m}^2 \text{ Body surface area}$

DETERMINING AN IV RATE

Most IV infusions are regulated by infusion pumps. If a mechanical infusion device is not available, use the following formulas to determine the infusion rate.

For a MAXI Drip Chamber: Use 10 drops/mL; thus

- 10 drops/min = 60 mL/h or
- 16 drops/min = 100 mL/h

For a MINI Drip Chamber: Use 60 drops/mL; thus

- 60 drops/min = 60 mL/h or
- 100 drops/min = 100 mL/h

ELECTROLYTE ABNORMALITIES: DIAGNOSIS AND TREATMENT

In all of the following situations, the primary goal should be to correct the underlying condition. Unless specified, all dosages are for adults. The complete differential diagnosis of laboratory findings can be found in Chapter 4.

Hypernatremia (Na⁺ >144 mEq/L [mmol/L])

Mechanisms: Most frequently, a deficit of total body water.

- Combined Sodium and Water Losses ("hypovolemic hypernatremia"). Water
 loss in excess of sodium loss results in low total body sodium. Due to renal (diuretics, osmotic diuresis due to glycosuria, mannitol, etc) or extrarenal (sweating, GI,
 respiratory) losses
- Excess Water Loss ("isovolemic hypernatremia"). Total body sodium remains normal, but total body water is decreased. Caused by diabetes insipidus (central and nephrogenic), excess skin losses, respiratory loss, others.
- Excess Sodium ("hypervolemic hypernatremia"). Total body sodium increased, caused by iatrogenic sodium administration (ie, hypertonic dialysis, sodium-containing medications) or adrenal hyperfunction (Cushing's syndrome, hyperaldosteronism).

Symptoms: Depend on how rapidly the sodium level has changed

- · Confusion, lethargy, stupor, coma
- Muscle tremors, seizures

Signs: Hyperreflexia, mental status changes

Treatment: Check the serum sodium levels frequently while attempting to correct hypernatremia.

- Hypovolemic Hypernatremia. Determine if the patient volume is depleted by determining if orthostatic hypotension (see page 286) is present; if volume is depleted, rehydrate with NS until hemodynamically stable, then administer hypotonic saline (½ NS).
- Euvolemic/Isovolemic. (No orthostatic hypotension) calculate the volume of free water needed to correct the Na* to normal as follows:

Body water deficit = Normal TBW - Current TBW

where

Normal TBW = $0.6 \times Body$ weight in kg

and

9

Current TBW = $\frac{\text{Normal serum sodium} \times \text{TBW}}{\text{Measured serum sodium}}$

- Give free water as D₅W, one-half the volume in the first 24 h and the full volume in 48 h. (Caution: The rapid correction of the sodium level using free water (D₅W) can cause cerebral edema and seizures.)
- Hypervolemic Hypernatremia. Avoid medications that contain excessive sodium (carbenicillin, etc). Use furosemide along with D₅W.

Hyponatremia (Na* <136 mEq/L [mmol/L])

Mechanisms: Most often due to excess body water as opposed to decreased body sodium. To define the cause, determine serum osmolality.

- · Isotonic Hyponatremia. Normal osmolality
- Pseudo-Hyponatremia. An artifact caused by hyperlipidemia or hyperproteinemia.
- Hypertonic Hyponatremia. High osmolality. Water shifts from intracellular to extracellular in response to high concentrations of such solutes as glucose or mannitol.
 The shift in water lowers the serum sodium; however, the total body sodium remains the same.
- Hypotonic Hyponatremia. Low osmolality. Further classified based on clinical assessment of extracellular volume status
- Isovolemic. No evidence of edema, normal BP. Caused by water intoxication (urinary osmolality <80 mOsm), SIADH, hypothyroidism, hypoadrenalism, thiazide diuretics, beer potomania
- Hypovolemic. Evidence of decreased skin turgor and an increase in heart rate and decrease in BP after going from lying to standing. Due to renal loss (urinary sodium >20 mEq/L) from diuretics, postobstructive diuresis, mineralocorticoid deficiency (Addison's disease, hypoaldosteronism) or extrarenal losses (urinary sodium <10 mEq/L) from sweating, vomiting, diarrhea, third spacing fluids (burns, pancreatitis, peritonitis, bowel obstruction, muscle trauma)
- Hypervolemic. Evidence of edema.(urinary sodium <10 mEq/L). Seen with CHF, nephrosis, renal failure, and liver disease
- Excess Water Intake. Primary (psychogenic water drinker) or secondary (large volume of sterile water used in procedures, eg, transurethral resection of the prostate or multiple tap water enemas)

Symptoms: Usually with Na⁺ <125 mEq/L (mmol/L); severity of symptoms correlates with the rate of decrease in Na⁺.

- · Lethargy, confusion, coma
- · Muscle twitches and irritability, seizures
- · Nausea, vomiting

Signs: Hyporeflexia, mental status changes

Treatment: Based on determination of volume status. Evaluate volume status by physical examination HR and BP lying and standing after 1 min, skin turgor, edema and by determination of the plasma osmolality. Do not need to treat hyponatremia from pseudo-hyponatremia (increased protein or lipids) or hypertonic hyponatremia (hyperglycemia), treat underlying disorder (see above).

- Life-Threatening. (Seizures, coma) 3–5% NS can be given in the ICU setting. Attempt to raise the sodium to about 125 mEq/L with 3–5% NS.
- Isovolemic Hyponatremia. (SIADH)

Restrict fluids (1000-1500 mL/d).

Demeclocycline can be used in chronic SIADH.

· Hypervolemic Hyponatremia

Restrict sodium and fluids (1000-1500 mL/d).

Treat underlying disorder. CHF may respond to a combination of ACE inhibitor and furosemide.

· Hypovolemic Hyponatremia

Give D5NS or NS.

Hyperkalemia

• (K+>5.2 mEq/L (mmol/L)

Mechanisms: Most often due to iatrogenic or inadequate renal excretion of potassium.

- Pseudo-Hyperkalemia. Due to leukocytosis, thrombocytosis, hemolysis, poor venipuncture technique (prolonged tourniquet time)
- Inadequate Excretion. Renal failure, volume depletion, medications that block
 potassium excretion (spironolactone, triamterene, others), hypoaldosteronism (including adrenal disorders and hyporeninemic states [such as Type IV renal tubular
 acidosis], NSAIDs, ACE inhibitors), long-standing use of heparin, digitalis toxicity,
 sickle cell disease, renal transplant
- Redistribution. Tissue damage, acidosis (a 0.1 decrease in pH increases serum K⁺ approximately 0.5–1.0 mEq/L due to extracellular shift of K⁺), beta-blockers, decreased insulin, succinylcholine
- Excess Administration. Potassium-containing salt substitutes, oral replacement, potassium in IV fluids

Symptoms: Weakness, flaccid paralysis, confusion.

Signs:

- · Hyperactive deep tendon reflexes, decreased motor strength
- ECG changes, such as, peaked T waves, wide QRS, loss of P wave, sine wave, asystole
- $K^+ = 7-8$ mEq/L (mmol/L) yields ventricular fibrillation in 5% of cases
- K⁺ = 10 mEq/L (mmol/L) yields ventricular fibrillation in 90% of cases

Treatment

- Monitor patient on ECG if symptomatic or if K⁺>6.5 mEq/L; discontinue all potassium intake, including IV fluids; order a repeat stat potassium to confirm.
- Pseudo-hyperkalemia should be ruled out. If doubt exists, obtain a plasma potassium in a heparinized tube; the plasma potassium will be normal if pseudo-hyperkalemia is present.
- Rapid Correction. These steps only protect the heart from potassium shifts, and total body potassium must be reduced by one of the treatments shown under Slow Correction.

Calcium chloride, 500 mg, slow IV push (only protects heart from effect of hyperkalemia) Alkalinize with 50 mEq (1 ampule) sodium bicarbonate (causes intracellular potassium shift)

50 mL D50, IV push, with 10-15 units regular insulin, IV push (causes intracellular potassium shift)

· Slow Correction

Sodium polystyrene sulfonate (Kayexalate) 20–60 g given orally with 100–200 mL of sorbitol or 40 g Kayexalate with 40 g sorbitol in 100 mL water given as an enema. Repeat doses qid as needed.

Dialysis (hemodialysis or peritoneal)

Correct Underlying Cause. Such as stopping potassium-sparing diuretics, ACE inhibitors, mineralocorticoid replacement for hypokalemia

Hypokalemia

• K+ < 3.6 mEq/L (mmol/L)

Mechanisms: Due to inadequate intake, loss, or intracellular shifts

- Inadequate Intake. Oral or IV
- GI Tract Loss. (Urinary chloride usually <10 mEq/d; "chloride-responsive alkalosis") yomiting, diarrhea, excess sweating, villous adenoma, fistula
- Renal Loss. Diuretics and other medications (amphotericin, high-dose penicillins, aminoglycosides, cisplatin), diuresis other than diuretics (osmotic, eg, hyperglycemia or ethanol-induced), vomiting (from metabolic alkalosis from volume depletion), renal tubular disease (renal tubular acidosis type II [distal], and [proximal]), Bartter's syndrome (due to increased renin and aldosterone levels), hypomagnesemia, natural licorice ingestion, mineralocorticoid excess (primary and secondary hyperaldosteronism, Cushing's syndrome, steroid use), and ureterosigmoidostomy
- Redistribution (Intracellular Shifts). Metabolic alkalosis (each 0.1 increase in pH lowers serum K⁺ approximately 0.5–1.0 mEq/L, due to intracellular shift of K⁺), insulin administration, beta-adrenergic agents, familial periodic paralysis, treatment of megaloblastic anemia

Symptoms

- · Muscle weakness, cramps, tetany
- · Polyuria, polydipsia

Signs

- Decreased motor strength, orthostatic hypotension, ileus
- ECG changes, such as flattening of T waves, "U" wave becomes obvious (U wave is the upward deflection after the T wave.)

Treatment: The therapy depends on the cause.

- A history of hypertension, GI symptoms, or use of certain medications may suggest the diagnosis.
- A 24-h urine for potassium may be helpful if the diagnosis is unclear. Levels
 20 mEq/d suggest extrarenal/redistribution, >20 mEq/d suggest renal losses.

-

- A serum potassium level of 2 mEq/L (mmol/L) probably represents a deficit of at least 200 mEq (mmol) in a 70-kg adult; to change potassium from 3 mEq/L (mmol/L) to 4 mEq/L (mmol/L) takes about 100 mEq (mmol) of potassium in a 70-kg adult.
- · Treat underlying cause.
- Hypokalemia potentiates the cardiac toxicity of digitalis. In the setting of digoxin use, hypokalemia should be aggressively treated.
- Treat hypomagnesemia if present. It will be difficult to correct hypokalemia in the presence of hypomagnesemia.
- Rapid Correction. Give KCl IV. Monitor heart with replacement >20 mEq/h. IV potassium can be painful and damaging to veins.

Patient <40 kg: $0.25 \text{ mEq/kg/h} \times 2 \text{ h}$

Patient >40 kg: $10-20 \text{ mEq/h} \times 2 \text{ h}$

Severe [<2 mEq/L (mmol/L)]: Maximum 40 mEq/h IV in adults

In all cases check a stat potassium following each 2-4 h of replacement.

 Slow Correction. Give KCl orally (see also Table 22–8, page 626) for potassium supplements).

Adult: 20–40 mEq two to three times a day (bid or tid) Pediatric patients: 1–2 mEq/kg/d in divided doses

Hypercalcemia

• $Ca^{2+} > 10.2 \text{ mg/dL} (2.55 \text{ mmol/L})$

Mechanisms

- · Parathyroid-Related. Hyperparathyroidism with secondary bone resorption
- Malignancy-Related. Solid tumors with metastases (breast, ovary, lung, kidney), or paraneoplastic syndromes, (squamous cell, renal cell, transitional cell carcinomas, lymphomas, and myeloma)
- Vitamin-D-Related. Vitamin D intoxication, sarcoidosis, other granulomatous disease
- High Bone Turnover. Hyperthyroidism, Paget's disease, immobilization, vitamin A intoxication
- Renal Failure. Secondary hyperparathyroidism, aluminum intoxication
- · Other. Thiazide diuretics, milk-alkali syndrome, exogenous intake

Symptoms

 Stones (renal colic) bones (osteitis fibrosa), moans (constipation), and groans (neuropsychiatric symptoms—confusion), as well as polyuria, polydipsia, fatigue, anorexia, nausea, vomiting

Signs

- · Hypertension, hyporeflexia, mental status changes
- · Shortening of the QT interval on the ECG.

Treatment: Usually emergency treatment if patient is symptomatic and Ca⁺²>13 mEq/L (3.24 mmol/L)

Use saline diuresis: D₅NS at 250–500 mL/h.

- Give furosemide (Lasix) 20–80 mg or more IV (saline and Lasix will treat most cases).
- Euvolemia or hypervolemia must be maintained. Hypovolemia results in calcium reabsorption.
- · Other Second-Line Therapies:

Calcitonin 2-8 IU/kg IV or SQ q6-12h if diuresis has not worked after 2-3 h

Pamidronate 60 mg IV over 24 h (one dose only)

Gallium nitrate 200 mg/m2 IV infusion over 24 h for 5 d

Plicamycin 25 μg/kg IV over 2–3 h (use as last resort—very potent)

Corticosteroids. Hydrocortisone 50-75 mg IV every 6 h.

Consider hemodialysis.

· Chronic Therapy:

Treat underlying condition, discontinue contributing medications (ie, thiazides).

Oral medications (prednisone 30 mg PO bid or phosphorus/potassium/sodium supplement [Neutra-Phos] 250–500 mg PO qid) can be effective in chronic therapy for such diseases as breast cancer or sarcoidosis.

Hypocalcemia

• Ca²⁺ < 8.4 mg/dL (2.1 mmol/L)

Mechanisms: Decreased albumin can result in decreased calcium (see discussion on page 61).

- PTH. Responsible for the immediate regulation of calcium levels
- Critical Illness. Sepsis and other ICU-related conditions can cause decreased calcium because of the fall in albumin often seen in critically ill patients, ionized calcium may be normal.
- PTH Deficiency. Acquired (surgical excision or injury, infiltrative diseases such as amyloidosis or hemachromatosis and irradiation) hereditary hypoparathyroidism (pseudo-hypoparathyroidism), hypomagnesemia
- Vitamin D deficiency. Chronic renal failure, liver disease, use of phenytoin or phenobarbital, malnutrition, malabsorption (chronic pancreatitis, postgastrectomy)
- Other. Hyperphosphatemia, acute pancreatitis, osteoblastic metastases, medullary carcinoma of the thyroid, massive transfusion

Symptoms

 Hypertension, peripheral and perioral paresthesia, abdominal pain and cramps, lethargy, irritability (in infants)

Signs

- Hyperactive DTRs, carpopedal spasm (Trousseau's sign, see page 27).
- Positive Chvostek's sign (facial nerve twitch, can be present in up to 25% of normal adults).
- Generalized seizures, tetany, laryngospasm
- · Prolonged QT interval on ECG

Treatment

Acute Symptomatic

100–200 mg of elemental calcium IV over 10 min in 50–100 mL of D₅W followed by an infusion containing 1–2 mg/kg/h over 6–12 h

10% calcium gluconate contains 93 mg of elemental calcium.

10% calcium chloride contains 272 mg of elemental calcium.

Check magnesium levels and replace if low.

Chronic

For renal insufficiency, use vitamin D along with oral calcium supplements (see the following lists) and phosphate-binding antacids (Phospho gel, ALTernaGEL).

Calcium supplements

Calcium carbonate (Os-Cal) 650 mg PO qid (28% calcium) Calcium citrate (Critical) 950-mg tablets (21% calcium)

Calcium gluconate 500- or 1000-mg tablets (9% calcium)

Calcium glubionate (Neo-Calglucon) syrup 115 mg/5 mL (6.4% calcium)

Calcium lactate 325- or 650-mg tablets (13% calcium)

Hypermagnesemia

• $Mg^{2+} > 2.1 \text{ mEq/L (mmol/L)}$

Mechanisms

- Excess Administration. Treatment of preeclampsia with magnesium sulfate
- · Renal Insufficiency. Exacerbated by ingestion of magnesium-containing antacids
- · Others. Rhabdomyolysis, adrenal insufficiency

Symptoms and Signs

- 3-5 mEq/L(mmol/L): Nausea, vomiting, hypotension
- 7–10 mEq/L (mmol/L): Hyperreflexia, weakness, drowsiness
- >12 mEq/L (mmol/L): Coma, bradycardia, respiratory failure

Treatment: Clinical hypermagnesemia requiring therapy is infrequently encountered in the patient with normal renal function.

- Calcium gluconate: 10 mL of 10% solution (93 mg elemental calcium) over 10–20 min in 50–100 mL of D₅W given IV to reverse symptoms (useful in patients being treated for eclampsia).
- Stop magnesium-containing medications (hypermagnesemia is most often encountered in patients in renal failure on magnesium-containing antacids).
- · Insulin and glucose as for hyperkalemia (page 186). Furosemide and saline diuresis
- · Dialysis

Hypomagnesemia

• Mg²⁺ <1.5 mEq/L (mmol/L)

Mechanisms

- Decreased Intake or Absorption. Malabsorption, chronic GI losses, deficient intake (alcoholics), TPN without adequate supplementation
- Increased Loss. Diuretics, other medications (gentamicin, cisplatin, amphotericin B, others), RTA, diabetes mellitus (especially DKA), alcoholism, hyperaldosteronism, excessive lactation
- Other. Acute pancreatitis, hypoalbuminemia, vitamin D therapy.

Symptoms

- · Weakness, muscle twitches, asterixis
- · Vertigo
- Symptoms of hypocalcemia (hypomagnesemia may cause hypocalcemia and hypokalemia)

Signs

- · Tachycardia, tremor, hyperactive reflexes, tetany, seizures
- ECG may show prolongation of the PR, QT, and QRS intervals as well as ventricular ectopy, sinus tachycardia

Treatment

· Severe: Tetany or Seizures

Monitor patient with ECG in ICU setting.

2 g magnesium sulfate in D₅W infused over 10–20 min. Follow with magnesium sulfate: 1 g/h for 3–4 h follow DTR and levels. Repeat replacement if necessary.

These patients are often hypokalemic and hypophosphatemic as well and should be supplemented.

Hypocalcemia may also result from hypomagnesemia.

Moderate

Mg²⁺ <1.0 mg/dL but asymptomatic

Magnesium sulfate: 1 g/h for 3-4 h, follow TR and levels and repeat replacement if necessary.

Mild

Magnesium oxide: 1 g/d PO (available over the counter in 140-mg capsules, and in 400- and 420-mg tablets). May cause diarrhea.

Hyperphosphatemia

• $PO_4^{-3} > 4.5 \text{ mg/dL } (1.45 \text{ mmol/L})$

Mechanisms

- Increased Intake/Absorption. Iatrogenic, abuse of laxatives or enemas containing phosphorus, vitamin D, granulomatous disease
- Decreased Excretion (Most Common Cause). Renal failure, hypoparathyroidism, adrenal insufficiency, hyperthyroidism, acromegaly, sickle cell anemia
- Redistribution/Cellular Release. Rhabdomyolysis, acidosis, chemotherapy-induced tumor lysis, hemolysis, plasma cell dyscrasias

Symptoms and Signs: Mostly related to tetany as a result of hypocalcemia (see page 189) caused by the hyperphosphatemia or metastatic calcification (deposition of calcium phosphate in various soft tissues)

Treatment

- · Low-phosphate diet
- Phosphate binders like aluminum hydroxide gel (Amphojel) or aluminum carbonate gel (Basaljel) orally
- Acute, severe cases: Acetazolamide 15 mg/kg q4h or insulin and glucose infusion, dialysis as last resort

Hypophosphatemia

• $PO_4^{-3} < 2.5 \text{ mg/dL } (0.8 \text{ mmol/L})$

Mechanisms

- Decreased Dietary Intake. Starvation, alcoholism, iatrogenic (hyperalimentation without adequate supplementation), malabsorption, vitamin D deficiency, phosphate-binding antacids (ie, ALTernaGEL)
- Redistribution. Conditions associated with respiratory or metabolic alkalosis (alcohol withdrawal, salicylate poisoning, etc), endocrine (insulin, catecholamine, etc), anabolic steroids, hyper- or hypothermia, leukemias and lymphomas, hypercalcemia, hypomagnesemia
- Renal Losses. RTA, diuretic phase of ATN, hyperparathyroidism, hyperthyroidism, hypokalemia, diuretics, hypomagnesemia, alcohol abuse, diabetes mellitus (poorly controlled)
- Other. Refeeding in the setting of severe protein-calorie malnutrition, severe burns, treatment of DKA

Symptoms and Signs: < 1 mg/dL (0.32 mmol/L): Weakness, muscle pain and tenderness, paresthesia, cardiac and respiratory failure, CNS dysfunction (confusion and seizures). rhabdomyolysis, hemolysis, impaired leukocyte and platelet function

Treatment: IV therapy is reserved for severe potentially life-threatening hypophosphatemia (<1.0–1.5 mg/dL) because too rapid correction can lead to severe hypocalcemia. With mild to moderate hypophosphatemia (1.5–2.5 mg/dL), oral replacement is preferred.

Severe. (<1.0–1.5 mg/dL)

Potassium or sodium phosphate. 2 mg/kg (0.08 mM/kg) given IV over 6 h. (Caution: Rapid replacement can lead to hypocalcemic tetany.)

• Mild to Moderate. (levels > 1.5 mg/dL)

Sodium-potassium phosphate (Neutra-Phos) or potassium phosphate (K-Phos): 1-2 tablets (250–500 mg PO $_4$ or 8 mM/tablet) PO bid or tid

Sodium phosphate (Fleet's Phospho-soda). 5 mL PO, bid or tid (128 mg PO₄ or 4 mM/mL)

BLOOD COMPONENT THERAPY

Blood Banking Procedures Routine Blood Donation Autologous Blood Donation Donor-Directed Blood Products Irradiated Blood Components Apheresis Preoperative Blood Set-Up Emergency Transfusions Blood Groups
Basic Principles of Blood Component
Therapy
Blood Bank Products
Transfusion Procedures
Transfusion Reactions
Transfusion-Associated Infectious
Disease Risks

BLOOD BANKING PROCEDURES

T&S or T&H: The blood bank types the patient's blood (ABO and Rh) and screens for antibodies. If a rare antibody is found, the physician will usually be notified, and if it is likely that blood will be needed, the type and screen order may be changed to a type and cross. This usually takes less than 1 h.

T&C: The blood bank types and screens the patient's blood as described in the previous section and matches specific donor units for the patient. The cross-match involves testing the recipient's serum against the donor blood cells.

STAT Requests: The bank sets up blood immediately and usually holds it for 12 h. For routine requests, the blood is set up at a date and time that you specify and usually held for 36 h.

ROUTINE BLOOD DONATION

Voluntary blood donation is the mainstay of the blood system in the United States. Donors must usually be >18 y old, in good health, afebrile. and weigh >110 lb. Donors are usually limited to 1 unit every 8 wk and 6 donations/y. Patients with a history of hepatitis, HB_sAg positivity, insulin-dependent diabetes, IV drug abuse, heart disease, anemia, and homosexual activity are excluded from routine donation. Patients are counseled about high-risk behaviors that may risk others if they have transmissible diseases and donate blood. Donor blood is tested for ABO, Rh, antibody screen, HB_sAg , antihepatitis B core antigen, hepatitis C antibody, anti-HIV-1 and 2. and anti-HTLV-1 and 2.

AUTOLOGOUS BLOOD DONATION

Preadmission autologous blood banking (predeposit phlebotomy) is popular for some patients anticipating elective surgery in which blood may be needed. General guidelines for autologous banking include good overall health status, a hematocrit greater than 34%, and 10

arm veins that can accommodate a 16-gauge needle. Patients can usually donate up to 1 unit every 3–7 days, until 3–7 days prior to surgery (individual blood banks have their own specifications), depending on the needs of the planned surgery. Iron supplements (eg, ferrous gluconate 325 mg PO tid) are usually given prior to and several months after the donation. The use of erythropoietin is being investigated in this preoperative setting. Units of whole blood can be held for up to 35 days.

DONOR-DIRECTED BLOOD PRODUCTS

This method of donation involves a relative or friend donating blood for a specific patient. This technique cannot be used in the emergency setting because it takes up to 48 h to process the blood for use.

This system has some drawbacks: Relatives may be unduly pressured to give blood, risk factors that would normally exclude the use of the blood (hepatitis or HIV positivity) become problematic, and ultimately the routine donation of blood for emergency transfusion may be adversely affected. These units are usually stored as packed red cells and released into the general transfusion pool 8 h after surgery unless otherwise requested.

IRRADIATED BLOOD COMPONENTS

Transfusion-associated GVHD, a frequently fatal condition, can be minimized through the highly selected irradiation of blood components. Patients who are at risk for GVHD include recipients of donor-directed units or HLA-matched platelets, fetal intrauterine transfusions, and selected immunocompromised and bone marrow recipients.

APHERESIS

Apheresis procedures are used to collect single-donor platelets (**plateletpheresis**) or white blood cells (**leukapheresis**); the remaining components are returned to the donor. **Therapeutic apheresis** is the separation and removal of a particular component to achieve a therapeutic effect (eg, **erythrocytapheresis** to treat polycythemia).

PREOPERATIVE BLOOD SET-UP

Most institutions have established parameters (MSBOS) for setting up blood before procedures. Some typical guidelines are given in Table 10–1 for the number of units of packed red cells or if only a T&S is requested.

EMERGENCY TRANSFUSIONS

Non-cross-matched blood is rarely transfused because most blood banks can do a complete cross-match within 1 h. In cases of massive, exsanguinating hemorrhage, type-specific blood (ABO- and Rh-matched only), usually available in 10 min, can be used. If even this delay is too long, type O, Rh-negative, packed red blood cells can be used as a last resort. When possible, it is generally preferable to support blood pressure with colloid or crystal-loid until properly cross-matched blood is available.

BLOOD GROUPS

Table 10-2 gives information on the major blood groups and their relative occurrences. O- is the "universal donor" and AB+ is the "universal recipient."

TABLE 10-1
Guidelines for Blood Required for Surgical Procedures

Procedure	Number of Units Needed
Amputation (lower extremity)	2
Cardiac procedure (CABG, valve)	4
Cholecystectomy (open and laparoscopic)	T&S
Colon resection	2
Colostomy	T&S
Cystectomy, radical with diversion	4
Esophageal resection	2
Exploratory laparotomy	2
Gastrectomy	2
Gastrostomy	T&S
Hemorrhoidectomy	T&S
Hernia	T&S
Hysterectomy	2
Liver resection	6
Live transplant	6
Mastectomy	T&S
Nephrectomy	2
Pancreatectomy	4
Parathyroidectomy	T&S
Pulmonary resection	2
Radical neck dissection	2
Radical prostatectomy	3-4
Renal transplant	2
Small bowel resection	2
Splenectomy	2
Thyroidectomy	T&S
Tracheostomy	2
Total hip replacement	2
TURP	2
VASCULAR PROCEDURES	
Abdominal aortic aneurysm	6
Aortofemoral bypass	4
Aortoiliac bypass	4
Carotid endarterectomy	T&S
Femoral popliteal bypass	4
Iliofemoral bypass	4
Portacaval shunt	6
Splenorenal shunt	6
Vein stripping	T&S
•	

Blood Groups and Guidelines for Transfusion Can Usually Receive* Type (ABO/Rh) Blood From Occurrences 1 in 3 0+ O(+/-)0-1 in 15 0 (-) A+ 1 in 3 A (+/-) or O (+/-)

1 in 16

1 in 12

1 in 67

1 in 29

1 in 167

TABLE 10-2

A (-) or O (-)

B (-) or O (-)

B (+/-) or O (+/-)

AB, A, B, or O (all + or -)

AB, A, B, or O (all –)

BASIC PRINCIPLES OF BLOOD COMPONENT THERAPY

Table 10-3 provides some common indications and uses for transfusion products. The following are the basic transfusion principles for adults.

Red Cell Transfusions

A-

B+

B-

AB+

AB-

Acute Blood Loss: Normal, healthy individuals can usually tolerate up to 30% blood loss without need for transfusion; patients may manifest tachycardia, mild hypotension without evidence of hypovolemic shock, Replace loss with volume (IV fluids, etc) replacement.

- Hgb >10 g/dL, rarely needs transfusion.
- Hgb 6-10 g/dL, transfuse based on clinical symptoms, unless patient has severe medical problems (ie, CAD, respiratory conditions).
- · Hgb <6 g/dL usually requires transfusion.

"Allowable Blood Loss": Often used to guide acute transfusion in the operating room setting. Losses less than allowable are usually managed with IV fluid replacement.

Weight in kg x 0.08 = Total blood volume

Total volume x = 0.3 = Allowable blood loss (assumes normal hemoglobin)

Example: A 70-kg adult

Estimated allowable blood loss = $70 \times 0.08 = 5600 \text{ mL} \times 0.3 = 1680 \text{ mL}$

Chronic Anemia: Common in certain chronic conditions such as renal failure, rarely managed with blood transfusion; typically managed with pharmacologic therapy (eg, erythropoietin). However, transfusion is generally indicated if Hgb < 6 g/dL or in the face of symptoms due to low hemoglobin.

^{*}First choice is always the identical blood type, other acceptable combinations are shown. An attempt is also made to match Rh status of donor and recipient; Rh negative can usually be given to an RH+ recipient safely

TABLE 10-3 Blood Bank Products

Product	Description	Common Indications
Whole blood (see also page 196)	No elements removed 1 unit = 450 mL ± 45 mL (HCT = 40%) Contains RBC, WBC, plasma and platelets (WBC & platelets may be nonfunctional) Deficient in factors V & VII	Not for routine use Acute, massive bleeding Open heart surgery Neonatal total exchange
Packed Red Cells (PRBC) (see also page 196)	Most plasma, WBC, platelets removed; unit = 250–300 mL. (HCT ≈ 75%) 1 unit should raise HCT 3%	Replacement in chronic and acute blood loss, GI bleeding, trauma
Universal Pedi-Packs	250–300 mL divided into 3 bags Contains red cells, some white cells, some plasma and platelets	Transfusion of infants
Leukocyte-Poor (Leukocyte-reduced) Red Cells	Most WBC removed by filtration to make it less antigenic <5 × 10 ⁶ WBC, few platelets, minimal plasma 1 unit = 200–250 mL	Potential renal transplant patients Previous febrile transfusion reactions Patients requiring multiple transfusions (leukemia, etc.)
Washed RBCs	Like leukocyte-poor red cells, but WBC almost completely removed <5 × 10 ⁸ WBC, no plasma 1 unit = 300 mL	As for leukocyte-poor red cells, but very expensive and much more purified

TABLE 10-3 (Continued)

Product	Description	Common Indications
Granulocytes (pheresis)	1 unit = ≈220 mL Some RBC, >1 × 10 ¹⁰ PMN/unit, Lymphocytes, platelets	See page 194
Platelets (see also page 201)	1 "pack" should raise count by 5000–8000 "6-pack" means a pool of platelets from 6 units of blood	Decreased production or destruction (ie, aplastic anemia, acute leukemia, postchemo, etc) Counts <5000–10,000 (risk of spontaneous hemorrhage) must transfuse
	1 pack = about 50 mL >5 × 10 ¹⁰ platelets unit, contains RBC, WBC	Counts 10,000–30,000 if risk of bleeding (headache, Gl losses, contiguous petechiae) or active bleeding Counts <50,000 if life-threatening bleed Prophylactic transfusion >20,000 for minor surgery or >50,000 for major surgery Usually not indicated in ITP or TTP unless life-threatening bleeding or preoperatively
Platelets, pheresis	>3 × 10 ¹⁰ platelets/unit 1 unit = 300 mL	See Platelets, may be HLA matched
Platelets, leukocyte-reduced	As above, but $<5 \times 10^6$ WBC/unit	See Platelets, may decrease febrile reactions and CMV transmission, alloimmunization to HLA antigens
Cryoprecipitated Antihemophilic Factor ("Cryo")	Contains factor VIII, factor XIII, von Willebrand's factor, and fibrinogen 1 unit = 10 mL	Hemophilia A (factor VII deficiency), when safer factor VIII concentrate not available; von Willebrand's disease, fibrinogen deficiency, fibrin surgical glue

TABLE 10-3 (Continued)

Product	Description	Common Indications
Fresh-Frozen Plasma (FFP)	Contains factors II, VII, IX, X, XI, XII, XIII and heat-labile V and VII About 1 h to thaw 150–250 mL (400–600 mL if single-donor pheresis)	Emergency reversal of Coumadin Massive transfusion (>5 L in adults) Hypoglobulinemia (IV immune globulin preferred) Suspected or documented coagulopathy (congenital or acquired) with active bleeding or before surgery) Clotting factor replacement when concentrate unavailable Not recommended for volume replacement If PT <22 s or PTT <70 s, 1 unit is usually
Single Donor Plasma	Like FFP, but lacks factors V and VIII About 1 h to thaw; 150–200 ml	sufficient No longer routinely used for plasma replacement Stable clotting factor replacement Coumadin reversal, hemophilia B (Christmas
Rho Gam (Rho D immune globulin)	Antibody against Rh factor (volume = 1 mL)	disease) Rh-mother with Rh+ baby, within 72 h of delivery, to prevent hemolytic disease of newborn; autoimmune thrombocytopenia

TABLE 10-3 (Continued)

	MOST H OSPITAL PHARMACIES AND ARE USUALL	E SENT FOR TYPING. THE FOLLOWING PRODUCTS Y ORDERED AS A MEDICATION.
Factor VII (purified antihemophilic factor)	From pooled plasma, pure Factor VIII Increased hepatitis risk	Routine for hemophilia A (factor VII deficiency
Factor IX concentrate (prothrombin complex)	Increased hepa ^l itits risk Factors II, VII, IX, and X Equivalent to 2 units of plasma	Active bleeding in Christmas disease (Hemophilia B or factor IX deficiency)
Immune serum globulin	Precipitate from plasma "gamma globulin"	Immune globulin deficiency Disease prophylaxis (hepatitis A, measles, etc.)
5% Albumin or 5% plasma protein fraction	Precipitate from plasma (see Drugs, Chapter 22)	Plasma volume expanders in acute blood loss
25% Albumin	Precipitate from plasma	Hypoalbuminemia, volume expander, burns Draws extravascular fluid into circulation

RBC Transfusion Formula: As a guide, one unit of packed RBCs raises the HCT by 3% (Hgb 1 g/dL) in the average adult. To roughly determine the volume of whole blood or packed red cells needed to raise a hematocrit to a known amount, use the following formula:

$$Volume \ of \ cells \ = \ \frac{Total \ blood \ volume \ of \ patient \ \times \ (Desired \ HCT \ - \ Actual \ HCT)}{HCT \ of \ transfusion \ product}$$

where total blood volume is 70 mL/kg in adults, 80 mL/kg in children; the HCT of packed cells is approximately 70, and that of whole blood is approximately 40.

White Cell Transfusions

- The use of white cell transfusions is rarely indicated today due to the use of genetically engineered myeloid growth factors such as GM-CSF (see Chapter 22)
- Indicated for patients being treated for overwhelming sepsis and severe neutropenia (<500 PMN/µL)

Platelet Transfusions

For indications, see Table 10-3

Platelet Transfusion Formula: Platelets are often transfused at a dose of 1 unit/10 kg of body weight. After administration of 1 unit of multiple-donor platelets, the count should rise 5000–8000/mm³ within 1 h of transfusion and 4500 mm³ within 24 h. Normally, stored platelets that are transfused survive in vivo 6–8 d after infusion. Clinical factors (DIC, aloimmunization) can significantly shorten these intervals. To standardize the corrected platelet count to an individual patient, use the CCI. Measure the platelet count immediately before and 1 h after the platelet infusion. If the correction is less than expected, do a workup to determine the possible cause (antibodies, splenomegaly, etc). Many institutions are now using platelet pheresis units. One platelet pheresis unit has enough platelets to raise the count by 6000–8000/mm³. Using a single unit has the advantage of exposing the patient to only one donor versus possibly six to eight. This limits HLA exposures and reduces the risks of infection transmission

$$CCI = \frac{Posttransfusion\ platelet\ count\ -\ Pretransfusion\ count\ \times\ Body\ surface\ area\ (m^2)}{Platelets\ given\ \times\ 10^{11}}$$

BLOOD BANK PRODUCTS

Table 10-3 describes products used in blood component therapy and gives recommendations for use of these products.

TRANSFUSION PROCEDURES

- 1. Draw a clot tube (red top), and sign the lab slips to verify that the sample came from the correct patient. The patient should be identified by referring to the ID bracelet and asking the patient, if able, to state his or her name. Place the patient's name, hospital number, date, and your signature on the tube label. Prestamped labels are not accepted by most blood banks.
- Obtain the patient's informed consent by discussing the reasons for the transfusion and the potential risks and benefits from it. Follow hospital procedure regarding the need

- for the patient to sign a specific consent form. At most hospitals, chart documentation is usually all that is necessary.
- When the blood products become available, ensure good venous access for the transfusion (18-gauge needle or larger is preferred in an adult).
- 4. Verify the information on the request slip and blood bag with another person, such as a nurse, and with the patient's ID bracelet. Many hospitals have defined protocols for this procedure; check your institutional guidelines.
- 5. Mix blood products to be transfused with isotonic (0.9%) NS only. Using hypotonic products such as D₅W may result in hemolysis of the blood in the tubing. Lactated Ringer's should NOT be used because the calcium could chelate the anticoagulant citrate.
- 6. Red cells are infused through a special filter. Specific leukocyte reduction filters are available and may be used in very specific circumstances (febrile transfusion reactions, to reduce potential CMV transmission, to reduce risk of alloimmunization to WBC antigens).
- 7. When transfusing large volumes of packed red cells (>10 units), monitor coagulation, Mg²*, Ca²*, and lactate levels. It is usually necessary to also transfuse platelets and FFP. Also, a calcium replacement is sometimes needed because the preservative used in the blood is a calcium binder and hypocalcemia can result after large amounts of blood are transfused. Also, for massive transfusions (usually >50 mL/min in adults and 15 mL/min in children), the blood should be warmed to prevent hypothermia and cardiac arrhythmias.

TRANSFUSION REACTIONS

Several types of transfusion reactions are possible:

- Acute intravascular hemolysis. Over 85% of adverse hemolytic reactions involving
 the transfusion of RBCs result from clerical error.. Usually caused by ABO incompatible transfusion. Can result in renal failure (<1/250,000 units transfused).
- Nonhemolytic febrile reaction. Usually mild, fever, chills, rigors, mild dyspnea. Due
 to a reaction to donor white cells (HLA) and more common in patients who have had
 multiple transfusions or delivered several children. (≅2–3:100 units transfused)
- Mild allergic reaction. Urticaria or pruritus can be caused by sensitization to plasma proteins in transfusion product. (≡1/100 units transfused)
- Anaphylactic reaction. Acute hypotension, hives, abdominal pain and respiratory distress; seen mostly in IgA-deficient recipients. (<1/1000 units transfused)
- 5. Sepsis. Usually caused by transfusion of a bacterially infected transfusion product, with platelets becoming an increasing risk. E. coli, Pseudomonas, Serratia, Salmonella, and Yersinia some of the more commonly implicated bacteria. (<1/500,000 RBC units transfused, 1/12,000 platelet units transfused)</p>
- Acute lung injury. Fever, chills, and life-threatening respiratory failure; probably induced by antibodies from donor against recipient white cells. (<1/5000 units transfused)
- 7. Volume overload. Usually due to excess volume infusion; can exacerbate CHF.

Detection of a Transfusion Reaction

- 1. Spin an HCT to look for a pink plasma layer (indicates hemolysis).
- Order serum for free hemoglobin and serum haptoglobin assays (haptoglobin decreases with a reaction) and urine for hemosiderin levels. Obtain a stat CBC to determine the presence of schistocytes, which can be present with a reaction.

If you suspect acute hemolysis, request a DIC screen (PT, PTT, fibrinogen, and fibrin degradation products).

Treatment of Transfusion Reactions

- 1. Stop the blood product immediately, and notify the blood bank.
- Keep the IV line open with NS, and monitor the patient's vital signs and urine output carefully.
- Save the blood bag, and have the lab verify the type and cross-match. Verify that the proper patient received the proper transfusion. Redraw blood samples for the blood bank
- Make specific recommendations, using the following guidelines; modifications should be based on clinical judgment.
 - Nonhemolytic febrile reaction: Antipyretics can be used and the transfusion continued with monitoring. Use leukocyte-washed transfusion products in future.
 - Mild allergic reaction: Administer Benadryl (25–50 mg IM/PO/IV). Resume the transfusion carefully only if the patient improves promptly.
 - Anaphylactic reaction. Terminate transfusion, monitor closely, give antihistamines (Benadryl 25–50 mg IM/PO/IV), corticosteroids (Solu-Medrol 125 mg IV, 2 mg/kg Peds IV), epinephrine (1:1000 0.3–0.5 mL SQ adults, 0.1 mL/kg Peds), and pressors as needed. Premedicate (antihistamines, steroids) for future transfusions; use only leukocyte-washed red cells.
 - Acute lung injury. Give ventilatory support as needed; use only leukocyte-washed red cells for future transfusions.
 - Sepsis: Culture the transfusion product and specimens from the patient; treat sepsis
 empirically by monitoring and administering pressors and antibiotics (third/fourthgeneration cephalosporin or piperacillin/tazobactam along with an aminoglycoside)
 until cultures return.
 - Volume overload. Employ a slow rate of infusion with selective use of diuretics.
 - Acute intravascular hemolysis. Prevent acute renal failure. Place a Foley catheter, monitor the urine output closely, and maintain a brisk diuresis with plain D₅W, mannitol (1–2 g/kg IV), furosemide (20–40 mg IV), and/or dopamine (2–10 μg/kg/min IV) as needed. Consider alkalinization of the urine with bicarbonate (see Chapter 22). Beware of DIC. A renal and hematology consult are usually indicated with a severe hemolytic reaction. Support pressure as needed (fluids, vasopressors such as dopamine).

TRANSFUSION-ASSOCIATED INFECTIOUS DISEASE RISKS Hepatitis

Incidence of posttransfusion hepatitis for Hep B is 1:63,000 units transfused and for Hep C is 1:103,000 units transfused. Anicteric hepatitis is much more common than hepatitis with jaundice. Screening of donors for HB_sAg and hepatitis C has greatly reduced these forms of hepatitis. Historically, the greatest risk is with pooled factor products (concentrates of Factor VIII). Use of albumin and globulins involves no risk of hepatitis.

HIV

Incidence is <1:600,000 units transfused. Antibody testing is routinely performed on the donor's blood. A positive antibody test means that the donor may be infected with the HIV virus; a confirmatory Western blot is necessary. Do a follow-up test on any donor found to

be HIV-positive because false-positives can occur. With screening, AIDS transmission has decreased. Because there is a delay of 22 d between HIV exposure and the development of the HIV antibody, a potential risk of HIV transmission exists even with blood from a donor who is HIV-negative. Newer molecular detection methods should decrease this to approximately 11 d.

CMV

Incidence in donors is very high (approaches 100% in many series), but clinically represents a major risk mostly for immunocompromised recipients and neonates. Leukocyte filters can reduce the risk of transmission if procedures are strictly followed.

HTLV-I, II

Very rare (<<1/641,000 units transfused). Use of leukocyte filters can decrease risk of transmission of HTLV.

Bacteria and Parasites

Sepsis due to bacteria is discussed on page 414. Parasites are very rarely transmitted, but careful donor screening is necessary, especially in endemic regions (eg, Chagas' disease in Central America).

11

DIETS AND CLINICAL NUTRITION

Hospital Diets Nutritional Assessment Nutritional Requirements Determining the Route of Nutritional Support Principles of Enteral Tube Feeding Postoperative Nutritional Support Infant Formulas and Feeding

HOSPITAL DIETS

The most commonly ordered standard hospital diets and their indications are listed in Table 11–1, page 206. The vast majority of patients admitted to the hospital can be given one of these hospital diets without any specific supplementation or modification. Most hospitals have diet manuals available for reference, and registered dietitians are usually on staff for nutritional consultation. A physician order for diet instruction by a clinical dietitian is recommended for all patients being discharged with a therapeutic or modified diet.

NUTRITIONAL ASSESSMENT

Nutritional screening should be incorporated into the history and physical evaluation of all patients. Identifying patients at nutrition risk is crucial because malnutrition is prevalent among hospitalized patients and has been associated with adverse clinical outcomes. Situations that predispose a patient to malnutrition include recent and continuing nausea, vomiting, diarrhea, inability to feed oneself, inadequate food intake (cancer-related, others), decreased nutrient absorption or utilization, and increased nutrient losses and nutritional requirements. If needed, detailed nutritional assessment may be needed for some patients and is discussed in the following section.

Although many patients are admitted to the hospital in a nutritionally depleted state, some patients become malnourished during their hospital stay. According to guidelines from the American Society for Parenteral and Enteral Nutrition, "patients should be considered malnourished or at risk of developing malnutrition if they have inadequate nutrient intake for 7 days or more or if they have a weight loss of 10% or more of their preillness body weight."

Formal evaluation is often necessary to identify patients at nutritional risk and to provide a baseline to assess whether therapeutic goals are being achieved with specialized nutritional support. The patient's history is useful in evaluating weight loss; dietary intolerance, including that for glucose or lactose; and disease states that may influence nutritional tolerance. Anthropometric evaluations include comparisons of actual body weight to ideal and usual body weight. Other anthropometric measurements, such as MAMC and TCF, have much

TABLE 11–1 Hospital Diets

Diet	Guidelines	Indications
House/regular	Adequate in all essential nutrients All foods are permitted Can be modified according to patient's food preferences	No diet restrictions or modifications
Mechanical soft	Includes soft-textured or ground foods that are easily masticated and swallowed	Decreased ability to chew or swallow Presence of oral mucositis or esophagitis May be appropriate for some patients with dysphagia
Pureed	Includes liquids as well as strained and pureed foods	Inability to chew or swallow solid foods Presence of oral mucositis or esophagitis May be appropriate for some patients with dysphagia
Full liquid	Includes foods that are liquid at body temperature Includes milk/milk products Can provide approximately: 2500–3000 mL fluid 1500–2000 Cal	May be appropriate for patients with severely impaired chewing ability Not appropriate for a lactase-deficient patient unless commercially available lactase enzyme tablets are provided
	60–80 g high-quality protein <10 g dietary fiber 60–80 g fat per day	provided
Clear liquid	Includes foods that are liquid at body temperature Foods are very low in fiber	Ordered as initial diet in the transition from NPO to solids
	lactose-free virtually fat-free	Used for bowel preparation before certain medical or surgical procedures
	Can provide approximately: 2000 mL fluid 400–600 Cal	For management of acute medical conditions warranting minimized biliary contraction or pancreatic exocrine secretion

TABLE 11-1 (Continued)

Clear liquid (continued)	<7 g low-quality protein <1 g dietary fiber <1 g fat/day This diet is inadequate in al		
	not be used >3 d without		
Low-fiber	Foods that are low in indigesti Decreases stool volume, trai frequency		Management of acute radiation enteritis and inflammatory bowel disease when narrowing or stenosis of the gut lumen is present
Carbohydrate controlled diet (ADA)	Calorie level should be adequ achieve desirable body wei Total carbohydrates are limi total calories Ideally fat should be limited calories	ght ted to 50–60% of	Diabetes mellitus
Acute renal failure	Protein (g/kg DBW) Calories Sodium (g/day) Potassium (g/day) Fluid (mL/day)	0.6 35–50 1–3 Variable Urine output + 500	For patients in renal failure who are not undergoing dialysis
Renal failure/ Hemodialysis	Protein (g/kg DBW) Calories (per kilogram DBW) Sodium (g/d) Potassium (g/d) Fluid (mL/d)	1.0–1.2 30–35 1–2 1.5–3 Urine output + 500	For patients in renal failure on hemodialysis

TABLE 11-1 (Continued)

Diet	Guidelines		Indications
Peritoneal dialysis	Protein (g/kg DBW) Calories (per kilogram DBW) Sodium (g/d) Potassium (g/d) Fluid (mL/d)	1.2-1.6 25-35 3-4 3-4 Urine output + 500	For patients in renal failure on peritoneal dialysis
Liver failure	In the absence of encephalopathy do not restrict protein In the presence of encephalopathy initially restricted protein to 40–60 g/d then liberalize in increments of 10 g/d as tolerated Sodium and fluid restriction should be specified based on severity of ascites and edema		Management of chronic liver disorders
Lactose-free	Limits or restricts mild products Commercially available lact are available on the mark	tase enzyme tablets	Lactase deficiency
Low-fat	<50 g total fat per day		Pancreatitis Fat malabsorption
Fat/cholesterol restricted	Total fat >30% total calories Saturated fat limited to 10% of calories <300 mg cholesterol <50% calories from complex carbohydrates		Hypercholesterolemia
Low-sodium	Sodium allowance should be to maximize nutritional intal "No-added salt" is 4 g/d; no salted food; 2 g/d avoids p < 1 g/d is unpalatable and the	as liberal as possible ke yet control symptoms added salt or highly processed foods (ie, med	ats)

interobserver variability and are generally not useful unless performed by an experienced evaluator. Absolute lymphocyte count is sometimes used as a marker of visceral proteins and immunocompetence. Visceral protein markers, such as prealbumin and transferrin, may be helpful in evaluating nutritional insult as well as catabolic stress. Although the most commonly quoted laboratory parameter of nutritional status is albumin, the albumin concentration often reflects hydration status and metabolic response to injury (ie, the acute phase response) more than the nutritional state of the patient, especially in patients with intravascular volume deficits. Due to its long half-life, albumin may be normal in the malnourished patient. Prealbumin is superior as an indicator of malnutrition only because of its shorter half-life. Use of these serum proteins as indicators of malnutrition is subject to the same limitation, however, because they are all affected by catabolic stress. Table 11–2, page 210, lists the parameters for identifying potentially malnourished patients; however, no single criterion should be used to assess a patient's nutritional status. Patients can generally be classified as mildly, moderately, or severely nutritionally depleted based on these parameters.

NUTRITIONAL REQUIREMENTS

Determining the patient's nutritional requirements is one of the first steps in prescribing a modified diet order or supplementation for a patient. The following list provides guidelines for estimating nutritional needs. Monitoring the patient's progress and adjusting nutritional goals on the basis of clinical judgment is important for ensuring that the patient's specific needs are being met. Caloric needs can be determined by one of two means: the Harris-Benedict BEE and the "rule of thumb" method.

Caloric Needs

A patient's caloric needs can be calculated by the following methods:

Harris-Benedict BEE

For men:

BEE =
$$66.47 + 13.75 (w) + 5.00 (h) - 6.76 (a)$$

For women:

BEE =
$$655.10 + 9.56 (w) + 1.85 (h) - 4.689 (a)$$

where w = weight in kilograms; h = height in centimeters; and a = age in years.

After the BEE has been determined from the Harris-Benedict equation, the patient's total daily maintenance energy requirements are estimated by multiplying the BEE by an activity factor and a stress factor.

Total energy requirements = BEE × Activity factor × Stress factor

Use the following correction factors:

Activity Level	Correction Factor	
Bedridden	1.2	
Ambulatory	1.3	
Level of Physiologic Stress	Correction Factor	
Minor operation	1.2	
Skeletal trauma	1.35	
Major sepsis	1.60	
Severe burn	2.10	

TABLE 11–2 Parameters Used to Identify the Malnourished Patient

Parameters	Measurement/I	nterpretation	Usefulness/Limitations	
ANTHROPOMETRIC MEASUREMENT				
Actual body weight (ABW) compared with ideal body weight (IBW)	"Rule-of-thumb" m	ethod to determine IBW		
, , ,		Step 1		
		lb) = 106 lb for 5 ft of h	eight, plus	
		inch of height over 5 ft	- (() .)	
		V (lb) = 100 lb for first 5		
	plus an additional 5 lb for each inch over 5 ft			
		Step 2		
	% IBW = ABW			
	IBW			
	% of IBW			
	90-110	Normal nutritional sta	atus	
	80–90	Mild malnutrition		
	70–80	Moderate malnutritio	n	
	<70	Severe malnutrition		
Actual body weight compared with	% UBW = ABW >	× 100		
usual body weight (UBW)	UBW	(100		
3354. 254) Weigin (5211)	% of UBW			
	85–95%	Mild malnutrition		
	75-84%	Moderate malnutritio	n	
	<75%	Severe malnutrition		
			1	

TABLE 11-2 (Continued)

Parameters	Measurement/Interpretation		Usefulness/Limitations	
BIOCHEMICAL PARAMETERS				
Serum albumin	3.5–5.2 g/dL 2.8–3.4 g/dL 2.1–2.7 g/dL <2 g/dL	Normal Mild depletion Moderate depletion Severe depletion	Routinely available Valuable prognostic indicator: depressed levels predict increased mortality and morbidity Inexpensive Large body stores and relatively long half-life (approximately 20 d) limit usefulness in evaluating short-term changes in nutritional status	
Transferrin (TFN)		Normal Mild visceral depletion Moderate depletion Severe depletion ated from the total iron- (TIBC) as follows: BC) – 43	Frequently available Depressed levels predict increased mortality and morbidity Smaller body pool and shorter half-life (8–10 days) than serum albumin If TFN is calculated from TIBC, levels will be increased with the presence of iron defi- ciency or chronic blood loss Levels are increased during pregnancy Levels are decreased if iron stores are increased as a result of hemosiderosis, hemochromatosis, thalassemia	

TABLE 11-2 (Continued)

10–15 mg/dL Mild depletion of acute change in nutritional status than is 5–10 mg/dL Moderate depletion albumin or TFN <5 mg/dL Severe depletion Not routinely available Levels are quickly depleted after trauma or acute infection. Also decreased in resport to cirrhosis, hepatitis, and dialysis, and the fore, should be interpreted with caution	Parameters	Measurement,	/Interpretation	Usefulness/Limitations
Levels are quickly depleted after trauma or acute infection. Also decreased in responsion to cirrhosis, hepatitis, and dialysis, and the fore, should be interpreted with caution Absolute lymphocyte count (calculated as WBC × % 900–1400 Moderate depletion by some nutritionists	Prealbumin	10-15 mg/dL	Mild depletion	Half-life is 2 d. Thus is more sensitive indicator of acute change in nutritional status than is albumin or TFN
(calculated as WBC × % 900–1400 Moderate depletion by some nutritionists		<5 mg/dL	Severe depletion	Levels are quickly depleted after trauma or acute infection. Also decreased in response to cirrhosis, hepatitis, and dialysis, and there-
	(calculated as WBC × %	900–1400	Moderate depletion	May not be valid in cancer patients. Not used by some nutritionists

"Rule of Thumb" Method

- Maintenance of the patient's nutritional status without significant metabolic stress requires 25–30 Cal/kg body weight/d.
- Maintenance needs for the hypermetabolic, severely stressed patient or for supporting weight gain in the underweight patient without significant metabolic stress requires 35–40 Cal/kg body weight/d.
- Greater than 40 Cal/kg body weight/d may be needed to meet the needs of severely burned patients.

Protein Needs

Maintenance requirements for nonstressed patients are 0.8 g of protein per kilogram of body weight. Repletion requirements of the nutritionally compromised patient are 1.2–2.5 g of protein per kilogram of body weight.

DETERMINING THE ROUTE OF NUTRITIONAL SUPPORT

Once nutritional support is indicated, the route for administration is chosen. Enteral supplementation by mouth or tube and parenteral nutrition are the main routes for providing nutritional support.

Enteral Supplementation and Tube Feeding

Enteral nutrition encompasses both supplementation by mouth and feeding by tube into the GI tract. If the patient's oral intake is inadequate, every effort should be made to increase intake by providing nutrient-dense foods, frequent feedings, or oral supplements. If such attempts are unsuccessful, tube feeding may be indicated. In addition, patients who have a functioning GI tract but for whom oral nutrition intake is contraindicated should be considered for tube feedings.

If the GI tract is functioning and can be used safely, tube feedings should be ordered instead of parenteral nutrition when nutrition support is necessary because it

- · Is more easily absorbed physiologically
- · Is associated with fewer complications than TPN
- · Maintains the gut barrier to infection
- · Maintains the integrity of the GI tract
- · Is more cost-effective than TPN
- Contraindications to tube feeding can be found in Table 11–3.

Parenteral Nutrition

Parenteral nutrition usually offers no advantage to the patient with a functioning GI tract. Because it does not achieve greater anabolism nor provide greater control over a patient's nutritional regimen, parenteral nutrition is indicated only when the enteral route is not usable; therefore, the following rule applies: If the gut works, use it.

Some patients, because of their disease states, cannot be fed enterally and require parenteral feedings. Enteral nutrition is to be avoided in the situations noted in Table 11–3. TPN is typically used in these patients and is discussed in detail in Chapter 12.

Although parenteral nutrition can be given either via central veins (TPN) or by peripheral veins (PPN), the tonicity of the fluid required to administer all nutritional requirements

TABLE 11-3 Contraindications to Tube Feeding

Complete bowel obstruction

GI bleeding

High-output (>500 mL/d) enterocutaneous fistula or fistula not located in the proximal or distal GI tract

Hypovolemic or septic shock

Inability to obtain safe enteral tube feeding access

Poor prognosis not warranting invasive nutritional support

Severe acute pancreatitis

Severe intractable diarrhea Severe intractable nausea and vomiting

Severe malabsorption

Anticipated duration of tube feeding therapy <5 d

intravenously requires central administration, and thus PPN may be used as a supplement, but is not adequate to provide all nutritional requirements.

PRINCIPLES OF ENTERAL TUBE FEEDING

The factors involved in choosing the route for enteral nutrition include the projected duration of feeding by this method, GI tract pathophysiology, and the risk for aspiration. Nasally placed tubes are the most frequently used. Patient comfort is maximized by using a smallbore flexible tube. When enteral feedings are started, it is often important to assess gastric residual volumes. The small-bore tubes do not allow for aspiration of residual volumes, however, which may be significant if gastric emptying is questionable. Thus, larger bore tubes are often used to start, and, once feeding tolerance is ensured, the tube is changed to a small-bore tube, which can be left in place comfortably for prolonged periods. Feeding directly into the stomach (as opposed to the bowel) is often preferable because the stomach is the best line of defense against hyperosmolarity. Patients at risk for aspiration require longer tubes into the jejunum or duodenum. Types of feeding tubes and placement procedures are discussed in detail in Chapter 13, page 272.

When long-term feeding is anticipated, a tube enterostomy is usually required. PEG tubes can usually be placed without general anesthesia. Patients with tumors, GI obstruction, adhesions, or abnormal anatomy, however, may require open surgical placement. A jejunal feeding tube may be threaded through a PEG for small-bowel feeding. The placement of a needle catheter or Witzel's jejunostomy during surgery generally allows for earlier postoperative feeding with an elemental formulation than waiting for the return of gastric emptying and colonic function.

Enteral Products

A variety of enteral products and tube feedings are available (see Table 11-4, page 215, for some examples). Check the enteral formulary for the specific products available in your facility.

TABLE 11–4 Composition of Some Commonly Available Enteral Formulas

	Component (per 100 kcal)						
	kcal/	Protein	Fat	Carbohydrates	Na ⁺	K ⁺	mOsm/
Product	mL	(g)	(g)	(g)	(mEq)	(mEq)	kg
Meal replacements	Require no	rmal proteolytic o	and lipolytic	function. Contain lactos	e.		
Compleat B	1.00	4.00	4.00	12.0	5.20	3.40	390
Lactose-free	Provides pr	oximal absorptio	n. Requires	normal proteolytic and l	polytic function	on. Low residue	.
Ensure	1.06	3.70	3.70	14.5	3.60	4.0	450
Ensure Plus	1.50	5.50	5.30	19.7	4.90	5.90	600
Isocal	1.06	3.70	3.80	14.4	2.40	2.60	300
Magnacal	2.0	3.5	4.0	12.5	2.20	1.60	590
Osmolite	1.06	3.70	3.80	14.4	2.40	2.60	300
Sustacal	1.00	6.10	2.30	13.8	4.10	5.40	620-700
Travasorb MCT	1.00	4.90	3.30	12.2	1.50	4.50	312
Elemental formulas	Provide rapid proximal absorption. Indicated for pancreatic-biliary dysfunction, selective malabsorption, fist						
	las, and sh	ort bowel syndro	ome (SBS). Lo	ow residue. Nutrients pr	edigested.		
Peptamen	1.0	4.0	3.9	12.7	2.20	3.21	270
Reabilan	1.0	3.15	4.30	13.2	3.05	3.20	350
Reabilan HN	1.33	4.36	4.30	11.9	3.26	3.18	490
Vital HN	1.00	4.20	1.00	18.8	2.70	3.40	450
Vivonex TEN	1.00	3.82	0.28	20.5	2.00	2.00	630
Vivonex	1.00	2.04	0.15	22.6	2.00	3.00	550

TABLE 11-4 (Continued)

Product	Component (per 100 kcal)							
	kcal/ mL	Protein (g)	Fat (g)	Carbohydrates (g)	Na ⁺ (mEq)	K ⁺ (mEq)	mOsm/ kg	
Special metabolic	May require vitamin-mineral supplement if used as principal source of nutrition.							
Amin-Aid	2.00	1.90	4.70	37.3	>1	>1	850	
Glucerna	1.0	4.18	5.57	9.37	4.03	4.0	375	
Pulmocare	1.5	4.17	6.14	7.04	3.80	2.95	490	
Hepatic Aid II	1.1 <i>7</i>	4.30	3.60	16.8	>1	>1	560	
Travasorb Hepatic	1.10	2.90	1.40	20.9	1.9	2.9	690	
Travasorb Renal	1.35	2.30	1.80	27.1	>1	>1	590	
Fiber-containing		ly complete tube te intolerance to l		may help maintain norr eedings.	nal bowel fun	ction and usefu	l in patients w	
Enrich	1.1	3.62	3.39	14.3 (1.3 g fiber)	3.35	3.94	480	
Jevity	1.06	4.20	3.48	14.4 (1.36 g fiber)	3.81	3.77	310	

To simplify selection, the nutritional components and osmolality of the enteral product are listed and help classify the formulations. The protein component can be supplied as intact proteins, partially digested hydrolyzed proteins, or crystalline amino acids. Each gram of protein provides 4 Cal. The carbohydrate source may be intact complex starches, glucose polymers, or simpler disaccharides such as sucrose. Carbohydrates provide 4 Cal/g. Fat in enteral products is usually supplied as long-chain fatty acids. Some enteral products, however, contain MCTs, which are transported directly in the portal circulation rather than via chyle production. Because MCT oil does not contain essential fatty acids, it cannot be used as the sole fat source. Long-chain fatty acids provide 9 Cal/g, and MCT oil provides 8 Cal/g.

The osmolality of an enteral product is determined primarily by the concentration of carbohydrates, electrolytes, amino acids, or small peptides. The clinical importance of osmolality is often debated. Hyperosmolal formulations, with osmolalities exceeding 450 mOsm/L, may contribute to diarrhea by acting in a manner similar to osmotic cathartics. Hyperosmolal feedings are well tolerated when delivered into the stomach (as opposed to the small bowel) because gastric secretions dilute the feeding before it leaves the pylorus to traverse the small bowel. Thus, feedings administered directly to the small bowel (eg, via feeding jejunostomy) should not exceed 450 mOsm/L.

Oral supplements differ from other enteral feedings in that they are designed to be more palatable so as to improve compliance. Although most enteral products do not contain lactose (Ensure, Osmolite, others), several oral supplements, commonly referred to as "meal replacements" (such as Compleat B) contain lactose and are therefore not appropriate for patients with lactase deficiency and are not normally used for tube feedings.

Based on osmolality and macronutrient content, enteral products can be classified into several categories. Low-osmolality formulas are isotonic and contain intact macronutrients. They usually provide 1 Cal/mL and require approximately 2 L to provide the RDA for vitamins. These products are appropriate for the general patient population and include products such as Ensure.

High-density formulas may provide up to 2 Cal/mL. These concentrated solutions are hyperosmolar and also contain intact nutrients. The RDA for vitamins can be met with volumes of 1500 mL or less. These products are used for volume-restricted patients. Examples are Nutren 2.0 and Ensure Plus HN.

Chemically defined or elemental formulas provide the macronutrients in the predigested state. These formulations are usually hyperosmolar and have poor palatability. Patients with compromised nutrient absorption abilities or GI function may benefit from elemental type feedings. Vivonex and Peptamen are two such products.

Disease-specific (special metabolic) enteral formulas have been developed for various disease states. Products for pulmonary patients, such as Pulmocare, contain a higher percentage of calories from fat to decrease the carbon dioxide load from the metabolism of excess glucose. Patients with hepatic insufficiency may benefit from formulations (eg, Hepatic-Aid II) containing a higher concentration of the branched-chain amino acids and a lower concentration of aromatic amino acids in an attempt to correct their altered serum amino acid profile. Formulas containing only essential amino acids have been marketed for the patient in renal failure (Amin-Aid). A low-carbohydrate, high-fat product for persons with diabetes (Glucerna) is available that also contains fiber to help regulate glucose control. Other fiber-containing enteral feedings are available to help regulate bowel function (Enrich, Jevity). The clinical utility of many of the specialty products remains controversial.

Initiating Tube Feedings

Guidelines for ordering enteral feedings are outlined in Table 11–5, page 218. In summary, when using enteral feedings:

TABLE 11–5 Routine Orders for Enteral Nutrition Administered by Tube Feeding

- 1. Confirm tube placement. (Usually by x-ray)
- 2. Elevate head of bed to 30-45 degrees
- Check gastric residuals in patients receiving gastric feedings. Hold feedings if >1.5-2x infusion rate. Significant residuals should be reinstilled and rechecked in 1 h. If continues to be elevated, hold tube feeding and begin NG suction.
- 4. Check patient weight 3x/wk.
- Record strict I&O
- 6. Request routine laboratory studies
- 1. Determine nutritional needs.
- 2. Assess GI tract function and appropriateness of enteral feedings.
- Determine fluid requirements and volume tolerance based on overall status and concurrent disease states.
- 4. Select an appropriate enteral feeding product and method of administration.
- 5. Verify that the regimen selected satisfies micronutrient requirements.
- Monitor and assess nutritional status to evaluate the need for changes in the selected regimen.

The tube feeding can be given into the stomach (bolus, intermittent gravity drip, or continuous) or into the small intestine by continuous infusion (Table 11–6, page 219). Enteral nutrition is best tolerated when instilled into the stomach because this method produces fewer problems with osmolarity or feeding volumes. The stomach serves as a barrier to hyperosmolarity, thus the use of isotonic feedings is mandated only when instilling nutrients directly into the small intestine. The use of gastric feedings is thus preferable and should be used whenever appropriate. Patients at risk for aspiration or with impaired gastric emptying may need to be fed past the pylorus into the jejunum or the duodenum. Feedings via a jejunostomy placed at the time of surgery can often be initiated on the first postoperative day, obviating the need for parenteral nutrition.

Although enteral nutrition is generally safer than parenteral nutrition, aspiration can be a significant morbid event in the care of these patients. Appropriate monitoring for residual volumes in addition to keeping the head of the bed elevated can help prevent this complication. A "significant residual" may be defined as 1½ times the instillation rate. This can be treated in a number of ways. Any transient postoperative ileus can best be treated by waiting for the ileus to resolve. Metoclopramide or erythromycin may be useful pharmacologic therapy for postop ileus (Chapter 22). Patients who have been tolerating feedings and develop intolerance should be carefully assessed for the cause. Feeding intolerance is characterized by vomiting, abdominal distention, diarrhea, or high gastric residual volumes.

Complications of Enteral Nutrition

Diarrhea: Diarrhea occurs in about 10–60% of patients receiving enteral feedings. The physician must be certain to evaluate the patient for other causes of diarrhea. Formula-related causes include contamination, excessively cold temperature, lactose intolerance, osmolality, and an incorrect method or route of delivery. Eliminate potential causes before using antidiarrheal medications.

TABLE 11-6 Tube Feeding Delivery Methods

Delivery Site/ Indication	Delivery Method	Notes	Suggested Feeding Progression
INTRAGASTRIC Appropriate for alert patients with intact gag and cough reflexes and for those with normal gastric emptying	Bolus	Rapid infusion of formula into the stomach by syringe or other feeding reservoir; generally 240–480 mL of formula is given every 3–6 h Feedings are usually given over a period of 5–15 min Associated symptoms of GI distress, such as bloating, nausea, and distention	Typical starter regimen: 60–120 mL of full- strength formula is generally provided Typical feeding progression: Volume of for- mula provided at each feeding may be increased in 60–120 mL increments every 12 h or as tolerated
INTRAGASTRIC	Intermittent gravity drip	Generally 240–480 mL of formula is allowed to drip from a feeding container through tubing over a 30–60 min period four to eight times per day Rate of formula administration is controlled with a clamp in the tubing May reduce the incidence of GI complications associated with bolus delivery Highly viscous formulas, such as those that contain 2 Cal/mL, may not flow through the tubing	Typical starter regimen: 60–120 mL of full- strength formula is generally provided Typical feeding progression: Volume of formula provided at each feeding may be increased to 60–120 mL increments every 12 h or as tolerated

TABLE 11-6 (Continued)

Delivery Site/ Indication	Delivery Method	Notes	Suggested Feeding Progression
INTRAGASTRIC	Continuous	More expensive than bolus method because feeding containers are necessary Not recommended for critically ill patients Preferred method to administer formula if gastric feeding is necessary for a critically ill patient because it reduces risk of aspiration Use of a feeding pump to deliver precise volumes of formula at a constant rate Goal feeding rates are typically between 80 and 125 mL/h, depending on the individual's nutritional requirements Volume- and rate-controlled delivery minimizes gastric emptying and reduces the incidence of osmotic diarrhea secondary to dumping syndrome	Typical starter regimen: Full-strength formula is generally initiated at a rate of 40 or 50 mL/h Typical feeding progression: Feeding rate is generally increased in increments of 10–15 mL/h every 12 h or as tolerated until the goal feeding rate is achieved

TABLE 11-6 (Continued)

Delivery Site/ Indication	Delivery Method	Notes	Suggested Feeding Progression
INTRAINTESTINAL Appropriate for patients who are at high risk for aspiration, including those who cannot keep the proper position during feeding (head of bed 30 degrees upright)	Continuous	In the hospital setting, the formula is usually provided over a 24-h period; home patients may cycle feedings over an 8–14-h period May be necessary to deliver formulas with high viscosity Necessity of feeding pump in addition to feeding bag and tubing increases cost Restricts ambulation in patients who are not critically ill Feeding pump required because excessively rapid formula delivery, as would occur with bolus or gravity drip administration, would probably result in dumping syndrome, allows tube feeding formula to be delivered in a more physiologic manner	Typical starter regimen: Full-strength formula is generally initiated at a rate of 40–50 mL/h; markedly hypertonic formulas (>600 mOsm/L) occasionally may be diluted to half-strength if dumpin syndrome is present or if a prolonged period without enteral nutrition has elapsed Typical feeding progression: Feeding rate is generally increased in increments of

222

TABLE 11-6 (Continued)

Delivery Site/ Indication	Delivery Method	Notes	Suggested Feeding Progression
and those without an intact gag reflex Required feeding route when proximal (ie, oral, esophageal, or gastric) GI obstruction or impairment is present Preferred delivery site for critically ill patients		80–125 mL/h, depending on the patient's nutritional needs Usually 24-h infusions are given in the hospital, but cyclic infusions are an option for the ambulatory or home patient Associated with high cost because of necessity of feeding containers and infusion pump Continuous infusions may restrict patient ambulation	10–12 mL/h every 12 h or as tolerated until the goal feeding rate is achieved; if hypertonic formula was initially diluted, the patient can be switched to full-strength formula after the goal feeding rate is achieved

- Check medication profile for possible drug-induced cause.
- Rule out Clostridium difficile colitis in patients receiving antibiotics (see Chapter 7).
- Attempt to decrease the feeding rate or try an alternative regimen such as bolus feeding.
- Change the formulation, for example, limit lactose or reduce the osmolality.
- Use pharmacologic therapy only after eliminating treatable causes (eg, give Lactobacillus powder [one packet tid to replenish gut flora]; most effective in patients on antibiotics) or antidiarrheal medications (loperamide [Lomotil], calcium carbonate).

Constipation: Although less common than diarrhea, constipation can occur in the enterally fed patient. Check to ensure that adequate fluid volume is being given. Patients with additional requirements may benefit from water boluses or dilution of the enteral formulation. Fiber can be added to help regulate bowel function.

Aspiration: Aspiration is a serious complication of enteral feedings and is more likely to occur in the patient with diminished mental status. The best approach is prevention. Elevate the head of the bed and carefully monitor residual fluid volume. Further evaluate any patient who may have aspirated or who is assessed as being at increased risk for aspiration prior to instituting enteral feedings. Such patients may not be candidates for gastric feedings, and small-bowel feedings may be necessary.

Drug Interactions: The vitamin K content of various enteral products varies from 22 to 156 mg/1000 Cal. This can significantly affect the anticoagulation profile of a patient receiving warfarin therapy. Tetracycline products should not be administered 1 h before or 2 h after enteral feedings to avoid the inhibition of absorption. Similarly, enteral feedings should be stopped 2 h before and after the administration of phenytoin.

POSTOPERATIVE NUTRITIONAL SUPPORT

Most patients can be started on oral feedings postoperatively, the question is when to begin them. Begin feedings once the bowel recovers motility. Motility is delayed in patients undergoing laparotomy, whereas feedings begin fairly quickly for patients who undergo surgery on other parts of the body, once they recover consciousness sufficiently to protect their airway. Remember that the gut recovers motility as follows: The small intestine never loses motility (peristalsis is observed in the OR), the stomach regains motility about 24 h postoperatively, and the colon is the last to recover at 72–96 h postoperatively. Thus, by the time a patient reports flatus, one can assume that the entire gut has regained motility. Feedings then begin, depending on the exact operation performed and the resulting gastrointestinal anatomy. Patients who are to begin oral feedings are usually started on clear liquids (see Table 11–1). As long as the patient is willing to eat regular food, there is no reason not to progress to a regular diet rapidly (after one meal of clear liquids), and there is **no need** to step through a progression from clear liquids to full liquids to a regular diet.

INFANT FORMULAS AND FEEDING

Bottle feeding is often chosen by the mother and, in general, commercially available formulas are recommended over homemade formulas because of their ease of preparation and their standardization of nutrients. Occasionally, special formulas are medically indicated and can only be supplied by commercially available formulas. Commonly used formulas are outlined in Table 11–7.

TABLE 11–7 Commonly Used Infant Formulas

Formula Indications*

Human milk

Donor Maternal

Breast milk fortifiers

Standard formulas

Isoosmolar

Enfamil 20 Similac 20 SMA 20 Higher Osmolality

Similac 24 & 27 SMA[†] 24 & 27

Low Osmolality Similac 13

Soy formulas

ProSobee (lactoseand sucrose-free) Isomil (lactose-free) Nursoy (lactose-free) Preterm infant <1200 g All infants

Full-term infants: as supplement to breast milk Preterm infants > 1800-2000 a

Term infants: for infants on fluid restriction or who cannot handle required volumes of 20-Cal formula to grow

Preterm and term infants: for conservative initial feeding in infants who have not been fed orally for several days or weeks. Not for long-term use.

Term infants: milk sensitivity, galactosemia, carbohydrate intolerance. Do not use in preterm infants. Phytates can bind calcium and cause rickets

Protein hydrosylate formulas

Nutramigen

Term infants: Gut sensitivity to proteins, multiple food allergies, persistent diarrhea, galactosemia.

ioseilia.

Pregestimil Preterm and term infants: disaccharidase defi-

ciency, diarrhea, GI defects, cystic fibrosis, food allergy, celiac disease, transition from TPN to oral feeding

ordi leedilig

Alimentum

Term infants: protein sensitivity, pancreatic insufficiency, diarrhea, allergies, colic, carbohydrate and fat malabsorption

Special formulas

Portagen

Preterm and term infants: pancreatic or bile acid insufficiency, intestinal resection

Similac PM 60/40

Preterm and term infants: problem feeders on standard formula; infants with renal, cardiovascular, digestive diseases that require decreased protein and mineral levels, breastfeeding supplement, initial feeding

TABLE 11-7 (Continued)

Formula Indications*

Premature formulas

Low osmolality Similac Special

Care 20 Enfamil Premature 20 Preemie SMA 20 Premature infants (<1800–2000 g) who are growing rapidly. These formulas promote growth at intrauterine rates. Vitamin and mineral concentrations are higher to meet the needs of growth. Usually started on 20 Cal/oz and advanced to 24 Cal/oz as tolerated.

Isoosmolar

Similac Special Care 24 Enfamil Special Care 24

Preemie SMA 24

Same as for low-osmolality premature formulas

Principles of Infant Feeding

Criteria for Initiating Infant Feeding: Most normal full-term infants are fed within the first 4 h after birth. The following criteria should usually be met before initiating infant feedings.

- The infant should have no history of excessive oral secretions, vomiting, or bilestained gastric aspirate.
- An examination should have been performed with particular attention to the abdomen. The examination should be normal with normal bowel sounds and a nondistended, soft abdomen.
- · The infant should be clinically stable.
- At least 6 h should pass before recently extubated infants are fed. The infant should be tolerating extubation well and have little respiratory distress.
- The respiratory rate should be <60 breaths/min for oral feeding and <80 breaths/min for gavage (tube) feeding. Tachypnea increases the risk of aspiration.

Prematurity: Considerable controversy remains concerning the timing of initial enteral feeding for the preterm infant. For the stable larger (>1500 g) premature infant, the first feeding may be given within the first 24 h of life. Early feeding may allow the release of enteric hormones that exert a trophic effect on the intestinal tract. On the other hand, appre-

^{*}Multivitamin supplementation such as Polyvisol (Mead Johnson) ½ mL/d may be needed for commercial formulas if baby is taking <2 oz/d.

[†]SMA has decreased sodium content and can be used in patients with congestive heart failure, bronchopulmonary dysplasia, and cardiac disease. Modified and produced with permission from Gomella, TL (ed) Neonatology, 4th ed. Norwalk, CT, Appleton & Lange, 1999

hension about necrotizing enterocolitis (mostly in very low birth weight infants) in the following circumstances often precludes the initiation of enteral feeding: perinatal asphyxia, mechanical ventilation, presence of umbilical vessel catheters, patent ductus arteriosus, indomethacin treatment, sepsis, and frequent episodes of apnea and bradycardia.

No established policies are available, and delay and duration of delay in establishing feeding with those conditions varies for every institution. In general, enteral feeding is started in the first 3 d of life, with the objective of reaching full enteral feeding by 2–3 wk of life. Parenteral nutrition including amino acids and lipids should be started at the same time to provide for adequate caloric intake.

Choice of Formula: (See Table 11–7, page 224.) Human breast milk is recommended for feeding infants whenever possible. Breast-feeding has many advantages: It is ideal for virtually all infants, produces fewer infantile allergies, is immunoprotective to the infant due to the presence of immunoglobulins, is convenient and economical, and offers several theoretical psychologic benefits to both the mother and child. Occasionally, an infant cannot be breast-fed due to extreme prematurity or other problems such as a cleft palate.

If commercial infant formula is chosen, no special considerations are needed for normal full-term newborns. Selection of the best formula for preterm infants may require more care. The majority of infant formulas are isoosmolar (Similac 20, Enfamil 20, and SMA 20 with and without iron). These formulas are used most often for healthy infants. Formulas for premature infants, containing 24 Cal/oz (Similac 24, Enfamil 24, "preemie" SMA 24), are also isoosmolar and are indicated for rapidly growing premature infants. Many other "specialty" formulas are available for such conditions as milk and protein sensitivity, among others. Many pediatricians recommend vitamin supplements with some formulas if the infant is taking <32 oz/day. An iron-containing formula is generally recommended.

Feeding Guidelines

- Initial feeding. For the initial feeding for all infants, use sterile water or 5% dextrose in water (D₅W) if the infant is not being breast-fed. Ten % dextrose in water (D₁₀W) should not be used because it is a hypertonic solution.
- 2. Subsequent feedings. There is controversy over whether infant formulas should be diluted for the next several feedings if the infant tolerates the initial one. Some clinicians advocate diluting formulas with sterile water and advance as tolerated (eg, ¼ strength, increase to ½ and then ¾ strength). Others feel this is unnecessary and that full-strength formula can be used if infants tolerate the initial feeding without difficulty. Breast milk is never diluted.

Oral Rehydration Solutions: Infants with mild or moderate dehydration, often due to diarrhea or vomiting, may benefit from oral rehydration formulas. These solutions typically include glucose, sodium, potassium, and bicarbonate or citrate. Common formulations include Pedialyte, Lytren, Infalyte, Resol and Hydrolyte.

TOTAL PARENTERAL NUTRITION

Common Indications Nutritional Principles Nitrogen Balance TPN Solutions Peripheral Parenteral Nutrition TPN Additives Fat Emulsions
Starting TPN
Assessing TPN Therapy
Stopping TPN
Disease-Specific TPN Formulations
Common TPN Complications

COMMON INDICATIONS

Total parenteral nutrition, also called "hyperalimentation," is the provision of all essential nutrients—protein, carbohydrates, lipids, vitamins, electrolytes, and trace elements—by the intravenous route. Nutrients may be supplied by either a peripheral or central vein. To provide a patient's entire nutritional requirement by vein, however, a central venous line must be used because of the tonicity of the fluid required. Peripheral veins simply cannot tolerate these hypertonic fluids, and thus peripheral IV alimentation can be used only as a supplement. Parenteral nutrition bypasses the GI tract and should be reserved for patients who are unable to receive nutritional support enterally. The principle of "if the gut works use it" is sound practice. How to determine the route of nutritional support is discussed on page 213. The following indications are appropriate for TPN initiation:

- Preoperatively, in the malnourished patient. There is no benefit for patients who are not malnourished.
- Postoperatively, for patients with a slow return of GI function or in patients with complications that limit or prohibit the use of the GI tract. The interval between surgery and initiation of nutritional support to prevent complications is not definitively known. However, many practitioners wait 7–10 d after surgery, anticipating the return of bowel function. If this does not occur, nutritional support is begun.
- Patients with Crohn's disease, ulcerative colitis, pancreatitis, fistulas, and shortbowel syndrome.
- Patients who are malnourished secondary to a disease or injury that results in inadequate oral intake. This may include patients with organ failure, severe metabolic stress, malignancies, burns, or trauma.

NUTRITIONAL PRINCIPLES

Nutritional assessment to determine the need for TPN requires a history (which includes weight changes over the previous 6 mo), physical, and laboratory evaluation. Indicators of long-term nutritional depletion include serum albumin and prealbumin levels,

anthropometrics, and total lymphocyte count. Nutritional assessment is presented in detail in Chapter 11, page 206.

To establish the appropriate caloric amount for TPN therapy, estimate the patient's daily nonprotein calories and nitrogen requirements. The best method for calculating the BEE requirements for nonprotein calories is the Harris–Benedict equation (Chapter 11, page 209). The weight used in this equation determines the amount of calories needed to maintain that weight; therefore, if the patient is morbidly obese, the ideal weight should be established as a goal.

Calculation of Caloric Requirements in Stressed Patients

The BEE obtained from the Harris–Benedict equation reflects the number of calories from carbohydrate and fat that should be provided to maintain the patient's weight under nonstressed conditions. Stress, in nutritional terms, is correlated with the amount of cate-cholamines and cortisol released endogenously. These biochemical mediators promote protein breakdown, which is necessary to provide glucose for the brain and red blood cells.

- Mild stress: Supply total calories at approximately 1.2–1.4 × BEE.
- Moderate stress: 1.5–1.75 × BEE.
- Severe stress: 1.75–2.0 × BEE.
- Ideally, 25–35 Cal/kg/d should be the dosing range. Bear in mind the patient's safety
 may be of concern should these values exceed a daily intake greater than 3000 Cal.
 In the event this occurs, dose conservatively until nitrogen balance data confirms the
 need for more aggressive caloric replacement.

Nutritional Component Considerations

The fundamental principle of TPN is the administration of sufficient protein to avoid catabolism of endogenous protein (muscle). Carbohydrates must be given to supply necessary calories (at a ratio of 150 Cal/g of nitrogen) to support these anabolic processes. Fat is given as a source of essential fatty acids. The basis for using TPN explains the necessity for protein, carbohydrate, and fat administration. In addition, TPN includes all necessary fluids, electrolytes, vitamins, and trace elements required to support life.

Studies have shown that doses between 4–7 mg/kg/min of carbohydrate (generally, do not exceed 5 mg/kg/min) provide optimal protein sparing with minimal liver toxicity. Assessment of the carbohydrate intake is important in order to limit complications from TPN.

Lipid calories should not exceed 3 g/kg/d due to increased complications. Additionally, no more than 50% of total daily calories should be administered as fat.

The best method for establishing a protein need for a given patient is the 24-h urine sample testing for **UUN levels**. This value reflects the amount of protein catabolism occurring daily. Urinary losses of 8–12 g/d are consistent with a mild stress condition, 14–18 g/d moderate stress, and greater than 20 g/d with severe stress.

Protein dosing should be modified based on the 24-h UUN and daily nitrogen balance. Initially, however, if the patient is considered mildly stressed, 0.8–1.2 g/kg/d is appropriate. In cases of moderate and severe stress (burned and head injured patients) 1.3–1.75 g/kg/d and 2–2.5 g/kg/d may be required, respectively. (Note: Generally, do not exceed 2.0 g/kg/d.) Several studies suggest that doses of protein in this range exceed the patients utilization capacity and may increase BUN. Adequate renal function must be present to provide such high protein loads. Patients with renal failure who are not receiving dialysis may be dosed at the minimum daily allowance, 0.6 g/kg/d, until a decision for dialysis is made. Once the patient is receiving dialysis, normal dosing may be instituted.

NITROGEN BALANCE

The best method for determining the adequacy of nutritional support is the calculation of nitrogen balance. A **positive nitrogen balance** implies that the amount of protein being administered is sufficient to cover the losses of endogenous protein that occur secondary to catabolism. This is the best therapeutic goal for TPN because it is impossible to determine whether the prescribed protein is preventing muscle breakdown or not. Once positive nitrogen balance has been achieved, however, protein replacement has been optimized. In critical care patients, nitrogen losses may be very high, and an attempt should be made to at least achieve nitrogen equilibrium. This may be impossible in the acute phase of injury, in severe trauma, or in burn cases. Thus, minimizing protein loss (–2 to –4 g/d) may be the goal during this period.

A **negative nitrogen balance** is indicative of insufficient protein replacement for the degree of skeletal muscle loss. Under most circumstances, an attempt to achieve positive nitrogen balance should be made. Patients with renal dysfunction or those who are severely stressed may not be able to achieve a positive balance due to safety concerns. The efficacy of protein doses exceeding 2.5 g/kg/d has not been established. Investigational agents (growth hormone, IGF-1) and specialized formulas (branched-chain amino acids, essential amino acids, glutamine) are being studied in these populations to assess their potential in improving nitrogen retention under these circumstances. The following are key concepts in determining nitrogen balance:

- Nitrogen balance = Nitrogen input Nitrogen output.
- 1 g of nitrogen = 6.25 g of protein.
- Nitrogen input = (Protein in grams/6.25 g nitrogen).
- Nitrogen output = 24-h UUN + 4 g/d (nonurine loss).
- The conditions and disease states that increase the amount of nonurine losses for nitrogen include high-output fistulas and massive diarrhea. Fecal nitrogen measurements can be obtained but are difficult for nursing staff to perform.

Sample Determination of Nitrogen Balance

A patient is receiving 2 L TPN/24 h with 27.5 g crystalline amino acid (protein) solution per liter.

- 1. $27.5 \text{ g protein/L} \times 2 \text{ L} = 55 \text{ g protein/24 h}.$
- 2. Recall that 1 g of nitrogen = 6.25 g of protein.
- 3. Nitrogen input = 55 g protein/6.25 g protein per gram N = 8.8 g.
- Patient voided 22.5 dL urine/ 24 h with UUN 66 mg/dL.
- 5. Nitrogen lost in urine = $22.5 \text{ dL} \times 66 \text{ mg/dL} = 1485 \text{ mg}$, or about 1.5 g.
- Add 4.0 g for nonurine nitrogen loss.
- 7. Nitrogen output = 1.5 g + 4.0 = 5.5 g.
- 8. Nitrogen balance = Input output = 8.8 5.5 = +3.3 g nitrogen.

TPN SOLUTIONS

Different strength CAA solutions are available (Table 12–1) to which the pharmacy can add varying concentrations of dextrose, electrolytes, vitamins, and trace elements. Most hospitals supply a "house," or standard, formula for patients with normal renal and hepatic function. Changes in the standard formulas can be made when necessary while a TPN solution is being infused based on measured laboratory parameters. Administration of TPN is never an emergency and in most cases can be provided within 24 h of prescribing. If a formula change is necessary based on a change in patient status, discontinue the TPN and replace it with $D_{10}W$ at the same rate until a new bag of TPN can be provided.

TABLE 12–1
Typical TPN Solutions for Adults

Component	Solution 1	Solution 2
:AA	4.25% (42.5 g/l)	4.25% (42.5 g/L)
Dextrose	25% (250 g/L,	12.5% (125 g/L,
	850 Cal/L)	425 Cal/L)
Na	50 mEq/L	50 mEq/L
K	50 mEq/L	50 mEq/L
Ca	6 mEq/L	6 mEq/L
Mg	6 mEq/L	6 mEq/L
PO₄	15 mMol/L	15 mMol/L
Cl	45 mEq/L	45 mEq/L

Amino acid formulas are supplied as CAA or SAA in concentrations ranging from 3.5–15%. These are diluted by the pharmacy to varying concentrations to provide for the necessary protein dose (2.75%, 4.25%, etc). The final concentrations of dextrose vary, but are usually either 12.5% or 25%. Examples of typical TPN solutions for adults are provided in Table 12–1.

The maximum rate of infusion of solution 1 from Table 12–1 should be 100-125 mL/h to avoid excessive glucose administration (remember to consider the patient's weight and the dosing guidelines of 4–7 mg/kg/min). Fat emulsions should be given with solution 1 to provide essential fatty acids (10%, 500 mL $3\times$ /wk) or as an additional calorie source. Solution 2 is designed to be given at a maximum rate of 125 mL/h, but this only provides 1275 Cal from dextrose and must be supplemented with a fat emulsion (10% 500 mL = 550 Cal, 20% 500 mL = 1000 Cal).

Many hospitals have adopted a "three-in-one" solution for the standard house formula. This involves the administration of protein, carbohydrate, and fat from the same TPN bag over a 24-h period; in other words, the fat is not administered peripherally through a separate site. Caution should be used when altering the standard formula in this situation because the fat emulsion may be less stable to additives and makes incompatibilities less visible. For example, the solution will be milky in color, and a calcium-phosphate problem, normally easily seen, would not be apparent. Additions to these formulations should be done in conjunction with a pharmacist to ensure that precautions are taken for appropriate additive concentrations.

Remember, the solutions described in Table 12–1 contain full concentrations of electrolytes and are for patients with normal renal function. For patients with renal impairment, the concentrations of potassium, magnesium, phosphorus, and protein should be reduced (see page 235).

PERIPHERAL PARENTERAL NUTRITION

If a deep line is contraindicated or impossible, a peripheral TPN solution (<7% dextrose with 2.75% SAA, electrolytes, and vitamins) can be given. The majority of nonprotein calories must be given as an IV fat emulsion. In this case, caloric goals will not be met. A posi-

tive nitrogen balance will not be achieved in most patients receiving parenteral nutrition by this route. This is usually used only as a supplement to enteric feedings.

TPN ADDITIVES

Vitamins are a necessary component to TPN solutions. A product conforming to recommendations of the American Medical Association Nutrition Advisory Group is usually used, such as multivitamin infusion-12 (MVI-12). The contents of 2 vials is added to 1 L of TPN solution daily (Table 12–2).

In addition to MVI-12, 5–10 mg of vitamin K (phytonadione) must be given IM weekly. Vitamin K may also be added to the TPN and given as a 1-mg IV dose daily.

Several manufacturers sell a trace element supplement that conforms to the AMA group's guidelines. Each milliliter contains 1.0 mg zinc, 0.4 mg copper, 4.0 mg chromium, and 0.1 mg manganese. Suggested doses for trace elements are listed in Table 12–3, page 232.

Trace element deficiencies are rare in hospitalized patients receiving short-term TPN supplements. Supplementation should be routine, however, to ensure trace element availability for cell restoration. In patients receiving long-term support or home TPN, additional trace element supplementation may be necessary.

Iron can be given as an injectable iron-dextran complex (Dexferrum, InFeD). Note, however, that owing to the inconvenience of its administration, many clinicians avoid injectable iron-dextran. A complete medical and hematologic work-up is often indicated before instituting parenteral iron replacement. Prior to receiving the first dose, a test IV dose of 0.5 mL is recommended. Anaphylaxis is rare, but a period of 1h should elapse before the therapeutic dose of iron is administered. Use the following equation to determine the dose of iron:

Total replacement dose (mL) = $0.0476 \times \text{Weight (kg)} \times [\text{Desired hemoglobin (g/dL)} - \text{Measured hemoglobin (g/dL)}] + 1 \text{ mL/5 kg weight (max 14 mL)}$

Maximum Daily Dose: Adults >50 kg: 100 mg iron; Peds <5 kg: 25 mg iron, 5–10 kg: 50 mg iron, 0–50 kg: 100 mg iron

The iron-dextran is supplied in an injectable form of 50 mg (Fe)/mL. The calculated dose should be added to TPN at 2 mL/L until the entire dose has been given.

TABLE 12–2
Typical Vitamins Provided in 1 L of TPN by Adding 2 Vials of Standard MVI–12

Ascorbic acid	100 mg	Pyridoxine (B ₆) 4 mg
Vitamin A	3300 IŪ	Dexpanthenol 15 mg
Vitamin D	200 IU	Vitamin E (α tocopherol) 10 IU
Biotin	60 µg	Thiamine (B ₁) 3 mg
Folic acid	400 µg	Riboflavin (B ₂) 3.6 mg
Vitamin B ₁₂	5 μg	Niacin 40 mg

Abbreviation: MVI-12 = multivitamin infusion-12.

TABLE 12–3
Suggested Trace Element Dosing

Trace Element	Parenteral Dose per Day	
Zinc	2.5-4.0 mg*	
Copper	0.5–1.5 mg	
Selenium	20-40mg	
Chromium	10-15mg	
Manganese	0.15-0.8 mg	

Insulin, when required, can be given subcutaneously as regular insulin using a sliding scale, as shown in Table 12–4. But the preferred method is to add the insulin directly to the TPN solution. This allows a constant infusion of insulin along with the infusion of dextrose, which avoids the peaks and valleys in blood glucose that occur when the sliding scale is used. The usual starting dose per liter of TPN is 10 units of regular insulin. Doses from 10 to 90 units/L may often be required. Insulin drips are not advised because TPN can be temporarily or permanently discontinued, which would then stop the insulin. Other additives include H₂ antagonists and heparin.

FAT EMULSIONS

Lipid emulsions were initially used only to provide essential fatty acids (linoleic acid, and linolenic acid in children). This could be done with minimal supplementation; as little as 4% of total calories per day would prevent the syndrome of EFAD. Most clinicians prescribe 500 mL of 10% lipid emulsion three times weekly to prevent this syndrome. The signs and symptoms of this deficiency include scaling skin rash, alopecia, and wound healing failure.

TABLE 12–4 Sliding Scale for Insulin Orders

Urine Glucose*	Regular Insulin Dose (Units, given SQ)	
0–1+	0	
2+	5	
3+	10	
4+	15	
Any acetone: call house officer		

Linoleic acid is a precursor to arachidonic acid, which is essential for prostaglandin and leukotriene synthesis. Once data became available establishing the problems associated with overfeeding of carbohydrate calories, the use of lipid for caloric supplementation became more recognized.

Commercially available intravenous fat emulsions are derived from soybean oil, with one product (**Liposyn II**) combining both soybean and safflower oil. The 10% products provide 1.1 Cal/mL, and the 20% products provide 2.0 Cal/mL. Pediatricians often prefer the Liposyn II product because of its higher percentage of linolenic acid.

Because the particle size of these emulsions closely approximates naturally occurring chylomicrons, parenteral infusion is possible. In addition, the emulsions are cleared from the bloodstream in a manner and rate similar to that for chylomicrons.

Before beginning the IV fat emulsion, the serum triglyceride level should be checked to ensure that hypertriglyceridemia is not present. Provided that the serum triglyceride level is below 400 mg/dL, the fat emulsion can be given over a 6–12-h period. The longer infusion rate is preferred. The first bottle should be given slowly (1 mL/min for 15 min to check for hypersensitivity reaction). Adverse reactions can include dyspnea, fever, chills, chest tightness, wheezing, headaches, and nausea.

Currently, the only absolute contraindication to the use of IV fat emulsion is type IV hypertriglyceridemia, although isolated cases of nontype IV intolerance to the solution have been reported. To monitor for the clearing of the fat from the bloodstream, a trough serum triglyceride level should be tested 8–12 h following the daily infusion of the fat emulsion. Because fat emulsions are primarily composed of triglycerides (essentially cholesterol free), if the blood is mistakenly drawn while the fat is being infused or shortly thereafter, the serum triglyceride level will be markedly elevated. Other possible contraindications include lipoid nephrosis, severe hepatic failure, and allergy to eggs (egg phosphatides are used as the emulsifying agent).

Fat emulsions can be administered through peripheral veins, although the vein may be damaged and cease to be functional in 2–3 days. For this reason, it is usually recommended that the fat emulsion be infused into the central line under strict aseptic technique via a sterile Y-connector. As mentioned earlier, some institutions combine the lipid with the TPN formula in one bag for 24-h administration. This limits the clinicians ability to validate fat clearance from the blood and makes baseline triglyceride data extremely important.

STARTING TPN

In general, TPN should not be started until a patient has a stable fluid and electrolyte profile. It is usually unwise to begin TPN in a patient who requires large amounts of fluid, may need resuscitation for trauma, or is septic. Once a patient's fluid and electrolyte requirements are reasonably stable, TPN can be started safely. The initiation of TPN is never an emergency.

Placement of a deep line must be done aseptically, as outlined in Chapter 13, page 253. Infection (bacteremia, fungemia) arising from the catheter or the catheter–skin interface is the most common complication of TPN. Many hospitals now have standardized order forms for starting patients on TPN.

1. Baseline laboratory tests:

- a. CBC with differential and platelets
- b. PT and PTT
- SMA-7 and SMA-12; in particular check phosphate, glucose, and routine electrolytes (Na, K, Cl)
- d. Urinalysis
- e. Baseline weight

2. Order the type of TPN desired along with the additives and supplements. Medications are generally not added to TPN solutions except insulin and H₂ receptor blockers. A 0.22-μm filter should be used with aqueous TPN (no fat). A 1.2-μm filter should be used with three-in-one TPN.

3. Nursing orders:

- a. Check urine for sugar and acetone every 6-8 h, house officer should be called if sugar is >2+ or acetone is present.
- b. Take vital signs every shift.
- c. Change tubing and deep-line dress every other day (or per hospital procedure).
- d. Weigh patient every other day.
- e. Monitor daily fluid balance

4. Laboratory monitoring:

- a. SMA-7 daily until patient is stable, then every other day.
- b. CBC with differential, platelets, PT/PTT, twice weekly.
- c. SMA-12 twice weekly (especially liver function tests).
- d. Triglyceride trough level (obtained at least 6 h after infusion has stopped, preferably prior to hanging next bottle of fat) once or twice weekly.
- 24-h urine for nitrogen balance determinations and creatinine clearance once or twice weekly.
- 5. Begin the solution at 25–50 mL/h when using a 25% or 50–75 mL/h when using a 12.5% dextrose solution. Increase by 25 mL/h every 24 h, providing the urine sugar levels are negative. Advance to the maximum rate based on the calculated daily caloric need (page 209). Begin the IV fat emulsion the next day, provided that the serum triglyceride levels are less than 400 mg/dL. Remember that glucose intolerance is the major adverse effect seen during the initial infusion period. Urine sugar and acetone levels should be less than 2+, and serum glucose values less than 180–200 mg/dL. If the sugar level rises above these levels, insulin must be given to achieve the desired level of caloric intake. If glucose intolerance develops when using a 25% dextrose solution, consider decreasing the amount of calories from dextrose and increasing the calories from fat. (Be sure to check that overfeeding is not occurring, ie, >4–7 mg/kg/min, in this case reduce the dose of carbohydrate prior to the addition of insulin). Glucose intolerance arising once the patient has been stabilized may signify sepsis.

ASSESSING TPN THERAPY

Nitrogen balance is a good measure of the success of the TPN regimen because the goal is protein-sparing (see page 229). Serum albumin will not change appreciably during TPN therapy lasting less than 3 wk. This is due to albumin's long half-life of 22–24 d. In stressed patients, albumin often falls due to reduced production because the body shifts to increased production of acute-phase reactant proteins.

STOPPING TPN

TPN can usually be stopped when necessary. Although widely practiced, there is rarely a need for a formal weaning schedule. If there are concerns about hypoglycemia, then a 10% dextrose solution can be administered after cessation of the TPN.

DISEASE-SPECIFIC TPN FORMULATIONS

Cardiac Failure: In patients with CHF, reduce water from 1 to 0.5 mL/Cal or 500 mL insensible loss plus measured water losses. This limits overloading with water from TPN. Other considerations include providing energy needs at the BEE + 30% for initiation of TPN calories, limiting protein initially to 0.8–1 g/kg and reducing sodium to 0.5–1.5 g/d.

Diabetes: Consider increasing the percentage of calories provided from fat. Ideally, blood sugar should be well controlled or at least not >200 when initiating TPN. Remember that no more than 50% of total intake should be from fat and not more than 3 g/kg/d. Fat provides 9 Cal/g. Commercial lipid emulsions provide 1.1 or 2 Cal/mL. Insulin should be added to the solution initially at 5–10 units/bag in patients requiring >20 units of insulin daily.

Geriatrics: Patients older than 75 years have a documented need for fewer calories. Use caution in monitoring total fluids to prevent overload.

Inflammatory Bowel Disease: TPN can be initiated in these patients at approximately $1.5 \times \text{RME}$ at 30 Cal/kg of ideal body weight. Protein needs vary from 1 to 2 g/kg of ideal body weight daily. Dose the protein based on a 24-h UUN. *Note:* Patients with fistulas lose nitrogen via this route and need additional protein. Zinc losses may be greater in this group of IBD patients also.

Liver Disease: Specialized formulas of amino acids that contain primarily branchedchain amino acids (leucine, isoleucine, and valine) are available for use in cases of liver disease. Theoretically, these products may improve arousal from hepatic encephalopathy by
competing with the aromatic amino acids that are precursors for some centrally active
amines. There is no definitive evidence that branched-chain formulas improve patient outcome. The specialized formulas should only be used in cases of severe hepatic disease accompanied by encephalopathy. In other clinical conditions of liver disease, standard
formulas should be used. Lipid emulsions are not recommended in cases of severe hepatic
failure when hypertriglyceridemia is present.

Pancreatic Disease: Total energy needs may be high in this disease (35 Cal/kg). Protein should be initiated at 1.5 g/kg/d. Intravenous fat may be administered in these cases because it is metabolized by peripheral tissue lipases. A reasonable nonprotein system would be 70% carbohydrate and 30% fat.

Pulmonary Disease: Carbohydrate metabolism produces higher amounts of CO₂ than does fat metabolism. Consequently, the patient with CO₂ retention problems often is stressed if overfed with carbohydrates. Increasing the percentage of daily nonprotein calories provided by fat (not >60%) may decrease the CO₂ load and assist with ventilator weaning. Higher fat percentages influence oxygen diffusion capacity and are not beneficial, especially in cases of mild pulmonary compromise. Phosphate depletion is a second clinically relevant concern in this population due to the depression of the hypoxic ventilatory drive. Once patients are started on TPN, PO₄⁻² often decreases due to the incorporation into ATP. Adequate supplementation and monitoring is very important in this group of patients.

Renal Failure: Several considerations become important in this disease. If a patient is not receiving dialysis or is not a dialysis candidate, protein must be restricted to 0.6–0.8 g/kg/d, and total energy needs must be limited to approximately 30 Cal/kg/d. Weight should be ideal or admission weight, so as to control for the influence of water

retention. Specialized amino acid formulas have been developed for this group of patients. These products provide higher concentrations of essential amino acids than the standard amino acid products. Theoretically, the nitrogen waste products are recycled to make the nonessential amino acids, thereby reducing the BUN content. Risks exist, however, for elevations in ammonia when arginine is not also supplemented. Consequently, manufacturers have modified the original formulas to include several nonessential amino acids. Due to these changes, the renal products provide a very similar amino acid profile to those of the SAA solutions at very low concentrations (2.5%). The cost differential can be significant. It is therefore recommended that patients with renal dysfunction receive SAA formulas at a reduced concentration to provide the minimum daily allowance of protein. TPN should not be supplemented with potassium or magnesium, and sodium should be reduced to 40–180 mEg/d once the GFR is <10 mL/min.

Patients receiving hemodialysis or peritoneal dialysis may be fed protein similarly to patients without renal disease. Doses of 1–1.2 g/kg/d may be used. Nitrogen balance calculations are not useful in this population due to the problem of renal clearance of urea waste inherent to kidney disease.

Sepsis or Trauma: Sepsis and trauma causes hypermetabolism and requires greater numbers of calories from nonprotein (30–35 Cal/kg) and protein (2–2.5 g/kg/d) sources. Estimates of RME should be increased by 50% initially, and some cases may support up to 100%. Note that feeding >3000 Cal/d is not recommended. Specialized amino acid formulas are also available for this group of patients. Again, these formulas include higher concentrations of the branched-chain amino acids. The reason for their inclusion in this population is to provide substrate directly to the skeletal muscle undergoing catabolism to provide gluconeogenic precursors. Although these formulas have been shown to normalize the amino acid profile and in some cases improve nitrogen balance, no studies have demonstrated an improved patient outcome. The additional cost of these formulas is a deterrent to their routine use in these populations until further data are available. Additional zinc supplementation is often recommended in this group of patients. Studies have shown losses to be increased in stress; therefore, daily supplementation of up to 15 mg of zinc may be appropriate.

COMMON TPN COMPLICATIONS

Hyperosmolar Nonketotic Coma: Usually found in improperly monitored patients with impaired insulin responses. Caused by excessive glucose levels, usually corrected by administration of insulin and rehydration. Sustained hyperglycemia (>220 mg/dL) depresses monocyte activity and could compromise the immune defenses.

Infection (Sepsis): The care of the deep-line site and tubing must be meticulous. Suspect sepsis if a previously stable patient becomes glucose-intolerant. If the patient becomes septic, the deep line should be considered a possible source. If no other source of infection can be identified, the deep line must be removed or changed and the tip sent for routine culture and sensitivity. Candida albicans is the most frequently encountered pathogen on the catheter, followed by Staphylococcus aureus, Staphylococcus epidermidis and gramnegative rods.

Hypophosphatemia: Severe hypophosphatemia can occur in patients started on TPN after severe weight loss and those with conditions such as anorexia nervosa (refeeding syndrome). This may also result from increased metabolic processes requiring phosphate and can significantly hamper weaning from the ventilator.

Elevated Liver Function Tests: The usual cause is excessive glucose infusion. When the primary metabolic pathway for glucose becomes saturated, excess glucose is converted to intracellular triglycerides in the liver. This is especially seen when rates exceed 4–7 mg/kg/min. A reduction in carbohydrate calories, supplementing with fat, is recommended.

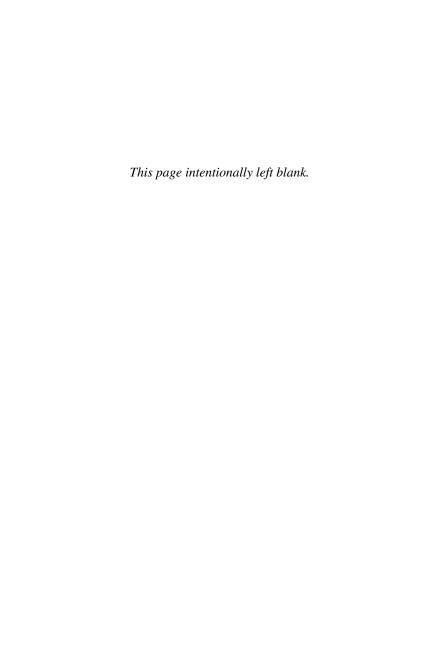
Cholestasis: This often occurs secondary to overfeeding of fat calories (>3 g/kg/d or >60% of total nonprotein calories).

Hyperkalemia: This is the most common electrolyte disturbance seen with TPN. Most TPN formulations contain potassium 40–50 mEq/L and are intended for patients with normal renal function. Excess potassium over and above that required for maintenance and urine losses (usually 3–5 mEq/g nitrogen) is included. Potassium must be closely followed in the elderly and those with impaired renal function. Additionally, many drugs contribute to potassium balance problems. These include some antibiotics that are potassium salts (eg, penicillins); oral phosphate supplements (Neutra-Phos); ACE inhibitors, which reduce potassium excretion (Captopril, Enalapril); and potassium-sparing diuretics (triamterene, spironolactone).

Metabolic Alkalosis: Modern SAAs are present as the acetate salt (80–100 mEq/L), which is converted to bicarbonate in vivo. In postoperative patients with nasogastric tubes, the loss of chloride, together with the high infusion of the acetate, can lead to a metabolic alkalosis. The increased use of histamine blockers and antacids in intensive care patients has also contributed to a higher incidence of this problem. Treating this condition requires increasing the chloride level in the solution and reducing the acetate.

Hyponatremia: Serum sodium levels of 127–135 mEq/L are commonly seen in patients on TPN. The cause is controversial but is probably due to mild SIADH; therefore the problem is probably an excess of water and not deficiency of sodium. It is usually asymptomatic and does not require a change in formula unless the sodium drops below 125 mEq/L.

Hypermagnesemia: This is usually seen in patients with renal failure. Antacid therapy may also contribute to this condition. If potassium is reduced in the TPN, magnesium should also be reduced.



BEDSIDE PROCEDURES

Procedure Basics Amniotic Fluid Fern Test Arterial Line Placement Arterial Puncture

Arthrocentesis (Diagnostic and Therapeutic)

Bone Marrow Aspiration and Biopsy Central Venous Catheterization

Chest Tube Placement

Cricothyrotomy (Needle and Surgical)

Culdocentesis
Doppler Pressures
Electrocardiogram
Endotracheal Intubation

Fever Work-up

Gastrointestinal Intubation

Heelstick

Internal Fetal Scalp Monitoring

Injection Techniques

Intrauterine Pressure Monitoring

IV Techniques

Lumbar Puncture

Orthostatic Blood Pressure

Measurement Pelvic Examination

Pericardiocentesis
Peripherally Inserted Central Catheter

(PICC Line)

Peritoneal Lavage

Peritoneal (Abdominal) Paracentesis Pulmonary Artery Catheterization Pulsus Paradoxus Measurement

Sigmoidoscopy (Rigid)

Skin Biopsy

Skin Testing Thoracentesis

Urinary Tract Procedures

Venipuncture

13

PROCEDURE BASICS

Universal Precautions

Universal precautions should be used whenever an invasive procedure exposes the operator to potentially infectious body fluids. Not all patients infected with transmissible pathogens can be identified at the time of hospital admission or even later in their course. Because pathogens transmitted by bloody and body fluids pose a hazard to personnel caring for such patients, particularly during invasive procedures, certain precautions are now *required* for *routine* care of all patients whether or not they have been placed on isolation precautions of any type. For these reasons, the CDC calls these Universal Precautions.

- 1. Wash hands before and after all patient contact.
- 2. Wash hands before and after all invasive procedures.
- Wear gloves in every instance in which contact with blood is certain or likely. For example, wear gloves for all venipunctures, for all IV starts, for IV manipulation, and for wound care.
- 4. Wear gloves once and discard. Do not wear the same pair to perform tasks on two different patients or two different tasks at different sites on the same patient.
- Wear gloves in every instance in which contact with any body fluid is likely, including urine, feces, wound secretions, respiratory tract care, thoracentesis, paracentesis, etc.

- 6. Wear gown when splatter of blood or of body fluids on clothing seems likely.
- 7. Additional barrier precautions may be necessary for certain invasive procedures when significant splatter or aerosol generation seems likely. This does not occur during most routine patient care activities. It may occur in certain instances in the operating room, emergency room, the ICUs, during invasive procedures, and during cardiopulmonary resuscitation. Always wear masks when goggles are worn and vice versa.

Informed Consent

Patients should be counseled before any procedure concerning the reason for it and the potential risks and benefits from it. Explaining the various steps often can make the patient more cooperative and the procedure easier on both parties. In general, procedures such as bladder catheterization, NG intubation, or venipuncture do not require a written informed consent beyond normal hospital sign in protocols. More invasive procedures, such as thoracentesis or lumbar puncture, for example, require written consent and must be obtained by a licensed physician.

Basic Equipment

Table 13–1 lists useful collections of instruments and supplies, often packaged together, that aid in the completion of the procedures outlined in this chapter. Local anesthesia is discussed in Chapter 17.

The size of various catheters, tubes and needles is often designated by **French unit** (1 french = 1/4 mm in diameter) or by "gauge." Reference listings for these designations can be found in Figure 13–1A. Designations of surgical scalpels, used in the performance of many basic bedside procedures and in the operating room are shown in Figure 13–1B.

TABLE 13–1 Instruments and Supplies Used in the Completion of Common Bedside Procedures

MINOR PROCEDURE TRAY

Sterile gloves

Sterlile towels/drapes

4×4 gauze sponges

Povidone-iodine (Betadine) prep solution

Syringes: 5-, 10-, 20-mL

Needles: 18-, 20-, 22-, 25-gauge

1% Lidocaine (with or without epinephrine)

Adhesive tape

INSTRUMENT TRAY

Scissors

Needle holder

Hemostat

Scalpel and blade (No. 10 for adult, No. 15 for children or delicate work) Suture of choice (2-0 or 3-0 silk or nylon on cutting needle; cutting needle best for suturing to skin)

French Catheter Scale in French units (1 French = 1/3 mm diameter)

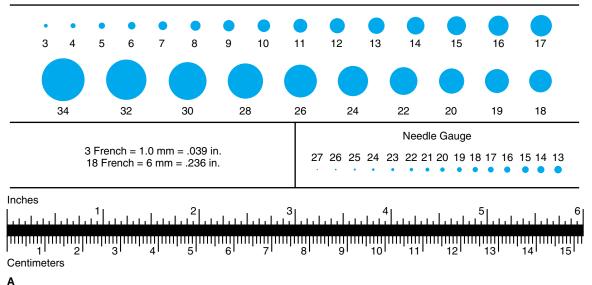


FIGURE 13-1A: French catheter guide and needle gauge reference. (Courtesy Cook Urological.)

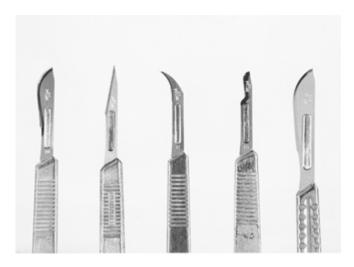


FIGURE 13–1B: Commonly used scalpel blades. From left to right: Number 10, 11, 12, 15, and 20. The No. 10 is the standard surgical blade; No. 11 is useful for press cuts into abscesses; No. 12 is used to open tubular structures; No. 15 is widely used for bedside procedures and for more delicate work; the No. 20 blade is used when large incisions are called for.

AMNIOTIC FLUID FERN TEST

Indication

· Assessment of rupture of membranes

Materials

- · Sterile speculum and swab
- · Glass slide and microscope
- Nitrazine paper (optional)

Procedure

- After placing a sterile speculum in the vagina, a sample of fluid which has "pooled" in the vault is swabbed onto a glass slide and allowed to air dry.
- 2. Amniotic fluid produces a microscopic arborization or "fern" pattern, which may be visualized with 10x magnification. False-positive results may occur if cervical mucus is collected; however, the ferning pattern of mucus is coarser. This test is unaffected by meconium, vaginal pH, and blood-to-amniotic-fluid ratios ≤ 1:10. Samples heavily contaminated with blood may not fern.

3. An additional test used to detect ruptured membranes entails the use of nitrazine paper, which has a pH turning point of 6.0. Normal vaginal pH in the pregnant woman ranges from 4.5 to 6.0; the pH of amniotic fluid is 7.0–7.5. A positive nitrazine test is manifested by a color change in the paper from yellow to blue. False-positive results are more common with the nitrazine paper test because blood, meconium, semen, alkalotic urine, cervical mucus, and vaginal infections can all raise the pH.

Complication

· Bacteria may be introduced if sterile technique is not used.

ARTERIAL LINE PLACEMENT

Indications

- Continuous blood pressure readings are needed (for patients on pressors, with unstable pressures, etc).
- · Frequent arterial blood gases are needed.

Contraindications

- Arterial insufficiency with poor collateral circulation (See Allen test, page 246)
- · Thrombolytic therapy or coagulopathy (relative)

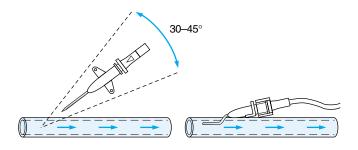
Materials

- Minor procedure and instrument tray (page 240)
- Heparin flush solution (1:1000 dilution)
- Arterial line set-up per local ICU routine (transducer, tubing and pressure bag with preheparinized saline, monitor)
- Arterial line catheter kit or 20-gauge catheter over needle, 1½-2 in. (Angiocath) with 0.025-in. guidewire (optional)

Procedure

(See Fig. 13-2)

- 1. The radial artery is most frequently used and that approach is described here. Other sites, in decreasing order of preference, are the ulnar, dorsalis pedis, femoral, brachial, and axillary arteries. Never puncture the radial and ulnar arteries in the same hand because this may compromise blood supply to the hand and fingers.
- 2. Verify the patency of the collateral circulation between the radial and ulnar arteries using the Allen test (page 246) or Doppler ultrasound probe. Have the ICU staff prepare the flush bag, tubing, and transducer, paying particular attention to removing the air bubbles.
- Place the extremity on an armboard with a roll of gauze behind the wrist to hyperextend the joint. Prep with povidone-iodine, and drape with sterile towels. Wear gloves and a mask.
- 4. Carefully palpate the artery, and choose the puncture site where it appears most superficial. Raise a very small skin wheal at the puncture site with 1% lidocaine using a 25-gauge needle.
- 5. a. Standard technique: See Figure 13–2. While palpating the path of the artery with the left hand, advance the 20-gauge (preferably 2 in. long) catheter-over-needle assembly into the artery at a 30-degree angle to the skin. Once a "flash" of blood is



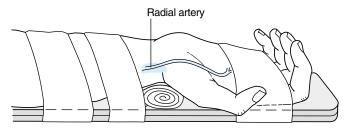


FIGURE 13-2 Technique for arterial line placement. (Reprinted, with permission, from: Gomella TL [ed]: *Neonatology: Basic Management, On-Call Problems, Diseases, Drugs, 4th ed. Appleton & Lange, Norwalk CT, 1998.)*

seen in the hub, advance the entire unit 1–2 mm, so that the needle and catheter are in the artery. If blood flow in the hub stops, carefully pull the entire unit back until flow is reestablished. Once the catheter is in the artery, hold the needle steady, and advance the catheter over the needle into the artery. The catheter should slide smoothly into the artery. Withdraw the needle completely and check for arterial blood flow from the catheter. A catheter that does not spurt blood is not in position. Briefly occlude the artery with manual pressure while the pressure tubing is being connected. *Note:* The pressure tubing system must be preflushed to clear all air bubbles prior to connection.

b. Alternative procedure ("through-and-through" technique): Use the same approach to the artery as in part a, however, purposely puncture the artery through the anterior and the posterior walls. This method is probably most useful in children and infants. Once a flash of blood is seen in the hub, advance the entire unit together until blood no longer fills the hub. (This can be done in a single motion.) S-I-o-w-I-y withdraw the entire unit until blood starts to fill the hub, then advance the catheter as the needle is withdrawn. Connect the tubing.

- c. Prepackaged kit technique: Kits, sometimes referred to as "quick catheters" are available with a needle and guidewire that allow the Seldinger technique to be used. Place the entry needle at a 30-degree angle to the skin site and insert until a flash of blood rises in the catheter. The catheter does not need to be advanced, but advance both the guidewire portion (orange handle in some kits) and the catheter into the vessel. Remove the wire and connect it to the pressure tubing.
- If placement is not successful, apply pressure to the site for 5 min and reattempt one or two more times. If still not successful, move to another site.
- Suture in place with 3-0 silk, and apply a sterile dressing. Splint the dorsum of the wrist to limit mobility and provide catheter stability.
- 8. If larger vessels such as the femoral artery are used, the clinician can employ the Seldinger technique for femoral artery cannulation: locate the vessel lumen with a small-gauge, thin-walled needle; pass a 0.035 floppy-tipped J("J" describes the configuration of the end of the floppy wire) guidewire into the lumen; and use the guidewire to pass a larger catheter into the vessel. Use a 16-gauge catheter assembly at least 6 in. long for the femoral artery.
- 9. Replace arterial lines using a different site every 4–7 d to decrease risk of infection.
- 10. Any amount of heparin can make the results of coagulation studies (PTT) inaccurate. If the blood is drawn from the arterial line and unexpectedly high results are obtained, always repeat the test and consider using standard venipuncture technique (see page 309). Despite the removal of the first 5–10 mL from the line, some of the heparinized flush solution can still get into the lab sample tube, yielding unreliable results.
- 11. Always compare the arterial line pressure with a standard cuff pressure. An occasional difference is normal (10–20 mm Hg) and should be incorporated when following the blood pressure.

Complications

Thrombosis, hematoma, arterial embolism, arterial spasm, arterial insufficiency with tissue loss, infection, hemorrhage, pseudo-aneurysm formation

ARTERIAL PUNCTURE

Indications

Blood gas determinations and when arterial blood is needed for chemistry determinations (eg, ammonia levels)

Materials

· Blood gas-sampling kit

or

- · 3-5-mL syringe
- 23-25-gauge for radial; 20-22 acceptable for femoral artery
- Heparin (1000 U/mL), 1 mL
- · Alcohol or povidone-iodine swabs
- · Cup of ice

Procedure

1. Use a "heparinized" syringe for blood gas and a "nonheparinized" syringe for chemistry determinations. If a blood gas kit is not available, a 3-5-mL syringe can be heparinized by drawing up 1 mL of 1:1000 solution of heparin through a small-gauge

- needle (23-25-gauge) into the syringe, pulling the plunger all the way back. The heparin is then expelled, leaving only a small amount, which coats the syringe.
- 2. In order of preference, the arteries are radial, femoral, and brachial. If using the radial artery, perform an Allen test prior to puncture of the artery to verify the patency of the ulnar artery. You do not want to damage the radial artery if there is no flow in the ulnar artery. To perform the Allen test, have the patient make a tight fist. Occlude both the radial and ulnar arteries at the wrist and have the patient open the hand. While maintaining pressure on the radial artery, release the ulnar artery. If the ulnar artery is patent, the hand should flush red within 6 s. A radial puncture can then be safely performed. If the color return is delayed on part of the hand or remains pale, do not perform the puncture because the collateral flow is inadequate. Choose an alternative site.
- 3. If using the femoral artery, use the mnemonic NAVEL to aid in locating the important structures in the groin. Palpate the femoral artery just below the inguinal ligament. From lateral to medial the structures are Nerve, Artery, Vein, Empty space, Lymphatic.
- 4. Palpate the chosen artery carefully. You may wish to inject Iidocaine subcutaneously for anesthesia (use a small needle such as a 25–27-gauge), but this often turns a "one-stick procedure" into a "two-stick" one. Palpate the artery proximally and distally with two fingers, or trap the artery between two fingers placed on either side of the vessel. Hyperextension of the joint often brings the radial and brachial arteries closer to the surface.
- 5. Prep the area with either a povidone-iodine solution or alcohol swab.
- 6. Hold the syringe like a pencil with the needle bevel up, and enter the skin at a 60–90-degree angle. Often you can feel the arterial pulsations as you approach the artery.
- 7. Maintaining a slight negative pressure on the syringe, obtain blood on the downstroke or on slow withdrawal (after both sides of the artery have been punctured). Aspirate very slowly. A good arterial sample, because of the pressure in the vessel, should require only minimal back pressure. If a glass syringe or special blood-gas syringe is used, the barrel usually fills spontaneously and it is not necessary to pull on the plunger.
- If the vessel is not encountered, withdraw the needle without coming out of the skin, and redirect it to the pulsation.
- 9. After obtaining the sample, withdraw the needle quickly and apply firm pressure at the site for at least 5 min or longer if the patient is receiving anticoagulants. Apply pressure even if a sample was not obtained in order to prevent a compartment syndrome from extravasated blood.
- 10. If the sample is for a blood-gas determination, expel any air from the syringe, mix the contents thoroughly by twirling the syringe between your fingers, remove and dispose of the needle, and make the syringe airtight with a cap. Place the syringe in an ice bath if more than a few minutes will elapse before the sample is processed. Note the inspired oxygen concentration and time of day on the lab slip.

ARTHROCENTESIS (DIAGNOSTIC AND THERAPEUTIC)

Indications

- Diagnostic. Arthrocentesis is helpful in the diagnosis of new-onset arthritis; to rule out infection in acute or chronic, unremitting joint effusion.
- Therapeutic. To instill steroids and maintain drainage of septic arthritis; relief of tense hemarthrosis or effusion

Contraindications

Cellulitis at injection site. Relative contraindication is a bleeding disorder; use caution if coagulopathy or thrombocytopenia is present or if the patient is receiving anticoagulants.

Materials

- Minor procedure tray (page 240) (18- or 20-gauge needle (smaller for finger or toe)
- · Ethyl chloride spray can be substituted for lidocaine.
- Two heparinized tubes for cell count and crystal examination
- Discuss with your microbiology lab their preference for transporting fluid for bacterial, fungal, AFB culture, and Gram's stain. A Thayer–Martin plate is needed if Neisseria gonorrhoeae (GC) is suspected.
- A small syringe containing a long-acting corticosteroid such as Depo-Medrol or triamcinolone is optional for therapeutic arthrocentesis.

Procedures, General

- 1. Obtain the patient's consent after describing the procedure and complications.
- Determine the optimal site for aspiration, identify landmarks, and mark site with indentation or sterile marking pen. Avoid injection of tendons.
- When aspiration is to be followed by corticosteroid injection, maintaining a sterile field with sterile implements minimizes the risk of infection.
- 4. Clean the area with povidone-iodine, dry and wipe over the aspiration site with alcohol. Povidone-iodine can render cultures negative. Let the alcohol dry before beginning procedure.
- 5. Anesthetize the area with lidocaine using a 25-gauge needle, taking care not to inject into the joint space. Lidocaine is bactericidal. Avoid preparations containing epinephrine, especially in a small digit. Alternatively, spray the area with ethyl chloride ("freeze spray") just prior to needle aspiration.
- 6. Insert the aspirating needle, applying a small amount of vacuum to the syringe. When the capsule is entered, fluid usually flows easily. Remove as much fluid as possible, repositioning the syringe if necessary.
- 7. If corticosteroid is to be injected, remove the aspirating syringe from the needle, which is still in the joint space. It is helpful to ensure that the syringe can easily be removed from the needle before step 6. Attach the syringe containing corticosteroid, pull back on the plunger to ensure you are not in a vein, and inject contents. Never inject steroids when there is any possibility of an infected joint. Remove the needle, and apply pressure to the area (leakage of subcutaneous steroids can lead to localized atrophy of the skin. Generally, the equivalent of 40 mg of methylprednisolone is injected into large joints such as the knee and 20 mg into medium-size joints such as the ankle or wrist. Warn the patient that a postinjection "flare" characterized by pain several hours after the injection can be treated with ice and NSAIDs.
- 8. Note the volume aspirated from the joint. As an example, the knee typically contains 3.5 mL of synovial fluid; in inflammatory, septic, or hemorrhagic arthritis, the volume can be much higher. A quick bedside test for viscosity is to allow a drop of fluid to fall from the tip of the needle. Normal synovial fluid is highly viscous and forms a several-inch long string; decreased viscosity is seen in infection. A mucin clot test (normally forms in < 1 min; a delayed result suggests inflammation) was once a standard test for RA, but is not now routinely performed.</p>
- 9. Joint fluid is usually sent for:
 - Cell count and differential (purple or green top tube)
 - Microscopic crystal exam using polarized light microscopy (purple or green top tube); normally no debris, crystals, or bacteria are seen; urate crystals are present with gout; calcium pyrophosphate in pseudo-gout.
 - Glucose (red top tube) See Table 13-2.

- Gram's stain, and cultures for bacteria, fungi, and AFB as indicated (check with your lab or deliver immediately in a sterile tube with no additives.)
- · Cytology if a malignant effusion is suspected clinically.

Arthrocentesis of the Knee

- Fully extended the knee with the patient supine. Wait until the patient has a relaxed quadriceps muscle because its contraction plants the patella against the femur, making aspiration painful.
- 2. Insert the needle posterior to the *medial* portion of the patella into the patellar-femoral groove. Direct the advancing needle slightly posteriorly and inferiorly (Fig. 13–3)

Arthrocentesis of the Wrist

 The easiest site for aspiration is between the navicular bone and radius on the dorsal wrist. Locate the distal radius between the tendons of the extensor pollicis longus and the extensor carpi radialis longus to the second finger. This site is just ulnar to the anatomic snuff box. Direct the needle perpendicular to the mark (Fig. 13–4).

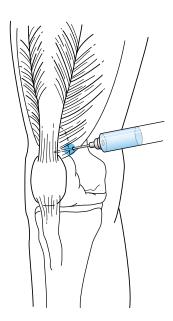


FIGURE 13-3 Arthrocentesis of the knee. (Reprinted, with permission, from: Haist SA et al [eds]: Internal Medicine on Call, 3rd ed. McGraw-Hill, New York, 2001.)

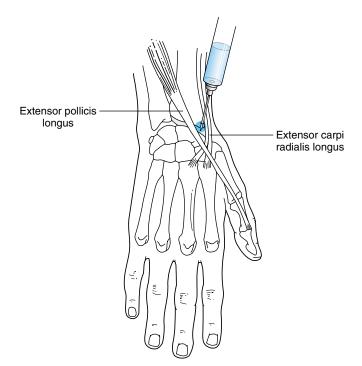


FIGURE 13-4 Arthrocentesis of the wrist. (Reprinted, with permission, from: Haist SA et al [eds]: Internal Medicine on Call, 3rd ed. McGraw-Hill, New York, 2001.)

Arthrocentesis of the Ankle

- The most accessible site is between the tibia and the talus. Position the angle of the foot
 to leg at 90 degrees. Make a mark lateral and anterior to the medial malleolus and medial and posterior to the tibialis anterior tendon. Direct the advancing needle posteriorly
 toward the heel.
- 2. The **subtalar ankle joint** does not communicate with the ankle joint and is difficult to aspirate even by an expert. Be aware that "ankle pain" may originate in the subtalar joint rather than in the ankle (Fig. 13–5).

Synovial Fluid Interpretation

Normal synovial fluid values and values in disease states are found in Table 13-2.

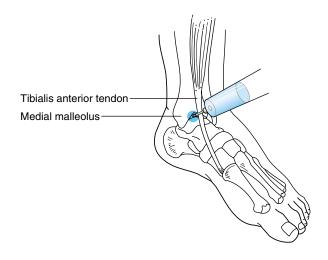


FIGURE 13-5 Arthrocentesis of the ankle. (Reprinted, with permission, from: Haist SA et al [eds]: Internal Medicine on Call, 3rd ed. McGraw-Hill, New York, 2001.)

Noninflammatory Arthritis: Osteoarthritis, traumatic, aseptic necrosis, osteochondritis desiccans

Inflammatory Arthritis: Gout (usually associated with elevated serum uric acid), pseudo-gout, RA, rheumatic fever, collagen–vascular disease

Septic Arthritis: Pyogenic bacterial (S. aureus GC and S. epidermidis most common). TB

Hemorrhagic: Hemophilia or other bleeding diathesis, trauma, with or without fracture

Complications

Infection, bleeding, pain. Postinjection flare of joint pain and swelling can occur after steroid injection and persist for up to 24 h. This complication is felt to be a crystal-induced synovitis due to the crystalline suspension used in long-acting steroids.

BONE MARROW ASPIRATION AND BIOPSY

Indications

- Evaluation of unexplained anemia, thrombocytopenia, leukopenia
- Evaluation of unexplained leukocytosis, thrombocytosis, search for malignancy primary to the marrow (leukemia, myeloma) or metastatic to the marrow (small-cell lung cancer, breast cancer)

74

TABLE 13-2 Synovial Fluid Analysis and Categories for Differential Diagnosis*

Parameter	Normal	Noninflammatory	Inflammatory	Septic	Hemorrhagic
Viscosity	High	High	Decreased	Decreased	Variable
Clarity '	Transparent	Transparent	Translucent-opaque	Opaque	Cloudy
Color	Clear	Yellow	Yellow to opalescent	Yellow to green	Pink to red
WBC (per μL)	<200	<3000	3000–50,000	>50,000 [†]	Usually <2000
Polymorphonuclear leukocytes (%)	<25%	<25%	50% or more	75% or more	30% ′
Culture ' ' '	Negative	Negative	Negative	Usually positive	Negative
Glucose (mg/dL)	Approx. serum	Approx. serum	>25, but <serum< td=""><td><25, ≪serum</td><td>>25</td></serum<>	<25, ≪serum	>25

^{*}See page 249 for additional information.

†May be lower if antibiotics initiated.

Abbreviation: WBC = white blood cells.

- Evaluation of iron stores; evaluation of possible disseminated infection (tuberculosis, fungal disease)
- · Bone marrow donor harvesting (aspiration)

Contraindications

- · Infection, osteomyelitis near the puncture site
- Relative contraindications include severe coagulopathy or thrombocytopenia (may be corrected by platelet transfusion); prior radiation to the region

Materials

Commercial kits are usually available that contain all the materials necessary. A technician from the hematology lab or BMT facility is necessary to ensure delivery and processing of specimens.

Procedure

- Explain the procedure to the patient and/or the legally responsible surrogate in detail, and obtain informed consent.
- Usually local anesthesia is all that is required; however, in extremely anxious patients, premedication with an anxiolytic or sedative such as diazepam (Valium) or midazolam (Versed) or an analgesic is reasonable.
- 3. Bone marrow can be obtained from numerous sites, the most common being the sternum, the anterior iliac crest, and the posterior iliac crest. The posterior iliac crest is the safest and usually the site of choice and is described here. Position the patient on either the abdomen or on the side opposite the side from which the biopsy specimen is to be taken.
- Identify the posterior iliac crest by palpation and mark the desired biopsy site with indelible ink.
- 5. Use sterile gloves and follow strict aseptic technique for the remainder of the procedure.
- 6. Prep the biopsy site with sterile povidone—iodine solution and allow the skin to dry. Then wipe the site free of the povidone—iodine with sterile alcohol. Use surgical drapes to cover the surrounding areas.
- 7. With a 26-gauge needle, administer 1% lidocaine solution intradermally to raise a skin wheal. Then, with the 22-gauge needle, infiltrate the subcutaneous and deeper tissues with lidocaine until the periosteum is reached. At this point, advance the needle just through the periosteum and infiltrate lidocaine subperiosteally. Infiltrate an area approximately 2 cm in diameter, using repeated periosteal punctures.
- Once you obtain local anesthesia, use a No. 11 scalpel blade to make 2–3-mm skin incision over the biopsy site.
- 9. Insert the bone marrow biopsy needle through the skin incision and then advance with a rotating motion and gentle pressure until the periosteum is reached. Once it is firmly seated on the periosteum, advance the needle through the outer table of bone into the marrow cavity with the same rotating motion and gentle pressure. Generally, a slight change in the resistance to needle advancement signals entry into the marrow cavity. At this point, advance the needle 2–3 mm.
- 10. Remove the stylet from the biopsy needle and attach a 10-mL syringe to the hub of the biopsy needle. Withdraw the plunger on the syringe briskly, and aspirate 1-2 mL of marrow into the syringe. This may cause severe, instantaneous pain, but slow withdrawal of the plunger or collection of more than 1-2 mL of marrow with each aspiration results in excessive contamination of the specimen with peripheral blood.

- 11. The marrow aspiration specimen can be used to prepare coverslips for viewing under the microscope or sent for special studies such as cytogenetics and cell markers or for culture. Repeat aspirations may be required to obtain enough marrow to perform all of the studies needed. Also note that certain studies may require heparin or EDTA for collection. Contact the appropriate lab prior to the procedure to ensure that specimens are collected in the appropriate solution.
- 12. If a biopsy is to be obtained, replace the stylet and withdraw the needle. Then reinsert the needle at a slightly different angle and location, still within the area of periosteum previously anesthetized. Once the marrow cavity has been reentered, again remove the stylet and advance the needle d 5–10 mm, using the same rotating motion with gentle pressure. Withdraw the needle several millimeters (but not outside of the marrow cavity) and redirect it at a slightly different angle and then advance again. Repeat this step several times. This should result in 2–3 cm of core material entering the needle. Rotate the needle rapidly on its long axis in a clockwise and then a counterclockwise manner. This severs the biopsy specimen from the marrow cavity. Withdraw the needle completely without replacing the stylet. Some operators prefer to hold their thumb over the open end of the needle to create a negative pressure in the needle as it is withdrawn. This may help prevent loss of the core biopsy specimen.
- 13. Remove the core biopsy by inserting a probe (provided with the biopsy needle) into the distal end of the needle and gently pushing the specimen the full length of the needle and out the hub end. This is important because attempting to push the specimen out the distal end may damage the specimen. Most biopsy needles are tapered at the distal end, presumably allowing the specimen to expand once in the needle and preventing it from being lost when the needle is withdrawn from the patient.
- 14. The core biopsy specimen is usually collected in formalin solution. Again, plans for special studies should be made prior to the procedure so that any special handling of the biopsy can be done.
- 15. Observe the biopsy site for excess bleeding and apply local pressure for several minutes. Clean the area thoroughly with alcohol and apply an adhesive bandage or gauze patch. Instruct the patient to assume a supine position and place a pressure pack between the bed or table and the biopsy site to apply pressure for 10–15 min. This is not an absolute requirement in patients without an underlying coagulopathy or thrombocytopenia, but still serves to decrease local hematoma formation. Patients with an underlying bleeding tendency should maintain pressure for 20–25 min. A patient who is stable at this point may resume normal activities.

Complications

Local bleeding and hematoma, retroperitoneal hematoma, pain, bone fracture, infection

CENTRAL VENOUS CATHETERIZATION

Indications

- Administration of fluids and medications, especially when no peripheral access is available
- Administration of hyperalimentation solutions or other hypertonic fluids (eg, amphotericin B) that damage peripheral veins
- Measurement of CVP (See Chapter 20, page 397)
- · Acute dialysis or plasmapheresis (Shiley catheter)
- Insertion of a pulmonary artery catheter or transvenous pacemaker

Contraindications

 Coagulopathy dictates the use of the femoral or median basilic vein approach to avoid bleeding complications.

Background

A central venous catheter (also known as a "deep line") is a catheter introduced into the superior vena cava, inferior vena cava, or one of their main branches. Generally, two techniques are used to place central venous lines. One of these (Seldinger technique) involves puncturing the vein with a relatively small needle through which a thin guidewire is placed in the vein. After the needle has been withdrawn, the intravascular appliance or a sheath through which a smaller catheter will be placed is introduced into the vein over the guidewire. The other technique involves puncturing the vein with a larger bore needle through which the intravascular catheter will fit. The ensuing discussion focuses on the Seldinger technique and placement of either a triple-lumen catheter or a sheath through which a smaller catheter (eg, a pulmonary artery catheter) will eventually be placed. The internal jugular and subclavian approaches are commonly used, but the femoral approach, although infrequently utilized, offers several advantages (see following discussion). Another technique, the PICC line is designed for more long-term outpatient administration of medications and is described on page 292.

Materials

Commercially available disposable trays provide all the necessary needles, wires, sheaths, dilators, suture materials, and anesthetics. If needles, guidewires, and sheaths are collected from different places, it is very important to make sure that the needle will accept the guidewire, that the sheath and dilator will pass over the guidewire, and that the appliance to be passed through the sheath will indeed fit the inside lumen of the sheath. Supplies should include the following items:

- Minor procedure and instrument tray (page 240); 1% lidocaine (mixed 1:1 with sodium bicarbonate 1 mEq/L removes the sting)
- Guidewire (usually 0.035 floppy-tipped J wire)
- · Vessel dilator
- Intravascular appliance (triple-lumen catheter or a sheath through which a pulmonary artery catheter could be placed)
- Heparinized flush solution 1 mL of 1:100 U heparin in 10 mL of NS (to be used to fill all lumens prior to placement to prevent clotting of the catheter during placement)
- Mask, sterile gown, highly recommended

Subclavian Approach (Left or Right)

The left subclavian approach affords a gentle, sweeping curve to the apex of the right ventricle and is the preferred entry site for placement of a temporary transvenous pacemaker without fluoroscopic assistance. Hemodynamic measurements are often easier to record from the left subclavian approach. From the left subclavian vein approach, the catheters do not have to negotiate an acute angle, as is commonly the case at the junction of the right subclavian with the right brachiocephalic vein en route to the superior vena cava. This is also a common site for kinking of the deep line. It also has the lowest risk of infection of various cen-

tral line sites. However, remember that the thoracic duct is on the left side, and the dome of the pleura rises higher on the left.

- Use sterile technique (povidone-iodine prep, gloves, mask, and a sterile field) whenever possible.
- 2. Place the patient flat or head down in the Trendelenburg position with the head in the center or turned to the opposite side (the "ideal" position is somewhat controversial, and left up to operator preference). It may be helpful to place a towel roll along the patient's spine.
- 3. Use a 25-gauge needle to make a small skin wheal 2 cm below the midclavicle with 1% lidocaine (mixed 1:1 with sodium bicarbonate 1 mEq/L to help remove the sting). At this point, a larger needle (eg, 22-gauge) can be used to anesthetize the deeper tissues as well as locate the vein.
- 4. Attach a large-bore, deep-line needle (a 14-gauge needle with a 16-gauge catheter at least 8–12 in. long) to a 10–20-mL syringe and introduce it into the site of the skin wheal.
- 5. Advance the needle under the clavicle, aiming for a location halfway between the suprasternal notch and the base of the thyroid cartilage. The vein is encountered under the clavicle, just medial to the lateral border of the clavicular head of the sternocleidomastoid muscle. In most patients this is roughly two finger-breadths lateral to the sternal notch. Apply gentle pressure on the needle at the skin entrance site to assist in lowering the needle under the clavicle (Fig. 13–7).
- Apply back pressure as the needle is advanced deep to the clavicle, but above the first rib. and watch for a "flash" of blood.
- 7. Free return of blood indicates entry into the subclavian vein. Remember that occasionally the vein is punctured through both walls, and a flash of blood may not appear as the needle is advanced. Therefore, if a free return of blood does not occur on needle advancement, withdraw the needle slowly with intermittent pressure. A free return of blood heralds the entry of the end of the needle into the lumen. Bright red blood that forcibly enters the syringe indicates that the subclavian artery has been entered. If the arterial entry occurs, remove the needle. In the majority of patients, the surrounding tissue will tamponade any bleeding from the arterial puncture. Because the artery is under the clavicle, holding pressure has little effect on bleeding.
- 8. a. If you are using an Intracath, remove the syringe, place a finger over the needle hub, and advance the catheter an appropriate distance through the needle. Then withdraw the needle to just outside the skin and snap the protective cap over the tip of the needle.
 - b. If you are using the Seldinger wire technique, advance the wire through the needle and then withdraw the needle. The pulse or ECG should be monitored during wire passage because the wire can induce ventricular arrhythmias. Arrhythmias usually resolve by calmly pulling the wire out several centimeters. Nick the skin with a No. 11 blade, and advance the dilator approximately 5 cm; remove the dilator and advance catheter in over the guidewire (use the brown port on the triple-lumen catheter). While advancing either the dilator or the catheter over the wire, periodically ensure that the wire moves freely in and out. When placing a Cordis, advance the catheter and dilator over the guidewire as one unit (see Chapter 20 Pulmonary Artery Catheter Insertion, page 402, for more details). If the wire does not move freely, it usually is kinked, and the catheter or dilator should be removed and repositioned. Maintain a firm grip on the guidewire at all times. Remove the wire and attach the IV tubing. Note that the wire used to insert a single-lumen catheter is

shorter than the wire supplied with the triple-lumen catheter. This is most critical when exchanging a triple-lumen for a single-lumen catheter; use the longer triple-lumen wire and insert the wire into the brown port. Place Shiley catheters using the Seldinger wire technique.

- 9. Attach the catheter to the appropriate IV solution, and place the IV bottle below the level of the deep-line site to ensure a good backflow of blood into the tubing. If no backflow occurs, the catheter may be kinked or not in the proper position.
- 10. Securely suture the assembly in place with 2-0 or 3-0 silk. Apply an occlusive dressing with povidone–iodine ointment.
- 11. Obtain a chest x-ray film immediately to verify placement of the catheter tip and to rule out pneumothorax. Ideally, the catheter tip lies in the superior vena cava at its junction with the right atrium, at about the fifth thoracic vertebra. Malpositioned catheters that go into the neck veins may be used only for saline infusion and not for monitoring or TPN infusion.
- 12. Catheters that cannot be manipulated at the bedside into the chest can usually be positioned properly in the interventional radiology suite with the aid of fluoroscopy.

Right Internal Jugular Vein Approach

Three different sites are described and used in accessing the right internal jugular vein: anterior (medial to the sternocleidomastoid muscle belly), middle (between the two heads of the sternocleidomastoid muscle belly), and posterior (lateral to the sternocleidomastoid muscle belly). The middle approach is most commonly used and has the advantage of using well-defined landmarks. The major disadvantage of the internal jugular site is the patient discomfort it causes. The site is difficult to dress and is uncomfortable for patients, particularly when turning the head.

Procedure

- 1. Sterilize the site with povidone-iodine, and drape area with sterile towels.
- 2. Administer local anesthesia with lidocaine in the area to be explored.
- 3. Place the patient in the **Trendelenburg** (head down) position.
- 4. Use a small-bore, thin-walled needle (21-gauge) with syringe attached to locate the internal jugular vein. It may be helpful to have a small amount of anesthetic in the syringe to inject during exploration for the vein if the patient notes some discomfort. Some prefer to leave this needle and syringe in the vein and place the large-bore needle directly over the smaller needle, into the vein. This is commonly called the "seeker needle" technique.
- 5. The internal diameter of the needle used to locate the internal jugular vein should be large enough to accommodate the passage of the guidewire.
- Percutaneous entry should be made at the apex of the triangle formed by the two heads of the sternocleidomastoid muscle and the clavicle. (See Fig. 13–6.)
- Direct the needle slightly lateral toward the ipsilateral nipple and enter at a 45-degree angle to the skin.
- 8. Often a notch can be palpated on the posterior surface of the clavicle. This actually can help locate the vein in the lateral/medial plane because the vein lies deep to this shallow notch.
- 9. Successful puncture of the vein is accomplished usually at an unnerving depth of needle insertion and is heralded by sudden aspiration of nonpulsatile venous blood. Bedside localizing Doppler ultrasound units are available in most operating rooms or intensive care units. They can aid in localization of the internal jugular vein if the standard techniques fail.

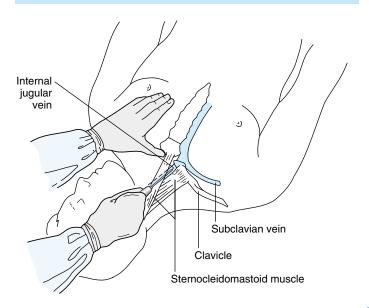


FIGURE 13-6 Technique for the catheterization of the internal jugular vein.

- 10. Inadvertent puncture of the carotid artery is common if the needle is inserted medial to where it should be on the middle approach and is common with the anterior approach. With arterial puncture, the syringe fills without negative pressure because of arterial pressure, and bright red blood pulsates from the needle after the syringe is removed. In this case remove the needle and apply manual pressure for 10–15 min to ensure adequate hemostasis.
- 11. Follow steps 8–12 as for subclavian line (page 255). On chest x-ray, the catheter tip should lie in the superior vena cava in the vicinity of the right atrium, at about the fifth thoracic vertebra.

Complications

Overall this is a safe procedure when the small-bore needle is first used to identify the vein.

- Pneumothorax can be detected when a sudden gush of air is aspirated instead of blood. A postprocedure chest x-ray should always be done to rule out pneumothorax and check for line placement. A pneumothorax requires chest tube placement in virtually all cases, especially when the patient is being supported on a ventilator. The left-sided approach is associated with higher risk for pneumothorax because of the higher dome of the left pleura compared with the right.
- · Perforation of endotracheal tube cuffs

- Hemothorax from vascular injury or hydrothorax from administration of IV fluids into the pleural space
- Catheter tip embolus: Never withdraw the catheter through the needle. It can shear
 off the tip.
- Air embolus: Make sure that the open end of a deep line is always covered with a
 finger. As little as 50–100 mL of air in a vein can be fatal. If you suspect that air
 embolization has occurred, place the patient's head down and turn on left side
 to keep the air in the right atrium. Obtain a STAT portable chest film to see if air
 is present in the heart.

Left Internal Jugular Vein Approach

The left internal jugular vein is not commonly used for central line placement. Better options exist and should be exhausted before resorting to this approach. The procedure is similar to right internal jugular vein approach. In addition to the usual procedural complications common to central lines, this approach has some unique complications, including inadvertent left brachiocephalic vein and superior vena cava puncture with intravascular wires, catheters, and sheaths and laceration of the thoracic duct resulting in chylothorax.

External Jugular Vein Approach

This is a safe approach to central venous catheterization but a very technically demanding procedure due to the difficulty in threading the catheter into the central venous system. This is also an uncomfortable insertion site for the patient because the dressing and IV tubing is on the neck. If the central venous system cannot be entered, this is also a site of last resort for placing a standard IV catheter ("peripheral") for the administration of routine nonsclerosing IV fluids. The external jugular vein is usually visible with the patient in the 30° Trendelenburg position. The vein, located in the subcutaneous tissues, crosses the sternocleidomastoid muscle arising from just behind the angle of the jaw inferiorly where it drains into the subclavian vein just lateral to the inferior aspect of the sternocleidomastoid muscle.

Procedure

- Place the patient in the Trendelenburg position with the head turned away from the side
 of insertion. Prep and drape the neck from the ear to the subclavicular area.
- Having the patient perform the Valsalva maneuver or gently occluding the vein near its insertion into the subclavian vein will help engorge the vein.
- At the approximate midportion of the vein, make a skin wheal with a 25-gauge needle and lidocaine solution. Use a 21-gauge needle to anesthetize the deeper subcutaneous tissue and to locate the vein.
- 4. Remove the syringe from the needle and insert a floppy-tipped J wire into the needle. Use the guidewire with gentle pressure to negotiate the turns into the intrathoracic portion of the venous system. If there is difficulty passing the wire, have the patient turn the head slightly to help direct the wire. Never forcibly push the wire. As a last resort, fluroscopy can be used to direct the wire into the superior vena cava.
- 5. Once a sufficient length of guidewire is passed, the locating needle can be removed.
- 6. An incision in the skin may have to be made to accommodate the catheter. The catheter is then slid over the guidewire and the guidewire is removed. Aspirate blood from the end of the catheter to confirm that it is in the venous system.
- Follow steps 8–12 as for placement via the subclavian vein (page 255).

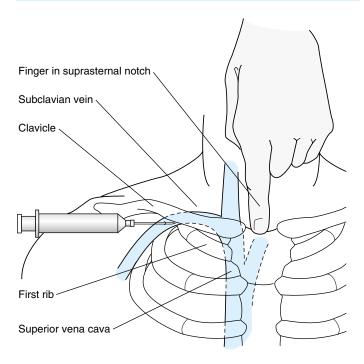


FIGURE 13-7 Technique for the catheterization of the subclavian vein.

Complications

See Right Internal Jugular Vein Approach, page 257.

Femoral Vein Approach

The femoral vein approach has several advantages. The procedure is safe, in that arterial and venous sites are more easily compressible, and it is impossible to cause pneumothorax from this site. Placement can be accomplished without interrupting cardiopulmonary resuscitation. This site can be used to place a variety of intravascular appliances, including temporary pacemakers, pulmonary artery catheters (expertise with fluoroscopy may be needed), and

triple-lumen catheters. The major disadvantages are the high risk of sepsis, the immobilization it causes, and the occasional need for fluoroscopy to ensure proper placement of pulmonary artery catheters or transvenous pacemakers.

Procedure

- 1. Place the patient in the supine position.
- Use sterile preparation and appropriate draping. Administer local anesthesia in the area to be explored.
- 3. Palpate the femoral artery. Use the "NAVEL" technique to locate the vein (see page 246).
- 4. Guard the artery with the fingers of one hand.
- 5. Explore for the vein just medial to the operator's fingers with a needle and syringe.
- It may be helpful to have a small amount of anesthetic in the syringe to inject with exploration.
- Direct the needle cephalad at about a 30-degree angle and insert below the femoral crease.
- Puncture is heralded by the return of venous, nonpulsatile blood on application of negative pressure to the syringe.
- 9. Advance the guidewire through the needle.
- 10. The guidewire should pass with ease into the vein to a depth at which the distal tip of the guidewire is always under the operator's control even when the sheath/dilator or catheter is placed over the guidewire.
- 11. Remove the needle once the guidewire has advanced into the femoral vein.
- 12. If the catheter is a French 6 or larger, a skin incision with a scalpel blade and the use of a vessel dilator are generally needed. The catheter can then be advanced along with the guidewire in unison into the femoral vein. Be sure always to control the distal end of the guidewire.
- 13. Follow steps 13 through 18 for the right internal jugular vein approach.

Complications

- The femoral deep line has the highest incidence of contamination and sepsis. If an
 occlusive dressing can remain in place and remain free from contamination, this is a
 safe option.
- DVT has occurred from femoral vein catheterization. The risk for DVT increases if the catheter remains in place for prolonged periods.
- Uncontrolled retroperitoneal bleeding can occur if the iliac/common femoral artery is inadvertently punctured above the inguinal ligament.

Removal of a Central Venous Catheter

- 1. Turn off the IV flow.
- Cut the retention sutures, and gently withdraw the catheter. Visually inspect the catheter to ensure it is intact.
- 3. Apply pressure for at least 2-3 min, and apply a sterile dressing.

CHEST TUBE PLACEMENT (CLOSED THORACOSTOMY, TUBE THORACOSTOMY)

Indications

· Pneumothorax (simple or tension)

- · Hemothorax, hydrothorax, chylothorax, or empyema evacuation
- Pleurodesis for chronic recurring pneumothorax or effusion that is refractory to standard management (eg, malignant effusion)

Materials

- Chest tube (20–36 French for adults, 12–4 French for children)
- · Water-seal drainage system (Pleurovac, etc) with connecting tubing to wall suction
- Minor procedure tray and instrument tray (see page 240)
- Silk or nylon suture (0 to 2-0)
- Petrolatum gauze (Vaseline) (optional)
- 4 × 4 gauze dressing and cloth tape

Background

A chest tube is usually placed to treat an ongoing intrathoracic process that cannot be managed by simple thoracentesis (see page 304). The traditional methods of chest tube placement are described. Percutaneous tube thoracostomy kits are also available based on the Seldinger technique. It can be used in dealing with small pneumothoraces when there is no risk of ongoing air leak, but it should not be used with more significant conditions (empyema, major pneumothorax >20%, tension pneumothorax, chronic effusions)

Procedure

If a patient manifests signs of a tension pneumothorax (acute shortness of breath, hypotension, distended neck veins, tachypnea, tracheal deviation) before a chest tube is placed, urgent treatment is needed. Insert a 14-gauge needle into the chest in the second intercostal space in the midclavicular line to rapidly decompress the tension pneumothorax and proceed with chest tube insertion.

- 1. Prior to placing the tube, review the chest x-ray unless an emergency does not allow enough time. For a pneumothorax, choose a high anterior site, such as the second or third intercostal space, midclavicular line, or subaxillary position (more cosmetic). Place a low lateral chest tube in the fifth or sixth intercostal space in the midaxillary line and direct posteriorly for fluid removal. (In most patients this location corresponds to the inframammary crease.) For a traumatic pneumothorax, use a low lateral tube because this condition usually is associated with bleeding. Rarely, a loculated apical pneumothorax or effusion may require placement of an anterior tube in the second intercostal space at the midclavicular line.
- 2. Choose the appropriate chest tube. Use a 24–28 French tube for pneumothorax and 36 French for fluid removal. A "thoracic catheter" has multiple holes and works best for nearly all purposes. The vast majority of tubes can be inserted painlessly with generous use of local anesthetics. If the procedure is elective, the patient is extremely anxious, and the patient's respiratory status is not compromised, sedation occasionally may be helpful.
- 3. Prep the area with povidone-iodine solution and drape it with sterile towels. Use 1ido-caine (with or without epinephrine) to anesthetize the skin, intercostal muscle, and periosteum of the rib; start at the center of the rib and gently work over the top. Remember, the neurovascular bundle runs under the rib (Fig. 13–8). The needle then can be gently "popped" through the pleura and the aspiration of air or fluid confirms the correct location for the chest tube.

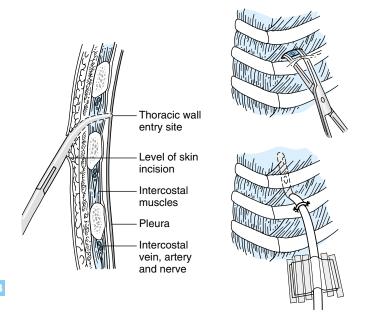


FIGURE 13-8 Chest tube technique demonstrating the procedure for creating a subcutaneous tunnel. *Note*: The skin incision is lower than the thoracic wall entry site. (Reprinted, with permission, from: Gomella TL [ed]: *Neonatology: Basic Management, On-Call Problems, Diseases, Drugs, 4th ed.* Appleton & Lange, Norwalk CT, 1998.)

- 4. Make a 2–3-cm transverse incision over the center of the rib with a No. 15 or 11 scalpel blade. Use a blunt-tipped clamp to dissect over the top of the rib and create a subcutaneous tunnel (see Fig. 13–8).
- 5. Puncture the parietal pleura with the hemostat, and spread the opening. BE CAREFUL NOT TO INJURE THE LUNG PARENCHYMA WITH THE HEMOSTAT TIPS. Insert a gloved finger into the pleural cavity to gently clear any clots or adhesions and to make certain the lung is not accidentally punctured by the tube.
- 6. Carefully insert the tube into the desired position with a hemostat or gloved finger as a guide. Make sure all the holes in the tube are in the chest cavity. Attach the end of the tube to a water-seal or Pleur-Evac suction system. Some chest tubes are provided with sharp trocars that are used to pierce the chest wall and place the chest tube simultane-

- ously with minimal amounts of dissection. These instruments are extremely dangerous and are usually placed in the anterior high position (ie, second, third, or fourth ICS).
- 7. Suture the tube in place. Place a heavy silk (0 or 2-0) suture through the incision next to the tube. Tie the incision together, then tie the ends around the chest tube. Make sure to wrap around the tube several times. Alternatively, a purse string suture (or "U stitch") can be placed around the insertion site. Make sure all of the suction holes are in the chest cavity before the tube is secured.
- 8. Cover the insertion site with plain gauze. Make the dressing as airtight as possible with tape, and secure all connections in the tubing to prevent accidental loss of the water seal. Some physicians still wrap the insertion site with petroleum (Vaseline or Xeroform) gauze; however, these materials are not foolproof: they are not water-soluble (therefore, they act as foreign bodies), inhibit wound healing, and do not actually provide a true seal.
- Start suction (usually -20 cm in adults, -16 cm in children) and take a portable chest x-ray immediately to check the placement of the tube and to evaluate for residual pneumothorax or fluid.
- 10. To remove a chest tube, make sure the pneumothorax or hemothorax is cleared. Check for an air leak by having the patient cough; observe the water-seal system for bubbling that indicates either a system (tubing) leak or persistent pleural air leak.
- 11. Take the tube off suction but not off water seal, and cut the retention suture. Have the patient inspire deeply and perform the Valsalva maneuver while you apply pressure with petrolatum gauze or with a sufficient amount of antibiotic ointment on 4 × 4 gauze with additional 4 × 4 gauze squares. Pull the tube rapidly while the patient performs the Valsalva maneuver and make an airtight seal with tape. Check an "upright" exhalation chest x-ray film for pneumothorax.

Complications

Infection, bleeding, lung damage, subcutaneous emphysema, persistent pneumothorax/hemothorax, poor tube placement, cardiac arrhythmia

CRICOTHYROTOMY (NEEDLE AND SURGICAL) Background

Cricothyrotomy is a true emergency procedure that should be performed when obtaining an airway using endotracheal or orotracheal intubation is impossible.

Indications

 When immediate mechanical ventilation is indicated, but an endotracheal or orotracheal tube cannot be placed (eg, severe maxillofacial trauma, excessive oropharyngeal hemorrhage)

Contraindications

Surgical cricothyrotomy is contraindicated in children < 12 y; use needle approach.

Basic Materials

- Oxygen connecting tubing, high-flow oxygen source (tank or wall)
- · Bag ventilator

- 12-14-gauge catheter over needle (Angiocath or other),
- · 6-12-mL syringe
- · 3-mm pediatric endotracheal tube adapter

Surgical Cricothyrotomy (minimum requirements)

- Minor procedure and instrument tray (page 240) plus tracheal spreader if available
- No. 5–7 tracheostomy tube (6–8 French endotracheal tube can be substituted)
- · Tracheostomy tube adapter to connect to bag-mask ventilator

Procedures

Needle Cricothyrotomy

- 1. With the patient supine, place a roll behind the shoulders to gently hyperextend the neck.
- Palpate the cricothyroid membrane, which resembles a notch located between the caudal end of the thyroid cartilage and the cricoid cartilage. Prep the area with povidone-iodine solution. Local anesthesia can be used if the patient is awake.
- Mount the syringe on the 12- or 14-gauge catheter-over-needle assembly, and advance through the cricothyroid membrane at a 45-degree angle, applying back pressure on the syringe until air is aspirated.
- 4. Advance the catheter, and remove the needle. Attach the hub to a 3-mm endotracheal tube adapter that is connected to the oxygen tubing. Allow the oxygen to flow at 15 L/min for 1-2 s on, then 4 s off by the use of a Y-connector or a hole in the side of the tubing to turn the flow on and off.
- The needle technique is only useful for about 45 min because the exhalation of CO₂ is suboptimal.

Surgical Cricothyrotomy

- 1. Follow steps 1 and 2 as for needle cricothyrotomy.
- 2. Make a 3-4-cm vertical skin incision through the cervical fascia and strap muscles in the midline over the cricothyroid membrane. Expose the cricothyroid membrane, and make a horizontal incision. Insert the knife handle, and rotate it 90 degrees to open the hole in the membrane. Alternatively, a hemostat or tracheal spreader can be used to dilate the opening.
- Insert a small (5–7-mm) tracheostomy tube, inflate the balloon (if present), and secure
 in position with the attached cotton tapes.
- 4. Attach to oxygen source and ventilate. Listen to the chest for symmetrical breath sounds.
- A surgical cricothyrotomy should be replaced with a formal tracheostomy after the patient has been stabilized and generally within 24–36 h.

Complications

 Bleeding, esophageal perforation, subcutaneous emphysema, pneumomediastinum, and pneumothorax, CO₂ retention (especially with the needle procedure)

CULDOCENTESIS

Indications

· Diagnostic technique for problems of acute abdominal pain in the female

.....

- Evaluation of female patient with signs of hypovolemia and possible intraabdominal bleeding
- · Evaluation of ascites, especially in possible cases of gynecologic malignancy

Materials

- · Speculum
- · Antiseptic swabs
- · Povidone-iodine or chlorhexidine
- 1% lidocaine
- 18–21-gauge spinal needle
- · 2 (10 mL) syringes and tenaculum

Procedure

- Culdocentesis should be preceded with a careful pelvic exam to document uterine position and rule out pelvic mass at risk of perforation by the culdocentesis.
- After obtaining the patient's informed consent, the vagina is prepped with antiseptic, such as iodine or chlorhexidine.
- Inject 1% lidocaine submucosally in the posterior cervical fornix prior to tenaculum application.
- 4. Traction is improved by application of the tenaculum to the posterior cervical lip.
- 5. Apply an 18–21-gauge spinal needle to a 10-mL syringe, filled with 1 mL of air.
- 6. As you move the needle forward through the posterior cervical fornix, apply light pressure to the syringe until the air passes. Maintain traction on the tenaculum as you advance the spinal needle to maximize the surface area of the cul de sac for needle entry.
- 7. After intraabdominal entry, ask the patient to elevate herself on elbows to permit gravity drainage into the area of needle entry. Apply negative pressure to the syringe. Slow rotation of the needle followed by slow removal may enable a pocket of fluid to be found and aspirated.
- If first culdocentesis attempt is not successful, the procedure can be repeated with a different angle of approach.
- Although perforation of viscus is a possibility, the complication rate has been very low.
 Fresh blood that clots rapidly is probably secondary to traumatic tap, and the procedure can be repeated.
- 10. If blood is aspirated, it should be spun for hematocrit and placed into an empty glass test tube to demonstrate the presence or absence of a clot. Failure of blood to clot suggests old hemorrhage.
- 11. If pus is aspirated, send specimens for GC, aerobic, anaerobic, Chlamydia, Myco-plasma, and Ureaplasma cultures.
- 12. If a malignancy is suspected, send fluid for cytologic evaluation.

Complications

Infection, hemorrhage, air embolus, perforated viscus

DOPPLER PRESSURES

Indications

- · Evaluation of peripheral vascular disease (ankle-brachial or ankle-arm index)
- Routine blood pressure measurement in infants or critically ill adults

- · Doppler flow monitor
- Conductive gel (lubricant jelly can also be used)
- · Blood pressure cuff

Procedure (Ankle-Brachial or Ankle-Arm Index)

- 1. Determine the blood pressure in each arm.
- Measure the pressures in the popliteal arteries by placing a BP cuff on the thigh. The pressures in the dorsalis pedis arteries (on the top of the foot) and the posterior tibial arteries (behind the medial malleolus) are determined with a BP cuff on the calf.
- 3. Apply conductive jelly and place the Doppler probe over the artery. Inflate the BP cuff until the pulsatile flow is no longer heard. Deflate the cuff until the flow returns. This is the systolic, or Doppler, pressure. Note: The Doppler cannot routinely determine the diastolic pressure, and a palpable pulse need not be present to use the Doppler.
- **4.** The **A/B** or **AAI** index is often computed from Doppler pressure. It is equal to the pressure in the ankle (usually the posterior tibial) divided by the systolic pressure in the arm. An A/B index of >0.9 is usually normal, and an index of <0.5 is usually associated with significant peripheral vascular disease.

ELECTROCARDIOGRAM

Basic ECG interpretation can be found in Chapter 19, page 367.

Indications

· Useful in the evaluation of chest pain and other cardiac conditions

Materials

- · ECG machine with paper and lead electrodes
- · Adhesive electrode pads

Procedure

- Most hospitals have converted to fully automated ECG machines. It is important to become acquainted with your particular machine prior to using it. The following is a general outline.
- Start with the patient in a comfortable, recumbent position. Explain the procedure to dispel any myths. Instruct the patient to lie as still as possible to cut down on artifacts in the tracing.
- 3. Plug in the ECG machine and turn it on.
- 4. Attach the electrodes as outlined here:
 - a. Patient Cables. The standard ECG machine has five lead wires, one for each limb and one for the chest leads. Newer machines have six precordial electrodes, which are all placed in the proper positions prior to performing the procedure. These may be color-coded in the following fashion:
 - · RA: White-right arm
 - · LA: Black-left arm
 - · RL: Green-right leg
 - · LL: Red-left leg
 - · C: Brown-chest

- b. Limb Electrodes. The limb electrodes are flat, rectangular plates held in place by rubber or Velcro straps that encircle the limb; newer machines may use self-adhering electrode pads. Place each electrode on the limb indicated, wrist or ankle, usually on the ventral surface. In case of amputation or a cast, the lead may be placed on the shoulder or groin with almost no effect on the tracing.
- c. Chest (Precordial) Electrodes. The chest electrode is brown and designated by the letter "C." It is attached to a suction cup that is attached in sequence to each of the positions on the precordium (see the following description). Newer machines allow all leads to be placed prior to running the ECG with all pads applied at the same time. This makes locating the proper positions much quicker and easier (Fig. 13–9). Precordial leads are placed as follows:
 - V_1 = fourth intercostal space just to the **right** of the sternal border
 - V_2 = fourth intercostal space just to the **left** of the sternal border
 - V_3 = midway between leads V_2 and V_4
 - V_4 = midclavicular line, above the fifth interspace

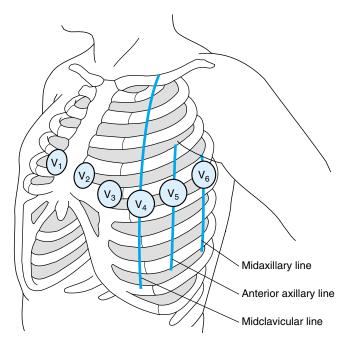


FIGURE 13-9 Location of the precordial chest leads used in obtaining a routine ECG.

- V₅ = anterior axillary line at the same level as V₄
- V_6 = midaxillary line at the same level as leads V_4 and V_5
- 4. Once the machine is warmed up and the electrodes are positioned or ready for positioning, make sure that the paper speed is set at 25 mm/s. When everything is ready, follow the directions for your particular machine to obtain the ECG tracing. It should include 12 different leads, that is, I, II, III, AVR, AVL, and V₁₋₆.
- Label the tracing with the patient's name, date, time, and any other useful information, such as medications, and your name. A routine 12-lead ECG should take 4–8 min.

Helpful Hints

- The second rib inserts at the sternal angle, and therefore the second intercostal space is directly inferior to the sternal angle. Feel down two more intercostal spaces and you have the fourth intercostal space to position V₁ and V₂.
- When you start seeing a solid blue or red line at the top or bottom of the strip, you are about to run out of paper. Always leave enough paper for the next user.
- Learn the color scheme for the leads; it could be very useful in an emergency. Some memory aids include
 - a. Red and green go to the legs: "Christmas on the bottom" or "When driving your car you use your left leg to brake (red light) and your right leg to go (green light)."
 - b. Black (left) and white (right) go to the arms: "Remember white is right and black is left."
 - c. Brown is for the chest.

ENDOTRACHEAL INTUBATION

Indications

- Airway management during cardiopulmonary resuscitation
- Any indication for using mechanical ventilation (respiratory failure, coma, general anesthesia, etc)

Contraindications

- · Massive maxillofacial trauma (relative)
- · Fractured larvnx
- · Suspected cervical spinal cord injury (relative)

Materials

- Endotracheal tube of appropriate size (Table 13–3)
- Laryngoscope handle and blade (straight [Miller] or curved [MAC]; size No. 3 for adults, No. 1–1.5 for small children)
- · 10-mL syringe, adhesive tape, benzoin
- · Suction equipment (Yankauer suction)
- Malleable stylet (optional)
- · Oropharyngeal airway

Technique

 Orotracheal intubation is most commonly used and is described here. Orotracheal intubation should be done only with great care in cases of suspected cervical spine injuries. In such cases nasotracheal intubation is preferred.

TABLE 13–3
Recommended Endotracheal Tube Sizes

Patient	(mm	
Premature infant	2.5-3.0	(uncuffed)
Newborn infant	3.5	(uncuffed)
3-12 mo	4.0	(uncuffed)
1–8 y	4.0-6.0	(uncuffed)*
8–16 y	6.0–7.0	(cuffed)
Adult [*]	7.0-9.0	(cuffed)

- 2. Any patient who is hypoxic or apneic must be ventilated prior to attempting endotracheal intubation (bag mask or mouth to mask). Remember to avoid prolonged periods of no ventilation if the intubation is difficult. A rule of thumb is to hold your breath while attempting intubation. When you need to take a breath, so must the patient, and you should resume ventilation, and reattempt intubation in a minute or so.
- Extend the laryngoscope blade to 90 degrees to verify the light is working, and check the balloon on the tube (if present) for leaks.
- 4. Place the patient's head in the "sniffing position" (neck extended anteriorly and the head extended posteriorly). Use suction to clear the upper airway if needed.
- 5. Hold the laryngoscope in the left hand, hold the mouth open with the right hand, and use the blade to push the tongue to patient's left while keeping it anterior to the blade. Advance the blade carefully toward the midline until the epiglottis is visualized. Use suction if needed.
- 6. If the straight laryngoscope blade is used, pass it under the epiglottis and lift upward to visualize the vocal cords (Fig. 13–10). If the curved blade is used, place it anterior to the epiglottis (into the vallecula) and gently lift anteriorly. In either case, do not use the handle to pry the epiglottis open, but rather gently lift to expose the vocal cords.
- While maintaining visualization of the cords, grasp the tube in your right hand and pass it through the cords. With more difficult intubations, the malleable stylet can be used to direct the tube.
- 8. In patients who may have eaten recently, gentle pressure placed over the cricoid cartilage by an assistant helps to occlude the esophagus and prevent aspiration during intubation. "Cricoid pressure" can also help visualize the vocal cords in patients whose larynx is situated more anteriorly than usual.
- 9. When using a cuffed tube (adult and older children), gently inflate air with a 10-mL syringe until the seal is adequate (about 5 mL). Ventilate the patient while auscultating and visualizing both sides of the chest to verify positioning. If the left side does not seem to be ventilating, it may signify that the tube has been advanced down the right mainstem bronchus. Withdraw the tube 1–2 cm, and recheck the breath sounds. Also auscultate over the stomach to ensure the tube is not mistakenly placed in the esophagus. Confirm positioning with a chest x-ray. The tip of the endotracheal tube should be a few centimeters above the carina.

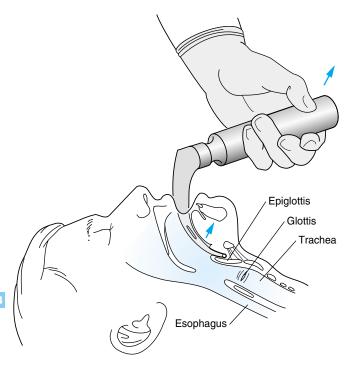


FIGURE 13-10 Endotracheal intubation using a curved laryngoscope blade.

10. Tape the tube in position, and insert an oropharyngeal airway to prevent the patient from biting the tube. Consider an orogastric tube to prevent regurgitation.

Complications

Bleeding, oral or pharyngeal trauma, improper tube positioning (esophageal intubation, right mainstem bronchus), aspiration, tube obstruction or kinking

FEVER WORK-UP

Although not a "procedure" in the true sense of the word, a fever work-up involves judicious use of invasive procedures. The true definition of a *fever* can vary from service to service. General guidelines to follow are a temperature of >100.4°F or ally on a medical or surgical

service, or a temperature greater than or equal to $101^\circ F$ rectally or $100^\circ F$ or ally in an infant or immunocompromised patient.

When evaluating a patient for a fever, consider if the temperature is oral, rectal, tympanic, or axillary (rectal and tympanic temperatures are about 1° higher and axillary temperatures are about 1° lower than oral); has the patient drunk any hot or cold liquids or smoked around the time of the determination; and is the patient on any antipyretics. Differential diagnosis of fever and fever of unknown origin are discussed in Chapter 3.

General Fever Work-Up

- 1. Quickly review the chart and medication record if the patient is not familiar to you.
- 2. Question and examine the patient to locate any obvious sources of fever.
 - a. Ears, nose, and throat: Especially in children
 - b. Neck: Tenderness or stiffness present
 - c. Nodes: Adenopathy
 - d. Lungs: Rales (crackles), rhonchi (wheezes), decreased breath sounds, or dullness to percussion. Can the patient generate an effective cough?
 - e. Heart: Heart murmur, which may suggest SBE
 - f. Abdomen: Presence or absence of bowel sounds, guarding, rigidity, tenderness, bladder fullness, or costovertebral angle tenderness
 - g. Genitourinary: When a Foley catheter is in place; appearance of the urine, grossly and microscopically
 - h. Rectal Exam: Tenderness or fluctuance to suggest an abscess, or acute prostatitis
 - i. Pelvic Exam: Especially in the postpartum patient
 - j. Wounds: Erythema, tenderness, swelling, or drainage from surgical sites
 - Extremities: Signs of inflammation at IV sites. Look for thigh or calf tenderness and swelling.
 - Miscellaneous: Consider the possibility of a drug fever (eosinophil count on the CBC may be elevated) or NG tube fever. Do all this before you begin to investigate the less common or less obvious causes of a fever

3. Laboratory Studies

- Basic: CBC with differential, urinalysis, cultures as indicated: urine, blood, sputum, wound, spinal fluid (especially in children less than 4–6 mo old)
- b. Other: Studies based on your evaluation:
 - (i) Radiographic: Chest or abdominal films, CT or ultrasound exams
 - (ii) Invasive: LP, thoracentesis, paracentesis are more aggressive procedures that may be indicated.

Miscellaneous Fever Facts

- 1. Causes of Fever in the Postop Patient: Think of the "Six W's":
 - a. Wind: Atelectasis secondary to intubation and anesthesia is the most common cause of a fever immediately after surgery. To treat, have the patient up and ambulating, getting incentive spirometry, P&PD, etc.
 - **b.** Water: UTI; may be secondary to a bladder catheter
 - c. Wound: Infection
 - d. Walking: Phlebitis, DVT
 - e. Wonder drugs: Drug fever (common causes are listed on page 46).
 - **f.** Woman: Endometritis, or mastitis. (These are common only in postpartum patients.)
- Elevated White Cell Counts: Commonly elevated secondary to catecholamine discharge after a stress such as surgery or childbirth

- Temperatures of 103–105°F: In adults, think of lung or kidney infections, or bacteremia.
- Lethargy, Combativeness, Inappropriate Behavior: Strongly consider doing an LP to rule out meningitis.
- Elderly Patients: Can be extremely ill without many of the typical manifestations; they may be hypothermic or deny any tenderness. You must be very aggressive to identify the cause.
- Infants and Children: Have normally elevated baseline temperatures (up to 3 mo 99.4°F, 1 y 99.7°F, 3 y 99.0°F)

GASTROINTESTINAL INTUBATION

Indications

- GI decompression: ileus, obstruction, pancreatitis, postoperatively
- · Lavage of the stomach with GI bleeding or drug overdose
- · Prevention of aspiration in an obtunded patient
- · Feeding a patient who is unable to swallow

Materials

- Gastrointestinal tube of choice (see following list)
- · Lubricant jelly
- · Catheter tip syringe
- · Glass of water with a straw, stethoscope

Types of Gastrointestinal Tubes

1. Nasogastric Tubes

- a. Levin: A tube with a single lumen, a perforated tip, and side holes for the aspiration of gastric contents. Connect it to an intermittent suction device to prevent the stomach lining from obstructing the lumen. Sometimes it is necessary to cut off the tip to allow for the aspiration of larger pills or tablets. The size varies from 10 to 18 French (1 French unit = ½ mm in diameter, see page 241).
- b. Salem-sump: A double-lumen tube, with the smaller tube acting as an air intake vent so that continuous suction can be applied. This is the best tube for irrigation and lavage because it will not collapse on itself. If a Salem-sump tube stops working even after it is repositioned, often a "shot" of air from a catheter-tipped syringe in the air vent will clear the tube. Both the Salem-sump and Levin tubes have radiopaque markings.
- 2. Intestinal Decompression Tubes ("long intestinal tubes")
 - a. Cantor tube: A long single-lumen tube with a rubber balloon at the tip. The balloon is partially filled with mercury (5–7 mL using a tangentially directed 21-gauge needle, then the air is aspirated), which allows it to gravitate into the small bowel with the aid of peristalsis. Used for decompression when the bowel is obstructed distally.
 - b. Miller-Abbott tube: A long double-lumen tube with a rubber balloon at the tip. One lumen is used for aspiration; the other connects to the balloon. After the tube is in the stomach, inflate the balloon with 5–10 mL of air, inject 2–3 mL of mercury into the balloon, and then aspirate the air. Functioning and indications are essentially the same as for the Cantor tube. Do not tape these intestinal tubes to the patient's nose or the tube will not descend. The progress of the tube can be followed on x-ray.

3. Feeding Tubes

Virtually any NG tube can be used as a feeding tube, but it is preferable to place a specially designed nasoduodenal feeding tube. These are of smaller diameter (usually 8 French) and are more pliable and comfortable for the patient. Weighted tips tend to travel into the duodenum, which helps prevent regurgitation and aspiration. Most are supplied with stylets that facilitate positioning, especially if fluoroscopic guidance is needed. Always verify the position of the feeding tube with an x-ray prior to starting tube feeding. Commonly used tubes include the mercury-weighted varieties (Keogh tube, Duo-Tube, Dobbhoff, Entriflex), the tungsten-weighted (Vivonex tube), and the unweighted pediatric feeding tubes.

Miscellaneous

- Sengstaken-Blakemore tube: A triple-lumen tube used exclusively for the control of bleeding esophageal varices by tamponade. One lumen is for gastric aspiration, one is for the gastric balloon, and the third is for the esophageal balloon. Other types of tubes used to control esophageal bleeding include the Linton and Minnesota tubes.
- Ewald tube: An orogastric tube used almost exclusively for gastric evacuation of blood or drug overdose. The tube is usually double lumen and large diameter (18-36 French).
- c. Dennis, Baker, Leonard tubes: These are used for intraoperative decompression of the bowel and are manually passed into the bowel at the time of laparotomy.

Procedure (For Nasogastric and Feeding Tubes)

- 1. Inform the patient of the nature of the procedure and encourage cooperation if the patient is able. Choose the nasal passage that appears most open. Have the patient sitting up if able.
- 2. Lubricate the distal 3–4 in. of the tube with a water-soluble jelly (K-Y Jelly or viscous lidocaine), and insert the tube gently along the floor of the nasal passageway. Maintain gentle pressure that will allow the tube to pass into the nasopharynx.
- 3. When the patient can feel the tube in the back of the throat, ask patient to swallow small amounts of water through a straw as you advance the tube 2-3 in. at a time.
- 4. To be sure that the tube is in the stomach, aspirate gastric contents or blow air into the tube with a catheter-tipped syringe and listen over the stomach with your stethoscope for a "pop" or "gurgle." The position of feeding tubes must be verified by a chest x-ray prior to institution of feedings to prevent accidental bronchial instillation.
- 5. NG tubes are usually attached either to low wall suction (Salem-sump type tubes with a vent) or to intermittent suction (Levin type tubes). The latter allows the tube to fall away from the gastric wall between suction cycles.
- 6. Feeding and pediatric feeding tubes in adults are more difficult to insert because they are more flexible. Many are provided with stylets that make their passage easier. Feeding tubes are best placed into the duodenum or jejunum in order to decrease the risk of aspiration. Administering 10 mg of metoclopramide (Reglan) IV 10 min before insertion of the tube assists in placing the tube into the duodenum. Once the feeding tube is in the stomach, the bell of the stethoscope can be placed on the right side of the patient's midabdomen. As the tube is advanced, air can be injected to confirm progression of the tube to the right, toward the duodenum. If the sound of the air becomes fainter, the tube is probably curling in the stomach. Pass the tube until a slight resistance is felt, heralding the presence of the tip of the tube at the pylorus. Holding constant pressure and slowly injecting water through the tube is often rewarded with a "give," which signifies passage through the pylorus. The tube often can be advanced far into the

7. Tape the tube securely in place but do not allow it to apply pressure to the ala of the nose. (*Note*: Intestinal decompression tubes should not be taped because they are allowed to pass through the intestine). Patients have been disfigured because of ischemic necrosis of the nose caused by a poorly positioned NG tube.

Complications

- · Inadvertent passage into the trachea may provoke coughing or gagging in the patient.
- Aspiration
- If the patient is unable to cooperate, the tube often becomes coiled in the oral cavity.
- The tube is irritating and may cause a small amount of bleeding in the mucosa of the nose, pharynx, or stomach. The drying and irritation can be lessened by throat lozenges or antiseptic spray.
- · Intracranial passage in patient with a basilar skull fracture
- · Esophageal perforation
- Esophageal reflux caused by the tube-induced incompetence of the distal esophageal sphincter
- Sinusitis can result from the tube, causing edema of the nasal passages that blocks drainage from the nasal sinuses.

HEELSTICK

Indication

· Frequently used to collect blood samples from infants

13 Materials

- · Alcohol swabs
- · Lancet
- · Capillary or caraway collection tubes
- · Clay tube sealer

Technique

- Although called a "heelstick," any highly vascularized capillary bed can be used (finger, ear lobe, or great toe). The heel can be warmed for 5–10 min by wrapping it in a warm washcloth.
- Wipe the area with an alcohol swab. Use Figure 13–11 to choose the site for the puncture on the foot. Use of these sites helps decrease the incidence of osteomyelitis.
- 3. Use a 4-mm lancet, and make a quick, deep puncture so that blood flows freely. Automated safety lancets (eg, BD Genie lancet for fingersticks and the BD Quick Heel Lancer for heelsticks) are also available. Wipe off the first drop of blood. Gently squeeze the heel and touch a collection tube to the drop of blood. The tube should fill by capillary action. Seal the end of the tube in clay.
- 4. Most labs can usually make laboratory determinations on small samples from the pediatric age group. A Caraway tube can hold 0.3 mL of blood. One to three caraway tubes can be used for most routine tests. For a capillary blood gas, the blood is usually transferred to a 1-mL heparinized syringe and placed on ice.
- 5. Wrap the foot with 4×4 gauze squares or apply an adhesive bandage.

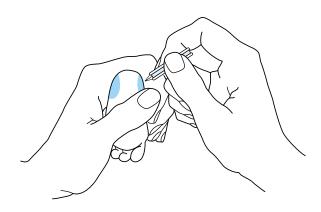


FIGURE 13-11 Demonstration of the preferred sites and technique of performing a heelstick in an infant. (Reprinted, with permission, from: Gomella TL [ed]: *Neonatology: Basic Management, On-Call Problems, Diseases, Drugs, 4th ed. Appleton & Lange, Norwalk CT, 1998.)*

INTERNAL FETAL SCALP MONITORING Indication

• To accurately assess FHR patterns during labor to screen for possible fetal distress

Contraindications

- · Presence of placenta previa
- When it is otherwise impossible to identify the portion of the fetal body where application is contemplated

Materials

- · Fetal scalp monitoring electrode
- · Sterile vaginal lubricant or povidone-iodine spray
- · Spiral electrode
- · Leg plate/fetal monitor

Technique

- Position the patient in the dorsal lithotomy position (knees flexed and abducted), and perform an aseptic perineal prep with sterile vaginal lubricant or povidone-iodine spray.
- Perform a manual vaginal exam, and clearly identify the fetal presenting part. The membranes must be ruptured prior to attachment of the spiral electrode.

- Remove the spiral electrode from the sterile package and place the guide tube firmly against the fetal presenting part. Electrode should not be applied to fetal face, fontanels, or genitalia.
- 4. Advance the drive tube and electrode until the electrode contacts the presenting part. Maintaining pressure on the guide tube and drive tube, rotate the drive tube clockwise until mild resistance is met (usually one turn).
- Press together the arms on the drive tube grip, which releases the locking device. Carefully slide the drive and guide tubes off the electrode wires while holding the locking device open.
- Attach the spiral electrode wires to the color-coded leg plate, which is then connected to the electronic fetal monitor.

Complications

 Fetal or maternal hemorrhage, fetal infection (usually scalp abscess at the site of insertion)

Interpretation

Normal FHR is 120–160 bpm. **Accelerations** are increases in the FHR, and although they can be associated with fetal distress (usually in association with late decelerations), they are almost always a sign of fetal well-being. **Decelerations** are transient falls in FHR related to a uterine contraction and are of three types:

- Early Decelerations: Seen in normal labor, slowing of the FHR clearly associated with
 the onset of the contraction and the FHR promptly returns to normal after the contraction
 is over. Usually caused by head compression, and occasionally by cord compression.
- Late Deceleration: Slowing of the FHR that occurs after the uterine contraction starts and the rate does not return to normal until well after the contraction is over. This type of pattern is often associated with uteroplacental insufficiency (fetal acidosis or hypoxia).
- 3. Variable Decelerations: Irregular pattern of decelerations unassociated with contractions caused by cord compression. If bradycardia persists, evaluate with scalp pH.

Other patterns seen include **beat-to-beat variability** (small fluctuations in FHR 5–15 BPM over the baseline FHR usually associated with fetal well-being); **tachycardia** (often an early sign of fetal distress, seen with febrile illnesses, hypoxia, fetal thyrotoxicosis); and **brady-cardia** (associated with maternal and fetal hypoxia, fetal heart lesions including heart block). **Sinusoidal** pattern can be drug-induced and is seen occasionally with severe fetal anemia.

INJECTION TECHNIQUES

Indications

- · Intradermal: Most commonly used for skin testing
- Subcutaneous: Useful for low-volume medications such as insulin, heparin and some vaccines
- Intramuscular: Administration of parenteral medications that cannot be absorbed from the subcutaneous layer or of high volume (up to 10 mL)

Contraindications

- · Allergy to any components of the injectate
- · Active infection or dermatitis at the injection site
- · Intramuscular injections are generally contraindicated with coagulopathy

Procedures

Intradermal (see Skin Testing, page 303)

Subcutaneous

- Deposit the drug within the fat but above the muscle. With careful placement nerve injury is rarely a danger.
- Choose a site free of scarring or active infection. Injection sites include the outer surface of the upper arm, anterior surface of the thigh, and lower abdominal wall. With repeated injections (diabetics, etc) sites should be rotated.
- 3. 25–27-gauge ¾-1-in. needles are most commonly used; volume of medication must not exceed 5 mL. Draw up the medication, making certain to expel any air bubbles.
- Clean site with an alcohol swab. Bunch up the skin between the thumb and forefinger so that the subcutaneous tissue is off the underlying muscle.
- Warn the patient that there will be "pinch" or "sting," and insert the needle firmly and rapidly at a 45-degree angle until a sudden release signifies penetration of the dermis.
- Release the skin, and aspirate to make certain a blood vessel has not been entered and inject slowly.
- Withdraw the needle and apply gentle pressure. A dressing is not usually necessary. Apply pressure longer if there is bleeding from the site.

Intramuscular

- Common sites include the deltoid, gluteus, and the vastus lateralis.
 - Deltoid Muscle: The safe zone includes only the main body of the deltoid muscle lying lateral and a few centimeters beneath the acromion. Low risk of radial nerve injury unless the needle strays into the middle or lower third of the arm.
 - Gluteus Muscles: This is the preferred site in children > 2 y and in adults. Draw an
 imaginary line from the femoral head to the posterior superior iliac spine. This site
 (upper outer quadrant of the buttocks) is safe for injections because it is away from
 the sciatic nerve and superior gluteal artery.
 - Vastus Lateralis Muscle (anterior thigh): A very safe site in all patients and the site
 of choice in infants. The only disadvantage of this site is that the firm fascia lata
 overlying the muscle can make needle insertion somewhat more painful.
- A 22-gauge, 1½-in. needle is acceptable for most intramuscular injections. Remove air bubbles from the syringe and needle. Wipe the skin with alcohol.
- 3. Gently stretch the skin to one side and warn the patient of a sting. Penetrate the skin at a 90-degree angle, and advance approximately 1 in. into the muscle. (Obese patients may require deeper penetration with a longer needle).
- Aspirate to make sure that you have not entered a vessel. Administer the medication. Gently massage the site with alcohol swab or gauze to promote absorption.

Complications

- · Nerve and arterial injury
- Abscesses (sterile or septic). Use good technique and rotate injection sites.
- · Bleeding can usually be controlled with pressure.

INTRAUTERINE PRESSURE MONITORING

Indication

To accurately assess uterine contraction during labor

Contraindication

· Presence of placenta previa

Materials

- · Pressure catheter and introducer
- · Transducer connected to fetal monitor
- · Sterile gloves, vaginal lubricant, povidone-iodine spray
- · 10-mL syringe, 30 mL sterile water

Procedure

- 1. Prime the transducer with sterile water.
- Position the patient in the dorsal lithotomy position (knees flexed and abducted), and perform an aseptic perineal prep with sterile vaginal lubricant or povidone–iodine spray.
- Perform a manual vaginal exam, and clearly identify the fetal presenting part. The membranes must be ruptured prior to insertion of catheter.
- **4.** Remove the catheter from the sterile package, and place the guide tube through fingers around the presenting part into the uterine cavity.
- 5. Prime the catheter with sterile water and thread through the guide tube.
- 6. Attach the distal catheter to transducer and zero to air.

Complications

Infection, placental perforation if low lying

IV TECHNIQUES

Indication

- To establish an intravenous access for the administration of fluids, blood, or medications
- (Other techniques include Central Venous Catheters, page 253 and PICC lines (page 292)

Materials

- IV fluid
- · Connecting tubing
- Tourniquet
- · Alcohol swab
- Intravenous cannulas (a catheter over a needle [eg, Angiocath, Insyte] or a butterfly needle)
- · Antiseptic ointment, dressing, and tape

Technique

- It helps to rip the tape into strips, attach the IV tubing to the solution, and flush the air
 out of the tubing before you begin. Using a catheter-needle assembly (Angiocath, etc)
 often helps to "break the seal" between the needle and catheter prior to the time that the
 catheter is in the vein so that dislodging the catheter is less likely.
- The upper, nondominant extremity is the site of choice for an IV, unless the patient is being considered for placement of permanent hemodialysis access. In this instance, the

upper nondominant extremity should be "saved" as the access site for hemodialysis. Choose a distal vein (dorsum of the hand) so that if the vein is lost, you can reposition the IV more proximally. Figure 13–12 demonstrates some common upper extremity

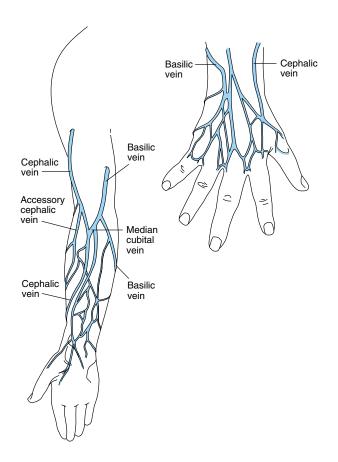


FIGURE 13–12 Principle veins of the arm used to place IV access and in venipuncture, the pattern can be highly variable. (Reprinted, with permission, from: Stillman RM [ed]: *Surgery, Diagnosis, and Therapy,* Appleton & Lange, Norwalk, CT, 1989.)

- veins; however, avoid veins that cross a joint space. Also avoid the leg because the incidence of thrombophlebitis is high with IVs placed there.
- 3. Apply a tourniquet above the proposed IV site. Use the techniques described in the section on venipuncture to help expose the vein (page 309). Carefully clean the site with an alcohol or povidone-iodine swab. If a large-bore IV is to be used (16 or 14), local anesthesia (1idocaine injected with a 25-gauge needle) is helpful.
- 4. Stabilize the vein distally with the thumb of your free hand. Using the catheter-over-needle assembly (Intracath or Angiocath), either enter the vein directly or enter the skin alongside the vein first and then stick the vein along the side at about a 20-degree angle. Direct entry and side entry IV techniques are illustrated in Figures 13–13 and 13–14. Once the vein is punctured, blood should appear in the "flash chamber" of a catheter-overneedle assembly. Advance a few more millimeters to be sure that both the needle and the tip of the catheter have entered the vein. Carefully withdraw the needle as you advance the catheter into the vein (see Fig. 13–13). Never withdraw the catheter over the needle because this procedure can shear off the plastic tip and cause a catheter embolus. Remove the tourniquet, and connect the IV line to the catheter. Blood loss can be minimized by compressing the vein with the thumb just proximal to the catheter.
- With the IV fluid running, observe the site for signs of induration or swelling that indicate improper placement or damage to the vein. See Chapter 9 for choosing IV fluids and how to determine infusion rates.
- Tape the IV securely in place, apply a drop of povidone-iodine or antibiotic ointment and sterile dressing. Ideally, the dressing should be changed every 24–48 h to help reduce infections. Arm boards are also useful to help maintain an IV site.
- 7. "Butterfly" or "scalp vein" needle can sometimes be used (see Fig. 13–14). This is a small metal needle with plastic "wings" on the side. It is very useful in infants, who often have poor peripheral veins but prominent scalp veins, children, and in adults who have small, fragile veins.
- 8. Troubleshooting difficult IV placement
 - If the veins are deep and difficult to locate, a small 3–5-mL syringe can be mounted
 on the catheter assembly. Proper positioning inside the vein is determined by aspiration of blood. If blood specimens are needed on a patient who also needs an IV, this
 technique can be used to start the IV and to collect samples at the same time.
 - Whaid's maneuver can be attempted (J Emerg Nurs, 1993;19:186). Spend about 1 min using both hands to "milk" blood from the arm toward the forearm. While holding the arm compressed with both hands, place a tourniquet above the elbow. Milk the blood from the fingers to the forearm for 3–5 min. When a vein becomes prominent, wrap your hand around the patient's wrist and place the IV.
 - If no extremity vein can be found, try the external jugular. Placing the patient in the head down position can help distend the vein.
 - If all these fail, the next alternative is a central venous line insertion.

LUMBAR PUNCTURE

Indications

- Diagnostic purposes: Analysis of CSF for conditions such as meningitis, encephalitis, Guillain-Barré syndrome, staging work-up for lymphoma, others
- Measurement of CSF pressure or its changes with various maneuvers (Valsalva, etc)
- Injection of various agents: Contrast media for myelography, antitumor drugs, analgesics, antibiotics

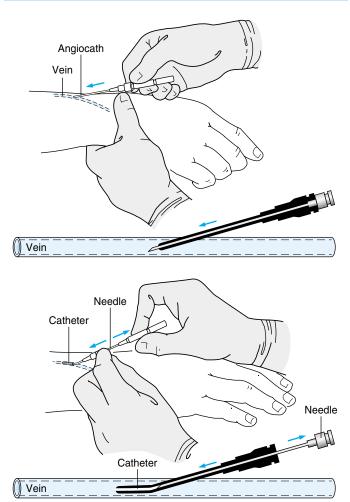


FIGURE 13–13 To insert a catheter-over-needle assembly into a vein, stabilize the skin and vein with gentle traction. Enter the vein and advance the catheter while removing the needle.

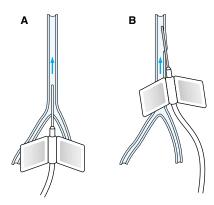


FIGURE 13–14 Example of a "butterfly" needle assembly and the two different techniques of entering a vein for intravenous access: A direct puncture; and B side entry. (Reprinted, with permission, from: Gomella TL [ed]: *Neonatology: Basic Management, On-Call Problems, Diseases, Drugs, 4th* ed. Appleton & Lange, Norwalk CT, 1998.)

Contraindications

- Increased intracranial pressure (papilledema, mass lesion)
- · Infection near the puncture site
- · Planned myelography or pneumoencephalography
- · Coagulation disorders

Materials

· A sterile, disposable LP kit

 \mathbf{or}

- Minor procedure tray (see page 240)
- Spinal needles (21-gauge for adults, 22-gauge for children)

Background

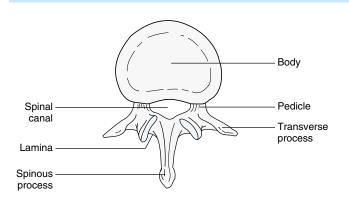
The objective of an LP is to obtain a sample of CSF from the subarachnoid space. Specifically, during an LP the fluid is obtained from the **lumbar cistern**, the volume of CSF located between the termination of the spinal cord (the conus medullaris) and the termination of the dura mater at the coccygeal ligament. The cistern is surrounded by the subarachnoid membrane and the overlying dura. Located within the cistern are the filum terminale and the nerve roots of the cauda equina. When an LP is done, the main body of the spinal cord is avoided and the nerve roots of the cauda are simply pushed out of the way by the needle.

The termination of the spinal cord in the adult is usually between L1 and L2, and in the pediatric patient between L2 and L3. The safest site for an LP is the interspace between L4

11.0

and L5. An imaginary line drawn between the iliac crests (the supracristal plane) intersects the spine at either the L4 spinous process or the L4–L5 interspace.

A spinal needle introduced between the spinous processes of L4 and L5 penetrates the layers in the following order: skin, supraspinous ligament, interspinous ligament, ligamentum flava, epidural space (contains loose areolar tissue, fat, and blood vessels), dura, "potential space," subarachnoid membrane, subarachnoid space (lumbar cistern) (Fig. 13–15).



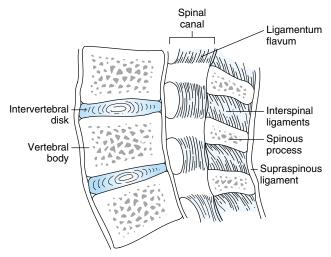


FIGURE 13–15 Basic anatomy for a lumbar puncture.

Technique

- 1. Examine the fundus for evidence of papilledema, and review the CT or MRF of the head if available. Discuss the relative safety and lack of discomfort to the patient to dispel any myths. Some clinicians prefer to call the procedure a "subarachnoid analysis" rather than a spinal tap. As long as the procedure and the risks are outlined, most patients will agree to the procedure. Have the patient sign an informed consent form.
- 2. Place the patient in the lateral decubitus position close to the edge of the bed or table. The patient (held by an assistant, if possible) should be positioned with knees pulled up toward stomach and head flexed onto chest (Fig. 13–16). This position enhances flexion of the vertebral spine and widens the interspaces between the spinous processes. Place a pillow beneath the patient's side to prevent sagging and ensure alignment of the spinal column. In an obese patient or a patient with arthritis or scoliosis, the sitting position, leaning forward, may be preferred.
- Palpate the supracristal plane (see under Background) and carefully determine the location of the L4–L5 interspace.
- 4. Open the kit, put on sterile gloves, and prep the area with povidone-iodine solution in a circular fashion and covering several interspaces. Next, drape the patient.
- 5. With a 25-gauge needle and 1idocaine, raise a skin wheal over the L4–L5 interspace. Anesthetize the deeper structures with a 22-gauge needle.
- 6. Examine the spinal needle with a stylet for defects and then insert it into the skin wheal and into the spinous ligament. Hold the needle between your index and middle fingers, with your thumb holding the stylet in place. Direct the needle cephalad at a 30–45-degree angle, in the midline and parallel to the bed (see Fig. 13–16).
- 7. Advance through the major structures and pop into the subarachnoid space through the dura. An experienced operator can feel these layers, but an inexperienced one may need to periodically remove the stylet to look for return of fluid. It is important to always replace the stylet prior to advancing the spinal needle. The needle may be withdrawn, however, with the stylet removed. This technique may be useful if the needle has passed through the back wall of the canal. Direct the bevel of the needle parallel to the long axis of the body so that the dural fibers are separated rather than sheared. This method helps cut down on "spinal headaches."
- 8. If no fluid returns, it is sometimes helpful to rotate the needle slightly. If still no fluid appears, and you think that you are within the subarachnoid space, inject 1 mL of air because it is not uncommon for a piece of tissue to clog the needle. Never inject saline or distilled water. If no air returns and if spinal fluid cannot be aspirated, the bevel of the needle probably lies in the epidural space; advance it with the stylet in place.
- 9. When fluid returns, attach a manometer and stopcock and measure the pressure. Normal opening pressure is 70–180 mm water in the lateral position. Increased pressure may be due to a tense patient, CHF, ascites, subarachnoid hemorrhage, infection, or a space-occupying lesion. Decreased pressure may be due to needle position or obstructed flow (you may need to leave the needle in for a myelogram because if it is moved, the subarachnoid space may be lost).
- 10. Collect 0.5–2.0-mL samples in serial, labeled containers. Send them to the lab in this order:
 - First tube for bacteriology: Gram's stain, routine C&S, AFB, and fungal cultures and stains
 - Second tube for glucose and protein: If a work-up for MS, order electrophoresis to
 detect oligoclonal banding and assay for myelin basic protein characteristic of MS
 - · Third tube for cell count: CBC with differential

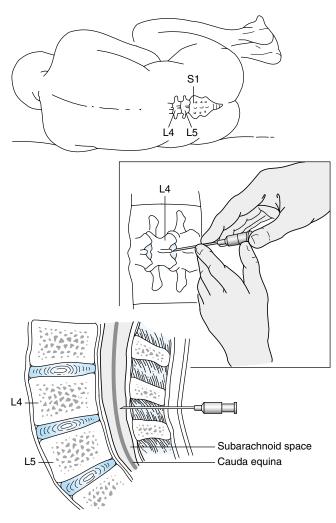


FIGURE 13–16 When performing a lumbar puncture, place the patient in the lateral decubitus position, and locate the L4–L5 interspace. Control the spinal needle with two hands, and enter the subarachnoid space.

· Fourth tube for special studies as clinically indicated:

VDRL neurosyphilis

CIEP (counterimmunoelectrophoresis) for bacterial antigens such as H. influenzae, S. Pneumoniae, N. meningitidis)

PCR assay for tuberculous meningitis or herpes simplex encephalitis (allows rapid diagnosis)

If Cryptococcus neoformans is suspected (most common cause of meningitis in AIDS patients) India ink preparation and cryptococcal antigen (latex agglutination test)

Note: Some clinicians prefer to send the first and last tubes for CBC because this procedure permits a better differentiation between a subarachnoid hemorrhage and a traumatic tap. In a traumatic tap, the number of RBCs in the first tube should be much higher than in the last tube. In a subarachnoid hemorrhage, the cell counts should be equal, and xanthochromia of the fluid should be present, indicating the presence of old blood.

- 11. Withdraw the needle and place a dry, sterile dressing over the site.
- 12. Instruct the patient to remain recumbent for 6–12 h, and encourage an increased fluid intake to help prevent "spinal headaches."
- 13. Interpret the results based on Table 13-4.

Complications

- Spinal headache: The most common complication (about 20%), this appears within the first 24 h after the puncture. It goes away when the patient is lying down and is aggravated when the patient sits up. It is usually characterized by a severe throbbing pain in the occipital region and can last a week. It is thought to be caused by intracranial traction caused by the acute volume depletion of CSF and by persistent leakage from the puncture site. To help prevent spinal headaches, keep the patient recumbent for 6–12 h, encourage the intake of fluids, use the smallest needle possible, and keep the bevel of the needle parallel to the long axis of the body to help prevent a persistent CSF leak.
- Trauma to nerve roots or to the conus medullaris: Much less frequent (some anatomic variation does exist, but it is very rare for the cord to end below L3). If the patient suddenly complains of paresthesia (numbness or shooting pains in the legs), stop the procedure.
- Herniation of either the cerebellum or the medulla: Occurs rarely, during or after
 a spinal tap, usually in a patient with increased intracranial pressure. This complication can often be reversed medically if it is recognized early.
- Meningitis.
- Bleeding in the subarachnoid/subdural space can occur with resulting paralysis especially if the patient is receiving anticoagulants or has severe liver disease with a coagulopathy.

ORTHOSTATIC BLOOD PRESSURE MEASUREMENT

Indication

· Assessment of volume depletion

Materials

· Blood pressure cuff and stethoscope

TABLE 13-4 Differential Diagnosis of Cerebrospinal Fluid

Condition	Color	Opening Pressure (mm H ₂ O)	Protein (mg/ 100 mL)	Glucose (mg/ 100 mL)	Cells (#/mm³)
NORMAL					
Adult Newborn	Clear Clear	70–180 70–180	15–45 20–120	45–80 2/3 serum	0–5 lymphocytes 40–60 lymphocytes
Viral infection ("aseptic meningitis")	Clear or opalescent	Normal or slightly increased	Normal or slightly increased	Normal	10–500 lymphocytes PMNs
Bacterial infection	Opalescent yellow, may clot	Increased	50–10,000	Increased, usually <20	25–10,000 PMNs
Granulomatous infection (TB, fungal)	Clear or opalescent	Often increased	Increased, but usually <500	Decreased, usually <20–40	10–500 lymphocytes
NEUROLOGIC					
Guillain–Barré Syndrome	Clear or Cloudy	Normal	Markedly increased	Normal	Normal or increased lymphocytes

(continued)

TABLE 13-4 (Continued)

Condition	Color	Opening Pressure (mm H ₂ O)	Protein (mg/100 mL)	Glucose (mg/100 mL)	Cells (#/mm³)
Multiple sclerosis	Clear	Normal	Normal or	Normal	0–20 lymphocytes
Pseudotumor cerebri MISCELLANEOUS	Clear	Increased	increased Normal	Normal	Normal
Neoplasm	Clear or xanthochromic	Increased	Normal or increased	Normal or decreased	Normal or increased lymphocytes
Traumatic tap	Bloody, no xanthochromia	Normal	Normal	SI increased	RBC = peripheral blood; Less RBC in tube 4 than in tube 1
Subarachnoid hemorrhage	Bloody or xanthochromic after 2–8 h	Usually increased	Increased	Normal	WBC/RBC ratio same as blood

Procedure

- Changes in blood pressure and pulse when a patient moves from supine to the upright
 position are very sensitive guides for detecting early volume depletion. Even before a
 person becomes overtly tachycardic or hypotensive because of volume loss, the demonstration of orthostatic hypotension aids in the diagnosis.
- 2. Have the patient assume a supine position for 5–10 min. Determine the BP and pulse.
- Then have the patient stand up. If the patient is unable to stand, have the patient sit at the bedside with legs dangling.
- 4. After about 1 min, determine the BP and pulse again.
- 5. A drop in systolic BP greater than 10 mm Hg or an increase in pulse rate greater than 20 (16 if elderly) suggests volume depletion. A change in heart rate is more sensitive and occurs with a lesser degree of volume depletion. Other causes include peripheral vascular disease, surgical sympathectomy, diabetes, and medications (prazosin, hydralazine, or reserpine).

PELVIC EXAMINATION

Indications

- · Part of a complete physical examination in the female
- · Used to assist in the diagnosis of diseases and conditions of the female genital tract

Materials

- Gloves
- · Vaginal speculum and lubricant
- Slides, fixative (Pap aerosol spray, etc), cotton swabs, endocervical brush and cervical spatula prepared for a Pap smear
- Materials for other diagnostic tests: Culture media to test for gonorrhea, Chlamydia, herpes; sterile cotton swabs, plain glass slides, KOH, and normal saline solutions as needed

Procedure

- 1. The pelvic exam should be carried out in a comfortable fashion for both the patient and physician. A female assistant must be present for the procedure. The patient should be draped appropriately with her feet placed in the stirrups on the examining table. Prepare a low stool, a good light source, and all needed supplies before the exam begins. In unusual situations examinations are conducted on a stretcher or bed; raise the patients buttocks on one or two pillows to elevate the perineum off the mattress.
- 2. Inform the patient of each move in advance. Glove hands before proceeding.
- 3. General inspection:
 - Observe the skin of the perineum for swelling, ulcers, condylomata (venereal warts), or color changes.
 - b. Separate the labia to examine the clitoris and vestibule. Multiple clear vesicles on an erythematous base on the labia suggest herpes.
 - c. Observe the urethral meatus for developmental abnormalities, discharge, neoplasm, and abscess of Bartholin's gland at the 4 or 8 o'clock positions.
 - d. Inspect the vaginal orifice for discharge, or protrusion of the walls (cystocele, rectocele, urethral prolapse).
 - e. Note the condition of the hymen.

4. Speculum examination:

- a. Use a speculum moistened with warm water not with lubricant (lubricant will interfere with Pap tests and slide studies). Check the temperature on the patient's leg to see if the speculum is comfortable.
- b. Because the anterior wall of the vagina is close to the urethra and bladder, do not exert pressure in this area. Pressure should be placed on the posterior surface of the vagina. With the speculum directed at a 45-degree angle to the floor, spread the labia and insert the speculum fully, pressing posteriorly. The cervix should pop into view with some manipulation as the speculum is opened.
- c. Inspect the cervix and vagina for color, lacerations, growths, nabothian cysts, and evidence of atrophy.
- d. Inspect the cervical os for size, shape, color, discharge.
- e. Inspect the vagina for secretions and obtain specimens for a Pap smear, other smear, or culture (see tests for vaginal infections and Pap smear in item 7).
- f. Inspect the vaginal wall; rotate the speculum as you draw it out to see the entire canal.

5. Bimanual examination:

- a. For this part, stand up. It is best to use whichever hand is comfortable to do the internal vaginal exam. Remove the glove from the hand that will examine the abdomen.
- b. Place lubricant on the first and second gloved fingers, and then, keeping pressure on the posterior fornix, introduce them into the vagina.
- c. Palpate the tissue at 5 and 7 o'clock between the first and second fingers and the thumb to rule out any abnormality of Bartholin's gland. Likewise, palpate the urethra and paraurethral (Skene's) gland.
- d. Place the examining fingers on the posterior wall of the vagina to further open the introitus. Ask the patient to bear down. Look for evidence of prolapse, rectocele, or cystocele.
- e. Palpate the cervix. Note the size, shape, consistency, and motility, and test for tenderness (the so-called **chandelier sign** or marked cervical tenderness, which is positive in PID).
- f. With your fingers in the vagina posterior to the cervix and your hand on the abdomen placed just above the symphysis, force the corpus of the uterus between the two examining hands. Note size, shape, consistency, position, and motility.
- g. Move the fingers in the vagina to one or the other fornix, and place the hand on the abdomen in a more lateral position to bring the adnexal areas under examination. Palpate the ovaries, if possible, for any masses, consistency, and motility. Unless the fallopian tubes are diseased, they usually are not palpable.

6. Rectovaginal examination:

- Insert your index finger into the vagina, and place the well-lubricated middle finger in the rectum.
- b. Palpate the posterior surface of the uterus and the broad ligament for nodularity, tenderness, or other masses. Examine the uterosacral and rectovaginal septum. Nodularity here may represent endometriosis.
- c. It may also be helpful to do a test for occult blood if a stool specimen is available.

7. Papanicolaou (Pap) smear:

The Pap smear is helpful in the early detection of cervical intraepithelial neoplasia and carcinoma. Endometrial carcinoma is occasionally identified on routine Pap smears. It is recommended that low-risk patients have routine Pap smears done every 2–3 y, but only after three annual Pap smears are negative. High-risk patients such as those exposed to in utero DES, patients with HPV infections, history of cervical dysplasia or cervical intraep-

ithelial neoplasia, more than two sexual partners in the patient's lifetime, and intercourse prior to age 20 should obtain an annual Pap smear.

- a. With the unlubricated speculum in place, use a wooden cervical spatula to obtain a scraping from the squamocolumnar junction. Rotate the spatula 360 degrees around the external os. Smear on a frosted slide that has the patient's name written on it in pencil. Fix the slide either in a bottle of fixative or with commercially available spray fixative. The slide must be fixed within 10 s or a drying artifact may occur.
- b. Next, obtain a specimen from the endocervical canal using a cotton swab or commercial available endocervical brush and prepare the slide as described in part a.
- c. Using a wooden spatula, an additional specimen should be obtained from the posterior/lateral vaginal pool of fluid and smeared on a slide.
- d. Complete the appropriate lab slips. Forewarn the patient that she may experience some spotty vaginal bleeding following the Pap smear.

8. Tests for cervical/vaginal infections:

- GC culture: Use a sterile cotton swab to obtain a specimen from the endocervical canal and plate it out on Thayer-Martin medium.
- b. Vaginal saline (wet) prep: Helpful in the diagnosis of Trichomonas vaginalis or Gardnerella vaginalis. A thin, foamy, white, pruritic discharge is associated with a Trichomonas infection. Mix a drop of discharge with a drop of NS on a glass slide and cover the drop with a coverslip. It is important to observe the slide while it is still warm to see the flagellated, motile trichomonads. If a patient has a thin, watery, gray, malodorous discharge, an infection with Gardnerella vaginalis may be present. Bacterial vaginosis is most often caused by G. vaginalis and can be diagnosed by the presence of "clue cells," which represent polymorphonuclear white cells dotted with the G. vaginalis bacteria, a vaginal pH of > 4.5 and a fishy amine odor with addition of KOH to the secretions. Alternatively, these can be seen by using a hanging drop of saline and a concave slide. Lactobacillus is normally the predominant bacteria in the vagina in the absence of specific infection and the normal pH is usually < 4.5.</p>
- c. Potassium hydroxide prep: If a thick, white, curdy discharge is present, the patient may have a Candida albicans (monilial) yeast infection. Prepare a slide with one drop of discharge and one drop of aqueous 10% KOH solution. The KOH dissolves the epithelial cells and debris and facilitates viewing of the hyphae and mycelia of the fungus that causes the infection.
- d. Gram's stain: Material can easily be stained in the usual fashion (Chapter 7, page 122). Gram-negative intracellular diplococci (so-called GNIDs) are pathognomonic of *Neisseria gonorrhoeae*. The most commonly found bacteria in Gram's stains are large gram-positive rods (lactobacilli), which are normal vaginal flora.
- e. Herpes cultures: A routine Pap smear of the cervix or a Pap smear of the herpetic lesion (multiple, clear vesicles on a painful, erythematous base) may demonstrate herpes inclusion bodies. A herpes culture may be done by taking a viral culture swab of the suspicious lesion or of the endocervix.
- f. Chlamydia cultures: Special swabs can be obtained from the microbiology lab for Chlamydia cultures.

PERICARDIOCENTESIS

Indications

- · Emergency treatment of cardiac tamponade
- · Diagnose the cause of pericardial effusion

Contraindications

- Minimal pericardial effusion (< 200 mL)
- · After CABG due to risk of injury to grafts
- · Uncorrected coagulopathy

Materials

- · Electrocardiogram machine
- Prepackaged pericardiocentesis kit or Procedure and instrument tray (page 240) with pericardiocentesis needle or 16–18-gauge needle 10 cm long

Background

Cardiac tamponade results in decreased cardiac output, increased right atrial filling pressures, and a pronounced pulsus paradoxus.

Procedure

- 1. If time permits, use sterile prep and draping with gown, mask, and gloves.
- Draining the pericardium can be approached either through the left para xiphoid or the left parasternal fourth intercostal space. The para xiphoid is safer, more commonly used, and described here (Fig. 13–17).
- 3. Anesthetize the insertion site with lidocaine. Connect the needle with an alligator clip to lead V on the ECG machine. Attach the limb leads, and monitor the machine.
- Insert the pericardiocentesis needle just to the left of the xiphoid and directed upward 45 degrees toward the left shoulder.
- Aspirate while advancing the needle until the pericardium is punctured and the effusion is tapped. If the ventricular wall is felt, withdraw the needle slightly. Additionally, if the needle contacts the myocardium, pronounced ST segment elevation will be noted on the ECG.
- If performed for cardiac tamponade, removal of as little as 50 mL of fluid dramatically improves blood pressure and decreases right atrial pressure.
- Blood from a bloody pericardial effusion is usually defibrinated and will not clot, whereas blood from the ventricle will clot.
- 8. Send fluid for hematocrit, cell count, or cytology if indicated. Serous fluid is consistent with CHF, bacterial infection, TB, hypoalbuminemia, or viral pericarditis. Bloody fluid (HCT >10%) may result from trauma; be iatrogenic; or due to MI, uremia, coagulopathy, or malignancy (lymphoma, leukemia, breast, lung most common)
- If continuous drainage is necessary, use a guidewire to place a 16-gauge intravenous catheter.

Complications

Arrhythmia, ventricular puncture, lung injury

PERIPHERALLY INSERTED CENTRAL CATHETER (PICC LINE) Indications

- · Home infusion of hypertonic or irrigating solutions and drugs
- · Long-term infusion of medications (antibiotics, chemotherapeutics)
- TPN
- · Repetitive venous blood sampling

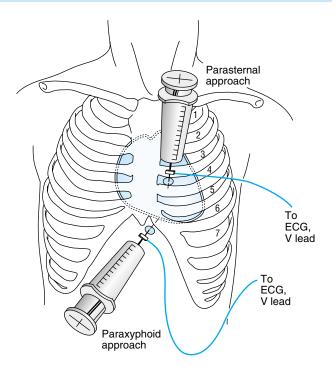


FIGURE 13-17 Techniques for pericardiocentesis. The paraxiphoid approach is the most popular. (Reprinted, with permission, from: Stillman RM [ed]: *Surgery, Diagnosis, and Therapy, Appleton & Lange, Norwalk CT, 1989.*)

Contraindications

- · Infection over placement site
- · Failure to identify veins in an arm with a tourniquet in place

Materials

- PICC catheter kit (contains most items necessary including the silastic long arm line)
- · Tourniquet, sterile gloves, mask, sterile gown, heparin flush, 10-mL syringes

Background

Installation of a PICC allows for central venous access through a peripheral vein. Typically, a long-arm catheter is placed into the basilic or cephalic vein (See Fig. 13–12) and is threaded into the subclavian vein/superior vena cava. PICCs are useful for long-term home infusion therapies. The design of PICC catheters can vary, and the operator should be familiar with the features of the device (attached hub or detachable hub designs).

Procedure

- Explain the procedure to the patient and then obtain informed consent. Position the patient in a sitting or reclining position with the elbow extended and the arm in a dependent position. The arm should be externally rotated.
- Using a measuring tape, determine the length of the catheter required. Measure from the extremity vein insertion site to the subclavian vein.
- Wear mask, gown, protective eyewear, and sterile gloves. Prep and drape the skin in the standard fashion. Set up an adjacent sterile working area.
- Anesthetize the skin at the proposed area of insertion. Apply a tourniquet above the proposed IV site.
- Trim the catheter to the appropriate length. Most PICC lines have an attached hub, and the distal end of the catheter is cut to the proper length. Flush with heparinized saline.
- Insert the catheter and introducer needle (usually 14-gauge) into the chosen arm vein as detailed in the section on IV techniques (page 279). Once the catheter is in the vein, remove the introducer needle.
- 7. Place the PICC line in the catheter and advance (use a forceps if provided by the manufacturer of the kit to advance the PICC line). Remove the tourniquet and gradually advance the catheter the requisite length. Remove the inner stiffening wire slowly once the catheter has been adequately advanced.
- Peel away the introducer catheter. Attach the Luer-lock, and flush the catheter again with heparin solution. Attempt to also aspirate blood to verify patency.
- Attach the provided securing wings, and suture in place. Apply a sterile dressing over the insertion site.
- Confirm placement in the central circulation with a chest x-ray. Always document the type of PICC, the length inserted, and the site of its radiologically confirmed placement.
- 11. If vein cannulation is difficult, a surgical cutdown may be necessary to cannulate the vein. If the catheter will not advance, fluoroscopy may be helpful.
- 12. Instruct the patient on the maintenance of the PICC. The PICC should be flushed with heparinized saline after each use. Dressing changes should be performed at least every 7 d under sterile conditions. Patient must be instructed to evaluate the PICC site for signs and symptoms of infection. Patient must also be instructed to come to the emergency room for evaluation of any fevers.
- 13. For venous samples, a specimen of at least the catheter volume (1-3 mL) must first be withdrawn and then discarded. The PICC must always be flushed with heparinized saline after each blood draw.

PICC Removal

Position the patient's arm at a 90-degree angle to his body. Remove the dressing and gently pull the PICC out. Apply pressure to site for 2–3 min. Always measure the length of the catheter and check prior documentation to ensure that the PICC line has been removed in its

entirety. If a piece of a catheter is left behind, an emergency interventional radiology consult is in order.

Complications

Site bleeding, clotted catheter, subclavian thrombosis, infection, broken catheter (leakage or embolization), arrhythmia (catheter inserted too far)

PERITONEAL LAVAGE

Indications

- Diagnostic peritoneal lavage (DPL) is used in the evaluation of intraabdominal trauma (bleeding, perforation) (Note: Spiral CT of the abdomen has largely replaced this as an initial screening for intraabdominal trauma in the emergency setting.)
- Acute peritoneal dialysis and the treatment of severe pancreatitis

Contraindications

None are absolute. Relative contraindications include multiple abdominal procedures, pregnancy, known retroperitoneal injury (high false-positive rates) cirrhosis, morbid obesity and any coagulopathy.

Materials

· Prepackaged diagnostic peritoneal lavage or peritoneal dialysis tray

Procedure

- A Foley catheter and a nasogastric or oro gastric tube must be in place. Prep the abdomen from above the umbilicus to the pubis.
- The site of choice is in the midline 1–2 cm below the umbilicus. Avoid the site of old surgical scars (danger of adherent bowel). If a subumbilical scar or pelvic fracture is present, a supraumbilical approach is recommended.
- Infiltrate the skin with 1idocaine with epinephrine. Incise the skin in the midline vertically, and expose the fascia.
- 4. Either pick up the fascia and incise it, or puncture it with the trocar and peritoneal catheter. Caution is needed to avoid puncturing any organs. Use one hand to hold the catheter near the skin and to control the insertion while using the other hand to apply pressure to the end of the catheter. After entering the peritoneal cavity, remove the trocar and direct the catheter inferiorly into the pelvis.
- During a diagnostic lavage, gross blood indicates a positive tap. If no blood is encountered, instill 10 mL/kg (about 1 L in adults) of lactated Ringer's solution or NS into the abdominal cavity.
- 6. Gently agitate the abdomen to distribute the fluid and after 5 min, drain off as much fluid as possible into a bag on the floor. (Minimum fluid for a valid analysis is 200 mL in an adult.) If the drainage is slow, try instilling additional fluid, carefully repositioning the catheter.
- Send the fluid for analysis (amylase, bile, bacteria, hematocrit, cell count). See Table 13–5 for interpretation.
- Remove the catheter and suture the skin. If the catheter is inserted for pancreatitis or peritoneal dialysis, suture it in place.

Criteria for Evaluation of Peritoneal Lavage Fluid

Positive >20 mL gross blood on free aspiration (10 mL in children)

≥100.000 RBC/mL

≥500 WBC/mL (if obtained >3 h after the injury)

≥175 units amylase/dL Bacteria on Gram's stain

Bile (by inspection or chemical determination of bilirubin content)

Food particles (microscopic analysis of strained or spun

specimen)

Intermediate Pink fluid on free aspiration

50,000-100,000 RBC/mL in blunt trauma

100-500 WBC/mL 75-175 units amylase/dL

Negative Clear aspirate

> ≤ 100 WBC/mL ≤75 units amylase/dL

Source: Reprinted, with permission, from: Way L (ed): Current Surgical Diagnosis and Treatment, 10e. Appleton and Lange, Norwalk CT. 1994. Abbreviations: RBC = red blood cells: WBC = white blood cells.

9. A negative DPL does not rule out retroperitoneal trauma. A false-positive DPL can be caused by a pelvic fracture or bleeding induced by the procedure (eg, laceration of an omental vessel).

Complications

Infection/peritonitis or superficial wound infection, bleeding, perforated viscus (bladder, bowel)

PERITONEAL (ABDOMINAL) PARACENTESIS

Indications

- · To determine the cause of ascites
- · To determine if intraabdominal bleeding is present or if a viscus has ruptured (Diagnostic peritoneal lavage is considered a more accurate test. See preceding procedure.)
- · Therapeutic removal of fluid when distention is pronounced or respiratory distress is associated with it (acute treatment only)

Contraindications

- · Abnormal coagulation factors
- Bowel obstruction, pregnancy

 Uncertainty if distention is due to peritoneal fluid or to a cystic structure (ultrasound can usually differentiate)

Materials

- Minor procedure tray (see page 240)
- Catheter-over-needle assembly (Angiocath, Insyte 18–20-gauge with a 1½-in. needle)
- 20–60-mL syringe
- · Sterile specimen containers

Procedure

Peritoneal paracentesis is surgical puncture of the peritoneal cavity for the aspiration of fluid. Ascites is indicated by abdominal distention, shifting dullness, and a palpable fluid wave.

- Explain the procedure and have the patient sign an informed consent form. Have the
 patient empty the bladder, or place a Foley catheter if voiding is impossible or if significant mental status changes are present.
- 2. The entry site is usually the midline 3-4 cm below the umbilicus. Avoid old surgical scars because the bowel may be adhering to the abdominal wall. Alternatively, the entry site can be in the left or right lower quadrant midway between the umbilicus and the anterior superior iliac spine or in the patient's flank, depending on the percussion of the fluid wave (Fig. 13-18).
- Prep and drape the patient appropriately. Raise a skin wheal with the lidocaine over the proposed entry site.
- 4. With the catheter mounted on the syringe, go through the anesthetized area carefully at an oblique angle while gently aspirating. You will meet some resistance as you enter the fascia. When you get free return of fluid, leave the catheter in place, remove the needle, and begin to aspirate. Sometimes it is necessary to reposition the catheter because of abutting bowel.
- Aspirate the amount of fluid needed for tests (20–30 mL). If the tap is therapeutic, 10–15 L can be safely removed. This large volume must be removed relatively slowly.
- Quickly remove the needle, apply a sterile 4 × 4 gauze square, and apply pressure with tape.
- Depending on the clinical picture of the patient, send samples for total protein, specific gravity, LDH, amylase, cytology, culture, stains, or CBC.

Complications

Peritonitis, perforated viscus, hemorrhage, precipitation of hepatic coma if patient has severe liver disease, oliguria, hypotension

Diagnosis of Ascitic Fluid

A complete listing is found in Chapter 3, page 43. **Transudative ascites** is found with cirrhosis, nephrosis, and CHF. **Exudative ascites** is found with tumors, peritonitis (TB, perforated viscus), hypoalbuminemia. See Table 13–6 to interpret the results of fluid analysis.

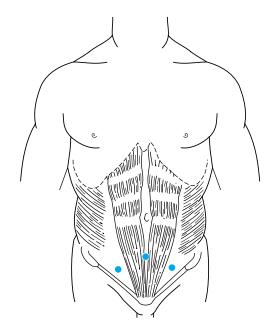


FIGURE 13–18 Preferred sites for abdominal (peritoneal) paracentesis. Be sure to avoid old surgical scars. (Reprinted, with permission, from: Krupp MA [ed]: *The Physician's Handbook*, 21st ed. Lange Medical Publications, Los Altos CA, 1985.)

PULMONARY ARTERY CATHETERIZATION

(See Chapter 20, page 399)

PULSUS PARADOXUS MEASUREMENT

(See also Chapter 20, page 393)

Indication

· Used in the evaluation of cardiac tamponade and other diseases

Materials

· Blood pressure cuff and stethoscope

TABLE 13–6
Differential Diagnosis of Ascitic of Pleural Fluid

Lab Value	Transudate	Exudate
Appearance	Clear yellow	Clear or turbid
Specific gravity	<1.016	>1.016
Absolute protein	< 3 g/100 mL	>3 g/100 mL
Protein (ascitic or pleural to serum ratio)	<0.5	>0.5
LDH (ascitic or pleural to serum ratio)	<0.6	>0.6
Absolute LDH	<200 IU	>200 IU
Glucose (serum to ascitic or pleural ratio)	<1	>1
Fibrinogen (clot)	No	Yes
WBC (ascitic)	$< 500 / \text{mm}^3$	$> 1000 / mm^3$
WBC (pleural)	Very low	$>2500/mm^{3}$
Differential (pleural)	,	PMNs early,
RBC (ascitic)		monocytes later >100 RBC/mm ³
OTHER SELECTED TESTS		

OTHER SELECTED TESTS

Cytology: Bizarre cells with large nuclei may represent reactive mesothelial cells and not a malignancy. Malignant cells suggest a tumor.

pH (pleural): Generally >7.3. If between 7.2 and 7.3, suspect TB or malignancy or both. If <7.2, suspect empyema.

Glucose (pleural): Normal pleural fluid glucose is % serum glucose. Pleural fluid glucose is much lower than serum glucose in effusions due to rheumatoid arthritis (0–16 mg/100 ml.); low <40 mg/100 ml in empyema. Triglycerides and positive Sudan stain (pleural fluid): Chylothorax. Food fibers (ascitic): Perforated viscus.

Abbreviations: LDH = lactate dehydrogenase; WBC = white blood cells; RBC = red blood cells; PMNs = polymorphonuclear neutrophils; TB = tuberculosis.

Background

Pulsus paradoxus is an exaggeration of the normal inspiratory drop in arterial pressure. Inspiration decreases intrathoracic pressure. The result is increased right atrial and right ventricular filling with an increase in right ventricular output. Because the pulmonary vascular bed also distends, these changes lead to a delay in left ventricular filling and subsequently a decreased left ventricular output. This drop in systolic blood pressure is usually <10 mm Hg.

In the case of cardiac compression (eg, acute asthma or pericardial tamponade), the right side of the heart fills more with inspiration and decreases the left ventricular volume to even greater degree as a result of compression of the pericardial sac. This exaggerated

decrease in left ventricular output drops the systolic pressure >10 mm Hg. See Figure 20–1 (page 394) for a graphic representation of a paradoxical pulse.

Procedure

- A simple, qualitative method involves palpating the radial pulse, which "disappears" on normal inspiration.
- A more precise quantitative method requiring that the patient take a breath, let it out, and hold it. Determine the systolic BP.
- Ask the patient to breathe again. Once the patient is breathing normally, drop the pressure in the cuff slowly until you hear the pulse during inspiration.
- The difference in systolic pressure should be <10 mm Hg. If not, a so-called paradox exists.
- Differential diagnosis includes pericardial effusion, cardiac tamponade, pericarditis, COPD, bronchial asthma, restrictive cardiomyopathies, hemorrhagic shock

SIGMOIDOSCOPY (RIGID)

Indications

- · Diagnosis and treatment of lower gastrointestinal problems
- · Part of the standard work-up of blood in the stool

Materials

- · Examination gloves, lubricant, tissues
- · Occult blood stool test kit (Hemoccult paper and developer)
- · Sigmoidoscope with obturator and light source
- Insufflation bag
- · Long (rectal) swabs and suction catheter
- · Proctologic examination table (helpful but not essential)

Procedure

- 1. Several techniques can be used to examine the distal large bowel. These include rigid sigmoidoscopy (endoscopic examination of the last 25 cm of the GI tract), flexible sigmoidoscopy (examination up to 40 cm from the end of the GI tract), proctoscopy (roughly synonymous to sigmoidoscopy, but technically means examination of the last 12 cm), and anoscopy (examination of the anus and most distal rectum).
- Enemas and cathartics are not routinely given before sigmoidoscopy, although some people prefer to give a mild prep such as a Fleet's enema just before the exam. Explain the procedure, and have the patient sign a consent form.
- 3. Sigmoidoscopy can be performed with the patient in bed lying on side in the knee-chest position, but the best results are obtained with the patient in the "jackknife" position on the procto table. Do not position the patient until all materials are at hand and you are ready to start.
- Converse with the patient to create distraction and to relieve apprehension. Announce each maneuver in advance. Glove before proceeding.
- 5. Observe the anal region for skin tags, hemorrhoids, fissures, and so on. Do a careful rectal exam with a gloved finger and plenty of lubricant, and check for fecal occult blood (Hemoccult test) on the stool recovered on the glove.

- 6. Lubricate the sigmoidoscope well with water-soluble jelly, and insert it with the obturator in place. Aim toward the patient's umbilicus initially. Advance 2–3 cm past the internal sphincter, and remove the obturator.
- 7. Always advance under direct vision and make sure that the lumen is always visible (Fig. 13–19). Insufflation (introducing air) may be used to help visualize the lumen, but remember this may be painful. It is necessary to follow the curve of the sigmoid toward the sacrum by directing the scope more posteriorly toward the back. A change from a smooth mucosa to concentric rings signifies entry into the sigmoid colon. The scope should reach 15 cm with ease. Use suction and the rectal swabs as needed to clear the way.
- 8. At this point, the sigmoid curves to the patient's left. Warn the patient that he or she may feel a cramping sensation. If you ever have difficulty negotiating a curve, do not force the scope.
- 9. After advancing as far as possible, slowly remove the scope; use a small rotary motion to view all surfaces. Observation here is critical. Remember to release the air from the colon before withdrawing the scope.
- 10. Inform the patient that he or she may experience mild cramping after the procedure.

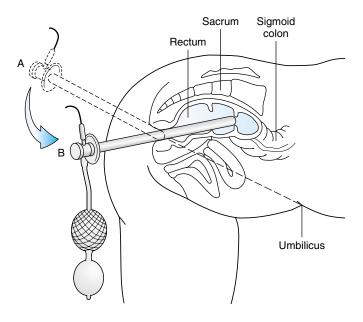


FIGURE 13-19 The sigmoidoscope is advanced under direct vision as shown.

Complications

· Bleeding, bowel perforation (rare)

SKIN BIOPSY

Indications

- · Any skin lesion or eruption for which the diagnosis is unclear
- · Any refractory skin condition

Contraindications

Any skin lesion that is suspected to be a malignancy (eg, melanoma) should be referred
to a plastic surgeon or dermatologist for excisional biopsy rather than a punch biopsy.

Materials

- · 2-, 3-, 4-, or 5-mm skin punch
- Minor procedure tray (page 240)
- Curved iris scissors and fine-toothed forceps (Ordinary forceps may distort a small biopsy specimen and should not be used.)
- · Specimen bottle containing 10% formalin
- Suturing materials (3-0 or 4-0 nylon)

Procedure

- If more than one lesion is present, choose one that is well developed and representative
 of the dermatosis. For patients with vesiculobullous disease, an early edematous lesion
 should be chosen rather than a vesicle. Avoid lesions that are excoriated or infected.
- Mark the area to be biopsied with a skin-marking pen. Inject the lidocaine to form a skin wheal over the site of the biopsy.
- 3. After putting on sterile gloves and preparing a sterile field, take the punch biopsy specimen. First, immobilize the skin with the fingers of one hand, applying pressure perpendicular to the skin wrinkle lines with the skin punch. Core out a cylinder of skin by twirling the punch between the fingers of the other hand. As the punch enters into the subcutaneous fat, resistance will lessen. At this point, the punch should be removed. The core of tissue usually pops up slightly and can be cut at the level of the subcutaneous fat with curved iris scissors without using forceps. If a tissue core does not pop up, it may be elevated by use of a hypodermic needle or fine-toothed forceps. Be sure to include a portion of the subcutaneous fat in the specimen.
- 4. Place the specimen in the specimen container.
- 5. Hemostasis can be achieved by pressure with the gauze pad.
- 6. Defects from 1.5 and 2-mm punches usually do not require suturing and heal with very minimal scarring. Punch defects that are 2–4 mm can generally be closed with a single suture.
- 7. A dry dressing should be applied and removed the following day.
- **8.** Sutures can be removed as early as 3 d from the face and 7–10 d from other areas.

Complications

Infection (unusual); hemorrhage (usually controlled by simple application of pressure); keloid formation, especially in a patient with a prior history of keloid formation

SKIN TESTING

Indications

- Screening for current or past infectious agent (TB, coccidioidomycosis, etc)
- · Screening for immune competency (so-called anergy screen) in debilitated patients

Materials

- Appropriate antigen (usually 0.1 mL)(eg, 5 TU PPD)
- A small, short needle (25-, 26-, or 27-gauge)
- · 1-mL syringe
- · Alcohol swab

Procedure

- 1. Skin tests for delayed type hypersensitivity (type IV, tuberculin) are the most commonly administered and interpreted. Delayed hypersensitivity (so called because a lag time of 12–36 h is required for a reaction) is caused by the activation of sensitized lymphocytes after contact with an antigen. The inflammatory reaction results from direct cytotoxicity and the release of lymphokines. Allergy tests (immediate wheal and flare) are rarely performed by the student or house officer.
- The most commonly used site is the flexor surface of the forearm, approximately 4 in. below the elbow crease.
- 3. Prep the area with alcohol. With the bevel of the 27-gauge needle up, introduce the needle into the upper layers of skin, but not into the subcutis. Inject 0.1 mL of antigen such as the PPD. The goal is to inject the antigen intradermally. If done properly, you will raise a discrete white bleb, approximately 10 mm in diameter (known as the Mantoux test). The bleb should disappear soon, and no dressing is needed. If a bleb is not raised, move to another area and repeat the injection.
- 4. Mark the test site with a pen, and if multiple tests are being administered, identify each one. Also, document the site in the patient's chart.
- 5. To interpret the skin test, examine the injection site at 48–72 h. If nonreactive, check again at 72 h. Measure the area of induration (the firm raised area), not the erythematous area. Use a ballpoint pen held at approximately a 30-degree angle and bring it lightly toward the raised area. Where the pen touches is the area of induration. Measure two diameters and take the average.
- It is important to check the PPD and other tests at intervals. If the patient develops a severe reaction to the skin test, apply hydrocortisone cream to prevent skin sloughing.

Specific Skin Tests

TST (Tuberculin Skin Testing): Routine TST in low-risk individuals is not currently recommended. High-risk individuals should undergo periodic TST (CXR findings suspicious for TB, recent contact of known or suspected TB cases, [includes health care workers], high-risk immigrants [Asia, Africa, Middle East, Latin America], medically underserved (IV drug abusers, alcoholics, homeless), chronically institutionalized, HIV-infected or immunosuppression)

The **Mantoux test** is the standard technique for TST and relies on the intradermal injection of **PPD**. The **tine test** for TB is no longer recommended by the CDC. The PPD comes in three tuberculin unit "strengths": 1 TU ("first"), 5 TU ("intermediate"), and 250 TU ("second"). 1 TU is used if the patient is expected to be hypersensitive (history of a positive

skin test); 5 TU is the standard initial screening test. A patient who has a negative response to a 5-TU test dose may react to the 250-TU solution. A patient who does not respond to the 250-TU is considered nonreactive to PPD. A patient may not react if he or she has not been exposed to the antigen or if the patient is anergic and unable to respond to any antigen challenge. A positive TST indicates the presence of *M. tuberculosis* infection, either active or past (dormant) and an intact cell-mediated immunity.

Interpretation of a positive PPD test is based on the clinical scenario. Patients who have been previously immunized with percutaneous BCG may give a false-positive PPD, usually 10 mm or less.

- 0-5 mm induration: Negative response
- ≥5 mm: Considered positive in contacts of known TB cases, CXR findings consistent with TB infection, HIV infection or in patients who are immunosuppressed, occasionally in non-TB mycobacterial infection due to cross reactivity
- ≥10 mm induration: Considered positive in patients with chronic diseases (diabetics, alcoholics, IV drug abusers, other chronic diseases), homeless, immigrants from known TB regions, children <4 y
- >15 mm induration: Positive in individuals who are healthy and otherwise do not meet the preceding risk categories

An anergy Screen (Anergy Battery): An anergy screen is based on the assumption that a patient has been exposed in the past to certain common antigens and a healthy patient is able to mount a reaction to them. To perform the screen, antigens such as mumps, or Candida. These are generally applied and read just like the PPD test (a reaction of >5 mm induration is considered a positive test and indicates intact cellular immunity). Anergy screens are sometimes used to evaluate a patient's immunological status and in the following specific situations: If you suspect a patient is PPD-positive, and the patient does not react to the test, do an anergy screen along with the PPD test to see if the patient has any cellular immune response.

THORACENTESIS

Indications

- · Determining the cause of a pleural effusion
- · Therapeutically removing pleural fluid in the event of respiratory distress
- Aspirating small pneumothoraces where the risk of recurrence is small (ie, postoperative without lung injury)
- Instilling sclerosing compounds (eg, tetracycline) to obliterate the pleural space

Contraindications

 None are absolute (pneumothorax, hemothorax, or any major respiratory impairment on the contralateral side, or coagulopathy)

Materials

Prepackaged thoracentesis kit with either needle or catheter (preferred)

\mathbf{or}

- Minor procedure tray (page 240)
- 20-60 mL syringe, 20- or 22-gauge needle 1½-in. needle, three-way stopcock
- · Specimen containers

Procedure

Thoracentesis is the surgical puncture of the chest wall to aspirate fluid or air from the pleural cavity. The area of pleural effusion is dull to percussion with decreased whisper or breath sounds. Pleural fluid causes blunting of the costophrenic angles on chest x-ray. Blunting usually indicates that at least 300 mL of fluid is present. If you suspect that less than 300 mL of fluid is present or you suspect that the fluid is loculated (trapped and not free-flowing), a lateral decubitus film is helpful. Loculated effusions do not layer out. Thoracentesis can be done safely on fluid visualized on lateral decubitus film if at least 10 mm of fluid is measurable on the decubitus x-ray. Ultrasound may also be used to localize a small or loculated effusion.

- Explain the procedure, and have the patient sign an informed consent form. Have the
 patient sit up comfortably, preferably leaning forward slightly on a bedside tray table.
 Ask the patient to practice increasing intrathoracic pressure using the Valsalva maneuver or by humming.
- 2. The usual site for thoracentesis is the posterior lateral aspect of the back over the diaphragm but under the fluid level. Confirm the site by counting the ribs based on the x-ray and percussing out the fluid level. Avoid going below the eighth intercostal space because the risk of peritoneal perforation is great.
- Use sterile technique, including gloves, povidone-iodine prep, and drapes. Thoracentesis kits come with an adherent drape with a hole in it.
- 4. Make a skin wheal over the proposed site with a 25-gauge needle and 1idocaine. Change to a 22-gauge, 1½-in. needle and infiltrate up and over the rib (Fig. 13–20); try

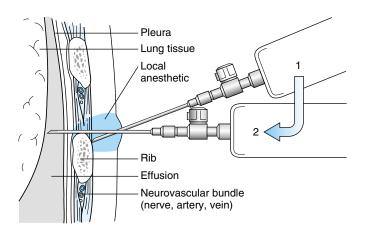


FIGURE 13-20 When performing a thoracentesis, the needle is passed over the top of the rib to avoid the neurovascular bundle.

- to anesthetize the deeper structures and the pleura. During this time, you should be aspirating back for pleural fluid. Once fluid returns, note the depth of the needle and mark it with a hemostat. This gives you an approximate depth. Remove the needle.
- 5. Use a hemostat to measure the 14–18-gauge thoracentesis needle to the same depth as the first needle. Penetrate through the anesthetized area with the thoracentesis needle. Make sure that you "march" over the top of the rib to avoid the neurovascular bundle that runs below the rib (see Fig. 13–20). With the three-way stopcock attached, advance the thoracentesis catheter through the needle, withdraw the needle from the chest, and place the protective needle cover over the end of the needle to prevent injury to the catheter. Next, aspirate the amount of pleural fluid needed. Turn the stopcock, and evacuate the fluid through the tubing. Never remove more than 1000–1500 mL per tap! This may result in hypotension or the development of pulmonary edema due to reexpansion of compressed alveoli.
- Have the patient hum or do the Valsalva maneuver as you withdraw the catheter. This maneuver increases intrathoracic pressure and decreases the chances of a pneumothorax. Bandage the site.
- Obtain a chest x-ray to evaluate the fluid level and to rule out a pneumothorax. An expiratory film may be best because it helps reveal a small pneumothorax.
- 8. Distribute specimens in containers, label slips, and send them to the lab. Always order pH, specific gravity, protein, LDH, cell count and differential, glucose, Gram's stain and cultures, acid-fast cultures and smears, and fungal cultures and smears. Optional lab studies are cytology if you suspect a malignancy, amylase if you suspect an effusion secondary to pancreatitis (usually on the left) or esophageal perforation, and a Sudan stain and triglycerides (>110 mg/dL) if a chylothorax is suspected.

Complications

 Pneumothorax, hemothorax, infection, pulmonary laceration, hypotension, hypoxia due to ventilation-perfusion mismatch in the newly aerated lung segment

Differential Diagnosis of Pleural Fluid

For a more complete differential, see Chapter 3. **Transudate** is usually associated with nephrosis, CHF, cirrhosis; an **exudate** is associated with infection (pneumonia, TB), malignancy, empyema, peritoneal dialysis, pancreatitis, chylothorax. See Table 13–6, page 299, for the differential diagnosis.

URINARY TRACT PROCEDURES Bladder Catheterization

Indications

- · Relieving urinary retention
- Collecting an uncontaminated urine specimen for diagnostic purposes
- · Monitoring urinary output in critically ill patients
- Performing bladder tests (cystogram, cystometrogram)

Contraindications

- · Urethral disruption, often associated with pelvic fracture
- · Acute prostatitis (relative contraindication)

Materials

- Prepackaged bladder catheter tray (may or may not include a Foley catheter)
- · Catheter of choice (see Fig. 13-21):

Foley: Balloon at the tip to keep it in the bladder. Use a 16–18 French for adults (the higher the number, the larger the diameter). Irrigation catheters ("three-way Foley") should be larger (20–22 French).

Coudé (pronounced "COO-DAY"): An elbow-tipped catheter useful in males with prostatic hypertrophy (the catheter is passed with the tip pointing to 12 o'clock).

Red rubber catheter (Robinson): Plain rubber or latex catheter without a balloon, usually used for "in-and-out catheterization" in which urine is removed but the catheter is not left indwelling.

Procedure

- Each insertion of a catheter implants bacteria into the bladder, so strict aseptic technique is mandatory.
- Have the patient lie supine in a well-lighted area; females with knees flexed wide and heels together to get adequate exposure of the meatus.
- Get all the materials ready before you attempt to insert the catheter. Open the kit, and put on the gloves. Open the prep solution, and soak the cotton balls. Apply the sterile drapes.

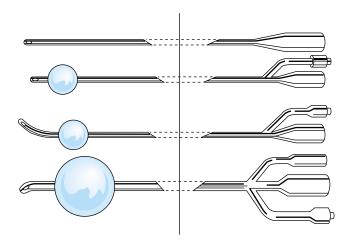


FIGURE 13-21 Types of bladder catheters include (from the top) the straight "Robinson" catheter [or red rubber catheter], Foley catheter with standard 5-mL balloon, the Coudé catheter, and "three-way" irrigating catheter with 30-mL balloon. Catheters have been shortened for illustrative purposes.

- Inflate and deflate the balloon of the Foley catheter to ensure its proper function. Coat the end of the catheter with lubricant jelly.
- 5. In females, use one gloved hand to prep the urethral meatus in a pubis-toward-anus direction; hold the labia apart with the other gloved hand. With uncircumcised males, retract the foreskin to prep the glans; use a gloved hand to hold the penis still.
- 6. The hand used to hold the penis or labia should not touch the catheter to insert it; a disposable forceps in the kit can be used to insert it. Or the forceps can be used to prep, then the gloved hand can insert the catheter.
- 7. In the male, stretch the penis upward perpendicular to the body to eliminate any internal folds in the urethra that might lead to a false passage. Use steady, gentle pressure to advance the catheter. The bulbous urethra is the most likely part to tear. Any significant resistance encountered may represent a stricture and requires urological consultation. In males with BPH, a Coudé tip catheter may facilitate passage. Some tricks used to get a catheter to pass in a male are to make sure that the penis is well stretched and to instill 30–50 mL of sterile water-based surgical lubricant (K-Y jelly) into the urethra with a catheter-tipped syringe prior to passage of the catheter. Viscous lidocaine jelly for urologic use can help lubricate and relieve the discomfort of difficult catheter placement. Allow at least 5 min after instillation of the lidocaine jelly for the anesthetic effect to take place.
- 8. In both males and females, insert the catheter to the hilt of the drainage end. Compress the penis toward the pubis. These maneuvers ensure that the balloon inflates in the bladder and not in the urethra. Inflate the balloon with 5–10 mL of sterile water or, occasionally, air. After inflation, pull the catheter back so that the balloon comes to rest on the bladder neck. There should be good urine return when the catheter is in place. If a large amount of lubricant jelly was placed into the urethra, the catheter may need to be flushed with sterile saline to clear the excess lubricant. A catheter that will not irrigate is in the urethra, not the bladder.
- Any male who is uncircumcised should have the foreskin repositioned to prevent massive edema of the glans after the catheter is inserted.
- 10. Catheters in females can be taped to the leg. In males, the catheter should be taped to the abdominal wall to decrease stress on the posterior urethra and help prevent stricture formation. The catheter is usually attached to a gravity drainage bag or some device for measuring the amount of urine. Many new kits come with the catheter already secured to the drainage bag. These systems are considered "closed" and should not be opened if at all possible.

"In-and-Out" Catheterized Urine

- If urine is needed for analysis or for culture and sensitivity, especially in a female patient, a so-called in-and-out cath can be done. This is also useful for measuring residual urine in males or females. The incidence of inducing infection with this procedure is about 3%.
- The procedure is identical to that described for bladder catheterization. The main difference is that a red rubber catheter (no balloon) is often used and is removed immediately after the specimen is collected.

Clean-Catch Urine Specimen

 A clean-catch urine is useful for routine urinalysis, is usually good for culturing urine from males, but is only fair for culturing urine from females because of the potential for contamination.

2. For males:

- Expose the glans, clean with a povidone-iodine solution and dry it with a sterile pad.
- b. Collect a midstream urine in a sterile container after the initial flow has escaped.

3. For females:

- a. Separate the labia widely to expose the urethral meatus; keep the labia spread throughout the procedure.
- b. Cleanse the urethral meatus with povidone—iodine solution from front to back, and rinse with sterile water.
- c. Catch the midstream portion of the urine in a sterile container.

Percutaneous Suprapubic Bladder Aspiration Indications

(Used most frequently in young children)

- · When urine cannot be obtained by a less invasive method
- · In the presence of urethral abnormalities
- · In the presence of a refractory UTI

Contraindications

· If the child has voided within the last hour, or if the bladder cannot be percussed

Procedure

- This procedure is almost exclusively limited to the very young pediatric patient (usually <6 months).
- Immobilize the child. Do not attempt this procedure if the child has voided within the last hour.
- 3. Palpate the bladder above the pubic symphysis (the bladder sticks high above the pubis in a young child when it is full). Some suggest occluding the urethra by holding the penis in a male and by inserting a finger in the rectum to exert pressure in the female. Percuss out the limits of the bladder.
- Obtain a 20-mL syringe with a 23- or 25-gauge, 1½-in. needle. Prep with povidone-iodine and alcohol 0.5–1.5 cm above the pubis. Anesthesia is not routinely used.
- Insert the needle perpendicular to the skin in the midline; maintain negative pressure on the downstroke and on withdrawal until urine is obtained (Fig.13–22).
- 6. If no urine is obtained, wait at least 1 h before reattempting the procedure.

VENIPUNCTURE

Materials

- A tourniquet (a 1½-in. Penrose drain or glove is acceptable)
- · Alcohol prep sponge
- Proper specimen tubes for desired studies (red top, purple top, etc.) (Table 13–7)
- Appropriate-sized syringe for volume of blood needed (5 mL, 10 mL, etc), or a Vacutainer tube and appropriate needle and Vacutainer holder
- A 20–22-gauge needle (Larger needles are uncomfortable, and smaller ones can cause hemolysis or clotting; the higher the gauge number, the smaller the needle.)

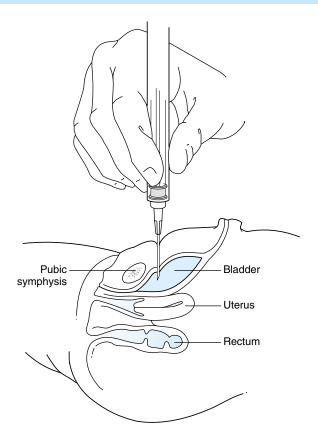


FIGURE 13–22 The technique and anatomic structures in suprapubic bladder aspiration. (Reprinted, with permission, from: Gomella TL [ed]: *Neonatology: Basic Management, On-Call Problems, Diseases, Drugs, 4th ed. Appleton & Lange, Norwalk CT, 1998.)*

Procedure

Venipuncture (**phlebotomy**) is the puncture of a vein to obtain a sample of venous blood for analysis. Blood cultures, IV techniques, and arterial punctures are discussed in other sections of the chapter.

TABLE 13-7
Tube Guide for Venipuncture Using the Vacutainer System*

Vacutainer Tubes	Vacutainer Hemogard Closure	Additive	Number or Inversions at Blood Collection (Invert gently, do not sho	ake) Laboratory Use
Black/red marbled "Tiger Top")	Gold	Clot activator and gel for serum separation	5	SST brand tube for serum demon- strations in chemistry. Tube inversions ensure mixing of clot activator with blood and clotting within 30 min
Green/red marbled	Light green	Lithium heparin and gel for plasma separation	8	PST brand tube for plasma determinations in chemistry. Tube inversions prevent clotting
Red	Red	None .	0	For serum determinations in chemistry, serology, and blood banking.
Yellow/black marbled	Orange	Thrombin	8	For stat serum determinations in chemistry. Tube inversions prevent clotting, usually in less than 5 min
Royal blue	Royal blue	Sodium heparin	8	For trace element, toxicology, and
		Na EDTÁ	8	nutrient determinations. Special
		None	0	stopper formulation offers the lowest verified levels of trace elements available. (See package insert)
Green	Green	Sodium heparin	8	For plasma determinations in
		Lithium heparin	8	chemistry. Tube inversions prevent
		Ammonium hepari	n 8	clotting

(continued)

TABLE 13-7 (Continued)

Vacutainer Tubes	Vacutainer Hemogard Closure		Number or Inversions at Blood Collection (Invert gently, do not shake) Laboratory Use		
Gray	Gray	Potassium oxalate/	8	For glucose determinations. Tube		
		Sodium fluoride		inversions ensure proper mixing of		
		Sodium fluoride	8	additive and blood. Oxalate and		
		Lithium iodoaceta		heparin, anticoagulants, will give		
			8	samples that are serum		
Brown	Brown	Sodium heparin	8	For lead determinations. This tube is ce fied to contain less than .01 µ/mL (p lead. Tube inversions prevent clotting		
Yellow	Yellow	Sodium polyanetholesulfona (SPS)	8 te	For blood culture specimen collections in microbiology. Tube inversions prevent clotting.		
Lavender	Lavender	Liquid EDTA	8	For whole blood hematology		
		Freeze-dried Na EDTA	8	determinations. Tube inversions prevent clotting		
Light blue	Light blue	0.105 M sodium citrate (3.2%)	8	For coagulation determinations on plasma specimens. Tube inversions		
		0.129 M sodium citrate (3.8%)	8	prevent clotting. <i>Note:</i> Certain tests require chilled specimens. Follow recommended procedures for collection and transport of specimen		

^{*}Based on products from Becton-Dickinson.

Abbreviation: EDTA = ethylene diamine tetraacetic acid.

- 1. Collect the necessary materials before you begin.
- 2. The most commonly used sites for routine venipuncture are the veins of the antecubital fossa (see Fig. 13–12, page 279). Other sites that can be used include the dorsum of the hand, the forearm, the saphenous vein near the medial malleolus, or the external jugular vein. If all the routine peripheral sites are unacceptable, the femoral vein can be used. Never draw a blood sample proximal to an IV site. The high concentration of IV fluid in the veins at this location may make the laboratory studies invalid.
- 3. Apply the tourniquet at least 2-3 in. above the venipuncture site. Have the patient make a fist to help engorge the vein. If veins are difficult to locate, some helpful techniques include slapping the vein to cause reflex dilation, hanging the extremity in a dependent position, wrapping the extremity in a warm soak, substituting a blood pressure cuff for the standard tourniquet, or applying nitroglycerin paste below and over the area may help dilate the veins.
- 4. Swab the site with the alcohol prep pad, and allow the alcohol to evaporate.
- 5. Use the syringe and needle with the bevel up and puncture the skin alongside the vein. After the needle is through the skin, use the thumb of your free hand to stabilize the vein and prevent it from rolling.
- 6. Enter the vein on the side at about a 30-degree angle while applying gentle back pressure on the syringe. Withdraw the sample slowly to prevent the vein from collapsing. An alternative acceptable technique is to enter both the skin and vein in one stick, however this maneuver requires practice because the vein is often stuck through and through.
- 7. The Vacutainer system is a very useful means of collecting blood, especially if several different sample tubes need to be filled. Mount a 20–22-gauge Vacutainer needle on the Vacutainer cup. Enter the vein as directed previously. Advance the collection tube onto the needle inside the Vacutainer. The vacuum inside the tube automatically collects the sample. If you hold the Vacutainer steady, several tubes can be collected in this fashion.
- 8. After the blood is collected (by whatever method), remove the tourniquet, withdraw the needle, and apply firm pressure with the alcohol swab or sterile gauze for 2–3 min. Elevation of the extremity is helpful. Current evidence indicates that bending the arm actually increases the size of the venipuncture site and should be discouraged.
- 9. If a needle and syringe are used, distribute the samples to the blood tubes. The best technique is to insert the needle into the tube and allow the vacuum to draw in the appropriate volume of blood for a given tube (this is most critical for coagulation studies). Distribute the blood to the coagulation and CBC tubes first because clotting of the blood in the syringe can invalidate the results. Mix the tubes thoroughly. Blood drawn for typing and cross-matching usually has special labels that require signature of the person that obtained the sample.
- 10. If no peripheral veins can be located, puncture of the femoral vein can be attempted. Locate the femoral artery. The mnemonic of lateral to medial structures in the groin is NAVEL: Nerve, Artery, Vein, Empty space, Lymphatic. The femoral vein should be just medial to the femoral artery. After prepping the skin, insert the needle perpendicular to the skin, and gently aspirate. The vein should be about 1–1½ in. below the skin. Apply firm pressure after the collection of the sample because hematomas are frequent complications of femoral venipunctures. Should you accidentally enter the femoral artery, it is acceptable to collect the sample. Apply pressure for a longer period if the artery is entered.
- In children and the elderly with fragile veins, a butterfly (21–25-gauge) can be used to obtain a sample (see Fig. 13–12).

12. When completed with the venipuncture needle, follow the CDC recommendations and DO NOT reshield the needle with the protective cap. Whenever possible, dispose of the needle immediately into the sharps collection container located on each hospital unit where blood is routinely drawn. Newer "safe needles" (Safety-Lok, ProGuard, Puncture-Guard, etc) are designed to attach to the Vacutainer system and have mechanisms to help protect the tip and hopefully diminish the incidence of accidental needlesticks.

PAIN MANAGEMENT

Terminology Classification of Pain Adverse Physiologic Effects of Pain Principles of Pain Control

Pain Measurement Practical Pain Management Patient-Controlled Analgesia

Evaluation of Patient with Pain

TERMINOLOGY

Pain is the most common symptom that brings patients to see a physician, and it is frequently the first alert of an ongoing pathologic process. The International Association for the Study of Pain defines pain as: An "unpleasant sensory and emotional experience associated with actual or potential tissue damage." Acute pain is common postoperatively and in acute injury. Chronic pain can be associated with conditions such as cancer and arthritis.

Oligoanalgesia is the failure to recognize or properly treat pain. This may result because the physician makes a judgment without asking the patient if she or he hurts or discredits the patient's response and bases the determination of pain severity on the physician's own subjective past pain experience. Accordingly, the gold standard for determining if a patient is in pain is to ask the patient if he or she hurts and then to attempt to objectively verify the report with monitors, touch, or direct vision.

Nociception is derived from the Latin word noci, meaning "harm or injury." It refers to the detection, transduction, and transmission of noxious stimuli. Stimuli generated from thermal, mechanical, or chemical tissue damage may activate nociceptors, which are free nerve endings. (All nociception produces pain but not all pain results from nociception.)

CLASSIFICATION OF PAIN

Pain can be broadly divided into acute and chronic pain.

Acute Pain

Acute pain is caused by noxious stimulation due to injury or disease process or abnormal function of muscle or viscera. It is a manifestation of autonomic, psychologic, and behavior responses, which can be self-limited and resolve with treatment (eg, after trauma, after surgery, MI, pancreatitis, or renal calculi). Acute pain is further classified as

- · Superficial. Nociception from skin, subcutaneous tissue, or mucous membrane. Localized, sharp, pricking, throbbing, or burning
- · Deep somatic. From muscle, tendon, joints, bones. Less localized, dull aching in character

[&]quot;Men do not fear death, they fear the pain of dying."

Visceral. From internal organ or coverings (parietal pleura, pericardium, or peritoneum). Can be localized or referred. May accompany sympathetic or parasympathetic manifestations as changes in BP or heart rate, nausea and vomiting

Chronic Pain

The determination of whether pain is chronic should not be based on its duration, but rather on the substantial damage it causes to an individual in terms of functional loss, psychologic distress (sleep and affective disturbances), and social and vocational dysfunction. This pain usually results from peripheral nociception of the peripheral or central nervous system, and it usually lacks neuroendocrine stress response: musculoskeletal disorders, chronic visceral disorders, lesions of peripheral nerves, nerve root, dorsal root ganglia (causalgia, phantom limb pain, postherpetic neuralgia), stroke, spinal cord injury, MS, or cancer.

ADVERSE PHYSIOLOGIC EFFECTS OF PAIN

This is usually associated with acute pain and is proportional to pain intensity. (Table 14–1)

PRINCIPLES OF PAIN CONTROL

- · Proper patient evaluation, including pain measurement
- · Good physician-patient relationship built on trust
- Consideration of both psychologic and emotional aspects
- Acknowledgment that treatment depends on patient's compliance, understanding, and cooperation
- · Possible combination therapy
- · Explanation of side effects (if unavoidable) and how to treat them
- Proper follow-up

EVALUATION OF PATIENT WITH PAIN

- 4
- Ask the patient if she or he is in pain? Bear in mind that you must trust and believe what the patient says.
- 2. Obtain a detailed history of this pain:
 - Character of the pain (dull, colicky, sharp)
 - · Duration of pain
- 3. Is the pain referred to other sites of the body (eg, ureteral calculi may be referred to the insilateral testicle)?
- 4. What relieves the pain: Rest, position?
- 5. What makes it worse: Movement, positions, activities?
- 6. Are there any accompanying symptoms: Nausea, vomiting, headache?
 - Perform a physical examination and request imaging studies if an organic cause is suspected.
 - Chronic pain frequently affects daily activity and social interaction so psychosocial evaluation may be indicated.

PAIN MEASUREMENT

The most commonly used two methods of pain measurement are Visual Analogue Scale (VAS) and McGill Pain Questionnaire (MPQ).

TABLE 14–1 Adverse Physiologic Sequelae of Pain

Organ System	Adverse Effect
RESPIRATORY	
Increased skeletal muscle tension Decreased total lung compliance	Hypoxia, hypercapnia Ventilation–perfusion abnormality, atelectasis, pneumonitis
ENDOCRINE	
Increased adrenocorticotropic hormone Decreased insulin, decreased testosterone Increased aldosterone, increased antidiuretic hormone Increased catecholamines Increased angiotensin II	Protein catabolism, lipolysis, hyperglycemia Decreased protein anabolism Salt and water retention, congestive heart failure Vasoconstriction Increased myocardial contractility
CARDIOVASCULAR	
Increased myocardial work	Dysrhythmias, angina
IMMUNOLOGIC	
Lymphopenia, depression of reticuloendothelial system, leukocytosis Reduced killer T-cell cytotoxicity	Decreased immune function

(continued)

TABLE 14-1 (Continued)

Adverse Effect
Increased incidence of thromboembolic phenomena
lleus
Urinary retention

Visual Analogue Scale

The VAS is a 10-cm horizontal line with the words NO PAIN at one end and WORST PAIN IMAGINABLE at the other end. The patient is asked to put a mark on this line at the point that identifies the intensity but not quality of his or her pain. This has been called the "fifth vital sign" and is commonly used in the hospital setting to guide pain management.

0 1 2 3 4 5 6 7 8 9 10 No pain Worst possible pain

McGill Pain Questionnaire

The MPQ (Melzack R: The McGill Pain Questionnaire: Major properties and scoring methods. *Pain* 1975;1:277–299.) is a checklist of words describing symptoms. Scores are then analyzed in various dimensions (sensory and affective) to identify the quality of pain. This tool is usually used in the detailed management of pain syndromes.

Psychologic Evaluation: A psychologic evaluation is indicated if medical examination fails to reveal any apparent cause for the patient's pain. The Minnesota Multiple Personality Inventory (Hathaway SR and McKinley JC: MMPI. University of Minnesota Press, Minneapolis, 1989.) and Beck Depression Inventory (Beck AT, Steer RA: Internal consistencies of the original and revised Beck Depression Inventory. J Clin Psychol 1984;40(6): 1365–1367.) are two commonly used tools for evaluating chronic pain and depression. These questionnaires should not only determine the patient's psychologic status but also evaluate his or her behavior and response to pain and its management.

Electromyography and Nerve Conduction Testing: This method differentiates between neurogenic and myogenic causes and confirms diagnoses of nerve entrapment, neural trauma, and polyneuropathies.

Thermography: Normally, heat from body surfaces is emitted in the form of infrared energy; this emission is symmetrical in homologous areas. Neurogenic pathophysiologic changes result in asymmetry. This infrared energy can be measured and displayed; hyperemission indicates an acute stage and hypoemission a chronic stage.

Diagnostic and Therapeutic Neural Blockade: Neural blockade with local anesthetics can be used to diagnose and manage both acute and chronic pain.

PRACTICAL PAIN MANAGEMENT

The goal of pain management is to provide the patient adequate relief with minimum side effects (eg, drowsiness). Always begin therapy with the lowest dose of any medication that provides relief. Oral, rectal, or transdermal routes are preferred over parental therapy.

Pain management can be generally divided into

- Pharmacologic
- Nonpharmacologic
- · Combinations according to the patient response and compliance

Pharmacologic

The World Health Organization has made specific recommendations concerning pain management. These principles apply primarily to cancer pain but can be used in any clinical setting. Start at step 1 and advance to the next level based on patient response.

Step 1: Nonopioid agents (NSAIDs, acetaminophen, etc)

Step 2: Weak opioids (codeine, oxycodone)

Step 3: Strong opioids (morphine, fentanyl)

Specific pharmacologic agents are reviewed in the following section and in Table 14–2. Supplements can enhance the effects of analgesics and allow dose reduction of some agents.

Nonopioid Analgesics: Aspirin, acetaminophen, and NSAIDs are the principal nonopioid analgesics used to treat mild and moderate pain. NSAIDs are primarily cyclooxygenase inhibitors that prevent prostaglandin-mediated amplification of chemical and mechanical irritants of the sensory pathways. Short-term perioperative use of ketorolac (Toradol) can reduce pain medication requirement. Side effects: Possible hepatotoxicity (large doses of acetaminophen); stomach upset, nausea, dyspepsia, ulceration of gastric mucosa, dizziness, platelet dysfunction, exacerbation of bronchospasm, and acute renal insufficiency (aspirin and NSAIDs).

Opioids: These drugs attach to opioid receptors, which are responsible for the analgesia. Side effects: Sedation, dizziness, miosis, nausea, vomiting and constipation from smaller doses, to respiratory depression, apnea, cardiac arrest and circulatory collapse, coma, and death after high intravenous doses. Opioids can be taken orally, parenterally, or neuroaxially (intrathecal/epidural). They are available in short- (q4h) and long-duration forms (eg, q12h, q24h). Opioids can also be given as a patient-controlled analgesia (PCA) (see section with that title). Comparison of the different opioid narcotic can be found in Table 14–2.

Antidepressants: The analgesic effect produced by antidepressants is due to reuptake of serotonin and norepinephrine. **Side effects:** Antimuscarinic effects (dry mouth, impaired visual accommodation, urinary retention), antihistaminic (sedation), and alpha adrenergic blockage (orthostatic hypotension).

Neuroleptics: Useful in patients with agitation and psychologic symptoms. **Side effects:** Extrapyramidal, mask-like facies, festinating gait, cogwheel rigidity (bradykinesia).

Anticonvulsants: These medications act by suppressing the spontaneous neural discharge. **Side effects:** Bone marrow depression, hepatotoxicity, possible ataxia, dizziness, confusion, and sedation (at toxic doses).

Corticosteroids: These are antiinflammatory analgesics. **Side effects:** HTN, hyperglycemia, and increased tendency to infection, peptic ulcer, osteoporosis, myopathies, and Cushing's syndrome.

Systemic Local Anesthetics: These drugs produce sedation and central analgesia. Side effects from excessive dosing: Toxicity with cardiovascular collapse and CNS symptoms in the form of tonic–clonic seizures. Respiratory arrest usually follows.

Nonpharmacologic

- Nerve blocks or neurolysis (destruction of the nerve)
- Radiation: Useful for cancer pain (ie, bony metastasis)
- Psychologic intervention: Using cognitive therapy, behavioral therapy or biofeedback relaxation technique and hypnosis
- Physical therapy: Heat and cold can provide pain relief by alleviating muscle spasm. Heat decreases joint stiffness and increases blood flow; cold vasoconstricts and reduces tissue edema.

TABLE 14-2 Selected Agents Commonly Used in Pain

	Route	Onset	Duration	Initial Dose	Maximum Dose
NON-OPIOID					
Acetaminophen (Tylenol, Datril)	PO	0.5 h	4 h	500-1000 mg	1200 mg
Aspirin/sodium salicylate	PO	0.5-1 h	4 h	500-1000 mg	3600 mg
Celecoxib (Celebrex)	PO	3 h	12 h	100 mg	400 mg
Diclofenac sodium (Voltaren)	PO	1 h	4–6 h	25-75 mg	200 mg
Ibuprofen (Motrin, Rufen)	PO	0.5 h	4–6 h	400 mg	3200 mg
Indomethacin (Indocin)	PO	0.5 h	4–6 h	25-50 mg	200 mg
Piroxicam (Feldene)	PO	1 h	48–72 h	10-20 mg	20 mg
Rofecoxib (Vioxx)	PO	2–3 h	24 h	12.5 mg	50 mg
OPIOID					
Codeine	IM	0.25–0.5 h	4–6 h	15 mg	60 mg
	PO	0.25-1 h	3–4 h	15 mg	60 mg
Fentanyl	IV	1.7-2.3 h	1 h	1–1.5 μg/kg	150
,	TD	1.7–2.3 h	1 h	25 mg/h	100 μg/h
Meperidine (Demorol)	PO	0.5-1 h	2–3 h	1-1.5 mg/kg	50-100 mg
, , , , , , , , , , , , , , , , , , , ,	IM	0.12-0.5 h	2-4 h	1-1.5 mg/kg	50-100 mg
Methadone (Dolophine)	PO	0.5–1 h	4–8 h	2.5–10 mg	160 mg
, , ,	IM	0.25 h	4–6 h	2.5-10 mg	160 mg
Morphine (various)	IV	Rapid	1–2 h	0.1-15 mg/kg	2.5-15 mg
1 , ,	IM	0.3 h	3–4 h	0.1-0.15 mg/kg	10-15 mg

(continued)

TABLE 14-2 (Continued)

	Route	Onset	Duration	Initial Dose	Maximum Dose
Nalbuphine (Nubain)	IV IM	_ 0.25 h	_ 3–6 h	1-5 mg 10-20 mg	160 mg 160 mg
OTHER/SUPPLEMENTS					
Amitriptyline	PO	7–21 d	_	25-150 mg	300 mg
Carbamazepine	PO	_	_	200 mg	1600 mg
Dexamethasone	PO	_	_	0.5-9 mg/kg	20-100 mg
	IV	_	_	0.5-9 mg/kg	20-100 mg
Haloperidol (Haldol)	PO	_	_	0.5–5 mg	100 mg
, , ,	IV	1 h	3 wk	0.5–5 mg	100 mg

Abbreviations: PO = by mouth; IV = intravenous; IM = intramuscular; TD = transdermal.

- Acupuncture: Needles inserted into discrete anatomically defined points and stimulated by mild electric current. Believed to release endogenous opioids
- Electrical stimulation of the nervous system: Can produce analgesia. The three
 methods are
- 1. Transcutaneous electrical stimulation (TENS) with electrodes applied to skin
- Spinal cord stimulation by inserting electrodes epidurally connected to external generator
- 3. Intracerebral stimulation with electrodes implanted in the periaqueductal or periventricular area

PATIENT-CONTROLLED ANALGESIA

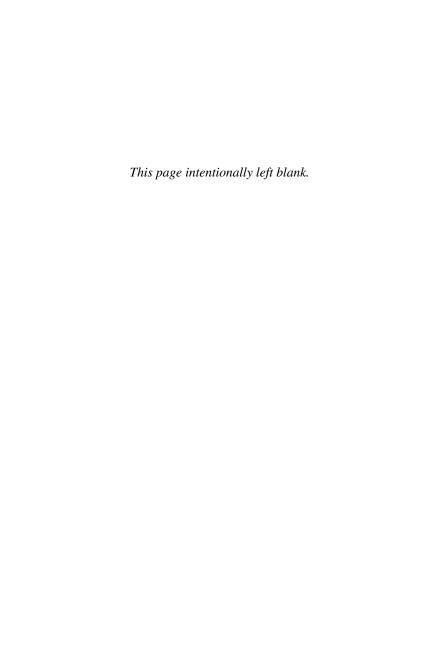
Most commonly used after surgery, allows the patient to self-administer the dose of narcotic via an IV pump. The patient treats the pain as soon as he or she feels necessary, thus avoiding the peak and trough of a narcotic dosing regimen that may lead to extremes of pain and potential oversedation. The pain management team can titrate the dose of the drug as required using a computerized system that controls the total dose and the interval between each dose with the use of a continuous basal infusion dosage. PCA duration varies based on procedure and patient response (eg, gyn 1–2 d, bowel 2–5 d, thoracotomy 4–6 d). Reduce dose in elderly (1/5–3/5). Consider discontinuation of PCA when patients are able to take analgesics PO.

PCA Parameters

- Dose: Number of mL (typically morphine concentration, page 321) given on activation of button by patient
- · Lockout: Minimum interval of time in minutes between PCA doses
- Hourly Max: Maximum volume (mL) that machine administers in an hour
- Basal Rate: Continuous infusion rate (not required on all patients)

The following table shows examples of PCA orders:

Typical Procedure	Dose (mL)	Lockout (min)	Hourly Max (mL)	Basal
Moderately painful (lower abdominal, incisions, minor orthopedic procedures)	1	6	8	None
Fairly painful (upper abdominal incisions)	1.5	6	10	None-1 mL/h
Very painful (thoracotomy, total knee replacement)	1.5	6	10	0.5– 1.5 mL



IMAGING STUDIES

X-Ray Preparations

Common X-Ray Studies: Noncontrast

Ultrasound CT Scans

Common X-Ray Studies: Contrast Ultrasound Spiral (Helical) CT Scan Magnetic Resonance Imaging (MR or MRI) Nuclear Scans

How to Read a Chest X-Ray

X-RAY PREPARATIONS

In general, follow this rubric: plain films before contrast, contrast before barium. Each hospital has its own guidelines for patient x-ray preps. Consult the radiology department prior to ordering. Examinations that require no specific bowel preparation include routine chest x-rays, flat and upright abdominal films, T-tube cholangiograms, cystograms, C-spines, skull series, extremity films, CT scan of the head or chest, and many others.

Studies that usually require such preps as enemas, laxatives, oral contrast agents, or those that require that the patient be NPO prior to the examination include oral cholecystogram, upper GI series, SBFT, barium enema, IVP, CT scan of the abdomen or pelvis, and many others.

COMMON X-RAY STUDIES: NONCONTRAST Chest

Chest X-Ray (Routine): Includes PA and lateral chest films. Used in the evaluation of pulmonary, cardiac and mediastinal diseases, and traumatic injury. See page 335 on How to Read a Chest X-Ray.

Expiratory Chest: Used to help visualize a small pneumothorax

Lateral Decubitus Chest: Allows small amounts of pleural effusion or suspected subpulmonary effusion to layer out and permits diagnosis of as little as 175 mL of pleural fluid

Lordotic Chest: Allows better visualization of apices and lesions of the right and left upper lobes. Often used in the evaluation of TB

Portable Chest and AP Films: Cannot be used to accurately evaluate heart size or widened mediastinum but can be used to detect effusions, pneumonia, edema, and to verify line or tube placement

Rib Details: Special views that more clearly delineate rib pathology; useful when plain chest radiogram or bone scan suggests fractures or other metastatic lesions.

15

Abdominal

Abdominal Decubitus: Used in debilitated patients instead of an upright abdominal film. The left side should be down to find free air outlining the liver and right lateral gutter.

Acute Abdominal Series ("obstruction series"): Includes a flat and upright abdominal (KUB) and chest x-ray. Good for initial evaluation of an acute abdomen (See KUB.)

Cross-Table Lateral Abdominal: Used in debilitated patients to look for free air or to identify an aortic aneurysm.

KUB, Supine and Erect: Short for "kidneys, ureter, and bladder" and also known as "flat and upright abdominal," "scout film," or "flat plate." Useful when the patient complains of abdominal pain or distension, and for initial evaluation of the urinary tract (80% of kidney stones and 20% of gallstones are visualized on these films). To read, look for calcifications, foreign bodies, the gas pattern, psoas shadows, renal and liver shadows, flank stripes, the vertebral bodies, and pelvic bones. On the upright, look for air—fluid levels of an adynamic ileus or mechanical obstruction and for free air under the diaphragm, which suggests a perforated viscus or recent surgery; however, the upright chest x-ray (especially the lateral view) is often best to spot a pneumoperitoneum.

Other Noncontrast X-Rays

C-Spine: Usually includes PA, lateral, and oblique films. Useful for the evaluation of trauma, neck pain, and neurologic evaluation of the upper extremities. All seven cervical vertebrae must be seen for this study to be acceptable.

DEXA: Measures bone mineral density at a variety of sites (femur/lumbar spine); used in the diagnosis and monitoring of response to treatment of osteoporosis

Mammography: Detects cancers greater than 5 mm in size. Two forms equal in diagnostic quality:

- Screen film. Produces standard black and white x-ray via a specially designed mammographic machine; 3–5× smaller radiation dose
- Xeromammography. Blue and white paper image using a general x-ray machine. Delivers a higher radiation dose. Current American Cancer Society screening guidelines for asymptomatic women: 35–39 baseline, 40–49 every 1–2 years, >50 every year.

Sinus Films (Paranasal Sinus Radiographs): Used to evaluate sinus trauma, sinusitis, neoplasms, or congenital disorders

Skull Films: Used to detect fractures and aid in the identification of pituitary tumors or congenital anomalies

Vertebral Radiography: Used to evaluate fractures, dislocations, subluxations, disk disease, and the effects of arthritic and metabolic disorders of the spine

COMMON X-RAY STUDIES: CONTRAST

An agent, such as barium or Gastrografin, or an intravenous contrast agent is used for these studies. If a GI tract fistula or perforation is suspected, inform the radiologist because this may affect the choice of contrast agent (ie, water-soluble contrast [eg, Gastrografin] instead

15

of barium). Standard IV contrast media are ionic and may be associated with rare contrast reaction when administered systemically (see following section). The use of nonionic contrast media may limit these side effects.

Ionic Contrast Media

· Oral cholecystographic agents: Telepaque etc

· GI contrast agents: Barium sulfate—Baro-CAT, Tomocat, etc

Injection: Diatrizoate meglumine—Hypaque Meglumine, Urovist Meglumine, Angiovist, etc

Diatrizoate sodium: Hypaque Sodium, Urovist Sodium, etc

Gadopentetate dimeglumine: Magnevist, etc

Iodamide meglumine: Renovue, etc Iothalamate meglumine: Conray, etc Iothalamate sodium: Angio Conray, etc

Diatrizoate meglumine and diatrizoate sodium: Angiovist, Hypaque-M, etc

· Not for intravascular use, for instillation into cavities:

Diatrizoate meglumine, Cystografin, etc

Diatrizoate meglumine and diatrizoate sodium Gastrografin, etc

Diatrizoate sodium: Oral or rectal (Hypaque sodium oral)

Iothalamate meglumine: Cysto-Conray urogenital

Diatrizoate meglumine and iodipamide meglumine: Sinografin intrauterine instillation

Nonionic Contrast Media

Injectable

Iohexol: OmnipaqueIopamidol: IsovueIoversol: Optiray

· Metrizamide: Amipaque

Contrast reactions to IV agents may occur; severe reaction occurs 1/1000 and death due to anaphylaxis 1/40,000. Reactions include hives, bronchospasm, or pulmonary edema. (Premedication with steroids may not prevent a reaction.) Vagal reactions (hypotension and bradycardia) are another adverse effect. A history of asthma is a risk factor and a previous reaction to contrast does not necessarily preclude using IV contrast (allergy to seafood or iodine is no longer considered an important risk factor). Premedication with two doses of PO methylprednisolone, once at 12 h prior and then 2 h prior to IV contrast, is effective in reducing the incidence of reactions. Alternatively, use of new and more expensive (up to 10× the cost) nonionic contrast agents, lessens pain and cardiac dysfunction, with a possible overall decrease in adverse reactions.

Angiography: A rapid series of films obtained after a bolus contrast injection via percutaneous catheter. Used to image the aorta, major arteries and branches, tumors, and venous drainage via late "run-off" films. Helical CT scans are now capable of generating angiographic images.

 DSA. This is the latest enhancement of this study, allows reverse negative views and requires less contrast load

- Cardiac angiography. Definitive study for diagnosis and assessment of severity of CAD. Significant (>70% occlusion) stenotic lesions seen: 30% involve single vessels, 30% involve two, and 40%, three vessels. Can discriminate angina secondary to aortic valve disease and that from CAD
- Cerebral angiography. Evaluation of intra- and extracranial vascular disease, atherosclerosis, aneurysms, and A-V malformations. Not used for detection of cerebral structural lesions (use MRI or CT instead)
- Pulmonary angiography. Visualization of emboli, intrinsic or extrinsic vascular abnormalities, A-V malformations, and bleeding due to tumors. Most accurate diagnostic procedure for PE but only used if lung V/O scan is not diagnostic

BE: Examining the colon and rectum. Indications include diarrhea, crampy abdominal pain, heme-positive stools, change in bowel habits, and unexplained weight loss

- Air-contrast BE. Done with the "double contrast" technique (air and barium) to better delineate the mucosa. More likely to show polyps
- Gastrografin enema. Similar to the barium enema, but water-soluble contrast is
 used (clears colon more quickly than barium). If the Gastrografin leaks from the GI
 tract, it is less irritating to the peritoneum (does not cause "barium peritonitis").
 Therapeutic in the evaluation of severe obstipation, colonic volvulus, perforation, diverticulitis, or postop anastomotic leak

Barium Swallow (Esophagogram): Evaluating the swallowing mechanism and investigating esophageal lesions or abnormal peristalsis

Cystogram: Bladder filled and emptied and a catheter in place. Used to evaluate bladder filling defects (tumors, diverticulum) and bladder perforation. Can also be done using CT scanning (see also VCUG)

Enteroclysis: Selective intubation of the proximal jejunum and rapid infusion of contrast. Better than an SBFT in evaluating polyps or obstruction (adhesions, internal hernia, etc). May be used to evaluate small-bowel sources of chronic bleeding after negative upper and lower endoscopy

ERCP: Contrast endoscopically injected into the ampulla of Vater to visualize the common bile and pancreatic ducts in evaluating obstruction, stones, and ductal pattern

Fistulogram (Sinogram): Injection of water-soluble contrast media into any wound or body opening to determine the connection of the wound or opening with other structures

HSG: Evaluating uterine anomalies (congenital, fibroids, adhesions) or tubal abnormalities (occlusion or adhesion) often as part of infertility evaluation. Contraindicated during menses, undiagnosed vaginal bleeding, acute PID, or if pregnancy suspected. Patient in pelvic exam position, speculum placed and uterine os cannulated; then contrast injected

ExU or IVP: Contrast study of the kidneys and ureters. Limited usefulness for evaluating bladder abnormalities. Indications include flank pain, kidney stones, hematuria, UTI, trauma, and malignancy. Bowel prep helpful but not essential. Verify recent creatinine level. **Nephrotomograms** often included that include cuts of the kidney to further define the three-dimensional location or nature of renal lesions or stones

Lymphangiography. Iodinated oil injected to opacify lymphatics of the leg, inguinal, pelvic, and retroperitoneal areas. Used to test the integrity of the lymphatic system or evaluate for metastatic tumors (testicular, etc) or lymphoma

Myelogram: Evaluating the subarachnoid space for tumors, herniated disks, or other cause of nerve root injury. Using LP technique, contrast injected in the subarachnoid space

OCG: Visualizing gallbladder in the evaluation of cholelithiasis or cholecystitis. Patient given oral contrast pills 12–24 h before the study. Serum bilirubin should be <2 mg/100 mL. Used infrequently

PTHC: Visualizing biliary tree in a patient unable to concentrate the contrast media (bilirubin >3 mg/100 mL). Percutaneous needle inserted into a dilated biliary duct; contrast injected.

Percutaneous Nephrostogram: In the management of renal obstruction, percutaneous placement through the renal parenchyma and into the collecting system to relieve and or evaluate the level and cause of obstruction

RPG: Contrast material injected into the ureters through a cystoscope. Indications include allergy to IV contrast, a kidney or ureter that cannot be visualized on an IVP, filling defects in the collecting system, renal mass, and ureteral obstruction

RUG: Demonstrates traumatic disruption of the urethra and urethral strictures

SBFT: Usually done after a UGI series. A delayed film shows the jejunum and ileum. Used in the work-up of diarrhea, abdominal cramps, malabsorption, and UGI bleeding

T-Tube Cholangiogram: Resolution of swelling in some patients who have a T-tube placed in the common bile duct for drainage after gallbladder and common bile duct surgery. To evaluate the degree of swelling, look for residual stones, and evaluate patency of bile duct drainage

UGI Series: Includes the esophagogram plus the stomach and duodenum. Useful for visualizing ulcers, masses, hiatal hernias, and in the evaluation of heme-positive stools and upper abdominal pain

VCUG: Bladder filled with contrast through a catheter, then catheter is removed, and the patient allowed to void. Used for diagnosis of vesicoureteral reflux and urethral valves and in the evaluation of UTI

Venography, Peripheral: Contrast slowly injected into small foot or ankle vein to evaluate patency of deep veins of leg and calf. Look for a filling defect or outline of a thrombus. Noninvasive exams for DVT, such as Doppler ultrasound and impedance plethysmography, often used together before invasive venography and are highly sensitive (>90%) for proximal thrombi. A radionuclide scan with technetium-99-labeled RBCs sometimes used but is less sensitive and specific than the previously mentioned tests.

ULTRASOUND

Abdominal: Gallbladder (95% sensitivity in diagnosing stones), thickening of wall, biliary tree (obstruction), pancreas (pseudo-cyst, tumor, pancreatitis), aorta (aneurysm), kidneys (obstruction, tumor, cyst), abscesses, ascites

Endovaginal: Most useful in the diagnosis of gynecologic pathology (uterus, ovaries)

Pelvic (A full bladder is desirable)

- Pregnancy. Fetal dating (biparietal diameters); diagnosis of multiple gestations; determination of intrauterine growth retardation, hydrocephalus, and hydronephrosis; localization of the placenta
- Gynecology. Ovarian and uterine masses (tumors, cysts, fibroids, etc.), ectopic pregnancy, abscesses

Thyroid: Evaluate thyroid nodules (cyst versus solid) and to direct biopsies. Ultrasound alone cannot usually differentiate benign from malignant lesions.

Transrectal: Most useful in the diagnosis of prostate pathology and directing prostate biopsies

Echocardiograms

- M-mode. Valve mobility, chamber size, pericardial effusions, septal size
- Two-dimensional. Valvular vegetations, septal defects, wall motion, chamber size, pericardial effusion, valve motion, wall thickness
- Doppler. Cross-valvular pressure gradients, blood flow patterns, and valve orifice areas in the work-up of cardiac valvular disease

Other Ultrasound Uses

Testicular (identify and characterize masses, eg, hydrocele versus tumor), intraoperative, determine bladder emptying

CT SCANS

Computerized tomography (also called CAT for computerized axial tomography) can be performed with or without intravenous contrast. A dilute oral contrast agent administered prior to abdominal or pelvic scans helps delineate the bowel. IV contrast is used to provide vascular and tissue enhancement for some CT scans; a current creatinine level should be available to determine suitability of IV contrast administration. Virtually any body part can be scanned depending on the indications, but it is most helpful in evaluating the brain, lung, mediastinum, retroperitoneum (pancreas, kidney, nodes, aorta), and liver, and to a lesser extent in the pelvis, colon, or bone. CT scans allow for the use of density measurements (also known as **Hounsfield units**) to differentiate cysts, lipomas, hemochromatosis, vascular ("enhancing") and avascular ("nonenhancing") lesions. In Hounsfield units, bone is +1000, water is 0, fat is -1000, and other tissues fall within this scale, depending on the machine settings. Metal and barium can cause distortion of the image.

Head: Evaluation of tumors, subdural and epidural hematomas, atrioventricular (A-V) malformations, hydrocephalus, and sinus and temporal bone pathology. Initial test of choice for trauma; may be superior to MRI in detecting hemorrhage within first 24–48 h

Abdomen: Images virtually all intraabdominal and retroperitoneal organs or disease processes. Good accuracy with abscesses, but ultrasound may show smaller collections adjacent to the liver, spleen, or bladder. Surgical clips or barium in the gut may cause artifacts. IV contrast usually given, so check creatinine level; when using a water-soluble contrast (Tomocat, others) to visualize the gut, the patient must receive an oral contrast beforehand.

Retroperitoneum: Useful for evaluating pancreatitis and its complications; pancreatic masses; nodal metastasis from colon, prostate, renal, or testicular tumors; adrenal masses (>3 cm suggestive of carcinoma); psoas masses; aortic aneurysms

Pelvis: Staging and diagnosis of bladder, prostate, rectal, and gynecological carcinoma

Mediastinum: Masses, ectopic parathyroids

Neck: Work-up of neck masses, abscesses, and other diseases of the throat and trachea

Chest: Able to find 40% more nodules than whole lung tomograms, which demonstrate 20% more nodules than plain chest x-ray. Although calcification is suggestive of benign disease (eg, granuloma), no definite density value can reliably separate malignant from benign lesions. Useful in differentiating hilar adenopathy from vascular structures seen on plain chest x-ray

Spine: MRI generally preferred over CT. However, rare conditions, contraindication to MRI, or artifact from metal may make the CT the preferred test.

SPIRAL (HELICAL) CT SCAN

Spiral CT can be used for any type of imaging (not commonly used for brain). It relies on rapid scan acquisition (ie, >8 frames/s). This minimizes motion artifact and allows for capturing a bolus of contrast at peak levels in the region being scanned. Standard CT is too slow to capture this peak flow. These contrast-enhanced scans allow detailed 3-D reconstruction and angiographic evaluations. Bony structures can also be visualized and do not require contrast. The term <code>spiral/helical</code> is derived from the fact that the tube spins around the patient while the table moves. Spiral CT can compensate for "streak" artifact due to implanted metallic devices. Examples for uses of this technology include diagnosis of PE, pretransplant angiography, evaluation of flank pain and determination of kidney stones (largely replacing emergency IVP), and rapid evaluation of trauma.

MAGNETIC RESONANCE IMAGING (MR OR MRI)

How It Works

Although the physics of MRI is beyond the scope of this section, certain key concepts are essential to interpreting studies generated by this technology. MRI uses measurements of the magnetic movements of atomic nuclei to delineate tissues. Specifically, when nuclei, such as hydrogen, are placed in a strong magnetic field, they resonate and emit radio signals when pulsed with radio waves. A defined sequence of magnetic pulses and interval pauses produces measured changes in the tissue's magnetic vectors, which results in an MRI image. T1, or longitudinal relaxation time, is the measurement of magnetic vector changes in the z axis during the relaxation pause. T2, or transverse relaxation time, is the magnetic vector changes in the x-y plane.

Each tissue, normal or pathologic, has a unique T1 and T2 for a given MRI field strength. In general T1 > T2. T1 = 0.1–2 s and T2 = 0.03–0.6 s. The inherent tissue differences between various T1's and T2's give the visual contrast seen between tissues on the MRI image. An image is **T1-weighted** if it depends on the differences in T1 measurements for visual contrast, or **T2-weighted** if the image depends on T2 measurements.

The most common pulse sequence is called spin echo (SE). Partial saturation (PS) and inversion recovery (IR) are two newer pulse sequences. Available MRI views are transverse, sagittal, oblique, and coronal.

How to Read an MRI

SE T1-Weighted Images: Provide good anatomic planes due to the wide variances of T1 values among normal tissues.

- · Brightest (high signal intensity): Fat
- · Dark or black: Pathological tissues, tumor or inflammation, fluid collections
- Black (low signal intensity): Respiratory tract, GI tract, calcified bone and tissues, blood vessels, heart chambers, and pericardial effusions

SE T2-Weighted Images: Pathology prolongs T2 measurements, and normal tissues have a very small range of T2 values. T2-weighted images provide the best detection of pathology and a decreased visualization of normal tissue anatomy. Tumor surrounded by fat may be lost on T2 imaging.

Brightest: Fat and fluid collections
 Bright: Pheochromocytomas

When to Use MRI

In general, MRI imaging is at least equal to CT imaging. MRI is superior to CT for imaging of brain, spinal cord, musculoskeletal soft tissues, adrenal and renal masses, and areas of high CT bony artifact. However, spiral CT may now have overcome some of these disadvantages.

Advantages

- · No ionizing radiation
- · Display of vascular anatomy without contrast
- · Visualization of linear structures: Spine and spinal cord, aorta, and cava
- · Visualization of posterior fossa and other hard to see CT areas
- · High-contrast soft tissue images

Disadvantages

- Claustrophobia due to confining magnet (Newer open MRI scanners may obviate this problem.)
- · Longer scanning time resulting in motion artifacts
- · Unable to scan critically ill patients requiring life support equipment
- Metallic foreign bodies: Pacemakers, shrapnel, CNS vascular clips, metallic eye fragments, and cochlear implants are contraindications

MRI Contrast: Gadolinium (gadopentetic dimeglumine) is an ionic contrast agent that acts as a paramagnetic agent and enhances vessels or lesions with abnormal vascularity.

Uses of MRI

MRI is very sensitive to motion artifact; anxious or agitated patients may require sedation. Intramuscular glucagon may be used to suppress intestinal peristalsis on abdominal studies. If metallic eye fragments are possible, a screening CT of the orbits should be obtained prior to any MRI examination. It is generally contraindicated in patients with intracranial aneurysm clips, intraocular metallic fragments, and pacemakers. Dental fillings and dental prostheses have thus far not been a problem.

Abdomen: Useful for differentiating adrenal lesions, staging tumors (renal, GI, pelvic), evaluation of abdominal masses, and virtually all intraabdominal organs and retroperitoneal structures. Useful in differentiating benign adenomas from metastasis

Chest: Mediastinal masses, differentiates nodes from vessels, cardiac diseases, tumor staging, aortic dissection or aneurysm

Head: Analysis of all intracranial pathology may identify demyelinating diseases; some conditions are better evaluated by CT (see previous section), including acute trauma. **MRS** may increase the sensitivity of diagnosis of many neurologic diseases by providing a biochemical "fingerprint" of tissues in the brain. Performed in conjunction with an MRI equipped with the MRS capability. Some uses include differentiating dementias, tumors, MS. and many others.

Musculoskeletal System: Bone tumors, bone and soft tissue infections, evaluation of joint spaces (except if a prosthesis is in place), marrow disorders, aseptic necrosis of the femoral head

Pelvis: Evaluation of all pelvic organs in males and females. Differentiates endometrium from myoma and adenomyosis. Diagnosis of congenital uterine anomalies (eg, bicornuate, septate). Endorectal surface coil allows enhanced imaging of structures such as the prostate.

Spine: Diseases of the spinal column (herniated discs, tumors, etc)

NUCLEAR SCANS

The following is a listing of some of the more commonly used nuclear scans and their purposes. Most are contraindicated in pregnancy; check with your nuclear medicine department.

Adrenal Scan: Used to accurately localize a pheochromocytoma when MRI or CT is equivocal. Uses labeled **MIBG**; patient must return several days later for imaging after administration.

Bleeding Scan: Used to detect the source of GI tract bleeding.

- 99mTC (technetium-99m) sulfur colloid scan. Used to detect bleeding of 0.05-0.1 mL/min.
- ^{99m}TC (technetium-99m)-labeled red cell scan. Same as sulfur colloid scan, but may be superior for localizing intermittent bleeding

Bone Scan: Metastatic work-ups (cancers most likely to go to bone: prostate, breast, kidney, thyroid, lung); evaluation of delayed union of fractures, osteomyelitis, avascular necrosis of the femoral head, evaluation of hip prosthesis, to distinguish pathological fractures from traumatic fractures

Brain Scan: Metastatic work-ups, determination of blood flow (in brain death or atherosclerotic disease), evaluation of space-occupying lesions (tumor, hematoma, abscess, [A-V] malformation), and encephalitis

Cardiac Scans: Diagnosis of MI, stress testing, ejection fractions, measurement of cardiac output, diagnosis of ventricular aneurysms

- Thallium-201 (²⁰¹TI). Examines myocardial perfusion via uptake of ²⁰¹TI by normal myocardium. Normal myocardium appears hot, and ischemic or infarcted areas cold. AMI (<12 h) seen as a hotspot, old MI (scar) seen as cold on both resting and exercise scans, and ischemia is cold on exercise scan and returns to normal after rest.
- Technetium-99m pyrophosphate. Recently damaged myocardium concentrates ^{99m}Tc pyrophosphate, producing a myocardial hotspot. Most sensitive 24–72 h after AMI
- Technetium-99m ventriculogram. ^{99m}Tc-labeled serum albumin or RBCs are used.
 Demonstrates abnormal wall motion, cardiac shunts, size and function of heart

chambers, cardiac output, and ejection fraction. Another form of this study is MUGA scan, data collection from which is synchronized to ECG, and selected aspects are used to create a "moving picture" of cardiac function. May be done at rest or during exercise stress test.

Gallium Scans: Location of abscesses (5–10 d old), chronic inflammatory lesions, original lymphoma staging or follow-up for disease detection, lung cancer, melanoma, other neoplastic tissues

Hepatobiliary Scans (HIDA-Scan, BIDA-Scan): Differential diagnosis of biliary obstruction (when bilirubin >1.5 and <7 mg/100 mL), acute cholecystitis, diagnosis of biliary atresia; NOT good for stones unless cystic duct is completely occluded and acute cholecystitis present

Indium-111 octreotide (OctreoScan): Imaging method for tumors with somatostatin receptors (pheochromocytoma, gastrinomas, insulinomas, small-cell lung cancer)

 I^{125} (Iodine-125) Fibrinogen Scanning: Used to detect venous thrombosis in the lower extremities. After injection of the tracer, the patient is scanned several hours and for several days after. Most useful to identify clot at or below the knees. False-positives with varicosities, cellulitis, incisions, arthritis, hematomas and with recent venography. Product availability is a problem at present.

Liver-Spleen Scan: Estimation of organ size, parenchymal diseases (hepatitis, etc), abscess, cysts, primary and secondary tumors

Lung Scan (V/Q Scan): Used along with a chest x-ray for evaluation of PE (a normal scan rules out a PE, an indeterminate scan requires further study via a pulmonary angiogram, and a clear perfusion deficit coupled with a normal ventilation scan is highly probable for a PE). V/Q scans can provide evidence of pulmonary disease, COPD, and emphysema.

Renal Scans: Agents are generally classified as functional tracers or morphologic tracers.

- ¹³¹I Hippuran. Primarily a renal function agent; useful in renal insufficiency for evaluation of function; visualization is poor, and radiation dose can be high
- Technetium-99m glucoheptonate. Useful as a combination renal cortical imaging
 agent and renal function agent; primarily used to evaluate overall function, but can
 be used to determine vascular flow and to visualize the renal parenchyma and collecting system
- Technetium-99m DMSA (dimercaptosuccinic acid). Used only as a renal cortical imaging agent
- Technetium-99m DTPA (diethylenetriamine pentaacetic acid). Primarily a renal function agent; useful for renal blood flow studies, estimation of GFR, evaluation of the collecting system
- Technetium-99m mercaptoacetyltriglycine (MAG3). A relatively new agent, primarily a functional agent, very good imaging of the renal parenchyma can be obtained within minutes of injection and a low radiation dose. May eventually replace all other renal agents.

Strontium-89 (Metastron): Not technically an imaging agent, but used in the palliative therapy of multiple painful bony metastasis (ie, prostate or breast cancer). Because this

is a pure beta emitter, the radioactivity remains in the body so no special precautions (other than blood and urine analysis) are needed.

SPECT Scan: Single-photon emission-computed tomography, a technique whereby multiple nuclear images are sequentially displayed similar to a CT scan; can be applied to many nuclear scans.

Thyroid Scan: Most commonly with technetium-99m pertechnetate. Useful for evaluation of nodules (solitary cold nodules require a tissue diagnosis because 25% are cancerous). Scan patterns in correlation with lab tests may help diagnose hyperfunctioning adenomas, Plummer's and Graves' diseases, and multinodular goiters; localize ectopic thyroid tissues (especially after thyroidectomy for cancer); and identify superior mediastinal thyroid masses

HOW TO READ A CHEST X-RAY Determine the Adequacy of the Film

- Inspiration: Diaphragm below ribs 8–10 posteriorly and 5–6 anteriorly
- · Rotation: Clavicles are equidistant from the spinous processes
- Penetration: Disc spaces are seen but bony details of spine cannot be seen

PA Film

Remember, the film is on the patient's chest and the x-rays are passing from back (posterior) to front (anterior). The structures described in the following material are shown in Figure 15–1.

Soft Tissues: Check for symmetry, swelling, loss of tissue planes, and subcutaneous air.

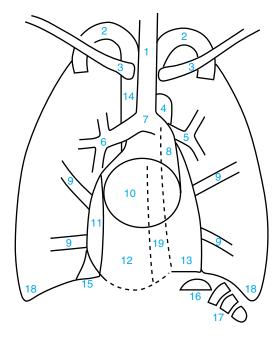
Skeletal Structures: Examine the clavicles, scapulas, vertebrae, sternum, and ribs. Look for symmetry. In a good x-ray, the clavicles are symmetrical. Check for osteolytic or osteoblastic lesions, fractures, or arthritic changes. Look for rib-notching.

Diaphragm: Sides should be equal and slightly rounded, although the left may be slightly lower. Costophrenic angles should be clear and sharp. Blunting suggests scarring or fluid. It takes about 100–200 mL of pleural fluid to cause blunting. Check below the diaphragm for the gas pattern and free air. A unilateral high diaphragm suggests paralysis (either from nerve damage, trauma, or an abscess), eventration or loss of lung volume on that side because of atelectasis or pneumothorax. A flat diaphragm suggests COPD.

Mediastinum and Heart: The aortic knob should be visible and distinct. Widening of the mediastinum is seen with traumatic disruption of the thoracic aorta. In children, do not mistake the normally prominent thymus for widening. Mediastinal masses can be associated with Hodgkin's disease and other lymphomas. The trachea should be in a straight line with a sharp carina. Tracheal deviation suggests a mass (tumor), goiter, unilateral loss of lung volume (collapse), or tension pneumothorax. The heart should be less than one-half the width of the chest wall on a PA film. If greater than one-half, think of CHF or pericardial fluid.

Hilum: The left hilum should be up to 2–3 cm higher than the right. Vessels are seen here. Look for any masses, nodes, or calcifications.

Lung Fields: Note the presence of any shadows from CVP lines, NG tubes, pulmonary artery catheters, etc. The fields should be clear with normal lung markings all the way to the periphery. The vessels should taper to become almost invisible at the periphery.

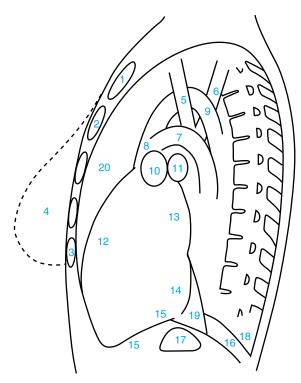


Posteroanterior Chest X-ray

- 1. Trachea
- 2. First rib
- 3. Clavicle
- 4. Aortic knob
- 5. Left pulmonary artery
- 6. Right pulmonary artery
- 7. Carina
- 8. Pulmonary trunk
- 9. Pulmonary veins

- 10. Left atrium
- 11. Right atrium
- 12. Right ventricle
- 13. Left ventricle
- 14. Superior vena cava
- 15. Inferior vena cava
- 16. Gastric air bubble
- 17. Splenic flexure air
- 18. Costophrenic angles
- 19. Descending aorta

FIGURE 15-1 Structures seen on a posteroanterior (PA) chest x-ray film.



Lateral Chest X-ray

- 1. Manubrium
- 2. Body of sternum
- 3. Xiphoid process
- 4. Breast shadow
- 5. Trachea
- 6. Scapula
- 7. Left pulmonary artery
- 8. Ascending aorta
- 9. Aortic arch
- 10. Right pulmonary artery

- 11. Left mainstem bronchus
- 12. Right ventricle
- 13. Left atrium
- 14. Left ventricle
- 15. Right diaphragm
- 16. Left diaphragm
- 17. Gastric air bubble
- 18. Costophrenic angles
- 19. Inferior vena cava
- 20. Retrosternal clear space

FIGURE 15-2 Structures seen on a lateral chest x-ray film.

Vessels in the lower lung should be larger than those in the upper lung. A reversal of this difference (called cephalization) suggests pulmonary venous hypertension and heart failure. **Kerley's B lines**, small linear densities found usually at the lateral base of the lung, are associated with CHF. Check the margins carefully; look for pleural thickening, masses, or pneumothorax.

If the lungs appear hyperlucent with a relatively small heart and flattening of the diaphragms, COPD is likely. Thin plate-like linear densities are associated with atelectasis.

To locate a lesion, do not forget to check a lateral film and remember the "silhouette sign." Obliteration of all or part of a heart border means the lesion is anterior in the chest and lies in the right middle lobe, lingula, or anterior segment of the upper lobe. A radiopacity that overlaps the heart but does not obliterate the heart border is posterior and lies in the lower lobes.

Examine carefully for the following:

- Coin lesions: Causes are granulomas (50% which are usually calcified), (histoplasmosis 25%, TB 20%, coccidioidomycosis 20%, varies with locale); primary carcinoma (25%), hamartoma (<10%), and metastatic disease (<5%).
- Cavitary lesions: Causes are abscess, cancer, TB, coccidioidomycosis, Wegener's granulomatosis.
- 3. Infiltrates: Two major types
 - a. Interstitial pattern. "Reticular." Causes are granulomatous infections, miliary TB, coccidioidomycosis, pneumoconiosis, sarcoidosis, CHF. "Honeycombing" represents end-stage fibrosis caused by sarcoid, RA, and pneumoconiosis.
 - Alveolar pattern. Diffuse, quick progression and regression. Can see either "butterfly" pattern or air bronchograms. Causes are PE, pneumonia, hemorrhage or PE associated with CHF

Lateral Film

Examine the structures shown in Figure 15–2. Use this study to check for the three-dimensional location of lesions. Pay close attention to the retrosternal clear space, costophrenic angles, and the path of the aorta.

INTRODUCTION TO THE OPERATING ROOM

Sterile Technique Entering the OR The Surgical Hand Scrub Preparing the Patient Gowning and Gloving Draping the Patient Finding Your Place Universal Precautions Latex Allergy

Working in the OR can be the best or worst experience of a clinical rotation. However, familiarity with OR procedure is crucial to the success of any such experience. Preparing yourself before you get to the OR by knowing the patient thoroughly and having a basic understanding of what is planned will greatly enhance your OR experience. Don't fall into the trap of stereotyping the nurses as cranky, the surgeons as egotistical, and the medical students as stupid. Avoid this by learning the routine of the OR. Be alert, attentive, and, above all, patient. Soon, the routine should become second nature. Most importantly, don't be afraid to admit to the scrub nurse and the circulating nurse that you're new at this. They are usually more than happy to help you follow correct procedures.

STERILE TECHNIQUE

Members of the OR team, which includes the surgeon, assistants, students, and scrub nurse (the one who is responsible for passing the instruments and gowning the OR team), maintain a sterile field. The circulating nurse acts as a go-between between the sterile and non-sterile areas.

Sterile areas include

- · Front of the gown to the waist
- Gloved hands and arms to the shoulder
- · Draped part of the patient down to the table level
- Covered part of the Mayo stand
- Back table where additional instruments are kept

The sides of the back table are not considered sterile, and anything that falls below the level of the patient table is considered contaminated.

ENTERING THE OR

From the moment you enter the OR, everything is geared toward maintaining a sterile field. The use of sterile technique begins in the locker room. Change into scrub clothing (remember to remove T-shirts and tuck the scrub shirt into the pants). Be sure that the ties of the scrub pants are also tucked inside the pants. Scrub clothes may occasionally be worn on the wards, provided that they are covered by a clinic coat or some other form of gown, but you

need to check your hospital or departmental requirements on this. If you do wear scrub clothing out of the OR, be sure that it is not bloodstained.

Pass into the anteroom to get your mask, cap, and shoe covers. The mask should cover your entire nose and mouth. Full hoods are necessary for men with a beard. The cap must cover all of your hair. Because of universal precautions, OR staff are now required to use protective eyewear while at the operative field. While wearing glasses, it is helpful to tape the mask to the bridge of your nose to prevent fogging during the surgery. Special masks are also available with self-adhesive strips to help prevent fogging of glasses. Tape the glasses to your forehead if you think they may be loose enough to fall onto the table during the operation! Do not wear nail polish, and remove any loose jewelry, watches, and rings before scrubbing. Make sure that shoelaces are tucked inside the shoe covers.

The mask does not need to be worn in the hall of the OR suite (but everything else does) at most hospitals. The mask must be worn in the OR itself, near the scrub sinks, and in the substerile room between ORs.

Find the operating room where the patient is located, and assist in transport, if necessary. Introduce yourself to the intern or resident and nurse, and try to get an idea of when to begin scrubbing (usually when the first surgeon starts to scrub). If you have a pager, follow the OR procedures and remove the pager if you are going to be scrubbed into the case.

THE SURGICAL HAND SCRUB

The purpose of a surgical hand scrub is to decrease the bacterial flora of the skin by mechanically cleansing the arms and hands before the operation. Key points to remember: (1) If contamination occurs during the scrub, it is necessary to start over, and (2) In emergency situations exceptions are made to the time allowed for scrubbing (as in obstetrics, when the baby is brought out from the delivery room and the student is still scrubbing!). Caps and masks should be properly positioned before the start of the scrub.

Povidone-Iodine (Betadine) Hand Scrub

Scrubbing technique depends somewhat on local custom. Some ORs want a timed scrub in which the duration of scrubbing is determined by watching the clock. Other ORs use an "anatomic" scrub in which the duration of scrubbing is determined by counting strokes. Either is acceptable, and you should find out what the custom is at your institution.

Timed Scrub

- 1. Perform a general prewash, with surgical soap and water, up to 2 in. above the elbows.
- Use disposable brushes if available. Aseptically open one brush and place it on the ledge above the sink for the second half of the scrub. Open another brush and begin the scrub with Betadine. Use the nail cleaner to clean under all fingernails.
- Scrub both arms during the first 5 min. Start at the fingertips and end 2 in. above the elbows; pay close attention to the fingernails and interdigital spaces. Discard the brush and rinse from fingertips to elbows.
- Take the second brush and repeat step 3. Always start at the fingertips and work up to the elbows.
- Always allow water to drip off the elbows by keeping the hands above the level of the elbows.
- Move into the OR to dry your hands and arms (back into the room to push the door open).
- **7.** Scrubbing times:
 - a. Ten minutes at the start of the day or with no previous scrub within the last 12 h and on all orthopedic cases

b. Five minutes with a previous scrub or between cases if you have not been out of the OR working with other patients

Chlorhexidine (Hibiclens) 6-Min Hand Scrub (Timed)

- 1. Wet your hands and forearms to the elbows with water.
- Dispense about 5 mL of Hibiclens into your cupped hands and spread it over both hands and arms to the elbows.
- Scrub vigorously for 3 min without adding water. Use a sponge or brush for scrubbing, and pay particular attention to fingernails, cuticles, and interdigital spaces.
- 4. Rinse thoroughly with running water.
- 5. Dispense another 5 mL of Hibiclens into your cupped hands.
- 6. Wash for an additional 3 min. There is no need to use a brush or sponge at this point. Rinse thoroughly. Move into the OR back first to dry your hands.

Anatomic Scrub

- 1. Perform a general prewash, with surgical soap and water, up to 2 in. above the elbows.
- Use disposable brushes if available. Aseptically open one brush and place it on the ledge above the sink for the second half of the scrub. Open another brush and begin the scrub with Betadine. Use the nail cleaner to clean under all fingernails.
- 3. Each surface is to be scrubbed vigorously 10 times. Start with each finger (each of which has four surfaces), proceeding to the hand, the forearm, and the arm above the elbow. After finishing one extremity, do the other from fingers to above the elbow. Be sure to include all parts of your hand, especially the interdigital spaces.
- 4. Rinse both arms thoroughly.
- 5. Now rescrub each extremity, this time not going above the elbow. This is done in a similar fashion, 10 times on each surface from fingers to elbow.
- 6. Rinse thoroughly and proceed into the OR.

PREPARING THE PATIENT

The exact technique may vary in different medical centers, but the patient prep involves mechanically cleansing the patient's skin in the region of the surgical site to reduce bacterial flora. Ask the intern or resident to guide you through the procedure the first time, and consider doing it yourself thereafter. It is always better to prep a wider area than you think necessary. For example, for a midline laparotomy, the patient is prepped from nipples to pubis, and from the flank at table level on one side to the table level on the other side.

Materials

Usually, a small prep table is present containing the following:

- Gloves
- Towels
- · Betadine or other scrub soap (optional)
- · Betadine or other paint solution
- · 4 × 4 gauze squares or sponges
- · Ring forceps (optional)

Technique

- 1. Patient prep is usually done before putting on the sterile gown. Don a pair of gloves, and scrub the area designated by the intern or resident for 4–6 min. Use the 4 × 4s (or sponges) and the soap solution. This is generally done three times with a gauze or sponge in each hand for a total of 4–6 min. Note, however, many times this traditional wound scrubbing is no longer performed routinely and is used only in specific circumstances, such as, contaminated wounds.
- 2. Drape the area with a towel, and then gently pat the area dry if the wound was scrubbed. Taking care not to contaminate the area, gently peel off the towel from one side, being careful not to allow the towel to fall back on the prepped area. Also be careful not to contaminate your own arms, so that you do not have to rescrub before gowning.
- 3. Use 4 × 4s or sponges to paint the exposed area with the Betadine or other provided solution, using the proposed incision site as the center. Move circumferentially away from the incision site. Never bring the 4 × 4s back to the center after they have painted more peripheral areas. This is done as a series of concentric circles. Some centers will only "paint" and not "scrub" with the soap solution. Some surgeons want the paint dried with a towel at the end, and others like to leave it "wet." Check with the resident or attending physician before you start, to find out exactly what is wanted.
- When you are finished with the prep, remove your gloves in a sterile manner and proceed to get your gown on.

GOWNING AND GLOVING

- If you have just completed the hand scrub, back into the room to push the door open; keep your hands above your elbows.
- Ask the scrub nurse for a towel. Do not be impatient because the scrub nurse is often very busy. Stick out one hand, palm up and well away from the body. The nurse will drape the towel over your hand.
- 3. Bend at the waist to maintain sterility of the towel. It should never touch your clothing.
- 4. With one-half of the towel, dry one arm, beginning at the fingers; change hands and dry the other arm with the remaining half of the towel. Never go back to the forearm or hands after drying your elbows.
- 5. Drop the towel in the hamper. Again, remember to keep your hands above your elbows.
- 6. Ask for a gown and hold your arms out straight. The scrub nurse will place the gown on you, and the circulator will tie the back for you.
- 7. The nurse will usually hold out a right glove with the palm toward you. Push your hand through the glove. Gloves come in different sizes-small (5½-6½), medium (7-7½), and large (8-8½)-and different materials: standard latex gloves, hypoallergenic (powder-free), reinforced (orthopedic), and latex-free. Ask the resident or scrub nurse for guidance on the type of glove to request. It is good form to ask the circulating nurse to open your gloves before you actually begin to scrub.
- Repeat the procedure with the left glove. It is easier if you use two fingers of your gloved right hand to help hold the left glove open.
- 9. Visually inspect the gloves for any holes.
- 10. Give the scrub nurse the long string of your front gown-tie. Hold the other string your-self and turn around in place. Tie the strings.
- 11. The nurse may offer you a damp sponge to clean the powder off the gloves (the powder has been implicated in some postoperative complications, eg, adhesions). This varies by locale.

12. Now wait patiently; stay out of the way, and keep your hands above your waist. Hold them together to prevent yourself from accidentally dropping them or touching your mask. This is one of the most difficult things for the neophyte to remember. Be attentive. The only things that are sterile are your chest to your waist in the front and your hands to the shoulders. Your back is not sterile, nor is your body below the waist. Avoid crossing your arms.

DRAPING THE PATIENT

Draping the patient is usually done by the surgeon and assistants. Watch how they do it, and consider helping at a later date. It is harder to keep sterile than it looks.

FINDING YOUR PLACE

The medical student is often the "low man or woman on the totem pole" and, initially, usually stands down by the patient's feet. Ask the senior surgeon where you should stand.

The first thing to remember is that once you are scrubbed, you must not touch anything that is not sterile. Put your hands on the sterile field and do not move about unnecessarily. If you need to move around someone else, pass back to back. When passing by a sterile field, try to face it. When passing a nonsterile field, pass it with your back toward it. If you are observing a case and are not scrubbed in, do not go between two sterile fields, and stay about 1 ft away from all sterile fields to avoid contamination (and condemnation!). When not scrubbed in, it often helps to keep your hands behind your back, being careful not to back into the instrument table.

Do not drop your hands below your waist or the table level. Do not grab at anything that falls off the side of the table—it is considered contaminated. If something falls, you can quietly inform the circulating nurse. Do not reach for anything on the scrub nurse's small instrument stand (the Mayo stand). You may ask for the instrument to be given to you.

If someone says that you have contaminated a glove or anything else, do not move and do not complain or disagree. Remember that the focus of the OR is maintaining a sterile field, so if anyone says, "You're contaminated," accept the statement and change gloves, gown, or whatever is needed. If a glove alone is contaminated, hold the hand out away from the sterile field, fingers extended and palms up, and a circulating nurse will pull the glove off. The same is true if a needle sticks you or if a glove tears. Tell the surgeon and scrub nurse that you are contaminated and change gloves.

If you have to change your gown, step away from the table. The circulator will remove first the gown and then the gloves. This procedure prevents the contaminated inside of the gown from passing over the hands. Regown and reglove without scrubbing again.

Always be aware of "sharps" on the field. When passing a potentially injurious instrument, always make the other members of the team aware that you are passing a sharp (ie, "needle back." "knife back," etc). Attempt to learn the names and functions of the common instruments. A knowledgeable student may be more likely to actively participate in the case.

At the end of the case (once the dressing is on the wound), you may remove the gown and gloves but not the mask, cap, or shoe covers. To protect yourself, remove your gown first, and remove your own gloves last. This keeps your hands clean of any blood or fluids that got onto your gown during the procedure. Assist in the transfer of the patient to the postoperative recovery room. Postop orders and a brief operative note are written immediately. See Chapter 2 (page 36) on how to write postop notes and orders. It is good form to offer to write the postop note and orders if you are comfortable with the process. Due to governmental regulations that affect attending physicians at teaching hospitals, the attending must often write the note him or herself. At the very least, the attending of record will

annotate an "attestation" to your note saying that the surgeon was "personally present during the critical portions of the procedure."

UNIVERSAL PRECAUTIONS

All operating room personnel are at risk for infection with blood-borne agents responsible for such diseases as AIDS and hepatitis. To reduce the incidence of such transmission, a set of guidelines called Universal Precautions has been developed by the CDC. The underlying principle is that, because patients cannot be routinely tested for HIV and are rarely tested preoperatively for hepatitis, the safest policy is to treat all patients as though they are infected with these agents. This approach ensures evenhanded treatment of all patients and the safest work environment for those who are exposed to the blood of others.

Minimizing the risks to all who are in the OR requires constant vigilance. Movements must be coordinated among surgeon, assistant, and technician. Fingers are never used to pick up needles; this is done only with another instrument. Fingers and hands should not be used as retractors. Two people should never be holding the same sharp instrument. Placing a sharp instrument down or handing it to another member of the team is always preceded by a verbal warning that notifies the recipient that a sharp object is about to be passed. Protective eyewear must be worn by all members of the operating team.

The practice of "double gloving" is often reserved for cases in which the patient is known to carry a transmissible agent. This technique definitely reduces the incidence of blood-skin contact, especially in light of the extraordinarily high incidence of unrecognized glove perforations. Until puncture-resistant gloves are developed, this is the best approach we have.

LATEX ALLERGY

Individuals with certain medical conditions or occupations that are heavily exposed to products containing natural rubber latex may became sensitized to it and develop allergic reactions. Up to 7% of health care workers can have allergic reactions. Certain conditions (ie, spina bifida, cerebral palsy) predispose patients to an 18–40% incidence of allergy. Reactions can vary from mild rash and itching to anaphylaxis. Latex products are found in a wide array of products, from gloves and drapes, to IV tubing. Occasionally patients will have documented latex allergy. Hospitals have latex allergy protocols, and hospitals maintain an inventory of latex-free products.

SUTURING TECHNIQUES AND WOUND CARE

Wound Healing Suture Materials Suturing Procedure Suturing Patterns Surgical Knots Suture Removal Tissue Adhesives

WOUND HEALING

The process of wound healing is generally divided into four stages: inflammation, fibroblast proliferation, contraction, and remodeling. There are three different types of wound healing: primary intent (routine primary suturing); secondary intent (the wound is not closed with suture and closes by contraction and epithelialization, most often used for wounds that are infected and packed open); and tertiary intent (also called delayed primary closure; the wound is left open for a time and then sutured at a later date, used often with grossly contaminated wounds).

SUTURE MATERIALS

Suture materials can be broadly defined as absorbable and nonabsorbable. **Absorbable sutures** can be thought of as temporary; these include plain gut; chromic gut; and synthetic materials such as polyglactin 910 (Vicryl), polyglycolic acid (Dexon), and poliglecaprone (Monocryl). These are resorbed by the body when left internally after a variable period (Table 17–1). Polydioxanone (PDS) is a long-lasting absorbable suture. Nonabsorbable sutures can be thought of as "permanent" unless they are removed; these include silk, stainless steel wire, polypropylene (Prolene), and nylon (see Table 17–1).

The size of a suture is defined by the number of zeros. The more zeros in the number, the smaller the suture. For example, a 5-0 suture (00000) is much smaller than a 2-0 (00) suture.

Most sutures come prepackaged and mounted on needles ("swaged on"). Cutting needles are used for tough tissues such as skin, and tapered needles are used for more delicate tissues such as the intestine. The most common needle for skin closure is the % in. circle cutting needle.

SUTURING PROCEDURE

The following guidelines cover the repair of lacerations in the emergency setting. Similar principles hold true for closure of wounds in the operating room. The choice of appropriate suture material is based on many factors, including location, extent of the laceration, strength of the tissues, and preference of the physician.

TABLE 17-1 Common Suture Materials

Suture (Brand Name)	Description	Tensile Strength*	Absorbed [†]	Common Uses
Fast catgut	Twisted/Fast absorption	3–5 d	30 d	Facial lacerations in children
Plain catgut	Twisted Rapidly absorbable	<i>7</i> –10 d	70 d	Vessel ligation, subcutaneous tissues
Chromic catgut	Twisted/absorbable	10–14 d	90 d	Mucosa
Polyglycolic acid (Dexon)	Braided/Absorbable	14–21 d	60–90 d	GI, subcutaneous tissues
Polyglactin 910 (Vicryl Rapide)	Braided/Absorbable	5 d	42 d	Skin repair needing rapid absorption
Polyglactin 910 (Vicryl)	Braided/Absorbable	21 d	56-70 d	Bowel, deep tissue
Poliglecaprone 25 (Monocryl)	Monofilament/ Absorbable	<i>7</i> –14 d	91–119 d	Skin, bowel
Polydioxanone (PDS)	Monofilament/ Absorbable	28 d	6 mo	Fascia, vessel anastomosis
Polyglyconate (Maxon)	Braided/Absorbable	28 d	6 mo	GI, muscle, fascia
Panacryl	Braided/Absorbable	>6 mo	>24 mo	Fascia, tendons

(continued)

TABLE 17-1 (Continued)

Suture (Brand Name)	Description	Common Uses
Nylon (Dermalon, Ethilon	Monofilament	Skin, drains
Nylon (Nurolon)	Braided	Tendon repair
Polyester (Ethibond, Tycron)	Braided	Cardiac, tendon
Polypropylene (Prolene)	Monofilament	Vessel, fascia, skin
Silk ′		GI, vessel ligation, drains
Stainless steel	Monofilament	Fascia, sternum

^{*}When suture looses approximately 50% strength.

[†]Approximate.

- Face: 5-0 and 6-0 nylon or polypropylene where cosmetic concerns are important
- · Scalp: 3-0 nylon or polypropylene
- Trunk or extremities: 4-0 or 5-0 nylon or polypropylene

Use 3-0 and 4-0 absorbable sutures such as Dexon or Vicryl to approximate deep tissues. Skin is usually best closed by using interrupted sutures placed with good approximation with a minimum amount of tension or by a running subcuticular suture. Tissue adhesives may be used selectively (see page 358). Suture patterns are discussed in the next section. Suture marks ("tracks") are the result of excessive tension on the tissue or leaving the sutures in for too long. Thus, the length of time and the technique used are probably more important in determining the final result than is the suture used in most cases.

- 1. Remove all foreign materials and devitalized tissues by sharp excision (debridement). Clean the wound with plain saline (antiseptic solutions used on wound cleansing should be discouraged because they can be toxic to viable cells). A useful technique involves irrigation with at least 200 mL of saline through a 35-mL syringe and a 19-gauge needle. Anesthesia may be necessary before any of this is done. If all the debris is not removed, traumatic "tattooing" of the skin may result.
- In general, do not suture infected or contaminated wounds, lacerations more than 6–12
 h old (24 h on the face), missile wounds, and human or animal bites without surgical
 consultation.
- 3. Anesthetize the wound by infiltrating it with an agent such as 0.5% or 1% lidocaine (Xylocaine). The maximum safe dosage is 4.5 mg/kg (about 28 mL of a 1% solution in an adult). Lidocaine and the other local anesthetic agents are available with epinephrine (1:100,000 or 1:200,000) added to produce local vasoconstriction that prolongs the anesthetic effect and helps decrease systemic side effects and bleeding. Epinephrine should be used with caution, particularly in patients with a history of hypertension, and should not be used on the digits, toes, or penis. 1 mL of 1:10 NaHCO₃ can be mixed with 9 mL of lidocaine to help minimize the discomfort of the injection. Commonly used local anesthetics are compared in Table 17–2.
- 4. When using local anesthetics, always aspirate before injecting to prevent intravascular injection of the drug. Anesthetize with a 26–30-gauge needle. Symptoms of toxicity from local anesthetics includes twitching, restlessness, drowsiness, light-headedness, and seizures.
- 5. Close the wound using one of the suturing patterns discussed in the next section. Use fine-toothed forceps (Adson or Brown-Adson) with gentle pressure to handle skin edges to decrease trauma. The toothed forceps are less traumatic to the skin than other forceps with flat surfaces that may crush the tissue.
- 6. Cover the wound and keep it dry for at least 24–48 h. Dry gauze or Steri-Strips are sufficient. On the face, simply covering with antibiotic ointment is often used, especially around the eyes or mouth. After that, the patient may shower and wet the wound. This will not increase the risk of infection.
- Finally, keep tetanus and antibacterial prophylaxis in mind, particularly for contaminated wounds (Table 17–3, page 350).

SUTURING PATTERNS

Opinions vary greatly on the ideal technique for skin closure. The following are the common techniques used for approximation of skin. Critical to any suturing technique is making certain that the edges of the wound closely approximate without overlapping or inversion and that there is no tension. Remember "approximation without strangulation" or eversion

TABLE 17–2 Local Anesthetic Comparison Chart for Commonly Used Injectable Agents

		Onset		Maximum Dose	
	Proprietary Names		Duration	mg/kg	Volume in 70-kg Adult*
Bupivacaine	Marcaine, Sensoricaine	7–30 min	5–7 h	3	70 mL of 0.25% solution
Lidocaine	Xylocaine, Anestacon	5–30 min	2 h	4	28 mL of 1% solution
Lidocaine with epinephrine (1:200,000)		5–30 min	2–3 h	7	50 mL of 1% solution
Mepivacaine	Carbocaine	5–30 min	2–3 h	7	50 mL of 1% solution
Procaine	Novocaine	Rapid	30 min-1 h	10–15	70–105 mL of 1% solution

TABLE 17–3 Tetanus Prophylaxis

History of Absorbed		, Minor unds	All Other Wounds*	
Tetanus Toxoid Immunization	Td†	TIG‡	Td^\dagger	TIG‡
Unknown or <3 doses <3 doses§	Yes No**	No No	Yes No ^{††}	Yes No

- *Such as, but not limited to, wounds contaminated with dirt, feces, soil, saliva, etc; puncture wounds; avulsions; and wounds resulting from missiles, crushing, burns, and frostbite.

 †Td = tetanus-diphtheria toxoid (adult type), 0.5 mL IM.
- For children <7 y of age, DPT (DT, if pertussis vaccine is contraindicated) is preferred to tetanus toxoid alone.
- For persons >7 years of age, Td is preferred to tetanus toxoid alone.
- DT = diphtheria-tetanus toxoid (pediatric), used for those who cannot receive pertussis.
 †TIG = tetanus immune alobulin, 250 U IM.
- §If only three doses of fluid toxoid have been received, then a fourth dose of toxoid, preferably an absorbed toxoid, should be given.
- **Yes, if >10 y since last dose.
- ††Yes, if >5 y since last dose.

Source: Based on guidelines from the Centers for Disease Control and reported in MMWR.

of the skin edges gives the best results (Figure 17–1). Figures 17–2 through 17–6 illustrate the commonly used suturing patterns. These include the simple interrupted suture (Fig. 17–2), running (locked or unlocked) suture (Fig. 17–3), vertical mattress suture (Fig. 17–4), horizontal mattress suture (Fig. 17–5), and subcuticular suture (Fig. 17–6).

SURGICAL KNOTS

There are two basic knot-tying techniques: the handed tie and the instrument tie. The twohanded tie is easier to learn than the one-handed tie, although one-handed ties may be more useful in certain situations (eg, with deep cavities or where speed is essential). Some programs frown on one-handed tying, especially for physicians early in their careers. Instrument ties are more useful for closing skin and for emergency room laceration repair. Figures 17–7, page 355, and 17–8, page 356, show the technique for tying a two-handed square knot. This is the standard surgical knot that should be learned first. Figure 17–9, page 357, shows the technique for an instrument tie.

SUTURE REMOVAL

The longer that suture material is left in place, the more scarring it will produce. Using a topical antibiotic (Polysporin, others) ointment on the wound is helpful in decreasing suture tract epithelialization. This epithelialization results from crusting around the suture that increases suture marks and subsequent scarring. Sutures can be safely removed when a wound has developed sufficient tensile strength. Situations vary greatly, but general guidelines for

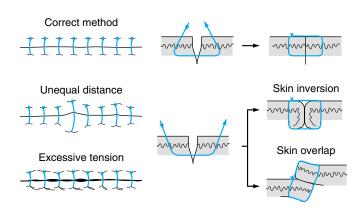


FIGURE 17-1 Proper method for simple interrupted suturing of a skin wound compared with incorrect techniques that result in poor scars from skin overlap, skin inversion, or necrosis of the skin edges because of excessive tension. (Reprinted, with permission from: Stillman RM [ed]: Surgery: Diagnosis and Therapy, Appleton & Lange, Stamford CT, 1989.)

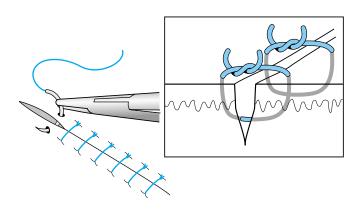


FIGURE 17-2 Simple interrupted suture. "Bites" are taken through the thickness of the skin, and the width of each stitch should equal the distance between sutures to avoid inverting the skin edges.

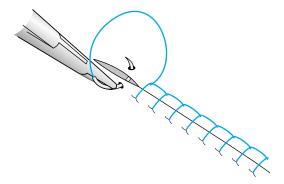


FIGURE 17-3 Continuous running suture. It allows rapid closure, but depends on only two knots for security and may not allow precise approximation of the skin edges. "Locking" each stitch, as shown, may increase scarring.

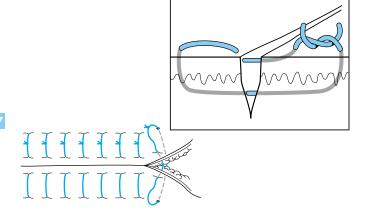


FIGURE 17-4 Vertical interrupted mattress suture. It allows precise approximation of the skin edges with little tension, but may result in more scarring than a simple stitch. The needle is placed in the skin in a "far, far, near, near" sequence.

П

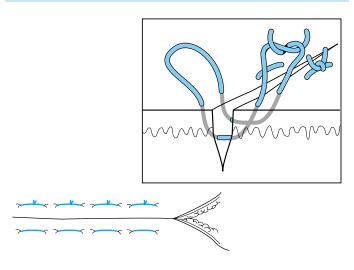


FIGURE 17-5 Horizontal interrupted mattress suture. This is an everting stitch that is more frequently used in fascia than in skin. It is often used in calloused skin such as the palms and soles.

removing sutures from different areas of the body are: face and neck, 3–5 d; scalp and body, 5–7 d; and extremities, 7–12 d. Any suture material or skin clips can be removed earlier if they have been reinforced with a deep absorbable suture or with the application of Steri-Strips after the suture is removed. Steri-Strips will stay in place more securely if tincture of benzoin (spray or solution) is applied to the skin and allowed to dry before the Steri-Strips are applied. The length of time absorbable sutures remain in tissues is shown in Table 17–1.

Suture Removal Procedure

- Gently clear away any dried blood with saline and gauze. Verify that the wound is sufficiently healed to allow suture removal. Use a forceps to gently elevate the knot off the skin. This can be uncomfortable for the patient.
- Cut the suture as close to the skin as possible so that a minimal amount of "dirty suture" is dragged through the wound. When removing continuous sutures, cut and pull out each section individually. Never pull a knot through the skin.
- 3. The use of skin staples is commonplace in the operating room because of the rapidity of closure and the nonreactive nature of the steel staples. These are typically removed 3–5 d after surgery (abdominal incisions) as shown in Figure 17–10. Because these are removed fairly quickly, reinforce the incision with Steri-Strips. When removing skin staples, make sure that the staple is completely reformed (see Figure 17–10) before removal to decrease patient discomfort.

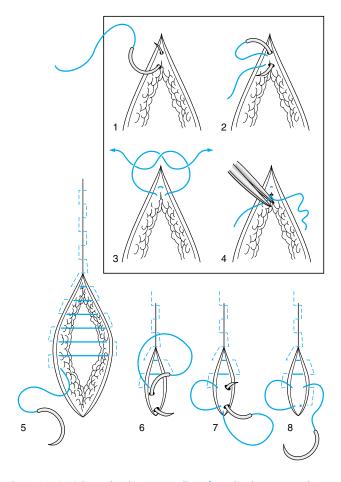


FIGURE 17-6 Subcuticular closure is usually performed with continuous, horizontally applied intradermal sutures. These are ideal for linear cosmetic closures because they eliminate possible cross-hatching deformities. If nonabsorbable suture material (eg, 5-0 or 6-0 Prolene) is used, the knot is placed on the skin and pulled taut. If absorbable (5-0 or 6-0 Dexon or Vicryl) is used, the knot is usually buried as shown. (Reprinted, with permission from: Stillman RM [ed]: *Surgery: Diagnosis and Therapy*, Appleton & Lange, Stamford CT, 1989.)

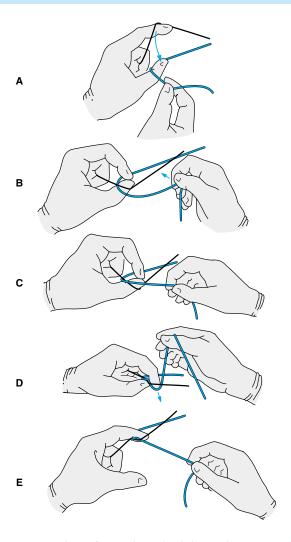


FIGURE 17-7 Technique for tying the two-handed square knot. Suture ends are uncrossed as step A begins (continued in Figure 17–8).

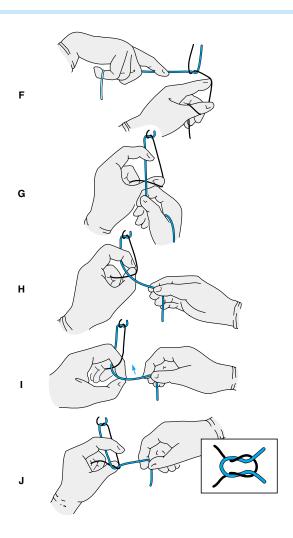


FIGURE 17-8 The two-handed square knot (continued from Figure 17-7). Hands must be crossed at the end of the first loop tie (step F) to give a flat knot; hands are not crossed at the end of the second loop tie (step J).

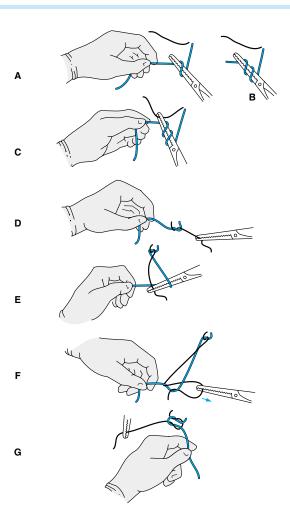


FIGURE 17-9 The instrument tie. Begin with either a single or double (illustrated) looping of the lower end of the suture around the needle holder. The first loop is laid flat without crossing the hands. Hands must be crossed after the second loop tie (step G) to produce a flat square knot.

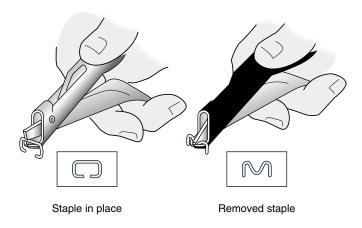


FIGURE 17-10 Removal of skin staples. The staple removal instrument is passed beneath the staple and completely closed. Be sure that the staple is completely "reformed" before removal to decrease patient discomfort. (Courtesy of Ethicon, Inc.)

TISSUE ADHESIVES

Octyl cyanoacrylate (Dermabond) is a topical skin adhesive (very similar to cyanoacrylate glue) that holds wound edges together. It is useful in wounds that are clean and easily opposed and for young children, for whom suture removal may be a problem. The wound should be nonmucosal on the face, torso, or extremity. It is recommended for wounds <8 cm with minimal tension (skin gap should be <0.5 cm). It is also useful for stabilizing wounds if the sutures were removed very early in order to minimize suture marks. It should not be used for puncture wounds, bites or wounds that need debridement, or in regions subjected to frequent movement (ie, hand or finger).

Gently approximate the wound edges with fingers or a forceps and place a small coating of the glue directly on the wound. After 2–3 min (after the glue has dried), an additional one or two coats may be applied. The glue will spontaneously separate in approximately 5–10 d. Once the glue is in place and stable, it is not necessary to use any topical medication or ointment. The patient may shower for brief periods. If the adhesive is too tacky, too much glue has been applied.

RESPIRATORY CARE

Respiratory Therapy Pulmonary Function Tests Differential Diagnosis of PFTs Oxygen and Humidity Supplements Bronchopulmonary Hygiene Topical Medications Metered-Dose Inhalers

RESPIRATORY THERAPY

Respiratory therapy is a vital component of health care. The objective is the treatment and care of all types of patients with cardiopulmonary diseases. Functions of the respiratory therapist include emergency care, ventilatory support, airway management, oxygen therapy, humidity and aerosol therapies, chest physiotherapy, physiologic monitoring, and pulmonary diagnostics.

PULMONARY FUNCTION TESTS

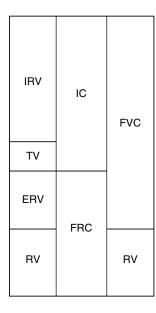
PFTs are useful in diagnosing a variety of pulmonary disorders. Common PFTs include spirometry, lung volume determinations, and diffusing capacity. Important measures include the FVC and the FEV $_1$. Spirometry may identify obstructive airway diseases such as asthma or emphysema when the ratio of FEV $_1$ /FVC is less than 70%, or restrictive lung diseases such as sarcoidosis or ankylosing spondylitis when both the FVC and FEV $_1$ are reduced. Spirometry may also be an important part of a preoperative evaluation. Spirograms can be obtained before and after the administration of bronchodilators if they are not contraindicated (ie, history of intolerance). Bronchodilator responsiveness will help in predicting the response to treatment and in identifying asthma.

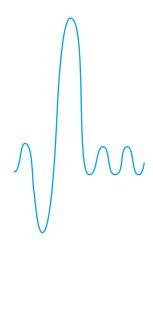
Lung volumes commonly determined by helium dilution must be ordered to definitively diagnose restrictive lung disease. This is usually indicated by TLC less than 80% of predicted normal. Diffusion capacity is important in the diagnosis of interstitial lung disease or pulmonary vascular disease, where it is reduced. It is also frequently followed to determine the response to therapy in interstitial diseases.

Obstructive pulmonary diseases include asthma, chronic bronchitis, emphysema, bronchiectasis, and lower airway obstruction. Restrictive pulmonary disease includes interstitial pulmonary diseases, diseases of the chest wall, and neuromuscular disorders. Interstitial disease may be due to inflammatory conditions [usual interstitial pneumonitis (UIP)], inhalation of organic dusts (hypersensitivity pneumonitis), inhalation of inorganic dusts (asbestosis), or systemic disorders with lung involvement (sarcoidosis).

Normal PFT values vary with age, sex, race, and body size. Normal values for a given patient are established from studies of normal populations and are provided along with the results. Arterial blood gases should be included in all PFTs.

Typical volumes and capacities are illustrated in Figure 18-1.





FVC = Forced vital capacity

RV = residual volume

FRC = functional residual capacity

TV = tidal volume

ERV = expiratory reserve volume

IRV = inspiratory reserve volume IC = inspiratory capacity

FIGURE 18-1 Lung volumes in the interpretation of pulmonary function tests.

Tidal Volume (TV): Volume of air moved during a normal breath on quiet respiration

Forced Vital Capacity (FVC): Maximum volume of air that can be forcibly expired after full inspiration

Functional Residual Capacity (FRC): Volume of air in the lungs after a normal tidal expiration (FRC = reserve volume + expiratory reserve volume)

Total Lung Capacity (TLC): Volume of air in the lungs after maximal inspiration

Forced Expired Volume in 1 Second (FEV_1): Measured after maximum inspiration, the volume of air that can be expelled in 1 s

Vital Capacity (VC): Maximum volume of air that can be exhaled from the lungs after a maximal inspiration

Residual Volume (RV): The volume of air remaining in the lungs at the end of a maximal exhalation

DIFFERENTIAL DIAGNOSIS OF PFTS

Table 18-1 shows the differential diagnosis of various PFT patterns. When interpreting PFTs, remember that some patients may have combined restrictive and obstructive diseases such as emphysema and asbestosis.

OXYGEN AND HUMIDITY SUPPLEMENTS

Table 18–2 describes various methods of oxygen and humidity supplementation.

TABLE 18–1
Differential Diagnosis of Pulmonary Function Tests

Restrictive Disease	Obstructiv Disease	re	
<u></u>	N or ↓		
↓ N or ↑	1.		
\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	Ĭ	Ĭ	
IRWAYS DISEAS	SE (COPD)		
Normal	Mild	Moderate	Severe
>75	60–75	40–60	<40
80–120	120-150	150–175	>200
NG DISEASE			
Norma	ıl Mild–Mo	derate Se	vere
ted) >80			-60 <50
>75 ed) 80–120			<i>75</i> > <i>75</i> ⊢80 <i>7</i> 0
	Disease Variable Normal Normal Normal Normal NORMAN N	Disease Disease	Disease Disease ↓

Abbreviations: N = normal; $\uparrow = \text{increased}$, $\downarrow = \text{decreased}$; FVC = forced vital capacity; FLC = total lung capacity; RV/FRC = residual volume/functional residual capacity; $FEV_1 = \text{forced expiratory volume in 1s}$; VC = vital capacity.

TABLE 18–2
Various Methods of Oxygen and Humidity Supplementation

Device	O ₂ Range	L/min	F_iO_2	Uses
Nasal cannula	Low	1–6	0.24-0.5	COPD, general oxygen needs
Simple face mask	Medium	6–8	0.5–0.6	General oxygen needs
Partial rebreathing face mask	High	8–12	0.6–0.7	High oxygen emergency needs
Nonrebreathing face mask	High	8–12	0.7-0.95	High oxygen emergency needs
Venturi mask	Low-medium	_	0.24–0.50	COPD (can specify exact F_iO_2)

Note: F_iO_2 may vary with fluctuations in the patient's minute ventilation when using a nasal cannula. This is not true when using the Venturi mask because it is a "high-flow oxygen enrichment system" that supplies three times the patient's minute ventilation, thus providing an exact F_iO_2 .

Abbreviation: COPD = chronic obstructive pulmonary disease.

Humidity Therapy

Humidity generators are divided into humidifiers and nebulizers. Patients with intact upper airways do not need as high a percentage of relative humidity (% RH) as do patients with artificial airways (endotracheal tubes or tracheostomy tubes). Artificial airways require higher humidity to prevent secretions from obstructing the tubes. To bring the % RH of the inspired gas up to room humidity (30–40% RH) when using the nasal cannula, simple oxygen mask, partial rebreathing mask, or nonrebreathing mask, the bubble-diffuser humidifier is the device of choice.

To provide medium to high levels of % RH, aerosol devices such as the face tent, aerosol mask, aerosol T piece, and aerosol collar are the devices of choice. The humidity generator for these devices is the aerosol-jet nebulizer, which can provide cool or heated mist. The gas that powers the nebulizer may be blended to any desired inspired oxygen concentration (F₁O₂).

BRONCHOPULMONARY HYGIENE

The following is a listing of the modalities available through the respiratory care or nursing services of most hospitals. All are designed to help patients with their bronchopulmonary hygiene, more commonly referred to as "pulmonary toilet." Bronchopulmonary hygiene is defined as maintenance of clear airways and removal of secretions from the tracheo-

bronchial tree. This is important for routine postoperative surgical patients, medical patients with obstructive pulmonary diseases, or any patient with excessive respiratory secretions.

Aerosol (Nebulizer) Therapy

Aerosolized medications such as bronchodilators and mucolytic agents can be delivered via nebulizer for spontaneously breathing, awake patients or intubated patients.

Indications

- · Treatment of COPD, acute asthma, cystic fibrosis, and bronchiectasis
- · Help in inducing sputum for diagnostic tests

Goals

- · Relief of bronchospasm
- · Help in decreasing the viscosity and in clearing of secretions

To Order: Specify the following:

- · Frequency
- · Heated or cool mist
- · Medications: In sterile water or NS
- F_iO₂
- Example. Albuterol 2.5 mg in 3 mL of sterile saline, FiO2 0.28.

Chest Physiotherapy

This technique uses P&PD along with coughing and deep breathing exercises (TC&DB). P&PD is performed by positioning the patient so that the involved lobes of the lung are placed in a dependent drainage position and then using a cupped hand or vibrator to percuss the chest wall. Nasotracheal suctioning is quite uncomfortable for the patient but is still useful in the appropriate clinical setting in the absence of significant coagulopathy.

Indication

 Treatment of pneumonia, atelectasis, and diseases resulting in weak or ineffective coughing

To Order

- 1. P&PD: Specify the following:
 - Frequency
 - Segments or lobes involved (RUL, etc)
 - Duration
 - Drainage only
- 2. TC&DB: Ordered on a timed schedule or as needed
 - Example. P&PD qid of RUL and RML 5 min/lobe or TC&DB q4h.

Incentive Spirometry

This method encourages patients to make a maximal and sustained inspiratory effort to help reinflate the lungs or prevent atelectasis.

Indications

- · Treatment of patients at risk for developing postoperative pulmonary complications
- · Treatment and prevention of atelectasis, especially in postoperative setting

Goals

Set for the patient depending on the device available:

- · Lighting lights
- · Moving Ping-Pong balls
- · Moving colored fluids in "blow bottles"

To Order

Specify the following:

- Frequency (such as 10 min q1–2h while awake)
- Device (if you have a preference)

Example. Incentive spirometry 10 min every hour with blow bottle.

TOPICAL MEDICATIONS

The following agents can be added to aerosol therapy to prevent or treat pulmonary complications caused by bronchoconstriction, mucosal congestion, or inspissated secretions. Remember, even though these are primarily topical agents, some systemic absorption can often occur.

Acetylcysteine (Mucomyst): A mucolytic agent useful for treating retained mucoid secretions; inspissated secretions; and impacted mucoid plugs seen in diseases such as COPD, cystic fibrosis, and pneumonia. A bronchodilator should be given along with Mucomyst.

Usual Adult Dosage. 1-3 mL of 20% acetylcysteine in 0.5 mL (2-10 mg) of Bronkosol

Albuterol (Ventolin, Proventil): A short-acting selective bronchodilator with principally beta-2 activity; can cause tachycardia. Onset 15 min. Peak effect at 0.5–1 h, duration 3–5 h

Usual Dosage. 2.5 mg in 3 mL NS q4h

Metaproterenol (Alupent, Metaprel): A short-acting bronchodilator with both beta-1 and beta-2 activity; can cause tachycardia. Peak effect at 0.5–1 h, duration 3–5 h.

Usual Dosage. 0.3 mL (10-15 mg) of a 5% solution in 2.5 mL NS bid-qid

Racemic Epinephrine: Contains both d and l forms of epinephrine. Useful because the alpha effects result in mucosal vasoconstriction that reduces mucosal engorgement and the bronchodilation lessens the risk of hypoxemia. Most useful for laryngotracheobronchitis and immediately after extubation in children.

Usual Dosage. 0.125-0.5 mL (3-10 mg) in 2.5 mL NS

Ipratropium Bromide (Atrovent): A parasympatholytic bronchodilating agent that causes bronchodilation and a decrease in secretions with "drying" of the respiratory mucosa. This is minimally absorbed and rarely results in tachycardia. Onset 45 min, duration 4–6 h

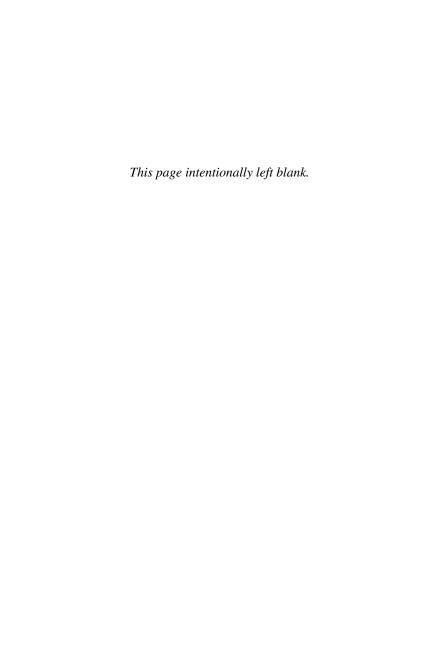
Usual Dosage. 0.5 mg in 3 mL NS qid

Atropine: A parasympatholytic agent that causes bronchodilation and a decrease in secretions with "drying" of the respiratory mucosa. This is readily absorbed and, therefore has cardiac effects (tachycardia).

Usual Dosage. 0.025-0.05 mg/kg of a 1% solution

METERED-DOSE INHALERS

All bronchodilating agents can be effectively delivered by metered-dose inhaler as long as proper technique is used. For these devices to be successful, in-patients must be well trained or have the assistance of a nurse or respiratory therapist. Albuterol and ipratropium bromide (Atrovent) can each be delivered two puffs q4h. A combination bronchodilator (Combivent) containing the equivalent of one puff of each is also available and provides synergistic bronchodilatation.



BASIC ECG READING

Introduction
Basic Information
Axis Deviation
Heart Rate
Rhythm

Cardiac Hypertrophy Myocardial Infarction Electrolyte and Drug Effects Miscellaneous ECG Changes

INTRODUCTION

The formal procedure for obtaining a readable ECG is given in Chapter 13, page 266. Every electrocardiogram should be approached in a systematic, stepwise fashion. Many automated ECG machines can give a preliminary interpretation of a tracing; however, all automated interpretations require analysis and sign-off by a physician. Determine each of the following:

- Standardization. With the ECG machine set on 1 mV, a 10-mm standardization mark (0.1 mV/mm) is evident (Figure 19–1).
- Axis. If the QRS is upright (more positive than negative) in leads I and aVF, the axis
 is normal. The normal axis range is -30 degrees to +105 degrees.
- Intervals. Determine the PR, QRS, and QT intervals (Figure 19–2). Intervals are
 measured in the limb leads. The PR should be 0.12–0.20 s, and the QRS, <0.12 s.
 The QT interval increases with decreasing heart rate, usually <0.44 s. The QT interval usually does not exceed one half of the RR interval (the distance between two
 R waves)
- Rate. Count the number of QRS cycles in a 6-s strip and multiply it by 10 to roughly
 estimate the rate. If the rhythm is regular you can be more exact in determining the
 rate by dividing 300 by the number of 0.20-s intervals (usually depicted by darker
 shading) and then extrapolating for any fraction of a 0.20-s segment.
- Rhythm. Determine whether each QRS is preceded by a P wave, look for variation in the PR interval and RR interval (the duration between two QRS cycles), and look for ectopic beats.
- Hypertrophy. One way to determine LVH is to calculate the sum of the S wave in V₁ or V₂ plus the R wave in V₅ or V₆. A sum >35 indicates LVH. Some other criteria for LVH are R >11 mm in aVL or R in I + S in aVF >25 mm.
- Infarction or Ischemia. Check for the presence of ST-segment elevation or depression, Q waves, inverted T waves, and poor R-wave progression in the precordial leads.

A more detailed discussion of each of these categories is presented in the following sections.

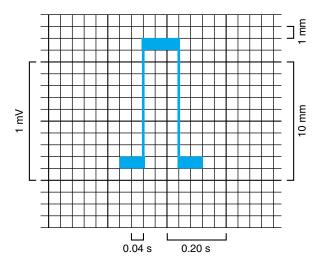


FIGURE 19-1 Examples of a 10-mm standardization mark and time marks and standard electrocardiogram paper running at 25 mm/s.

BASIC INFORMATION

Equipment

Bipolar Leads

- Lead I: Left arm to right arm
- · Lead II: Left leg to right arm
- · Lead III: Left leg to left arm

Precordial Leads: V_1 to V_6 across the chest, as shown in the section on electrocardiograms in Chapter 13 (see Figure 13–9, page 267).

ECG Paper: With the ECG machine set at 25 mm/s, each small box represents 0.04 s and each large box 0.2 s (see Figure 19–1, above). Most ECG machines automatically print a standardization mark.

Normal ECG Complex

Note: A small amplitude in the Q, R, or S wave is represented by a lowercase letter; a large amplitude by an uppercase letter. The pattern shown in Figure 19–2 could also be noted as qRs.

P Wave. Caused by depolarization of the atria. With normal sinus rhythm, the P wave is upright in leads I, II, aVF, V₄, V₅, and V₆ and inverted in aVR.

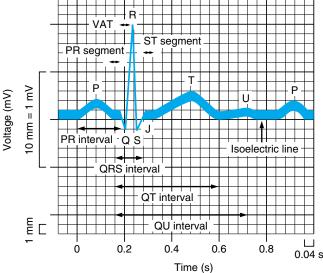


FIGURE 19-2 Diagram of the electrocardiographic complexes, intervals, and segments. The U wave is normally not well seen. (Reprinted, with permission, from: Goldman MJ [ed]: Principles of Clinical Electrocardiography, 12th ed. Lange Medical Publications, Los Altos CA, 1986.)

- QRS Complex. Represents ventricular depolarization
- · Q Wave. The first negative deflection of the QRS complex (not always present and, if present, may be pathologic)
- R Wave. The first positive deflection (R) is the positive deflection that sometimes occurs after the S wave)
- · S Wave. The negative deflection following the R wave
- T Wave. Caused by repolarization of the ventricles and follows the QRS complex. Normally upright in leads I, II, V3, V4, V5, and V6 and inverted in aVR

AXIS DEVIATION

The term axis, which represents the sum of the vectors of the electrical depolarization of the ventricles, gives some idea of the electrical orientation of the heart in the body. In a healthy person, the axis is downward and to the left, as shown in Figure 19-3.

FIGURE 19-3 Graphic representation of the "axis deviation." Electrocardiographic representations of each type of axis are shown in each quadrant. The large arrow is the normal axis.

The QRS axis is midway between two leads that have QRS complexes of equal amplitude, or the axis is 90 degrees to the lead in which the QRS is isoelectric, that is, the amplitude of the R wave equals the amplitude of the S wave.

- Normal Axis. QRS positive in I and aVF (0–90 degrees). Normal axis is actually –30 to 105 degrees
- LAD. QRS positive in I and negative in aVF, -30 to -90 degrees
- RAD. QRS negative in I and positive in aVF, +105 to +180 degrees
- Extreme Right Axis Deviation. QRS negative in I and negative in aVF, +180 to +270 or -90 to -180 degrees

Clinical Correlations

- RAD. Seen with RVH, RBBB, COPD, and acute PE (a sudden change in axis toward the right), as well as in healthy individuals (occasionally)
- LAD. Seen with LVH, LAHB (-45 to -90 degrees), LBBB, and in some healthy individuals

HEART RATE

Bradycardia: Heart rate <60 bpm
Tachycardia: Heart rate >100 bpm
Rate Determination: Figure 19–4.

- Method 1. Note the 3-s marks along the top or bottom of the ECG paper (15 large squares). The approximate rate equals the number of cycles (ie, QRSs) in a 6-s strip × 10.
- Method 2. (for regular rhythms). Count the number of large squares (0.2-s boxes) between two successive cycles. The rate is equal to 300 divided by the number of squares. Extrapolate if the QRS complex does not fall exactly on the 0.2-s marks (eg, if each QRS complex is separated by 2.4 0.20-s segments, the rate is 120 bpm. The rate between two 0.20-s segments is 150 bpm, and between three 0.20-s segments is 100 bpm.

RHYTHM

Sinus Rhythms

Normal: Each QRS preceded by a P wave (which is positive in II and negative in aVR) with a regular PR and RR interval and a rate between 60 and 100 bpm (Figure 19–5)

Sinus Tachycardia: Normal sinus rhythm with a heart rate >100 bpm and <180 bpm (Figure 19-6)

Clinical Correlations. Anxiety, exertion, pain, fever, hypoxia, hypotension, increased sympathetic tone (secondary to drugs with adrenergic effects [eg, epinephrine]), anticholinergic effect (eg, atropine), PE, COPD, AMI, CHF, hyperthyroidism, and others

Sinus Bradycardia: Normal sinus rhythm with a heart rate <60 bpm (Figure 19–7)

Clinical Correlations. Well-trained athlete, normal variant, secondary to medications (eg, beta-blockers, digitalis, clonidine), hypothyroidism, hypothermia, sick sinus syndrome (tachy-brady syndrome), and others



FIGURE 19-4 Sample strip for rapid rate determination (see text for procedure). Estimating the rate by counting the number of beats (eight) in the two 3-s intervals. The rate is 8 × 10, or 80 bpm (method 1). Using method 2, each beat is separated from another beat by four 0.20-s intervals, so you divide 300 by 4, and the rate is 75 bpm. Because the beats are separated by exactly four beats, you do not need to extrapolate.



FIGURE 19-5 Normal sinus rhythm.

Treatment

- If asymptomatic (good urine output, adequate BP, and normal sensorium), no therapy needed.
- · If hypotensive or disoriented: See Chapter 21, page 460

Sinus Arrhythmia: Normal sinus rhythm with a somewhat irregular heart rate. Inspiration causes a slight increase in rate; expiration decreases the rate. Normal variation between inspiration and expiration is 10% or less.

Atrial Arrhythmias

PAC: Ectopic atrial focus firing prematurely followed by a normal QRS (Figure 19–8). The compensatory pause following the PAC is partial; the RR interval between beats 4 and 6 is less than between beats 1 and 3 or 6 and 8.

Clinical Correlations. Usually not of clinical significance; can be caused by stress, caffeine, and myocardial disease

PAT: A run of three or more consecutive PACs. The heart rate is usually between 140 and 250 bpm. The P wave may not be visible, but the RR interval is very regular (Figure 19–9).

Clinical Correlations. Can be seen in healthy individuals but also occurs with a variety of heart diseases. Symptoms include palpitations, light-headedness, and syncope.

Treatment

Increase Vagal Tone. Valsalva maneuver or carotid massage



FIGURE 19-6 Sinus tachycardia. The rate is 120-130 bpm.



FIGURE 19-7 Sinus bradycardia. The rate is approximately 38 bpm.

- Medical Treatment. Can include adenosine, verapamil, digoxin, edrophonium, or beta-blockers (propranolol, metoprolol, and esmolol). Verapamil and beta-blockers should be used cautiously at the same time because asystole can occur.
- Cardioversion with Synchronized DC Shock. Particularly in the hemodynamically unstable patient (see Chapter 21, page 467)

MAT: An atrial arrhythmia that originates from ectopic atrial foci. It is characterized by varying P-wave morphology and PR interval and is irregular (Figure 19–10).

Clinical Correlations. Most commonly associated with COPD, also seen in elderly patients, CHF, diabetes, or use of theophylline. Antiarrhythmics are often ineffective. Treat the underlying disease.

AFib: Irregularly irregular rhythm with no discernible P waves. The ventricular rate usually varies between 100 and 180 bpm (Figure 19–11). The ventricular response is slower with digoxin, verapamil, or beta-blocker therapy and with AV nodal disease.

Clinical Correlations. Seen in some healthy individuals but commonly associated with organic heart disease (CAD, hypertensive heart disease, or rheumatic mitral valve disease), thyrotoxicosis, alcohol abuse, pericarditis, PE, and postoperatively.

Treatment

 Pharmacologic Therapy. Intravenous adenosine, verapamil, digoxin, and betablockers (propranolol, metoprolol, and esmolol) can be used to slow down the ventricular response, and quinidine, procainamide, propafenone, ibutilide, and



FIGURE 19-8 Premature atrial contraction (PAC). The fifth beat is a PAC.

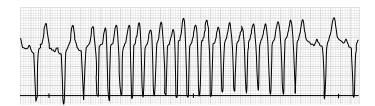


FIGURE 19-9 Paroxysmal atrial tachycardia.

amiodarone can be used to maintain or convert to sinus rhythm (see individual agents in Chapter 21)

 DC-Synchronized Cardioversion. Indicated if associated with increased myocardial ischemia, hypotension, or pulmonary edema (see Chapter 21, page 467)

Atrial Flutter: Characterized by sawtooth flutter waves with an atrial rate between 250 and 350 bpm; the rate may be regular or irregular depending on whether the atrial impulses are conducted through the AV node at a regular interval or at a variable interval (Figure 19–12).

Example: One ventricular contraction (QRS) for every two flutter waves = 2:1 flutter. Clinical Correlations. Seen with valvular heart disease, pericarditis, ischemic heart disease, pulmonary disease including PE, and alcohol abuse

Treatment. Do **NOT** use quinidine or procainamide (atrial conduction may decrease to the point where 1:1 atrial:ventricular conduction can occur and the ventricular rate will increase and hemodynamic compromise can occur), otherwise, similar to treatment of atrial fibrillation. Ibutilide (a new Class III antiarrhythmic) is very effective.

Nodal Rhythm

AV Junctional or Nodal Rhythm: Rhythm originates in the AV node. Often associated with retrograde P waves that may precede or follow the QRS. If the P wave is present, it is negative in lead II and positive in aVR (just the opposite of normal sinus rhythm) (Fig-



FIGURE 19-10 Multifocal atrial tachycardia.



FIGURE 19-11 Atrial fibrillation.

ure 19–13). Three or more premature junctional beats in a row constitute a junctional tachycardia, which has the same clinical significance as PAT.

Ventricular Arrhythmias

PVC: As implied by the name, a premature beat arising in the ventricle. P waves may be present but have no relation to the QRS of the PVC. The QRS is usually >0.12 s with a left bundle branch pattern. A compensatory pause follows a PVC that is usually longer than after a PAC (Figure 19–14). The RR interval between beats 1 and 3 is equal to that between beats 3 and 5. Thus, the pause following the PVC (the fourth beat) is fully compensatory. The following patterns are recognized:

- Bigeminy. One normal sinus beat followed by one PVC in an alternating fashion (Figure 19–15)
- · Trigeminy. Sequence of two normal beats followed by one PVC
- Unifocal PVCs. Arise from one site in the ventricle. Each has the same configuration in a single lead. (See Figure 19–14.)
- Multifocal PVCs. Arise from different sites; therefore, have different shapes (Figure 19–16)

Clinical Correlations. PVCs occur in healthy persons and with excessive caffeine ingestion, anemia, anxiety, organic heart disease (ischemic, valvular, or hypertensive), secondary to medications (epinephrine and isoproterenol; from toxic level of digitalis and theophylline),



19

FIGURE 19–12 Atrial flutter with atrioventricular (AV) block (3:1 to 5:1 conduction).



FIGURE 19-13 Junctional rhythm with retrograde P waves (inverted) following the QRS complex.

or predisposing metabolic abnormalities (hypoxia, hypokalemia, acidosis, alkalosis, or hypomagnesemia)

Criteria for Treatment. In the setting of an AMI:

- >5 PVCs in 1 min (many clinicians would treat any PVC associated with an MI or injury pattern on ECG)
- PVCs in couplets (two in a row)
- · Numerous multifocal PVCs
- PVC that falls on the preceding T wave (R on T)

Treatment. See also Chapter 21, page 459.

- Lidocaine. Most commonly used; other antiarrhythmics include procainamide, and amiodarone.
- Treatment of aggravating cause often sufficient (eg, treat hypoxia, hypokalemia, or acidosis)

Ventricular Tachycardia: By definition, three or more PVCs in a row (Figure 19–17). Appears as a wide QRS usually with an LBBB pattern (as opposed to a narrow complex seen with supraventricular tachycardia). May occur as a short paroxysm or as a sustained run with a rate between 120 and 250 bpm. Can be life-threatening because of associated hypotension and has a tendency to degenerate into ventricular fibrillation. Treatment of nonsustained ventricular tachycardia is controversial.



FIGURE 19–14 Premature ventricular contractions (PVCs). The fourth and eighth beats are PVCs.

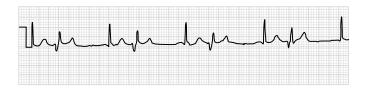


FIGURE 19-15 Ventricular bigeminy.

Clinical Correlations. See the section on PVCs. Patients with ventricular aneurysm are more susceptible to developing ventricular arrhythmias.

Treatment. See Chapter 21, page 459.

Ventricular Fibrillation: Erratic electrical activity from the ventricles, which fibrillate or twitch asynchronously. No cardiac output occurs with this rhythm (Figure 19–18).

Clinical Correlations. One of two patterns seen with cardiac arrest (the other would be asystole or flat line)

Treatment. See Chapter 21, page 252.

Heart Blocks

First-Degree Block: PR interval >0.2 s (or five small boxes). Usually not clinically significant (Figure 19–19). Drugs such as beta-blockers, digitalis, and calcium channel blockers (especially verapamil) can cause first-degree block.

Second-Degree Block

Mobitz Type I (Wenckebach). Progressive prolongation of the PR interval until the P wave is blocked and not followed by a QRS complex (Figure 19–20). May occur as a 2:1, 3:2, or 4:3 block. The ratio of the atrial:ventricular beats can vary. With a 4:3 block, every fourth P wave is not followed by a QRS.



FIGURE 19–16 Multifocal PVCs. The second, sixth, seventh, and ninth beats are PVCs. Only the second and sixth PVCs have the same morphology.

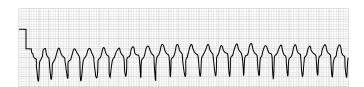


FIGURE 19-17 Ventricular tachycardia.

Clinical Correlations. Seen with acute myocardial ischemia such as inferior MI, ASDs, valvular heart disease, rheumatic fever, or digitalis or propranolol toxicity. Can be transient. May progress to bradycardia (rare)

Treatment. Usually expectant; if bradycardia occurs: atropine, isoproterenol, or a pace-maker

Mobitz Type II. A series of P waves with conducted QRS complexes followed by a nonconducted P wave. The PR interval for the conducted beats remains constant. May occur as a 2:1, 3:2, or 4:3 block. The ratio of the atrial:ventricular beats can vary. With a 4:3 block, every fourth P wave is not followed by a QRS. (Note: AV block that is 2:1 can be either Mobitz type I or type II and may be difficult to differentiate. In general, Mobitz I has a prolonged PR with a narrow QRS; Mobitz II has a normal PR interval with a bundle branch pattern [wide ORS]).

Clinical Correlations. Implies severe conduction system disease that can progress into complete heart block. May be seen in acute anterior MI and cardiomyopathy.

Treatment. Use of a temporary cardiac pacemaker, particularly when associated with an acute anterior MI

Third-Degree Block: Complete AV block with independent atrial and ventricular rates. The ventricular rate is usually 20–40 bpm (Figure 19–21).

Clinical Correlations. May occur as the result of degenerative changes in the conduction system in the elderly, from digitalis toxicity, transiently with an acute inferior MI (due



FIGURE 19-18 Ventricular fibrillation.



FIGURE 19-19 First-degree AV block. The PR interval is 0.26 s.

to temporary ischemia of the AV junction), and after acute anterior MI (much higher probability of mortality than after inferior MI); can result in syncope or CHF

Treatment. Usually requires placement of a temporary or permanent pacemaker

BBB: Complete BBB is present when the QRS complex is >0.12 s (or three small boxes on the ECG strip). Look at leads I, V_1 , and V_6 . Degenerative changes and ischemic heart disease are the most common causes.

RBBB: The RSR' pattern seen in V_1 and or V_2 . Also a wide S in leads I and V_6 (Figure 19–22)

Clinical Correlations. May be seen in healthy persons but usually associated with diseases affecting the right side of the heart (pulmonary hypertension, ASD, or ischemia); sudden onset is associated with pulmonary embolism or acute exacerbation of COPD.

LBBB: The RR' in leads I and/or V₆. The QRS complex may actually be more slurred than double-peaked as in the RBBB. A wide S wave is seen in V₁ (Figure 19–23).

Clinical Correlations. Associated with organic heart disease (hypertensive, valvular, and ischemic) as well as severe aortic stenosis. Development of a new LBBB after an AMI may be an indication for inserting a temporary cardiac pacemaker.



FIGURE 19-20 Second-degree AV block, Mobitz type I (Wenckebach), with 4:3 conduction



FIGURE 19-21 Third-degree AV block (complete heart block). The atrial rate is 100 bpm; the ventricular rate is 47 bpm.

CARDIAC HYPERTROPHY Atrial Hypertrophy

Atrial Hypertrophy: P wave >2.5 mm in height and >0.12 s wide (three small boxes on the ECG paper)

 \emph{RAE} : Tall, slender, peaked P waves in leads II, III, aVF (may also be seen in V_1 and V_2 . (Figure 19–24)

Clinical Correlations. Seen with chronic diffuse pulmonary disease, pulmonary hypertension, and congenital heart disease (ASD)

LAE: Notched P wave ("P mitral pattern") seen in leads I and II. A wide (0.11 s or greater), slurred biphasic P in V_1 with a wider terminal than initial component (negative deflection) (Figure 19–25)

Clinical Correlations. Seen with mitral stenosis or mitral regurgitation or secondary to LVH with hypertensive cardiovascular disease

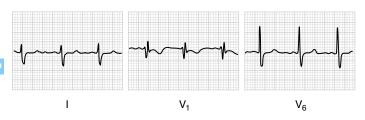


FIGURE 19-22 Leads I, V_1 , and V_6 demonstrate the right bundle branch block (RBBB) pattern.

8.6



FIGURE 19-23 Leads I, V_1 , and V_6 demonstrate the left bundle branch block (LBBB) pattern.

Ventricular Hypertrophy

RVH: Tall R wave in V_1 (R wave >S wave in V_1), persistent S waves in V_5 and V_6 , progressively smaller R wave from V_1 to V_6 , slightly widened QRS intervals (Figure 19–26), and strain pattern with ST-segment depression and T-wave inversion in V_1 to V_3 . May also see a pattern of small R waves with relatively large S waves in V_1 to V_6 . Invariably right axis deviation (>105 degrees) is present.

Clinical Correlations. Associated with mitral stenosis, chronic diffuse pulmonary disease, chronic recurrent PE, congenital heart disease (eg, tetralogy of Fallot), and biventricular hypertrophy (VH and RVH, with LVH findings often predominating).

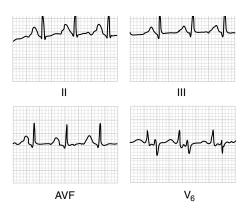


FIGURE 19–24 Right atrial enlargement, leads II, III, aVF, and V_1 . Note the tall P waves in II, III, and aVF and the tall slender P waves in V_1 .



FIGURE 19-25 Left atrial enlargement.

LVH: Voltage criteria (patients >age 35): S in V_1 or V_2 plus an R in V_5 or V_6 >35 mm, or R wave in aVL >11 mm, or R wave in I plus S wave in III >25 mm, or an R in V_5 or V_6 >26 mm. The QRS complex may be >0.10 s wide in V_5 or V_6 . ST-segment depression and T-wave inversion in the anterolateral leads (I, aVL, V_5 , and V_6) suggest LVH with strain (Figure 19–27).

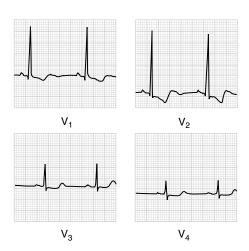


FIGURE 19-26 Right ventricular hypertrophy, leads V_1 , V_2 , V_3 , and V_4 . Note the tall R waves in V_1 and V_2 , greater than the R waves in V_3 and V_4 .

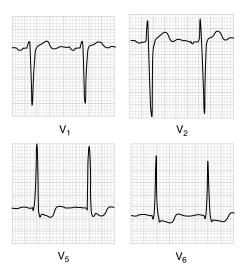


FIGURE 19-27 Left ventricular hypertrophy, leads V_1 , V_2 , V_5 , and V_6 . The S wave in the V_2 + R wave in V_5 is 55 mm. Note the ST changes and T-wave inversion in V_5 and V_6 , suggesting "strain."

Clinical Correlations. Hypertension, aortic stenosis or insufficiency, long-standing CAD, and some forms of congenital heart disease

MYOCARDIAL INFARCTION

(See also Chapter 21, page 459.)

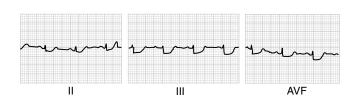


FIGURE 19-28 ST-segment depression in leads II, III, and aVF in a patient with acute inferior subendocardial ischemia/infarction.

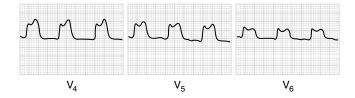


FIGURE 19–29 ST elevation in leads V_4 , V_5 , and V_6 in a patient with acute anterolateral transmural ischemia/infarction.

Myocardial Ischemia: Inadequate oxygen supply to the myocardium because of blockage or spasm of the coronary arteries. The ECG can show ST-segment depression (subendocardial ischemia) (Figure 19–28), ST elevation (transmural ischemia) (Figure 19–29), or symmetrically inverted ("flipped") T waves (Figure 19–30) in the area of ischemia (eg, inferior ischemia in II, III, and F; anterior ischemia in V_1 to V_6 ; lateral ischemia in I, aVL; anterolateral ischemia in I, aVL, V_5 , and V_6 ; anteroseptal ischemia in V_1 , V_2 , V_3 , and V_4 .

MI: Refers to myocardial necrosis caused by severe ischemia. Can be transmural (ST elevation early, T-wave inversion, and Q waves late) or subendocardial (ST depression and T-wave inversion without evidence of Q waves). Table 19–1 outlines the localization of MIs.

- Acute Injury Phase. Hyperacute T waves, then ST-segment elevation. Hyperacute T waves return to normal in minutes to hours. ST elevation usually regresses after hours to days. Persistent ST elevation suggests a left ventricular aneurysm.
- Evolving Phase. Occurs hours to days after an MI. Deep T-wave inversion occurs and then replaces ST-segment elevation, and the T wave may return to normal.
- Q Waves. Occur hours to days after a transmural MI. A Q wave is the initial negative
 deflection of the QRS complex. A "significant" Q wave is 0.04 s in duration and
 >25% the height of the R wave (Figure 19–31). May regress to normal after years.

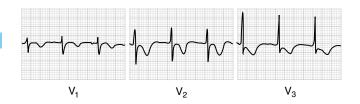


FIGURE 19-30 Inverted T waves.

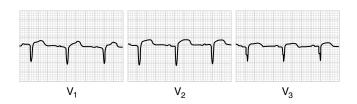


FIGURE 19–31 Q waves in leads V_1 , V_2 , and V_3 in a patient with an acute anteroseptal transmural myocardial infarction. Note the ST elevation in helping to determine the acute nature of the infarction.

ELECTROLYTE AND DRUG EFFECTS Electrolytes

Hyperkalemia: Narrow, symmetrical, diffuse, peaked T waves. With severe hyperkalemia, PR prolongation occurs, the P wave flattens and is lost, and the QRS widens and can progress to ventricular fibrillation (Figure 19–32).

Hypokalemia: ST-segment depression with the appearance of U waves (a positive deflection after the T wave) (Figure 19–33)

TABLE 19–1 Localization of Transmural Myocardial Infarction on ECG

Location of MI	Presence of Q Wave or ST-Segment Elevation	Reciprocal ST Depression	
Anterior	V ₁ to V ₆ (also poor R-wave progression in leads V ₁ to V ₆)*	II, III, aVF	
Lateral	I, aVL, V ₅ , V ₆	V_1, V_3	
Inferior	II, III, aVF	I, aVL, possibly anterior leads	
Posterior	Abnormally tall R and T waves in V_1 to V_3	V_1 to V_3	
Subendocardial	dial No abnormal Q wave. ST-segment elevation in the anterior, lateral, or inferior leads		

^{*}Normally in V_1 to V_6 , the R-wave amplitude gradually increases and the S wave decreases with a "biphasic" QRS (R = S) in V_3 or V_4 . With an anterior MI, there will be a loss of R-wave voltage and the biphasic QRS will appear more laterally in V_4 to V_6 , hence the term *poor R-wave progression*.

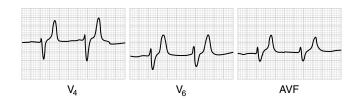


FIGURE 19-32 Diffuse tall T waves in leads V_4 , V_6 , and aVF with widened QRS and junctional rhythm (loss of P waves), representing hyperkalemia.

Hypercalcemia: Short QT intervalHypocalcemia: Prolonged QT interval

Drugs

Digitalis Effect: Downsloping ST segment

Digitalis Toxicity

- Arrhythmias. PVCs, bigeminy, trigeminy, ventricular tachycardia, ventricular fibrillation, PAT, nodal rhythms, and sinus bradycardia.
- Conduction Abnormalities. First-degree, second-degree, and third-degree heart blocks

Quinidine and Procainamide: With toxic levels, prolonged QT, flattened T wave, and QRS widening

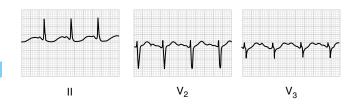


FIGURE 19–33 Leads II, V_2 , and V_3 in a patient with hypokalemia. A U wave is easily seen in V_2 and V_3 , but difficult to distinguish from the T wave in II.

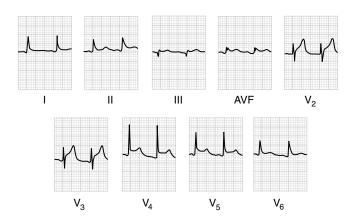


FIGURE 19-34 Acute pericarditis.

MISCELLANEOUS ECG CHANGES

Pericarditis: Diffuse ST elevation concave upward and/or diffuse PR depression and/or diffuse T-wave inversion (Figure 19–34)

Clinical Correlations. Idiopathic, viral infections, as well as other infections, including bacterial, fungal, and TB, AMI, collagen-vascular diseases, uremia, cancer, Dressler's syndrome, and postpericardiotomy syndrome

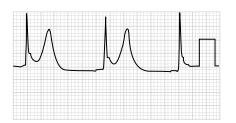


FIGURE 19-35 Sinus bradycardia, J-point elevation with ST-segment elevation and prolonged QT interval (0.56 s) in a patient with hypothermia.



FIGURE 19-36 Short PR interval and delta waves in leads II, aVF, and V_3 in a patient with Wolff-Parkinson-White syndrome.

Hypothermia: Sinus bradycardia, AV junctional rhythm, or ventricular fibrillation common. Classically, J point (the end of the QRS complex and the beginning of the ST segment) elevated and an intraventricular conduction delay and a prolonged QT interval possible (Figure 19–35)

WPW Syndrome: A preexcitation syndrome caused by conduction from the SA node to the ventricle through an accessory pathway that bypasses the AV node. Classically, a short PR interval occurs along with a delta wave (a delay in the initial deflection of the QRS complex). Clinically, these patients commonly have tachyarrhythmias, such as atrial fibrillation (Figure 19–36).

CRITICAL CARE

Treatment of the Critically Ill Patient ICU Progress Note
Cardiovascular System
Cardiovascular Physiology
Central Venous Pressure
Pulmonary Artery Catheters
Determinations of Cardiac Output
Shock States
Clinical Pulmonary Physiology

Indications for Intubation
Mechanical Ventilators
Specific Problems in Critically Ill
Patients
Quick Reference to Critical Care
Formulas/ICU Formulas
Guidelines for Adult Critical Care Drug
Infusions

TREATMENT OF THE CRITICALLY ILL PATIENT

Patients in the ICU setting typically have multisystem disease or injuries. The interactions between different dysfunctional organ systems is complicated and often overwhelming for the student or junior house officer.

This chapter describes a system-by-system approach to dealing with the critically ill patient. This approach forces the clinician to focus sequentially on each major organ system and to evaluate each system's function and interaction with other organ systems. This approach also allows the physician to integrate abnormalities within each system into a strategy for treating the patient as a whole. A complete but concise daily progress note will document this critical evaluation and integration process.

ICU PROGRESS NOTE

The ICU progress note is a concise, well-organized means of documenting the events of the past 24 h. The organization of a daily progress note is outlined here. The most important parts of this note are the assessment and the plan. Although the collected data can be found elsewhere in the chart, the physician's written assessment and interpretation of these data and events communicate the medical decision-making process to all who read the chart.

A simple organizational approach to the daily ICU progress note:

- A. Outline the patient's problem list and/or injury summary.
 - Include all active problems, major inactive problems, significant past medical history.
- B. Outline events and procedures of the past 24 h.
- C. List current medications.
- D. Flow sheet data...

- Include vital signs, pulmonary artery catheter data, ventilator settings, laboratory and culture data.
- 2. Also include radiographic data.
- E. List physical exam findings.
- F. Provide impression and assessment. Each of the following systems should be addressed daily.
 - 1. Neurologic function
 - 2. Pulmonary function, including mechanical ventilator
 - 3. Cardiovascular function
 - 4. Gastrointestinal function
 - 5. Genitourinary function
 - 6. Metabolic and nutritional status
 - 7. Hematologic function
 - 8. Infectious disease status
 - 9. Prophylaxis (ie, DVT, ETOH, stress ulcer, etc)

With each of the areas listed in item 9, try to anticipate and avoid complications

G.Outline therapeutic plan for the day.

The following is an example of an ICU progress note that uses this approach. It is written for a trauma patient but can easily be modified for any clinical setting.

Sample ICU Progress Note

PROBLEM LIST:

- S/P MVA
- Left pulmonary concussion
- Left hemopneumothorax S/P left chest tube
- Grade 4 splenic injury S/P splenectomy
- · Acute renal failure
- ARDS
- Complex past medical history:

Hypertension Gout

Allergic: Morphine sulfate

EVENTS OF PAST 24 HOURS:

- Increasing FiO₂ and PEEP
- Renal Consult

CURRENT MEDICATIONS

- Dopamine
- Fentanyl infusion
- Ativan infusion
- Pepcid
- Vancomycin

FLOW SHEET DATA:

• P 150 (NSR), BP 110/65, I/O: 3400/2210,

Sample ICU Progress Note (continued)

- PAP 45/20, PCWP 14, CO 3.78, CI 2.54, EDVI 89
- Ventilator Setting: SIMV rate 16/4, 75%, PEEP 12, PS 10
- Lab data: Hct 30%, WBC 17.5

PHYSICAL EXAM:

- Neurologic: Intubated, sedated, moves all 4 extremities to painful stimuli
- HEENT pupil equal and reactive EOM intact
- Neck immobilized
- Cardiovascular: RRR, no increased JVD, 2+ capillary refill, toes warm
- Pulmonary: Coarse BS bilat., decreased on left. Chest tube in place
- Gastrointestinal: Midline incision healing well, soft, nondistended, no guarding, + bowel sounds
- Extremities: Warm well perfused

ASSESSMENT:

- Neurologic: Stable, continue sedation while on ventilator.
- Cardiovascular: Continues to require intermittent fluid challenge to maintain BP, this may be the cause of acute renal failure. Will continue fluids and may add dopamine to improve CO.
- Pulmonary: Worsening Fio₂ and PEEP requirements overnight, likely ARDS complicated by pulmonary contusion. Will obtain CXR this AM and wean Fio₂ and increase PEEP as tolerated by BP and CO.
- Gastrointestinal: S/P splenectomy, ileus continues, will place feeding tube today.
- Renal: Acute renal failure continues. Will proceed with renal ultrasound to R/O postrenal cause.
- Hematologic: S/P splenectomy HCT stable, will give postsplenectomy vaccines

Abbreviations: See Abbreviations list at the beginning of the book.

CARDIOVASCULAR SYSTEM

Cardiovascular instability is one of the most common problems faced in the ICU. Understanding the approach to the evaluation of the cardiovascular system is essential to treating any critically ill patient.

Inspection

Inspection of the cardiovascular system is divided into three main areas:

Jugular Venous Distention

 Daily examination of the patient in the ICU should include examination of neck veins to look for JVD. A patient sitting at a 45-degree angle who has distended neck veins has a CVP of 12–15 cm H₂O or higher.

 Distended neck veins in the face of systemic hypotension in the acutely ill or injured patient suggest:

Tension pneumothorax Pericardial tamponade Cardiac dysfunction

Precordial Contusion

 Bruising of the anterior chest wall is commonly associated with blunt trauma from a steering wheel. Such an injury pattern should alert the physician to the possibility of a myocardial contusion. Treatment of this condition consists of continuous ECG monitoring and vigorous correction of arrhythmias.

Extremity Perfusion

- Check all four extremities for distal perfusion, including pulses, color, temperature, and capillary refill.
- · Pay special attention to the following areas:

Sites distal to long bone fractures or dislocations Sites distal to indwelling arterial catheters

Blood Pressure

Blood pressure over the short term is considered adequate if renal perfusion is maintained. In a young, previously healthy individual, an adequate BP usually corresponds to a MAP of greater than 70 mm Hg.

Technical Tip: If the cuff is too small an obese arm will give a systolic BP 10–15 mm Hg higher than the actual pressure.

Systolic Hypertension: A systolic blood pressure >140 mm Hg with a normal diastolic pressure. In the acute care setting, systolic hypertension is thought to be secondary to increased cardiac output.

Systolic hypertension is seen in the following situations:

- · Generalized response to stress
- Pain
- · Thyrotoxicosis
- Anemia

Diastolic Hypertension: A diastolic pressure >90 mm Hg.

Isolated diastolic hypertension is associated with three general disease categories:

- · Renal disease
- · Endocrine disorders
- Neurologic disorders

Treatment of Hypertension: Hypertension is of concern in the ICU when confronting a new MI or a vascular anastomosis and especially following carotid artery surgery. Ideally, the systolic blood pressure in this instance is maintained above 130 and below 160. A systolic pressure >180 mm Hg usually requires immediate treatment. Several drugs are commonly used to treat acute hypertension in the ICU setting. These include nitroprusside (Nipride), hydralazine (Apresoline), labetalol (Normodyne), a beta-blocker, or nitroglycerin. Beta-blockade should be used with Nipride in treating hypertension associated with an

aortic aneurysm. The emergency management of hypertension is discussed in Chapter 21, page 470 and the specific agents are discussed on page 439 and in Chapter 22.

Pulse Pressure

Pulse pressure is the difference between systolic and diastolic blood pressures.

Wide Pulse Pressure: A pulse pressure >40 mm Hg.

A wide pulse pressure is associated with:

- · Thyrotoxicosis
- · Arterial venous fistula
- Aortic insufficiency

Narrow Pulse Pressure: A pulse pressure <25 mm Hg.

A narrow pulse pressure is associated with:

- · Significant tachycardia
- · Early hypovolemic shock
- · Pericarditis
- · Pericardial effusion or tamponade
- Ascites
- · Aortic stenosis

Mean Arterial Blood Pressure

MAP is calculated by taking the diastolic pressure plus one third of the pulse pressure. MAP is used to calculate several other hemodynamic variables.

Paradoxical Pulse: Paradoxical pulse is a function of the change in intrathoracic pressures during inspiration and expiration. Normally, systolic blood pressure falls between 6 and 10 mm Hg with inspiration. This fall is reflected by a systolic blood pressure that varies with respiration. If this variation occurs over a range >10 mm Hg, the patient is said to have a paradoxical pulse (Figure 20–1). For the technique to measure the paradoxical pulse, see Chapter 13, page 298.

Conditions associated with a paradoxical pulse:

- · Pericardial tamponade
- · Asthma and COPD
- · Ruptured diaphragm
- · Pneumothorax

Heart Murmurs

Monitor the ICU patient for the development of a new murmur. Murmurs are classically described as systolic or diastolic. All new murmurs should be characterized by their intensity, location, and variation with position and respiration. Diastolic murmurs are practically always pathologic. Details on heart murmurs can be found in Chapter 1, page 14.

Systolic Murmurs: Abrupt onset caused by conditions that have clinical significance for the acutely ill patient:

Papillary muscle injury. Papillary muscle dysfunction following AMI is characterized
by an apical systolic murmur. The injury to the papillary muscle may cause a murmur

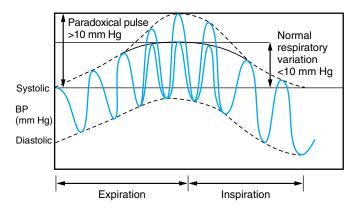


FIGURE 20-1 The paradoxical pulse.

of grade I–II/VI. After rupture of the papillary muscle, a sudden pansystolic murmur of grade II–IV/VI may appear. The diagnosis of papillary muscle rupture can be made either at cardiac catheterization or by echocardiography.

Intraventricular septum rupture. May be indicated by the appearance of a loud systolic murmur of abrupt onset. A catastrophic event that may follow MI. Usually accompanied by massive pulmonary edema. This situation is an indication for emergency cardiac catheterization.

Diastolic Murmurs: The major concern is the appearance of a diastolic murmur in the acutely injured patient is bacterial endocarditis, an entity that is becoming more common in patients who are treated in ICUs for long periods. Foreign bodies, such as central venous lines, hyperalimentation lines, and pulmonary artery catheters, all contribute to the increasing incidence of bacterial endocarditis.

Gallop. Defined as three sequential heart sounds in which the first two beats of the
triplet are closer together than the third. The result is a sound that resembles the gallop
of a horse.

A newly occurring gallop may herald the onset of one or more of the following:

- MI
- · Severe CHF
- · Mitral regurgitation secondary to injury of the papillary muscle
- Anemia
- 2. Pericardial friction rub. Classically described as the sound of two pieces of leather rubbing together. Frequently high pitched and may be intermittent. Common following open heart surgery (in this setting, does not necessarily indicate pathologic changes).

Development of a pericardial friction rub should cause one to suspect one of the following:

- · Pericarditis
- Pericardial effusion
- · MI near the surface of the pericardium

CARDIOVASCULAR PHYSIOLOGY

Prior to a discussion of central venous pressure and pulmonary artery catheters, a brief review of cardiovascular physiology may be helpful.

Definitions

Cardiac Output: Defined as the quantity of blood pumped by the heart each minute. Normal output in an adult is 3.5–5.5 L/min.

Cardiac Index: Used to compensate for body size. Defined as the CO divided by the patient's body surface area. The normal CI is 2.8–3.2 L/min/m². A CI of <2.5 requires immediate assessment and treatment.

Determinants of Cardiac Output

Cardiac output is determined by heart rate and stroke volume. Stroke volume depends on the following:

- Preload
- Afterload
- Contractility

Preload: The initial length of the myocardial muscle fiber is proportional to the left ventricular end-diastolic volume. As the volume of blood remaining in the heart after each beat (end-diastolic volume) increases, the stretch on individual myocardial muscle cells increases. As the stretch increases, the energy of contraction increases proportionally until an optimal tension develops.

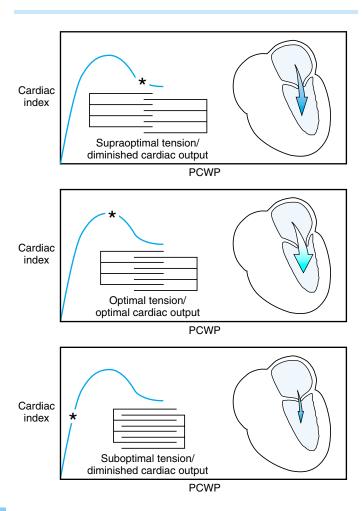
Starling's Law: When the myocardial muscle cell is stretched, the developed tension increases to a maximum and then declines as the stretch becomes more extreme (Figure 20–2).

Afterload: Defined as the resistance to ventricular ejection. Measured clinically by the calculation of SVR.

Contractility: The ability of the heart to alter its contractile force and velocity *independent* of fiber length. In simple terms, it represents the intrinsic strength of the individual muscle fiber cells. Contractility can be increased by stimulation of beta-receptors in the heart (see below).

Brief Review of the Adrenergic, or Sympathetic Nervous System

Cardiac output and its determinants (preload, afterload, and contractility) are all influenced by the adrenergic nervous system. The adrenergic system releases catecholamines (epinephrine and norepinephrine), which bind to end-organ receptors. These adrenergic receptors are divided into two classes, designated alpha (α) and beta (β) , and their actions are summarized in Table 20–1.



 $\begin{tabular}{ll} \textbf{FIGURE 20-2} & Representation of Starling's law. PCWP = pulmonary capillary wedge pressure. \end{tabular}$

TABLE 20–1 Adrenergic Receptors and Their Actions in the Cardiovascular System

Receptor	Site	Action
Beta-1	Myocardium SA node	Increased contractility Increased heart rate
Beta-2	Arterioles Lungs	Vasodilatation Bronchodilatation
Alpha	Peripheral arterioles	Vasoconstriction

Alpha-1 Receptors: Adrenergic receptors found primarily in the peripheral arterial system. When stimulated, these receptors cause vasoconstriction and increase BP, SVR, and afterload.

Beta-1 Receptors: Found primarily on the SA node of the heart. When activated, these receptors stimulate the SA node to increase the heart rate and increase contractility. This increases CO and BP.

Beta-2 Receptors: Found in the peripheral vascular tree as well as in the bronchial wall smooth muscle. Activation causes vasodilation of the peripheral vasculature and bronchodilatation. Hemodynamically, this decreases SVR, BP, and afterload.

These adrenergic receptors are important because many of the cardiovascular drugs used in the ICU act through their sympathomimetic properties. These drugs usually have specific receptor affinity (ie, β versus α) and consequently differ in their effects. Drugs that act on alpha-1 receptors, for example, are called "vasopressors" because they cause vaso-constriction. Drugs that act on beta-1 receptors are conversely called "inotropes" because they increase contractility and heart rate. Commonly used sympathomimetics are listed in Table 20–2. A guide to administration of these agents appears in Table 20–10.

CENTRAL VENOUS PRESSURE

The CVP catheter is one of two major devices used in cardiovascular instrumentation. The other major device, the pulmonary artery catheter (often called the Swan–Ganz catheter), is considered in the next section.

The CVP reading reflects the right ventricular filling pressure. This filling pressure defines the ability of the right side of the heart to accept and pump blood.

Method

A 14-gauge intravenous catheter is inserted into the internal jugular or subclavian vein (see Chapter 13). A pressure transducer connected to the monitor provides the recordings. A chest x-ray is required to confirm the position of the catheter in the superior vena cava. The zero point for the manometer is usually 5 cm below the sternal notch, in the midaxillary line.

TABLE 20–2
Actions of Sympathomimetic Drugs

Drug	Beta-1	Beta-2	Alpha	
Dopamine	++++	++	++++	
Dobutamine	++++	++	+	
Isoproterenol	++++	+++	0	
Norepinephrine	++	0	++++	
Phenylephrine	0	0	++++	
Epinephrine	++++	++	++++	

Key: + = Relative effect; 0 = no clinically significant effect.

Implications

More important than the actual isolated measurements of CVP are the relative changes that take place as a patient's fluid or cardiac status changes. Therefore, serial readings are made. The implications of CVP readings are given in Table 20–3.

CVP Limitations

- CVP does not reflect total blood volume or left ventricular function.
- CVP will be altered by changes in pulmonary artery resistance and compliance of the right ventricle.
- Use may be limited by changes in intrathoracic pressure, such as those that occur
 during positive pressure ventilation or pneumothorax or in the presence of tumors.
- CVP may be normal in the face of sepsis or hypovolemia accompanied by compromised myocardial function.

TABLE 20-3
Interpretation of CVP Readings

Reading (cm H ₂ 0)	Description	Implications
<4 4–10 >10	Low Midrange High	Fluids may be pushed Not clinically useful Suspect CHF, cor pulmonale, COPD, ten- sion pneumothorax, cardiac tamponade

Abbreviations: CVP = central venous pressure; CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease.

- Occult left ventricular failure may occur in the presence of normal CVP.
- · Patients with COPD may require an elevated CVP to optimize their cardiac output.
- Pulmonary artery catheter readings are more accurate measurements of a patient's fluid and cardiac status than is the CVP.

Technical Tips

- · If CVP readings do not fluctuate with respiration, the readings are inaccurate.
- · If appropriate, remove the patient from the ventilator when taking a CVP reading.
- Have the head of the bed flat when taking readings, so that serial readings are comparable.
- Always use the same zero point (5 cm below the sternum in the midaxillary line) so that serial readings are comparable.

PULMONARY ARTERY CATHETERS

The pulmonary artery (PA or Swan–Ganz) catheter is a device that allows the measurement of central circulatory parameters useful in the treatment of the acutely ill patient. Volume status, vascular tone (both pulmonary and peripheral), and the heart's pumping ability are all monitored with the PA catheter. The catheter actually passes through the heart; its distal end is in the pulmonary artery (Figure 20–3). It allows the measurement of the pulmonary artery pressure (PAOP, the pulmonary artery occlusion pressure (PAOP, also known as the pulmonary capillary wedge pressure, PCWP), the CO, and the CVP. Newer technology also allows for the continuous monitoring of mixed venous oxygen saturation (SvO₂), measurement of the right ventricular ejection fraction (REF), and the right ventricular end-diastolic volume index (RVEDVI).

Indications

Common clinical conditions requiring PA catheter monitoring include:

- · Acute heart failure
- · Complex circulatory and fluid conditions (massive resuscitation)
- · Shock states
- · Diagnosis of pericardial tamponade
- Intraoperative management (aneurysm repair, elderly patient undergoing major surgery)
- · Complicated MI

Catheter Description

The original PA catheter, still commonly called the Swan–Ganz catheter after its inventors, consists of three lumens and a thermistor at the tip (Figure 20–4). It is typically marked in 10-cm increments and is radiopaque.

Lumens

- Balloon port. Usually a square white port that inflates the balloon at the tip of the catheter. Inflation of the balloon requires between 1 and 1.5 mL of air.
- Proximal port. Located approximately 30 cm proximal to the tip, it lies in the superior vena cava. May be used for the administration of routine IV fluids when not being used in determinations of CO.

FIGURE 20–3 Relative positioning of the pulmonary artery catheter.

Distal port. Lies in the pulmonary artery beyond the balloon. This port is attached to
a pressure transducer that provides continuous PAP tracings and allows intermittent
PAOP monitoring.

Thermistor. A temperature sensor. Provides continuous measurements of core temperature as well as measurements used in the thermal dilation method for determination of CO. (This method is described later in this chapter.)

Modifications of Pulmonary Artery Catheter: Several modifications of the original Swan–Ganz catheters allow for additional functions and measurement capabilities. These modifications include additional ports for administration of IV medication or parenteral nutrition.

- Pacing Swans have extra ports (approximately 19 cm from the tip) through which
 pacing wires are passed into the right ventricle. Other models contain electrodes
 along the surface of the catheter, capable of pacing both the right atrium and ventricle.
- Oximetric PA catheter includes the standard ports of the Swan-Ganz type with fiberoptic components that emit light impulses to and from the distal end of the catheter. These light impulses are then reflected back by hemoglobin to monitors that continuously calculate O₂ saturation (See Figure 20-4).
- Right ventricular ejection catheter is capable of determining the right ventricular
 ejection fraction, which is then used to calculate the EDVI. The EDVI is the best indicator of preload in the shock state.

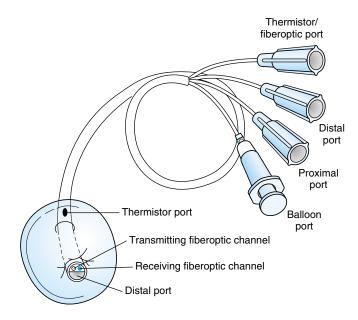


FIGURE 20-4 An example of a pulmonary artery catheter. This one features an oximetric measuring feature (see text for a complete description).

Contraindications: If a PA catheter is needed to treat a patient in a critical care setting, there are no absolute contraindications. Patients with LBBB may experience complete heart block and may require placement of a temporary pacemaker prior to catheter placement. As with all indwelling catheters that are frequently manipulated, PA catheters increase the risk of infection.

Materials: In most institutions, a single brand of a flow-directed, balloon-tipped PA catheter is available (See Figure 20–4). An insertion kit provides the catheter as well as an introducer sheath; flexible J-tip guidewire; vessel dilator; catheter contamination shield; and the various syringes, needles, preparation material, local anesthetic, and other items needed to insert the catheter (Figure 20–5). The monitoring system (transducers, pressure tubing, stopcocks) and heparinized, pressurized flush system are usually set up by the nursing staff.

Pulmonary Artery Catheterization Procedure

- Informed consent is usually required. The patient should be closely monitored with an ECG. Emergency resuscitation medications must be on hand in the event of an arrhythmia.
- 2. Choose a site and prep and drape the area. A widely draped field is needed because of the length of the tubing and guidewire. The choice of site is dictated by patient variables and operator experience. The easiest sites to place a PA catheter without fluoroscopic guidance are the right internal jugular vein and the left subclavian vein. In a patient who may receive thrombolytic therapy or who has a coagulopathy, femoral and median basilic veins are better routes.
- 3. Use a strict sterile approach with gown, gloves, and mask.

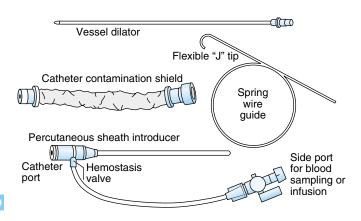


FIGURE 20-5 Additional items used for pulmonary artery catheter placement. (Reprinted, with permission, from: Chesnutt MS, et al [eds]: Office & Bedside Procedures. Appleton & Lange, Stamford CT, 1992.)

4. Prepare the PA catheter by attaching it to the monitor and flushing the lumens with heparinized saline solution (1 mL of 1:100 U heparin in 10 mL of NS). Check the balloon's function, and gently tap the catheter to ensure that an appropriate waveform is present on the monitor. Set the pressure transducer level to the middle of the patient's chest. This is approximately the level of the left atrium (midpoint of the chest wall at the fourth intercostal space). Some clinicians advocate checking the balloon for leaks by placing it in a container of sterile saline. Note: Never fill the balloon with fluid; use air or CO₂. The volume is typically 1-1.5 mL, depending on the catheter size. Place the catheter through the contamination shield and lay it on the sterile field.

- 5. The central vein is cannulated. (See Central Venous Catheterization, Chapter 13, page 253, for details.) Pass the flexible end of the J-wire (standard size is 45 cm long and 0.035 in. in diameter) into the vein through the needle. In general, never push a guidewire where it does not want to go and always keep one hand on the guidewire. Make sure the flexible tip is passed, not the more rigid end. The stiff end can more easily perforate a vessel.
- Mount the introducer sheath on the vessel dilator. Pass the guidewire through the vessel dilator. If the skin site is insufficient, nick it with the No. 11 blade provided in the set.
- 7. Pass the vessel dilator into the vessel first. A slight twisting motion may be necessary to then advance the sheath into the vessel (Figure 20–6). Slowly remove the guidewire and the vessel dilator. Most PA catheter sheaths have a hemostatic valve mechanism that prevents air from entering the central system and blood from pouring out. If no valve mechanism is present, place a finger over the end of the sheath to prevent excessive blood loss or air embolization. It is handy to mount a syringe on the side port to aspirate blood to confirm proper intravascular positioning of the sheath. After the position is confirmed, flush with heparinized flush solution.

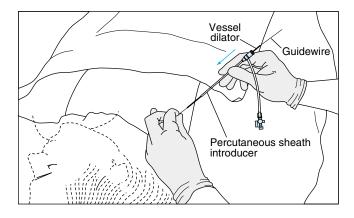


FIGURE 20-6 The introducer sheath and the vessel dilator are passed into the vessel. (Reprinted, with permission, from: Chesnutt MS, et al [eds]: Office & Bedside Procedures. Appleton & Lange, Stamford CT, 1992.)

- 8. Once the sheath is in place, the prepared catheter (fluid-filled, contamination sheath in place) can be advanced into the sheath (Figure 20–7). Once you have advanced it approximately 15 cm, the balloon will clear the tip of the sheath and can be gently inflated with 1.5 mL of air, using the volume-limiting syringe provided with the set (for a No. 7 or 7.5 French catheter). The maximum amount of air to be used with smaller catheters (No. 5 French) is 1.0 mL. If you encounter resistance to full inflation, consider that the balloon may not have yet cleared the sheath or that it may be in an extravascular location.
- 9. Once the balloon is inflated, advance the catheter to the level of the right atrium under the guidance of the pressure waveform and the ECG. Monitor the waveform and ECG at all times while advancing the balloon catheter. Figure 20–8 displays the normal pressures that can be seen as the catheter is advanced. Advance the catheter with the balloon inflated, and withdraw it with the balloon deflated. PA catheters usually come with a preformed curve on the tip. The catheter should be inserted pointing the catheter tip anteriorly and to the left. Positioning in the right atrium is probably best determined by watching for the characteristic waveform. The right atrium is generally located approximately 20 cm from the right internal jugular or subclavian vein insertion site and approximately 25–30 cm from the left subclavian vein insertion site. Advance the catheter steadily. An abrupt change in the pressure tracing occurs as the catheter enters the right ventricle. There is generally little ectopy on entry into the right ventricle; however, as the catheter advances into the right ventricular outflow tract, PVCs may occur. Keep advancing the catheter until the ectopy disappears and the pulmonary artery tracing is obtained. If this does not occur, deflate the balloon, withdraw the catheter, and

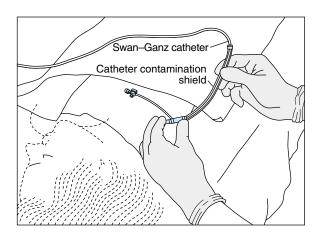
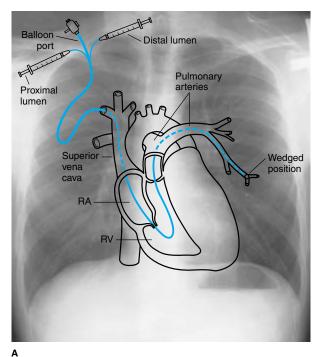


FIGURE 20–7 The fluid-filled pulmonary artery catheter is passed into the introducer sheath. (Reprinted, with permission, from: Chesnutt MS, et al [eds]: *Office & Bedside Procedures*. Appleton & Lange, Stamford CT, 1992.)



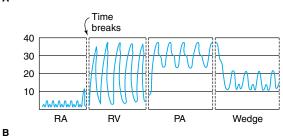


FIGURE 20-8 Positioning and pressure waveforms seen as the pulmonary artery catheter is advanced. (Reprinted, with permission, from: Haist SA, et al [eds]: *Internal Medicine on Call*, 2nd ed. Appleton & Lange, Stamford CT, 1996.)

make another attempt with the balloon inflated after slightly rotating the catheter. Obtain the PCWP after advancing the catheter another 10–15 cm. The catheter's final position should be such that the PCWP is obtained with full balloon inflation and the PAP tracing is present with the balloon deflated. In the "ideal position," transition from PAP to PCWP (and vice versa) occurs within three or fewer heart beats. In an adult, the typical length to the pulmonary artery position is 40–45 cm. **Never withdraw the catheter with the balloon inflated.** (See Figure 20–8 for normal waveforms seen as the catheter is advanced. Table 20–4 shows normal PA catheter measurements.)

- 10. Once the position is acceptable, lock the contamination shield onto the sheath. This allows readjustment of the catheter should this be necessary after the sterile field is taken down. Suture the sheath (using 3-0 or 4-0 nylon on a cutting needle), suture or secure the catheter in place and dress according to your institution's practice (often with a transparent dressing), and connect fluid to the inflow port on the sheath. This inflow port on the sheath can be used for IV fluid and some medication administration. Obtain a chest x-ray to document the catheter's present position as well as to rule out a pneumothorax or other complication from central venous catheterization. A properly positioned catheter should lie just beyond the vertebral bodies in the nonwedged position.
- 11. Common problems. Catheter placement is much more difficult if severe pulmonary artery hypertension is present. If there is significant cardiac enlargement, particularly dilation of the right heart structures, the catheter may have a propensity to coil and get lost in its path to the right ventricular outflow tract. Fluoroscopy may be required to get the catheter into the correct position and it will hold this position poorly. Placement of the catheter in the pulmonary artery may also be difficult in the setting of a low cardiac output because the balloon-tipped catheter depends on blood flow to carry it through the right heart chambers.
- 12. Cardiac output can be measured by thermal dilution. First, connect the thermistor to the cardiac output computer. Then rapidly inject fluid (usually 10 mL of ice-cooled NS) through the right atrial port. Have someone set the computer as you inject. The computer displays the CO. Repeat two more times. If all of these values are approximately the same, then average the readings and record. Newer continuous cardiac output monitoring PA are available in some units (see pages 401 and 412). For normal cardiac output and index, see Table 20-4.

Complications

- Most complications that occur in the course of PA catheterization are related to central vein cannulation and include arterial puncture, placement of the wire or catheter in the extravascular space, and pneumothorax.
- Arrhythmias are another common complication. The most common of these are transient PVCs that occur when the catheter is advanced into the right ventricular outflow tract. If a patient with a PA catheter suddenly develops frequent premature ventricular complexes, displacement of the catheter should be suspected.
- VT and VF are rare occurrences.
 - Transient RBBB occurs occasionally as the catheter passes through the right ventricular outflow tract. In a patient with preexisting LBBB, this can result in complete heart block. In this setting, some form of backup pacing should be readily available. Complete heart block has been reported but occurs rarely.
- Significant pulmonary infarcts and pulmonary artery rupture are serious but infrequent complications of PA catheters secondary to permanent wedge or peripheral placement of the catheter.

TABLE 20–4
Normal Pulmonary Artery Measurements

Right atrial pressure	1–7 mm Hg
Right ventricular pressure	1–7 IIIII 1 Ig
Systolic	15-25 mm Hg
Diastolic	0–8 mm Hg
PAP	0–0 mm rig
Systolic	15-25 mm Hg
Diastolic	8–15 mm Hg
Mean	10–20 mm Hg
PCWP (PAOP)	6–12 mm Hg
Cardiac output	3.5–5.5 L/min
Cardiac index	2.8–3.2 L/min/m ²
Mixed venous O ₂ saturation (SvO ₂)	70–80%
Right ventricular ejection fraction	80–120 mL
<u> </u>	
Abbreviations: PAP = pulmonary artery pre	essure; PAOP = pulmonary artery occlusion

6. Most complications and problems tend to increase with the time the catheter is in place. The risk of bacteremia and SBE is significant in severely ill patients receiving chronic instrumentation. In the setting of unexplained fever, the catheter and sheath should always be removed and cultured. The catheter and sheath should be replaced at a different site if a pulmonary catheter is still indicated.

Pulmonary Artery Catheter Measurements

Pulmonary Artery Pressure: Measured when the PA catheter is in its resting position in the pulmonary artery (balloon deflated). Measures both systolic pulmonary artery pressure and diastolic pulmonary artery pressure.

Pulmonary Artery Occlusion Pressure: (also called the "pulmonary capillary wedge pressure," or "wedge pressure"). A reflection of the left atrial pressure. Measured when the balloon at the tip of the PA catheter is slowly inflated with air (maximum 1.5 mL) and carried out, by blood flow, into one of the smaller branches of the pulmonary artery. The balloon must be deflated after each PAOP measurement to avoid pulmonary infarction. In the absence of mitral valvular disease, PAOP correlates closely with the LAP and with the left ventricular end-diastolic pressure. This correlation exists because of the unobstructed continuity between the pulmonary artery and the left side of the heart. As a result of this continuity, the PAOP can never be greater than the PAD. If the LVEDP increases, this should be reflected by an increase in PAOP, which, in turn, increases the PAD. Therefore, if a PA catheter monitor shows a wedge pressure higher than the PAD pressure, a technical error must exist. This is an important method to check the accuracy of the PAOP.

Left Ventricular End-Diastolic Pressure: LVEDP is a measure of preload and is used to guide fluid resuscitation and optimize cardiac output. Recall that to optimize stroke

volume on the Starling curve, the preload must be adequate to stretch the wall of the left ventricle. Too little volume (hypovolemia) results in too little tension and therefore a decreased CO. Conversely, too much preload volume causes overstretching beyond the point of maximum tension and causes a decrease in CO. Clinically, the PAOP is used to keep preload in an optimum range to maximize stroke volume. The normal PAOP varies between 6 and 12 mm Hg, but may be higher for different disease states.

Right Ventricular Ejection Fraction, Right Ventricular End-Diastolic Volume Index: A rapid-response thermistor and the cardiac output computer are used to calculate the REF. Once REF and CO are known, the EDVI can be calculated. The EDVI is another measure of preload, and it allows a more accurate assessment of volume status regardless of pulmonary status. For example, a patient with severe ARDS may have markedly elevated peak inspiratory pressures. Although the CVP and PAOP may be falsely elevated, the EDVI is measuring a volume, not a pressure, allowing a more precise determination of volume status across a wide variety of clinical situations. The normal range for EDVI is 80–120 mL.

Differential Diagnosis

Table 20–4 shows normal pulmonary artery measurements (see also Figure 20–8), and the differential diagnosis based on these and other critical care parameters is shown in Table 20–5.

Clinical Applications

The PA catheter allows the clinician to measure a patient's volume status and myocardial performance. As stated earlier, myocardial performance or CO depends on heart rate and stroke volume. Stroke volume is, in turn, dependent on preload, afterload, and contractility.

Heart Rate: Heart rate, in addition to stroke volume, determines the cardiac output. The body increases the HR to increase CO in the face of inadequate perfusion. Hence, tachycardia is an additional indicator of O₂ delivery/demand imbalance. Tachycardia >120 bpm increases myocardial O₂ demand significantly and should be promptly treated. The PA catheter allows the establishment of adequate myocardial filling pressures such that the HR may be clinically manipulated to maximize CO. In a patient with adequate filling pressures, slow HR (<80 bpm), and a low CO, drugs that speed up the heart (called "chronotropes") may be used to increase CO. Alternatively, tachycardia >120 bpm with an adequate PAOP may be pharmacologically slowed to decrease the strain on the heart.

Preload (Stroke Volume): Indicated by the PAOP or EDVI, a reflection of left ventricular end-diastolic volume. In simple terms, preload is the amount of blood in the heart prior to contraction. Consequently, preload represents the stretch placed on the individual myocardial cell. When the PAOP is optimized, myocardial performance is optimized according to the Starling curve.

- 1. Clinical implications in a healthy heart. A low PAOP or EDVI means suboptimal myocardial muscle tension and, consequently, suboptimal myocardial performance. Cardiac output may be increased by the administration of fluids. The result is an increase in left ventricular end-diastolic volume, an increase in myocardial muscle tension, and improved myocardial performance.
- 2. Clinical implications in a failing heart. Long-standing myocardial disease may shift the Starling curve to the left. Consequently, a significantly elevated PAOP may be required to optimize myocardial performance. It is common for patients who have just undergone heart valve replacement to require a PAOP of 20–25 mm Hg to optimize

TABLE 20–5
Differential Diagnosis Based on Hemodynamic Parameters*

Diagnosis	Blood Pressure	CVP	СО	PCWP/LVEDP	PAP	PVR	SVR	
Cardiogenic shock Cardiac tamponade Hypovolemic shock Septic shock Pulmonary embolus	↓ ↓ ↓	↑ ↑ ↓ ↓	↓ ↓ ↓	↑ ↑ ↓ ↓ – or ↓	↑ ↑ ↓ ↓	↑ ↑ ↓ ↑	↑ ↑ ↓ ↓	

^{*}These trends are usually seen with the conditions noted. Clinical variables (medications, secondary conditions) can vary some of these trends.

Abbreviations: CVP = central venous pressure; CO = cardiac output; PCWP = pulmonary capillary wedge pressure; PAP = pulmonary artery pressure; PVR = peripheral vascular resistance; SVR = systemic vascular resistance; î = usually increased; \$\pmu\$ = usually decreased; LVEDP = left ventricular end-diastolic pressure, — = usually not changed.

cardiac output. Patients with a recent MI may require a PAOP of $16-18~\mathrm{mm}$ Hg to optimize output.

Afterload: Defined as the resistance to ventricular ejection. Measured clinically by the calculation of systemic vascular resistance:

$$SVR = \frac{(MAP - CVP) \times 80}{Cardiac \text{ output } (L / min)}$$

Normal SVR = $900 - 1200 \text{ dynes/s/cm}^3$

1. Indications for afterload reduction.

- · Significant mitral regurgitation
- · An increased PAOP in the face of an elevated SVR and a decreased cardiac index
- 2. Treatment. Nitroprusside (Nipride) is the drug of choice.

Contractility: The ability of the heart to alter its contractile force and velocity independent of fiber length is difficult to measure clinically. Digitalis can improve contractility. Care should be maintained to ensure normal levels of serum potassium prior to the administration of digitalis.

Correctable metabolic causes for depressed contractility include:

- Hypoxia
- Acidosis (pH <7.3)
- · Hypophosphatemia
- · Adrenal insufficiency
- · Hypothermia

The most common causes are **hypoxia and acidosis**. These must be corrected before inotropic therapy can be effective.

DETERMINATIONS OF CARDIAC OUTPUT

Several methods are currently available to determine (CO). These include:

- · Thermal dilution technique
- A–Vo₂ difference calculation

Thermal Dilution Technique

This requires the use of a PA catheter. A measured amount of saline (usually 10 mL) at a known temperature is injected into the proximal port of the PA catheter, and a temperature-sensitive thermistor located at the distal end of the pulmonary artery senses the temperature change in the surrounding blood. The cardiac output computer then integrates the magnitude and rate of change in temperature and calculates CO.

Arteriovenous Oxygen (A-Vo₂) Difference

A reasonable estimate of cardiac output can be made on the basis of A– Vo_2 difference. A– Vo_2 difference is a measure between the oxygen content of arterial blood drawn from a peripheral artery and the oxygen content of mixed venous blood drawn from the distal lumen of a PA catheter (Table 20–6).

TABLE 20-6
Calculation of Cardiac Index Based on A-Vo₂ Difference

<2 3–4
>5

A-Vo₂ difference = Arterial O₂ content - Mixed venous O₂ content

Concept: The A-Vo₂ difference measures the extraction of oxygen by the tissues during a single transit time through the circulation. Thus, the A-Vo₂ difference is a function of (1) Pao₂, (2) Hgb, (3) CO, and (4) tissue O₂ consumption.

- If cardiac output is low. Transit time is long and the tissues extract large amounts
 of oxygen during a single circulation time. Thus, the oxygen content of mixed venous blood is low and the A-Vo₂ difference is large
- If cardiac output is high. Circulation time is shorter and the amount of oxygen extracted is low. Consequently, the A–Vo₂ difference is low

Calculations: The A-Vo₂ difference is inversely proportional to CO. Therefore, the following approximations can be made:

1. Determining Oxygen Content. To calculate the A-Vo₂ difference, the oxygen content of both arterial and mixed venous blood must determined. Oxygen content describes the amount of O₂ the blood is able to carry. Because only a small percentage of O₂ is dissolved in plasma, the vast majority is carried by hemoglobin. Hence,

Oxygen content = Oxygen bound to Hgb + Oxygen dissolved in plasma

where Sao₂ is arterial O_2 saturation, Hgb is hemoglobin content in g/dL, and Pao₂ is arterial partial pressure of O_2 . The constant 1.39 is the O_2 -binding capacity of Hgb (mL of O_2 /g of Hgb), and 0.0031 is mL of O_2 dissolved in 100 mL of plasma per mm Hg of Pao₂. The normal O_2 content of arterial blood is 16–20 mL of O_2 /100 mL of blood.

Similarly,

$$Cvo_2 = Svo_2 \times [Hgb] \times 1.39 + (0.0031 \times Pvo_2)$$

where Cvo₂ is the O₂ content of mixed venous blood, Svo₂ is the mixed venous O₂ saturation.

Assuming that the amount of dissolved blood in plasma is small, then:

$$A-Vo_2 = Cao_2 - Cvo = 1.39 \times Hgb \times (Sao_2 - SVo_2)$$

2. Calculation of A-Vo₂ Difference.

- · Obtain hemoglobin concentration.
- Determine Sao₂ from heparinized peripheral arterial blood or from a pulse oximeter.
- Determine Svo₂ from a heparinized mixed venous blood sample from the distal lumen of a PA catheter or from an oximetric Svo₂ monitor (see the following discussion).
- Calculate the A-Vo₂ difference according to the preceding formula, and determine the CI based on Table 20-6.

Continuous Svo₂ Monitoring

Oximetric pulmonary artery catheters house fiberoptic channels that allow direct measurement of mixed venous saturation (Svo₂). These fiberoptics carry light impulses that are reflected by hemoglobin according to its O₂ saturation. An optical microprocessor then displays a continuous graph of Svo₂ measurements. Calibration is periodically confirmed with a heparinized blood sample drawn from the oximetric catheter's distal port.

Clinical Application

- Follow trends in the O2 supply/demand balance.
- A decrease in Svo₂ is often the first indicator of early organ dysfunction. This early warning allows correction of the problem before hemodynamic compromise.
- Treatment interventions (eg, transfusions, fluid mobilization, drugs) may be assessed by following Svo₂ changes long before other hemodynamic parameters are adversely affected.
- Clinically, Svo₂ values between 60% and 80% represent adequate tissue perfusion.
- Svo₂ of <60% should prompt an immediate assessment of O₂ delivery or unrecognized conditions causing increased O₂ demand. As O₂ delivery falls, Svo₂ falls because there is less O₂ for the tissues to consume. Similarly, if O₂ consumption increases, then Svo₂ also falls. A decline of Svo₂ should therefore prompt a review of the parameters describing O₂ delivery (ie, CO, Hgb, Sao₂) and consumption (Sao₂ Svo₂). These parameters identify the causes of Svo₂ decline and their specific treatments:
 - Sao₂ <90% demands increased ventilatory support.
 - · Decreased CO requires optimizing myocardial function.
 - · Low Hgb requires transfusion.
- Svo₂ of >80% indicates increased metabolic demands, requires evaluation for conditions such as unrecognized seizures, shivering, mobilization, and large tissue defects (Figure 20–9).
- Inaccurate readings of Svo₂ may occur as a result of fibrin buildup on the tip of the
 catheter, fiberoptic fracture (rare), and impingement of the tip of the catheter on the
 vessel wall. Overall, however, these catheters are accurate and sensitive with daily
 calibration.

Continuous Cardiac Output

This technology allows measurement of the CO on a continuous basis. The specially designed PA catheter emits small pulses of energy that heat the surrounding blood. The cardiac

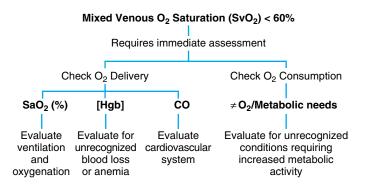


FIGURE 20-9 Algorithm for assessment of decreased SvO₂.

output computer then calculates the CO based on the magnitude and the rate of temperature change.

Continuous Sao₂ Monitoring (Pulse Oximeter)

The same fiberoptic technology used to measure mixed venous O_2 saturation is also used to measure arterial O_2 saturation (SaO₂). A light-emitting external probe is placed around a well-perfused appendage such as a digit, earlobe, lip, or bridge of the nose. The light is transmitted through the appendage to be reflected by hemoglobin according to its O_2 saturation (recall that the hemoglobin molecule absorbs different wavelengths of light at different O_2 saturations). The oximeter, in addition to calculating Hgb O_2 saturation, can also determine the pulse rate and is referred to as the "pulse oximeter." An SaO₂ of <90% implies inadequate oxygenation and requires immediate intervention. However, an SaO₂ >90% does not necessarily imply adequate O_2 delivery (see following section). **Pulse oximeter is not useful in the setting of smoke inhalation and CO poisoning.**

SHOCK STATES

Shock is defined as inadequate perfusion or oxygen delivery to meet metabolic demand.

Types of Shock

Shock can be divided into four major classes. Specific therapeutic interventions are also discussed in this chapter on page 431 and in Chapter 21 (page 460).

- Hypovolemic (low or high hematocrit)
- · Cardiogenic
- Septic
- · Neurogenic

Hypovolemic Shock: Is due to acute loss of extracellular volume. Most often due to hemorrhage in the setting of trauma but may also be due to diarrhea, vomiting, or thermal injury. Characterized by a low cardiac output, low PAOP, and elevated SVR. Svo2 is decreased.

Therapy. Should be directed toward volume replacement and increased hemoglobin concentration to improve myocardial performance.

Cardiogenic: May be due to intrinsic pump failure, dysrhythmia, or compression (ie, tamponade). Characterized by a low cardiac output, high PAOP, and elevated SVR. The basic defect is one of myocardial performance. Svo₂ is decreased.

Therapy. Should be aimed at optimizing PAOP and increasing contractility, while decreasing SVR.

Septic (Systemic Inflammatory Response Syndrome): Sepsis implies that the shock state is due to an infectious cause. The SIRS has similar hemodynamic characteristics but is not due to an infectious agent (ie, sterile pancreatitis). Characterized by a high CO, low PAOP, and low SVR. Septic shock is characterized by prearteriolar shunting, which results in a false increase in Svo₂, despite tissue hypoxia.

Therapy. Should be aimed at increasing PAOP and increasing SVR simultaneously. In true septic shock the primary treatment is therapy directed against the infectious cause (ie, drainage of abscess).

Neurogenic: Is typically due to high cervical spine injuries or high spinal anesthetics. Characterized by a low cardiac output, low PAOP, and low SVR. Svo2 is decreased.

Therapy. Should be aimed at increasing SVR. In the setting of acute trauma with spinal cord injury always assume hemorrhage is the cause of hypotension and treat with fluid resuscitation before using vasoactive agents to raise SVR.

Summary

Shock describes states of inadequate tissue perfusion and O2 delivery. Svo2 is decreased in all shock states except septic shock. The goal in all shock states is to improve myocardial performance by effecting changes in preload, afterload, contractility, and systemic vascular resistance. The PA catheter is used to guide these cardiovascular manipulations.

CLINICAL PULMONARY PHYSIOLOGY

The goal of treating any critically ill patient is to optimize both oxygenation and tissue perfusion. Pulmonary and cardiovascular physiology are intimately interwoven to achieve this goal. It does little good to optimize cardiovascular function if, because of poor pulmonary function, there is no oxygen for the hemoglobin to transport (ie, low Sao₂). Ventilation refers to the mechanical movement of air into and out of the respiratory system. Oxygenation refers to the diffusion of oxygen from the alveoli to the blood in the pulmonary capillaries and from there to the tissues. Figure 20-10 shows ventilation and oxygenation in typical alveoli.

Ventilation

Several parameters, such as volumes and capacities, are important in assessing the adequacy of ventilation. Spirometry provides both dynamic information (patient's ability to move air into and out of the lungs) as well as static volume measurements. The subdivisions of the lung capacities are shown on a spirometric graph in Figure 20-11.

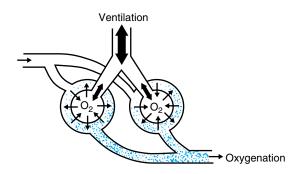


FIGURE 20-10 Ventilation and oxygenation in typical alveoli.

Basic Lung Volumes: Four basic lung volumes that together make up the total lung capacity (See Figure 20–11):

Tidal volume. The volume of inspired gas during a normal breath. In healthy individuals at rest, the tidal volume is 6–10 mL/kg.

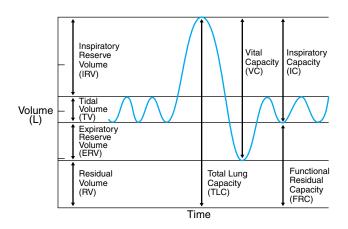


FIGURE 20-11 Spirometric graph with volumes and capacities of the lung.

- Inspiratory reserve volume. The volume of gas that can be maximally inspired beyond the amount inspired during a tidal volume breath
- 3. Expiratory reserve volume. The volume of gas that can be maximally expired beyond the amount expired at the end of a tidal volume breath
- Residual volume. The volume of gas that remains in the lung after a maximal expiratory effort

Lung Capacity: The sum of two or more of these lung volumes make up four divisions called lung capacities (See Figure 20–11).

- Total lung capacity. The total amount of gas in the lung at the end of maximal inspiration
- 2. Vital capacity. The volume of gas expired after a maximal inspiration followed by maximal expiration. Frequently used in determining whether a patient can successfully be weaned from the ventilator. Normal vital capacity is 65–75 mL/kg. A vital capacity of <15 mL/kg is an indication for continued ventilatory support. VC = ERV + TV + IRV (Figure 20–12).</p>
- Inspiratory capacity. The volume of gas expired from maximal inspiration to end TV. IC = TV + IRV.
- 4. Functional residual capacity. The gas remaining in the lung following normal expiration (tidal volume). Acts as a buffer against extreme changes in alveolar Po₂ and consequent dramatic changes in arterial Po₂ with each breath. FRC = ERV + RV (Figure 20–13).

Clinical Implications

These volumes and capacities are important parameters for assessing ventilation because they may change under different conditions (ie, atelectasis, obstruction, consolidation, small airway collapse). For example, the ERV decreases with small airway collapse, thus decreasing FRC. These alterations in lung volumes consequently affect respiratory reserve and the

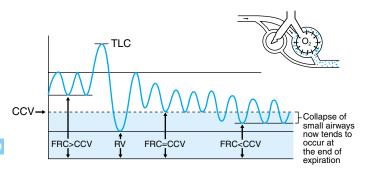


FIGURE 20–12 Functional residual capacity (FRC) and critical closing volume (CCV). TLC = total lung capacity; RV = residual volume.

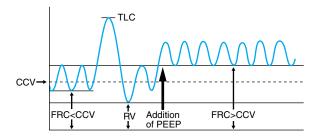


FIGURE 20–13 The effect of positive end-expiratory pressure (PEEP) is to increase the functional residual capacity (FRC); CCV = critical closing volume; TLC = total lung capacity; RV = residual volume.

patient's ability to ventilate and oxygenate. The contributing factors and the point at which they influence such volume changes must be understood to optimize support. The critical closing volume is an expression that describes the minimum volume and pressure necessary to keep small airways from collapsing during expiration.

Critical Closing Volume: The volume of gas and, consequently, pressure in the lung during expiration at which small airway collapse occurs. When collapse occurs, blood is shunted around nonventilated alveoli, thus decreasing the available surface area for gas exchange. The critical closing volume is greatly affected by compliance. Therefore, different minimum volumes and pressures may be required to prevent collapse under varying lung conditions. If the CCV is greater than the FRC (air in the lung after tidal expiration), collapse tends to occur (see Figure 20–12).

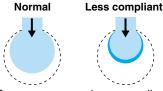
One method to overcome the CCV is to increase the amount of **positive end-expiratory pressure** in the lung (see the following discussion on PEEP). The effect of PEEP is to increase FRC by preventing small airway collapse at the end of expiration. This improves alveolar ventilation, decreases shunting and improves oxygenation (see Figure 20–13).

Lung compliance. Relates the *change* in lung volume and the *change* in pressure required to produce volume change (Figure 20–14). May be measured at the bedside and is a reflection of FRC and CCV.

Compliance =
$$\frac{\Delta V}{\Delta P}$$

Dynamic compliance is determined by measuring the tidal volume and dividing it by the peak inspiratory pressure.

$$Dynamic compliance = \frac{Tidal \ volume}{Peak \ inspiratory \ pressure - PEEP}$$



Same pressure produces a smaller volume in the less compliant lung.



Increasing positive pressure maintains volume in the less compliant lung.

FIGURE 20-14 Concept of pulmonary compliance.

Normal $> 80-100 \text{ mL/cm H}_2\text{O}$

Static compliance is similarly calculated by substituting static peak pressure for peak inspiratory pressure. Static peak pressure is measured by occluding the exhalation port at the beginning of exhalation (no flow = static pressure).

Comparing dynamic with static compliance may indicate the type of processes causing changes in the elasticity of the lung. Dynamic compliance is affected by both elasticity and airway resistance. Static compliance, in contrast, is not affected by airway resistance because there is no flow. Hence, a reduction in dynamic compliance without a change in static compliance indicates an airway resistance problem such as obstruction, bronchospasm, or collapse of the small airways. A reduction in both static and dynamic compliance may indicate a decrease in lung elasticity such as pulmonary edema, atelectasis, or excessive PEEP.

Oxygenation

Oxygenation is the process of transporting oxygen from the alveolus across the capillary membrane into the pulmonary circulation and subsequently distributing that oxygen to the body's tissues.

Tests for the assessment of oxygenation include

- Measurement of arterial O₂ saturation (SaO₂) with pulse oximetry
- · Calculation of oxygen delivery (or carrying capacity)
- Calculation of right-to-left shunt fraction (Qs/Qt)

Arterial Oxygen Saturation: See page 162.

Oxygen Delivery: Delivery of O₂ to the tissue, also called the O₂ carrying capacity, depends on CO in addition to the oxygen content of blood (Cao₂).

$$O_2$$
 delivery = $CO \times Cao_2 = CO (L/min) \times Sao_2 \times 1.39 [Hgb] \times 10$

Normal delivery is around 800 mL of O2/min, with an average normal O2 uptake of 250 mL of O2/min.

Note that this equation simplifies O₂ delivery to three parameters: CO, Sao₂, and [Hgb]. These are measured with a PA catheter, pulse oximeter, and spun hematocrit, respectively.

- Calculating the A-a Gradient: To calculate the alveolar-to-arterial gradient:
- 1. Place the patient on 100% oxygen (F_iO₂) for 20 min.
- 2. Next obtain a peripheral arterial blood gas measurement.
- 3. Calculate the alveolar Po2. After breathing 100% oxygen for 20 min, the only gases other than oxygen within the alveoli are H₂O and excreted CO₂ from tissue metabolism. Thus, the partial pressure of oxygen within the alveoli is easily calculated. The alveolar Po2 equals

```
760 Barometric pressure (in torr)
```

- -47 Partial pressure H₂O
- -40 Pco₂ from peripheral sample
- 673 Alveolar Po₂ (PAO₂)
- 4. Subtract the peripheral arterial oxygen content (Pao₂) from the alveolar Po₂ Example:

```
673 Alveolar Po<sub>2</sub> (PAO<sub>2</sub>)
-200 Peripheral Pao
  473 A-a gradient
```

Rule: The larger the gradient, the more serious the degree of respiratory compromise. Any A-a gradient >400 torr indicates severe respiratory distress resulting from a process interfering with oxygen transfer (low Pao₂). (Normal A-a gradient = 20-65 torr)

Shunt Fraction: In clinical practice, the A-a gradient is calculated primarily because it may be used to calculate the shunt fraction equation. The shunt fraction (normal = <5%) reflects the ratio of ventilated alveoli to perfused capillaries. A shunt fraction of 5% (assuming normal perfusion) means that 5% of the blood leaving the pulmonary capillaries has passed without being oxygenated. In an ideal state, the volume of lung ventilation equals the volume of pulmonary capillary blood flow (Figure 20-15). Alterations in these ventilationperfusion relationships result from two causes:

- Relative obstruction of alveolar ventilation
- · Relative obstruction of pulmonary blood flow
- 1. Perfusion greater than ventilation: Figure 20-16 depicts the extreme situation in which alveolus A receives no ventilation, but perfusion continues. Therefore, a complete pulmonary A-V shunt exists with respect to that alveolus.
- 2. Ventilation greater than perfusion: Figure 20-17 depicts uniform ventilation to A and B, but no blood flow to the alveolus. This situation increases physiologic dead space and increases the shunt equation.
- 3. Compensation mechanism: Figure 20-18 represents the compensatory change that occurs when an alveolus is partially occluded. Blood flow is preferentially shunted to other, more efficiently ventilated alveolar units.

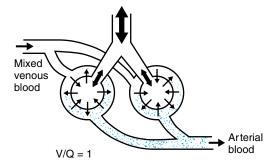


FIGURE 20-15 Ventilation-perfusion (V/Q) ratio.

Principle. It is important to recognize that at any given time, even in the normal state, gradations of all these situations exist simultaneously within the lung. The normal shunt fraction is approximately 5%. Alterations in either ventilation or perfusion can seriously affect oxygenation.

1. Decreased lung-to-blood transfer. Associated factors are

- · Pulmonary edema
- ARDS
- Atelectasis
- Pneumonia

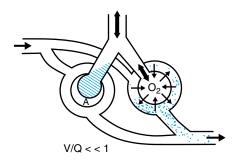


FIGURE 20–16 Perfusion greater than ventilation.

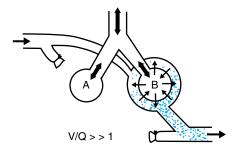


FIGURE 20-17 Ventilation greater than perfusion.

2. Decreased perfusion. Associated factors are

- Massive PE.
- Continued micropulmonary embolization

Calculation of the Shunt Fraction. Q is the mathematical symbol for flow. Therefore, Qs is the symbol for the amount of flow through the pulmonary shunt. Qs is defined as that portion of the cardiac output that does not participate in gas exchange, that is, the volume of blood that is shunted past nonventilated alveoli. Qt is the symbol for total cardiac output. Therefore, the volume of blood shunted past nonventilated alveoli divided by the total cardiac output (shunted plus nonshunted blood) is Qs/Qt (Figure 20–19).

The shunt fraction is defined as

$$\frac{\text{Qs (\%)}}{\text{Qt}} = \frac{\text{Cco}_2 - \text{Cao}_2 \times 100}{\text{Cco}_2 - \text{Cvo}_2}$$

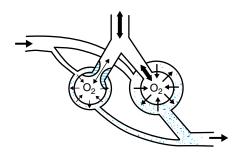


FIGURE 20-18 Compensation for ventilation-perfusion mismatching.

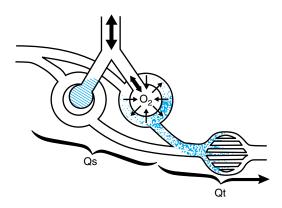


FIGURE 20-19 Representation of the shunt fraction.

where Cco_2 is O_2 content (mL/100 mL) of blood leaving the alveolar capillary bed, Cao_2 is arterial O_2 content (mL/100mL), and Cvo_2 is mixed venous O_2 content (mL/100mL) in the pulmonary artery.

The oxygen content of the capillary blood (Cco₂) is calculated using the alveolar Po₂ (Pao₂) from the alveolar–arterial gradient calculation.

$$Cco_2 = [Hgb] (1.39) (1.0) + Pao_2 (0.0031)$$

where Cao_2 is measured when the patient should be on and Fio_2 of 1.0 (100% O_2).

Similarly, the O_2 content of mixed venous blood found in the pulmonary artery may be calculated as follows:

$$Cvo_2 = [Hgb] (1.39) (Svo_2) + Pvo_2 (0.0031)$$

where Svo₂ is the O₂ saturation of mixed venous blood.

Concept of the Shunt Fraction. Qs/Qt represents the amount of pulmonary flow "shunted," or not participating in gas exchange over the total cardiac output. For example, a shunt fraction of 0.25 indicates that 25% of the pulmonary blood flow is shunted. Thus, the equation serves as a useful index of ventilation–perfusion inequality. The normal value is <5%.

Breaking the equation down reveals that the numerator reflects lung-to-blood transfer (ie, A–a gradient), or "ventilation." The denominator describes O_2 consumption (ie, A– V_{O_2} difference), which, in turn, reflects CO, or "perfusion." Simplifying the denominator further illustrates that this equation is also a function of the four basic measured parameters describing O_2 delivery and demand: Sao₂, CO, Hgb, and Svo₂. Knowledge of these four measurements along with the alveolar–arterial gradient allows for early recognition and treatment of ventilation–perfusion mismatching.

Alveolar-to-Arterial Gradient $[P(A-a)o_2]$ Provides an assessment of alveolar-capillary gas exchange

- · Alveolar Po2 (PAO2) minus calculated
- · Arterial Po2 (Pao2) minus measured

Calculating the A-a Gradient. To calculate the alveolar-to-arterial gradient:

- 1. Place the patient on 100% oxygen (Fio₂) for 20 min.
- 2. Next obtain a peripheral ABG measurement.
- Calculate the alveolar Po₂. After breathing 100% oxygen for 20 min, the only gases other than oxygen within the alveoli are H₂O and excreted CO₂ from tissue metabolism.

$$[(713) \times \text{Fio}_2 - (\text{Paco}_2)] - \frac{\text{Pao}_2}{0.8}$$

INDICATIONS FOR INTUBATION

The decision to intubate a patient for prolonged ventilator support is one of the most difficult decisions for clinicians. It is easy for the physician to be lulled into a false sense of security by marginal blood gases. The following indications can be used as a basic checklist for respiratory support:

- Inability to adequately ventilate (eg, chest trauma, sedation, paralyzed or fatigued respiratory muscles)
- Inability to adequately oxygenate (eg, pulmonary edema, ARDS)
- · Excessive work of breathing (eg, prophylaxis for impending collapse)
- Protection of airway (eg, unconscious, altered mental status, massive resuscitation, facial trauma)

These basic indications should be used in conjunction with **clinical judgment** in the final decision for mechanical ventilation. The decision to intubate, if made in a timely and appropriate fashion, can turn an otherwise traumatic intubation into a controlled and elective procedure. Table 20–7 lists some common parameters used to evaluate the need for respiratory support in adults.

MECHANICAL VENTILATORS

Classes of Ventilators

The two classic types of ventilator are the pressure-limited and the volume-limited ventilators. Although newer ventilators combine many of the qualities of both classes, it is conceptually advantageous to discuss the two types separately. Additionally, several other types of ventilators are occasionally used.

Pressure Limited: These ventilators deliver a volume of air until a preset pressure is reached. They are used in some neonatal units. They are not generally used to ventilate adult patients, because changes in airway pressure and in lung and chest wall compliance may result in an inadequate minute ventilation. This technique is reserved for patients who fail to respond to traditional modes of ventilation.

Volume Limited: A preset volume of air is delivered regardless of the opposing pressure. This is the most common class of ventilator used. (*Note:* A pressure limit setting usually allows the venting of excessive pressure to prevent barotrauma.)

TABLE 20-7 Indicators of Respiratory Failure

Condition	Normal Range (adults)
Paco ₂ >60 mm Hg Pao ₂ <70 mm Hg on 50% mask Tachypnea >30 breaths/min Altered mental status such that the patient is unable to protect the airway against aspiration	35–45 mm Hg 80–100 mm Hg on room air 10–20 breaths/min

High-Frequency Ventilation: Rapid oscillations of breath (60–1200 cycles) used with or without the bulk delivery of gases to the lung. Several forms of this type of ventilation exist, including high-frequency jet ventilation, high-frequency positive pressure ventilation, and high-frequency oscillation.

Ventilator Modes

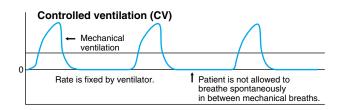
Ventilator modes are represented in Figure 20-20.

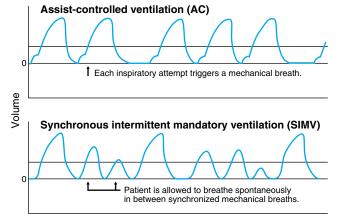
Controlled Ventilation: The patient gets a breath only when it is delivered by the machine. The patient cannot initiate any of his or her own breaths. Used in the past on patients who were intentionally paralyzed by drugs.

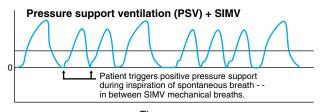
Assist Controlled: The patient gets a full mechanical tidal volume each time he or she attempts an inspiratory effort. The respiratory frequency is determined by the patient, although a backup rate is set to ensure a minimum minute ventilation.

- Advantages of AC is that patients can easily increase their minute ventilation even if they are weak and have a poor inspiratory effort.
- Disadvantage is the predisposition to hyperventilation if the patient becomes agitated or has an altered respiratory drive because of neurologic injury. Agitation may also lead to "breath stacking," in which the ventilator delivers a second tidal volume before completing the expiratory phase of the first breath. Fortunately, this is rarely a clinical problem because the patient often feels more comfortable and consequently less agitated because of the decreased work of breathing on AC.

Synchronous IMV: The respirator delivers a set number of breaths each minute and allows the patient to supplement ventilation with his or her own inspiratory efforts between machine breaths. This allows the patient to use the respiratory muscles. As the ventilator rate decreases progressively, the patient assumes more of the work of breathing. The ventilator also senses when the patient is taking a breath and will not deliver the mandatory breath until after the patient's own breath is completed. This was developed to prevent the patient's working against the ventilator or receiving a double tidal volume (ie, a mechanical tidal volume on top of a spontaneous breath). This is the most commonly used type of ventilatory mode in conjunction with pressure support and PEEP.







Time

Pressure Support Ventilation: A preset level of positive pressure is turned on only during the inspiratory phase and is turned off during expiration. The patient controls the rate and inspiratory time while augmenting tidal volume and inspiratory flow. The higher the pressure support, the less work the patient expends to take a breath. Thus, PSV is comfortable because the patient has more control of his or her ventilation. PSV serves as an ideal weaning mode because the pressure can be turned down slowly, with changes as small as 1 cm H₂O. This allows the patient to assume the workload of breathing in small increments. PSV is often integrated with SIMV as a backup to ensure a minimum minute ventilation.

Positive End-Expiratory Pressure: Positive pressure applied during expiration. It represents the supraatmospheric pressure remaining in the airways at the end of expiration. PEEP increases alveolar ventilation by preventing small airway collapse, thereby increasing FRC. PEEP also is often used prophylactically against atelectasis, particularly in the postoperative period. It has become a standard modality to treat pulmonary edema. Increasing levels of PEEP is typically used to decrease the Fio₂, in an attempt to limit oxygen toxicity. One disadvantage of PEEP, however, is that it may decrease the cardiac index by decreasing left ventricular end-diastolic volume and should be used cautiously in patients at risk for myocardial ischemia.

Pressure Regulated Volume Control: This mode of ventilation is used in the setting of increased airway pressure. A microprocessor in the ventilator adjusts the pressure needed to achieve the proper tidal volume.

Continuous Positive Airway Pressure: Positive pressure throughout inspiration and expiration without mechanical assistance during ventilation. This is equivalent to PS plus PEEP at a constant pressure level. The patient does all the breathing on his or her own. Often used as a last step before extubation. A CPAP trial may be performed at room air or an Fio₂ of 40%. (See the discussion on extubation-weaning trials page 427.)

High-Frequency Ventilation: The physiologic explanation of HFV defies conventional teaching and is under current study. Despite the marked reduction in flow rates, oxygenation and CO₂ exchange are still achieved. HFV may be ideally suited to treat such conditions as bronchopleural fistulas or may serve as a more desirable form of ventilation during surgeries requiring a minimum of lung movement.

Ventilator Management

Ventilator Orders

Once the decision has been made to place a patient on a ventilator, the patient must be intubated with an appropriate endotracheal tube (see Chapter 13, page 268). The following is a sample of typical initial ventilator orders for an adult:

- Mode (ie, AC, SIMV)
- · Fio₂ 30-100%
- Rate 8-12/min
- Tidal volume 5-7 mL/kg
- Pressure support (level depends on the clinical situation)
- PEEP (5 cm H₂O or higher, if needed)

Ventilator Setting Changes

The following four **basic** respiratory parameters can be changed to improve ventilation, oxygenation, and compliance, and to prevent ventilator induced lung injury:

- · Fio₂
- Minute volume (tidal volume X rate)
- · Pressure support
- PEEP
- 1. Fio₂. Initially, an Fio₂ that ensures a saturation (Sao₂) >90% is set on the ventilator. Once adequate oxygenation is established, the Fio₂ is decreased to avoid oxygen toxicity. Because of the danger of oxygen toxicity, an Fio₂ >50% is to be avoided. Increasing the level of PEEP is often a helpful means of decreasing the Fio₂ requirement while maintaining adequate oxygenation.
- Minute volume. Adjust to maintain PCo₂ within a normal range (35–45 mm Hg). Usually done by increasing tidal volume. Changes in rate are usually limited by a decrease in PCo₂, with a resultant respiratory alkalosis.
- 3. Pressure support. After the patient's respiratory pattern is established on SIMV, pressure support may be added initially at a level of 5-8 cm H₂O. Pressure support may then be turned up to a level that allows the patient to breathe at a comfortable rate (eg, <30 bpm). Depending on the stability and mental status of the patient, the number of SIMV backup breaths may be turned down to allow the patient more control of his or her ventilation. PS rarely needs to be turned up beyond 35 cm H₂O.
- 4. PEEP. Added to decrease Fio₂ while maintaining Pao₂. Five centimeters of PEEP is considered physiologic and is often enough to stabilize the Po₂. If the patient continues to deteriorate, PEEP is added in 2- to 3-cm increments until oxygenation is improved. This usually is at a level of 10–12 cm. Serial measurements of compliance are made to confirm improvement in pulmonary mechanics.

High-Dose PEEP. If additional PEEP is required, a pulmonary artery catheter is essential to monitor cardiac output, mixed venous saturation, pulmonary artery pressures, and the shunt fraction. Static pulmonary compliance and oxygen saturation are also followed. At high levels of PEEP, intrathoracic pressure increases to a point that **venous return is impaired.** Thus, left ventricular end-diastolic volume decreases along with cardiac output. This point defines the maximum level of PEEP and may vary considerably from patient to patient or for the same patient over time.

PEEP Side Effects

- Falsely elevated PAOP (PCWP)
- · Decreased cardiac output
- Barotrauma (pneumothorax, alveolar rupture, pneumomediastinum)

Ventilator Weaning: Prior to the successful weaning of a patient from the ventilator, assess the patient's pulmonary mechanics and oxygenation. Additionally, the major problem that required the patient be placed on mechanical ventilation must have been corrected.

Pulmonary Mechanics. These provide useful information regarding a patient's ability to perform the work of respiration. Routine pulmonary mechanics consist of:

- · Vital capacity
- · Tidal volume
- · Spontaneous respiratory rate
- Lung compliance
- · Inspiratory force

Inspiratory Force. The maximum negative pressure that can be exerted against a completely closed airway. A function of respiratory muscle strength. An inspiratory force

between 0 and -25 would indicate that the patient is incapable of generating adequate inspiratory effort to allow extubation.

 $\label{lem:criteria} \emph{Criteria for Weaning}. These are based on the assessment of pulmonary mechanics and of oxygenation (Table 20–8).$

Checklist for Weaning

- Correction of primary problem (eg, pneumonia has been treated, hemodynamic stability)
- · Level of consciousness stable or improving
- · Stable vital signs
- Respiratory rate <30
- · Blood gases in the vicinity of:

Sao₂ >90% Pao₂ >70 mm Hg Pco₂ <55 mm Hg pH >7.35

- Vital capacity >15 mL/kg
- Tidal volume in adults (50-70 kg) >400 mL
- Inspiratory force > -30 cm H₂O

Weaning Modes. Modern respirators are designed to facilitate weaning. Once the preceding criteria have been met, a ventilator mode appropriate to the clinical situation, such as SIMV or PSV, is usually selected. SIMV and PSV are considered weaning modes because the patient is allowed to assume more of the workload of breathing as mechanical support is withdrawn.

Extubation Trials. Once weaning has achieved minimal ventilatory settings, various trials off mechanical support (while still intubated) may be attempted. **CPAP trials** with 5 cm of positive pressure is the most commonly used. For example, a 5-cm CPAP trial with

TABLE 20–8
Criteria for Weaning from Mechanical Ventilation

Parameter	Value
Pulmonary mechanics	
Vital capacity	>10-15 mL/kg
Resting minute ventilation (tidal volume × rate)	<10 L/min
Spontaneous respiratory rate	<30 breaths/min
Lung compliance	>100 mL/cm H20
Negative inspiratory forces (NIF)	> -25 cm H_2O
Oxygenation	
Á-a gradient	<300-500 mm Hg
Shunt fraction	<15%
Po ₂ (on 40% Fio ₂)	>70 mm Hg
Pco ₂	<45 mm Hg

an Fio₂ at 21% (room air) or 40% should result in a Pao₂ of >50 mm Hg or 70 mm Hg, respectively. **T-piece trials**, which provide only humidified air with no pressure, are also occasionally used, but may be unnecessarily stressful to the patient. CPAP is thought to be more physiologic because positive pressure partially counterbalances the added resistance encountered by breathing through a long, narrow ET tube. These trials may vary in duration from 30 min to several hours and are used primarily as the last test prior to extubation. Patients without COPD are usually capable of going from IMV-4, Fio₂ 30%, and PEEP of 5 cm $\rm H_2O$ to an extubation trial. The ventilator remains at the bedside in case respiratory support needs to be restarted.

Order of Weaning. The following steps are taken routinely:

- Sequentially reduce Fio₂ by 10% until an Fio₂ of 50% is tolerated. Use pulse oximetry (Sao₂) to assist in weaning because it reduces the number of ABGs needed. Fio₂ can be decreased as long as Sao₂ >90–92% or Pao₂ >70 mm Hg.
- Sequentially reduce the IMV rate to a level of 4 breaths per minute. Add pressure support to maintain adequate minute volume. ABGs as well as capnography are used to monitor for hypercarbia.
- 3. Sequentially reduce PEEP in 2- to 3-cm H₂O increments while maintaining Sao₂ >90%, until a level of 5 cm H₂O is achieved. Follow Fio₂. If a PA catheter is present, mixed venous saturation information will allow for calculation of the shunt equation. Qs/Qt should be kept below 0.25.
- 4. Sequentially reduce pressure support by 2- to 3-cm H₂O increments, maintaining minute volume until a pressure support of 5 cm H₂O is met. Monitor respiratory rate, work of breathing, and Pco₂.

Essential Tips in Ventilator Management

- · Avoid changing more than one ventilator parameter at a time.
- A Po₂ <60 or an Sao₂ <90% requires a return to previous levels of respiratory support.
- A Po₂ of 60–70 or an Sao₂ of 90% requires a hold at the current level of respiratory support.
- A Po₂ >70 or an Sao₂ ≥92% allows for progression of weaning.

Extubation: A patient who is able to maintain a $Po_2 > 70$, a $Pco_2 < 45$, and a respiratory rate <25 for 1–2 h on a T piece or CPAP trial is ready for extubation.

- Disconnect the ET tube from the ventilator or T piece.
- 2. Suction the patient's endotracheal tube and oral pharynx.
- 3. Deflate the endotracheal balloon.
- 4. Have the patient take a deep breath.
- 5. As the patient expires forcefully, remove the tube and clean any secretions.
- 6. Apply nasal cannula at 2-4 L/min.
- 7. Check postextubation blood gases.

SPECIFIC PROBLEMS IN CRITICALLY ILL PATIENTS

Adult Respiratory Distress Syndrome

ARDS, also called "wet lung" or "shock lung," is respiratory failure associated with acute pulmonary injury manifested by marked respiratory distress and hypoxia. Pulmonary capillary membranes become more permeable, resulting in pulmonary edema in the setting of low to normal pulmonary artery pressures.

Clinical Criteria for the Diagnosis of ARDS

- Pao₂: Fio₂ ratio of < 200
- Recent diffuse bilateral panlobar infiltrates on chest x-ray
- Pulmonary wedge pressure (PAOP) <18
- · Lack of an alternative clinical explanation for pulmonary findings

Etiology

The cause of ARDS is multifactorial. There are three primary mechanisms of injury:

- Increased pulmonary vascular resistance. Neurogenic pulmonary edema is caused
 by a dramatic increase in pulmonary capillary hydrostatic pressure. This increase
 forces fluid across the capillary membrane and results in interstitial and then alveolar
 edema.
- 2. Permeability edema. Circulating toxic substances within the bloodstream can cause the pulmonary capillary membrane to become leaky and allow extravasation of protein into the interstitial space. This extravasation increases the interstitial hydrostatic pressure and eventually results in injury to the alveolar membrane. At this point, fluid and protein migrate into the alveolar space and directly impede oxygen exchange. Several factors have been implicated as mediators to this increased capillary—alveolar permeability, including prostaglandins and oxygen radicals. Sepsis is often the primary cause.
- Injury to the alveolar membrane. Conditions directly toxic to the alveolar membrane include
 - · Smoke inhalation
 - High doses of oxygen (>60% Fio₂)
 - Aspiration

Treatment

Primary efforts are directed at treating the underlying condition while providing sufficient pulmonary support. Currently, no specific therapy is available for ARDS.

- 1. Aggressive ventilatory support. Use PEEP to maintain the Fio₂ <0.6 while maintaining a Po₂ >70 mm Hg. Use the Pao₂, volume status, and level of PEEP to guide ventilatory management. Although some may advocate increased levels of PEEP to minimize intrapulmonary shunting (Qs/Qt) without regard to Pao₂, doing so may necessitate increased intravascular volume and inotropic support of the heart. Many clinicians recommend using Pao₂ as a guide to increasing PEEP, rather than following the shunt fraction specifically.
- Aggressive fluid administration. Maintain cardiac output and peripheral perfusion.
 The use of colloid versus crystalloid remains controversial. Many clinicians recommend the use of crystalloid (NS, lactated Ringer's) and blood to maintain the hematocrit above 30–35%.
- 3. Aggressive monitoring. Use a PA catheter to guide fluid administration (by following filling pressures), and observe the effect of added PEEP on cardiac output. Inotropic agents may be indicated if cardiac output remains low despite adequate filling pressures. Use an arterial line to obtain arterial blood for frequent ABG determinations.
- 4. Pulmonary toilet. To manage secretions
- 5. Chest x-rays. To monitor lung status
- **6.** Watch for associated DIC (see page 434).
- 7. Steroids are not indicated in the treatment of ARDS.

Clinical Correlations

ARDS should be anticipated in the following clinical situations:

- · Severe head injury
- · Severe trauma with prolonged hypotension
- · Massive fluid resuscitation
- · Sepsis
- · Necrotizing pancreatitis
- · Burn of the respiratory tract or aspiration
- · Severe chest contusion

Shock

(See also Algorithm, Chapter 21, page 460.)

Shock is inadequate tissue perfusion, and is a syndrome with several possible causes. All four of these have in common a resultant poor perfusion of tissues that leads to tissue injury and death if untreated. The most common classification is based on etiology and includes hypovolemic, cardiogenic, septic, and neurogenic types. Treatment of shock is always directed at treatment of the underlying problem, maximizing cardiac performance to restore tissue perfusion, and maintaining essential physiologic support to keep oxygenation and renal function as normal as possible.

Hypovolemic Shock: Caused by inadequate circulating blood volume

Physiology. Low cardiac output, low wedge pressure, elevated peripheral vascular resistance as a result of reflex vasoconstriction

Therapy

- 1. Correct source of blood loss (hemorrhage).
- Replete intravascular volume with packed cells, isotonic crystalloid fluids (normal saline, lactated Ringer's), or colloid.

Cardiogenic Shock: Caused by primary "pump" failure

Physiology. Low cardiac output, high wedge pressure resulting from fluid accumulation in the pulmonary capillary bed, elevated peripheral vascular resistance

Therapy. Directed at improving cardiac performance

- 1. Optimize filling pressures (preload).
- 2. Decrease afterload (vasodilation with nitroglycerin, nitroprusside, etc).
- 3. Improve contractility (dobutamine).

Septic Shock: Decreased peripheral (systemic) resistance as a result of massive infection

Physiology. High cardiac output (until late stages), low wedge pressure, low peripheral vascular resistance

Therapy

- 1. Treat the cause of sepsis (parenteral antibiotics, drainage of abscess).
- 2. Administer fluids to increase filling pressures.
- 3. Increase vascular resistance (pressors such as dopamine).
- **4.** Provide inotropic support of the heart as needed.

Neurogenic Shock: Caused by loss of sympathetic vascular tone (eg, cord injury)

Physiology. Low cardiac output, low wedge pressure, low peripheral vascular resistance Therapy. Optimize filling pressures, increase peripheral vascular resistance (norepinephrine, phenylephrine).

Acute Renal Failure

Many patients in the ICU are unable to receive oral nutrition or fluid. Therefore, particular attention must be paid to fluid and electrolyte requirements in the critically ill patient. The following data provide useful information:

- Urine output. One of the best and simplest parameters for following fluid balance.
- Daily weight. Because daily changes in weight are mostly the result of loss or gain
 of fluid.
- Pulmonary artery catheter data. In a critically ill patient in whom the fluid status is not discernible, a PA catheter can be placed to determine intravascular fluid status.

Oliguria and Progressive Azotemia: These conditions are the final result of a number of pathologic processes that constitute acute renal failure. Once recognized, the primary goal of the clinician is to identify the cause and treat the underlying condition. To simplify the multitude of causes, renal failure is usually divided into prerenal, renal, and postrenal causes. These are outlined in Chapter 6.

Acute tubular necrosis. (eg. Nephrotoxic medications, ischemia), intravascular volume depletion, and congestive heart failure are the most common causes of renal failure in the ICU patient.

The following outline describes the general approach to the problem of oliguria or anuria in an ICU patient.

Physical Examination

- Vital signs. Hypotension with or without associated tachycardia can be a sign of hypovolemia, indicating prerenal causes of oliguria. Orthostatic blood changes also point to hypovolemia.
- 2. Mucous membranes. Dry mucous membranes indicate overall fluid depletion.
- Lungs. Fluid overload often manifests itself as pulmonary edema, often heard when auscultating the chest.
- 4. Abdomen. Low urine output may result from postrenal obstruction, which may be manifest as bladder distention, palpable on examination. Bladder palpation may cause pain, also indicating distention. A distended abdomen may indicate ileus with associated fluid sequestration in the bowel.
- 5. Extremities. Fluid overload may be evident as peripheral edema.

Diagnostic Studies

- 1. Laboratory results
- Bladder catheterization. If a catheter is in place, irrigate it gently to confirm proper drainage.
- Radiographic. Renal ultrasonography helps evaluate for possible postrenal obstruction. Avoid intravenous contrast studies if possible.

Therapeutic trials. These can be used as an adjunct to differentiate prerenal from renal azotemia. After obstruction has been ruled out, failure to respond to these measures with increased urine flow most likely indicates an intrinsic renal cause of azotemia. Furosemide has little effect in ATN.

- Fluid challenge (1000 mL of NS infusion, rapid)
- Furosemide 80 mg IV push
- · Mannitol 25 g IV
- · Dopamine infusion

Management. As a general approach, daily intake and output should be closely reviewed, and daily weights are very useful. Follow electrolytes, particularly potassium, closely. Many clinicians remove potassium from the IV fluids immediately in cases of renal failure to prevent accumulation of deadly potassium levels.

Prerenal

- 1. Optimize hemodynamic status to maximize cardiac output and, hence, renal perfusion.
- 2. Replete fluids. Use blood in anemic patients; otherwise, use isotonic fluid or albumin.
- Once you are sure that fluid status is optimal and urine output is still suboptimal, use low-dose dopamine (2-5 mg/kg/min) to dilate the renal vessels. A PA catheter is usually needed to monitor the patient at this point.

Renal

- 1. Optimize fluid status, keeping cardiac filling pressures in the normal range.
- 2. Try furosemide (20–40 μg) once fluid status is optimal.
- **3.** If there is no response to furosemide, try mannitol 12.5–25 g IV.
- **4.** Metolazone can be given if there is still no response (5–10 mg PO).
- 5. If the patient is fluid-overloaded, use furosemide in increasing doses to diurese fluid.
- 6. Restrict fluids, salt, and particularly potassium.
- 7. Treat the usual metabolic acidosis with sodium bicarbonate.
- 8. Dialysis may be necessary.

Postrenal

- 1. Check the Foley catheter for patency, replacing it immediately if there is any question.
- Obtain a urologic consultation. Prostatic obstruction in men can be easily corrected with a Foley catheter. Decompression of the upper urinary tracts may require stents or percutaneous drainage.

Stress Ulceration

The development of stress ulceration in the ICU patient is a serious complication. Most importantly, it is a largely preventable problem. It is common in neurosurgical (Cushing's ulcers) and burn (Curling's ulcers) patients. The pathophysiology is related to diminished blood flow to the viscera in stress situations, leading to alterations in the mucosal barrier to the effects of gastric acid.

Prophylaxis

- Routine cardiovascular support of perfusion
- Routine use of H₂ blockers (Pepcid, etc)
- Antacid administration (eg, Maalox 30 mL per NG tube q2h). In patients with renal failure, use aluminum hydroxide, avoid magnesium-containing antacids
- · Enteral feedings, when tolerated, remain a good method to neutralize gastric acid.

Treatment of Ulceration

- 1. Early endoscopy is indicated in upper GI bleeding.
- A clearly visible lesion (bleeding vessel) warrants operative intervention, but diffuse gastritis is best treated initially with aggressive antacid and H₂ blocker therapy. Persistent bleeding from gastritis may warrant total gastrectomy.

Acalculous Cholecystitis

Cholecystitis in the absence of stones is not uncommon in the ICU patient, and is probably related to diminished blood flow in the critically ill patient, although the exact pathophysiology remains unclear. First and foremost in the treatment of this potentially fatal condition is to remain vigilant for its development in the critically ill patient. Presenting signs are similar to those in healthy patients with cholecystitis and include right upper quadrant pain, fever, leukocytosis, and elevated liver chemistries (especially bilirubin or alkaline phosphatase). The most valuable test is an HIDA scan. Nonvisualization of the gallbladder is clear evidence of cholecystitis. Treatment is surgical (cholecystectomy), and should be done as early as possible to avoid perforation.

Nutrition

The nutritional needs of the critically ill patient are of major significance in overall patient care. Restoring the patient to an anabolic state will hasten recovery. The details of TPN, or hyperalimentation, as well as enteral feedings are covered in Chapters 11 and 12. Remember the following two rules:

- The "5-day" rule applies to most patients. If you do not think the critically ill patient
 can take nutrition for 5 days because of postoperative ileus, intubation, etc, be sure to
 start nutritional support by the fifth day.
- 2. "If the gut works, use it." That is, do not use parenteral nutrition if the GI tract is functioning. Enteral nutrition (eg, oral, NG tube, jejunostomy tube) should be used in all patients with a functioning intestinal tract. The enteral feeding is reviewed in Chapter 11.

Disseminated Intravascular Coagulation

DIC is a complex management problem that often presents in the critically ill patient. This clinical syndrome may accompany a number of disease states, including shock syndromes, sepsis, malignancy, and some obstetric conditions. As with many of the pathologic conditions that accompany major illness (eg, ARDS), the successful treatment of DIC depends on treating the underlying condition.

Diagnosis: The diagnosis of DIC is usually contemplated in the critically ill patient who develops thrombocytopenia, and occasionally an elevated PT. The following list details other laboratory findings that are caused by the effect of plasmin on fibrinogen. They result in increased levels of fibrin monomers and feedback stimulation of the fibrinolytic system, yielding fibrin degradation products and increased plasmin formation.

- · Low fibrinogen level
- · Elevated FSP level
- Elevated PTT
- · Microangiopathic RBC morphology

Treatment: The treatment of this disease is controversial.

- 1. The most important element of therapy is to identify and treat the underlying cause.
- 2. Treat associated shock appropriately to maintain cardiovascular stability.
- If there is evidence of thrombosis (eg, PE), begin heparin therapy with a loading dose of 100 U/kg followed by a drip at 10–15 U/kg/h (see Chapter 22).
- 4. Administer FFP to replenish fibrinogen.

5. If the patient is bleeding severely, despite replacement therapy with FFP and platelets, begin antifibrinolytic therapy with epsilon-aminocaproic acid (Amicar). Use a loading dose of 4 g, followed by 1 g/h, for a total of 12 g. In general, if there is no improvement after 12 h, therapy should be stopped.

Line Sepsis

Indwelling catheters not only provide a convenient means of infusing fluids and medications, but also act as a portal of entry for bacteria. With the widespread use of indwelling intravenous catheters (eg, central venous lines), the diagnosis of infection from the catheter itself must be considered when evaluating a febrile patient in the ICU. As a general rule, fever in a person with a central line should be attributed to the line until proven otherwise

The most common mechanism of line sepsis is entry of skin flora along the catheter tract. The use of clear polyurethane dressings left in place for prolonged periods has been associated with increased risk of infection and should be avoided. Some institutions have a policy of routine line changes, over a guidewire, every 3–4 d. Little objective data support this practice; in fact, some evidence suggests that this practice is associated with an increased rate of complications. Prevention of line sepsis is best accomplished by meticulous aseptic technique during placement and meticulous care of the line once in place.

Treatment: A presumed episode of line sepsis is treated by determining whether the line is actually responsible. Erythema at the entry site may suggest the cause. Short-term central venous catheters that may be infected are best treated by removing the line. The catheter may be changed over a guidewire, but some centers do not advocate this practice. Cultures of the intracutaneous segment are essential.

In the absence of florid sepsis, or if placement of a new line would jeopardize the ability to obtain vascular access, then quantitative cultures of blood from a peripheral site and the line may be obtained and treatment may be based on the results of these cultures, once available. Empiric antimicrobial therapy may be started in the interim. Using isolator tubes (Dupont), colony counts are performed 16–18 h after obtaining the culture. If the colony count from the catheter is equal to or greater than five times the count from the peripheral culture, the result is interpreted as probable catheter infection.

Pulmonary Embolism

PE is a major cause of death in the United States (approximately 150,000 deaths annually) and the world. Deep venous thrombosis is known to be responsible for a majority of PE in hospitalized patients. It is estimated that about 90% of all PE originate in the femoral–iliac–pelvic veins. DVT is caused by the classical causes of thromboses: vessel injury, hypercoagulability, or stasis.

Prevention of DVT: Prevention is especially important in "high-risk" patients (those with malignancy, obesity, previous history, age >40 years, extensive abdominal/pelvic surgery, immobilization). For patients undergoing surgery, prevention should be initiated in the operating room. Intermittent compression stockings and the selected use of heparin have greatly reduced the incidence of DVT in the postoperative patient. Remember that prophylaxis against DVT is effective **only when started preoperatively** for those patients undergoing surgery.

Physical Methods. These include leg elevation, intermittent compression devices, early postoperative ambulation.

Pharmacologic Methods

- Heparin 5000 U SQ q12h. Check the platelet count (eg, every 3 days) because of risk of thrombocytopenia.
- · Coumadin for chronic therapy
- Enoxaparin is now the drug of choice in many institutions for high-risk patients, despite the high cost of therapy.

Diagnosis of Pulmonary Embolus

- · Maintain a high index of suspicion.
- Signs and symptoms. None is diagnostic, but may include dyspnea, tachypnea, tachycardia, chest pain (usually pleuritic), Po₂ <80 (compare with baseline).
- Routine chest x-ray may show localized volume loss or Hampton's hump due to pulmonary infarction.
- Nuclear V/Q scan. A normal scan effectively rules out PE, and a positive scan is sufficient evidence to treat the patient. An indeterminate scan in a symptomatic patient with a high index of suspicion necessitates angiography.
- · Spiral CT scan. This scan is helpful in identifying proximal pulmonary emboli.
- · Pulmonary angiogram. The "gold standard."

Treatment

- Support oxygenation. Monitor ABGs, and support as indicated. Intubation may be necessary.
- Use intravenous heparin. Prevents clot propagation, decreases inflammation, and allows intrinsic fibrinolysis to lyse the clot.
 - a. Bolus with 80–100 U/kg and start an intravenous drip at 10–15 U/kg/h. Adjust the drip to keep the PTT at 2–2.5 × control values. The half-life of heparin is 1.5 h, so check the PTT at 3–6 h after adjusting the rate of heparin administration.
 - b. Monitor the platelet count because some patients can manifest "heparin-induced thrombocytopenia."
 - Start oral warfarin (Coumadin) by day 7 of heparin therapy, to maintain a therapeutic ratio. (See Chapter 22, page 637.
 - In cases of massive embolus, thrombolytic therapy (streptokinase) can be used in the absence of contraindications.
 - Open embolectomy, using cardiopulmonary bypass, has been effective in some cases of massive PE.
- In patients who cannot undergo systemic anticoagulation (those with recent surgery, stroke, GI bleeding, etc) or patients with recurrent emboli despite adequate therapy, vena caval interruption may be indicated using an intracaval filter or a caval clip (placed transabdominally).

QUICK REFERENCE TO CRITICAL CARE/ICU FORMULAS

See Table 20-9

GUIDELINES FOR ADULT CRITICAL CARE DRUG INFUSIONS

See Table 20-10

TABLE 20-9
Quick Reference to Common ICU Equations

Derivation	Normal
Measured	2–10 mm Hg
Measured	15-30/0-5 mm Hg
Measured	15-30/8-15 mm Hg
	5–11 mm Hg
	3.5–5.5 L/min
	2.8–4.2 L/min/m ²
$\frac{DBP \times (\underline{SBP} - \underline{DBP})}{3}$	85–90 mm Hg
$PAD \times (PAS - PAD)$ 3	11-18 mm Hg
$\frac{(MAP - CVP)}{CO} \times 80$	770-1500 dynes/s/cm ⁵
$\frac{(MPAP - PCWP)}{CO} \times 80$	20–120 dynes/s/cm ⁵
$[(713) \times Fio_2 - (Paco_2)] - Pao_2$	Room air 2–22 mmHg 100% Fio ₂ 10–60 mmHg
(Hgb x 1.39) $SaO_2 + (PaO_2 \times 0.0031)$	16-22 mL 0 ₂ /dL blood
(Hgb x 1.39) $SvO_2 + (PvO_2 \times 0.0031)$	12-17 mL 0 ₂ /dL blood
$CaO_2 - CvO_2 = (Hgb \times 1.39) (SaO_2 - SvO_2)$	$3.5-5.5$ mL O_2 /dL blood
$Hgb \times SaO_2 \times CO \times 10$	700–1400 mL/min delivery
	Measured Measured Measured Measured Measured (CO = SV × HR) CO × BSA DBP × (SBP - DBP) 3 PAD × (PAS - PAD) 3 (MAP - CVP) × 80 CO (MPAP - PCWP) × 80 CO [(713) × Fio ₂ - (Pao ₂)] - Pao ₂ (Hgb × 1.39) Sao ₂ + (Pao ₂ × 0.0031) (Hgb × 1.39) Svo ₂ + (Pvo ₂ × 0.0031)

(continued)

TABLE 20-9 (Continued)

Determination	Derivation	Normal
O ₂ consumption Qs/Qt (shunt fraction)	(CaO ₂ – CvO ₂) × CO × 10 (CcO ₂ – CvO ₂) × CO × 10 (CcO ₂ – CvO ₂)	180-280 mL/min 0.05
ICP CPP	Measured MAP – ICP	0–20 mmHg keep >70 mmHg

Abbreviations: RAP = right atrial pressures; CVP = central venous pressure; RVP = right ventricular pressure; PAS = pulmonary artery systolic; PAD = pulmonary artery diastolic; PCWP = pulmonary capillary wedge pressure; CO = cardiac output; CI = cadiac input; MAP = mean arterial pressure; MPAP = mean pulmonary artery pressure; SVR = systemic vascular resistance; PVR = pulmonary vascular resistance; ICP = intracranial pressure; CPP = cerebral perfusion pressure; BSA = body surface area; DBP = diastolic blood pressure; SBP = systolic blood pressure; Fio₂ = inhaled O_2 ; Hgb = hemoglobin; Sao₂ = arterial oxygen, Svo₂ = mixed venous oxygen saturation; Qs = volume of shunted blood (ie, blood shunted past nonventilated alveoli, not participating in gas exchange); Qt = total cardiac output; CCO₂ = O_2 content of alveolar-capillary blood; CVO₂ = mixed venous O_2 content of pulmonary artery blood.

TABLE 20–10
Guidelines for Adult Critical Care Drug Infusions*

Drug	Dilution	(Final Concentration) Flow Rate = mL/h	Usual Dose Range
Amrinone	500 mg	(2 mg/mL)	
(Inocor)	250 mL	1500 μg/min = 45 1000 μg/min = 30	LD = 0.75 μg/kg MD = 5-20 μg/kg/min
	(150 mL PSS+	$750 \mu \text{g/min} = 22.5$	1 0, 0,
	100 mL drug)	$500 \mu g/min = 15$	
	PSS only	350 μg/min = 10.5	
Diltiazem			
(Cardizem)	125 mg 125 mL	(1 mg/mL)	Bolus = 0.25 mg/kg
	125 mL	5 mg/h = 5	over 2 min; may give second bolus 0.35
		10 mg/h = 10	mg/kg 15 min after
			initial bolus
	(100 mL diluent	15 mg/h = 15	
	+25 mL drug)	G .	MD = 5-15 mg/h
	D ₅ W or PSS		-
Dobutamine	500 mg	(2000 μg/ml)	2.5–20 μg/kg/min
(Dobutrex)	250 mL	$1500 \mu g/min = 45$. 5 0

(continued)

TABLE 20-10 Continued

Drug	Dilution	(Final Concentration) Flow Rate = mL/h	Usual Dose Range
Dobutamine (continued)	D₅W or PSS	1250 μ g/min = 37.5 1000 μ g/min = 30 750 μ g/min = 22.5 500 μ g/min = 15 250 μ g/min = 7.5	
Dopamine	$\frac{400 \text{ mg}}{250 \text{ mL}}$ D ₅ W or PSS	(1600 μg/ml) 1400 μg/min = 52.5 1200 μg/min = 45 1000 μg/min = 37.5 800 μg/min = 30 600 μg/min = 22.5 400 μg/min = 15 200 μg/min = 7.5	0.5–2.0 μg/kg/min (renal) 2.0–10 μg/kg/min (inotropic) 10–20 μg/kg/min (vasopressor)
Epinephrine	$\frac{3 \text{ mg}}{250 \text{ mL}}$ D ₅ W or PSS	(12 µg/ml) 4 µg/min = 20 3 µg/min = 15 2 µg/min = 10 1 µg/min = 5	Initially 1 μg/min Titrate to response
Esmolol (Brevibloc)	5000 mg 500 mL D ₅ W or PSS	(10 mg/mL) 5000 μg/min = 30 4000 μg/min = 24 3000 μg/min = 18	LD = 500 µ/kg/min over 1 minute MD = 50 µ/kg/min, titrate to response. Increase by 50 µ/kg/min increments every 5 minutes

TABLE 20-10 (Continued)

Drug	Dilution	(Final Concentration) Flow Rate = mL/h	Usual Dose Range
Isoproterenol (Isuprel)	$\frac{2 \text{ mg}}{500 \text{ mL}}$ D ₅ W or PSS	(8 μg/ml) 10 μg/min = 75 6 μg/min = 45 4 μg/min = 30 2 μg/min = 15 1 μg/min = 7.5	Initially: 1–4 μg/min Titrate up to 20 μg/min
Labetalol (Trandate)	$\begin{array}{c} 200 \text{ mg} \\ \hline 200 \text{ mL} \\ (160 \text{ mL diluent} \\ +40 \text{ mL drug}) \\ \hline \text{D}_{\text{S}} \text{W or PSS} \end{array}$	(1 mg/ml) 2 mg/min = 120	Bolus = 20 mg over 2 min Additional 20–80 mg may be given every 10 min until response or maximum of 300 mg or Initially 2 mg/min Titrate to response
Lidocaine (Xylocaine)	$\frac{2 \text{ g}}{250 \text{ mL}}$ D ₅ W or PSS	(8 mg/mL) 4 mg/min = 30 3 mg/min = 22.5 2 mg/min = 15 1 mg/min = 7.5	LD = 1-1.5 mg/kg over 2 min MD = 1-4 mg/min Maximum 4 mg/min
Nicardipine (Cardene)	25 mg 250 mL	(0.1 mg/mL) 5 mg/h = 50 7.5 mg/h = 75	Initially: 5 mg/h Titrate to BP: increase rate by 2.5 mg/h every 5–15 min

(continued)

TABLE 20-10 (Continued)

Drug	Dilution	(Final Concentration) Flow Rate = mL/h	Usual Dose Range
Nicardipine (continued)	D₅W or PSS	10 mg/h = 100 12.5 mg/h = 125 15 mg/h = 150	Maximum: 15 mg/h MD 3 mg/h
Nitroglycerin (Tridil)	100 mg 250 mL D ₅ W or PSS (glass bottle)	(400 μg/ml) 80 μg/min = 12 60 μg/min = 9 40 μg/min = 6 20 μg/min = 3 10 μg/min = 1.5	Initially 5–10 µg/min Titrate up by 10–20 µg/min every 5 min based on current dose and patient condition
Nitroprusside (Nipride)	100 mg 250 mL D₅W	(400 μg/ml.) 300 μg/min = 45 200 μg/min = 30 150 μg/min = 22.5 100 μg/min = 15 70 μg/min = 10.5 50 μg/min = 7.5	Initially: 0.3–0.5 μg/kg/min Titrate to response every few minutes Maximum: 10 μg/kg/min
Norepinephrine (Levophed)	$\frac{4 \text{ mg}}{250 \text{ mL}}$ D ₅ W or PSS	(16 µg/ml) 12 µg/min = 45 8 µg/min = 30 6 µg/min = 22.5 4 µg/min = 15 2 µg/min = 7.5	Initially: 8–12 μg/min Titrate to response

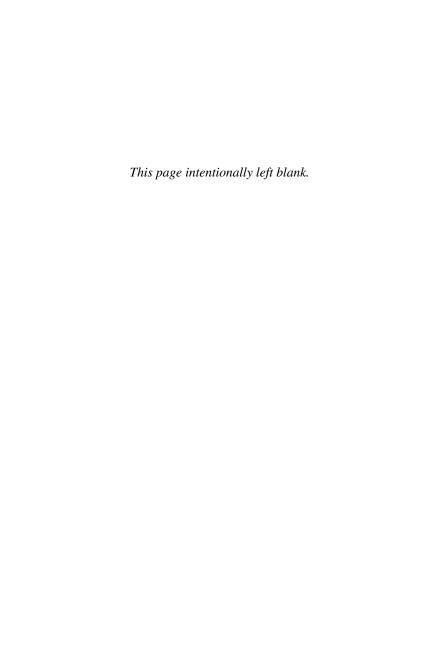
(continued)

TABLE 20-10 (Continued)

Drug	Dilution	(Final Concentration) Flow Rate = mL/h	Usual Dose Range
Phenylephrine (Neo-Synephrine)	50 mg 250 mL	(200 μg/ml.) 100 μg/min = 30 80 μg/min = 24	Initially: 10–50 μg/min
	D₅W or PSS	60 μg/min = 18 50 μg/min = 15	Titrate to response
Procainamide	2 g 250 mL	(8 mg/mL)	LD = 17 mg/kg over 1 h, or 100 mg
(Procan)	250 mL	4 mg/min = 30 3 mg/min = 22.5	every 5 min up to 1 g MD = 1-4 mg/min
	D₅W or PSS	2 mg/min = 15 1 mg/min = 7.5	U
Vasopressin	100 units	(0.4 units/mL)	0.1-0.4 units/min
(Pitressin)	250 mL	0.4 units/min = 60	
	D /// DCC	0.3 units/min = 45	Maximum 0.9 units/min
	D₅W or PSS	0.2 units/min = 30 0.1 units/min = 15	

Abbreviation: LD = loading dose; MD = maintenance dose; BP = blood pressure; PSS = physiologic saline solution; D₅W = dextrose 5% in water *These agents must be administered in the appropriately monitored clinical setting.

Source: Reprinted, with permission, from Thomas Jefferson University Pharmacy and Therapeutic Committee, Philadelphia, PA.



EMERGENCIES

Cardiopulmonary Resuscitation Advanced Cardiac Life Support and Emergency Cardiac Care* Advanced Cardiac Life Support Drugs Electrical Defibrillation and Cardioversion Other Common Emergencies

CARDIOPULMONARY RESUSCITATION

Emergency cardiac care guidelines from the American Heart Association now recommend that health care providers have the following items readily available: gloves, a barrier device or bag mask, and an automated defibrillator to handle cardiac emergencies. In cardiopulmonary resuscitation, remember there are now **two** sets of **ABCDs**:

Primary Survey

- Airway: Assess and manage noninvasively.
- · Breathing: Use positive pressure ventilations.
- · Circulation: Perform chest compressions as needed.
- Defibrillation: Assess for VT/VF and defibrillate using an AED. These are also called PADs and are becoming widely available in public areas such as airports, stadiums, health clubs, and shopping malls.

Secondary Survey: Uses advanced medical techniques

- Airway: Assess and manage with airway device (eg, endotracheal intubation, etc).
- Breathing: Verify tube function and placement, use positive pressure ventilation system through tube.
- · Circulation: Start IV, attach ECG, use rhythm-based ACLS medications.
- Differential Diagnosis: Search for, find, and treat problems according to AHA algorithms presented in this chapter.

Adult CPR

(Victim's age ≥8 y)

One Rescuer

- Determine unresponsiveness (shake and shout). If the patient is unresponsive, call for help (activate EMS system, eg, call "code," dial 911). In trauma situation do not move
- * The section on basis CPR and ACLS are based on guidelines from the American Heart Association and the International Liaison Committee on Resuscitation [Circulation 2000;102 (Sup 1)] and the Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care by the American Heart Association in Collaboration with the International Liaison Committee on Resuscitation (ILCOR).

- the victim unless in immediate danger. Roll victim on to back as a unit if lying face down. Protect the neck.
- 2. Kneel at the level of the victim's shoulder. Open the airway (head-tilt, chin-lift,), determine breathlessness ("look [chest movement], listen [for air escaping], feel [for air movement]") for no more than 10 s. In the unresponsive victim with spontaneous respiration, place the victim in the recovery position. Jaw thrust maneuver recommended as alternative for health care providers especially if neck injury is suspected. If the victim is breathing, place in the RECOVERY POSITION (see page 449).
- 3. If not breathing, give patient two slow ventilations (2 s/inspiration) while maintaining airway. Use pocket mask or bag mask. Volume should be between 0.8–1.2 L. A barrier device (face shield or mask with one-way valve) is recommended if mouth-to-mouth or mouth-to-nose contact is necessary. Ventilate 10–12 breaths/min. If unable to ventilate, reposition head and try again. If unsuccessful, perform the FOREIGN BODY OBSTRUCTION AIRWAY SEQUENCE (see page 448).
- **4.** Check for circulation (breathing, coughing, movement). Palpate the carotid artery no more than 10 s to determine lack of a pulse. If pulse is present, perform rescue breathing: 1 ventilation every 5 s (10–12 ventilation/min).
- 5. If no pulse, use four cycles of 15 compressions and two ventilations (compression rate 100/min, two ventilations 1.5–2 s each). Depth of compression 1.5–2 in. or slightly greater to generate carotid pulse. Apply compressions to lower half of sternum using the heels of both hands placed on top of each other.
- After the four cycles (approximately 1 min of CPR), pause and check for return pulse and spontaneous respirations.
- If no pulse or respiration, resume cycles with two ventilations, then compressions, as noted earlier.
- 8. Incorporate appropriate ACLS management guidelines.

Two-Rescuer Adult CPR For laypersons

- Second rescuer identifies him or herself. Verify that EMS has been notified. If so, second rescuer gets into position opposite first rescuer. If EMS not notified, the second rescuer does so before assisting first rescuer.
- 2. First rescuer continues CPR.
- If and when first rescuer tires, second rescuer takes over one-person CPR as described in the preceding section.

For health care professionals

- Sequence to continue from one-rescuer CPR as mentioned in previous section. Second rescuer identifies him or herself and gets into position for compressions.
- 2. First rescuer completes compression and ventilation cycle (15 compression and two ventilations)
- First rescuer then checks for spontaneous pulse and breathing, states: "No pulse...continue CPR." then ventilate once (1.5–2 s).
- 4. Second rescuer resumes compressions at same rate of 80–100/min.("1 & 2 & 3 & 4 & 5 & pause," ventilate) Ratio of five compressions to one breath. If airway is protected, do not pause for ventilations.
- 5. When ready to switch, rescuer doing compressions says "switch & 2 & 3 & 4 & 5 &."
- **6.** Both rescuers change position simultaneously immediately after ventilation.
- 7. Rescuer who will perform ventilations opens airway and performs a 5-s pulse check.
- 8. If no pulse, give ventilation. Rescuer states "No pulse...continue CPR."

In patient with unprotected airway, cricoid pressure may be applied (Sellick's maneuver) by a third rescuer (if health care professional) to help limit gastric distention.

Child CPR

(Victim's age 1-8 y)

- Determine unresponsiveness, and shout for help. Activate EMS system (call code or 911).
- Open airway (head-tilt, chin-lift; jaw thrust if neck trauma is suspected), determine breathlessness (follow "look, listen, feel" rubric as for adult). If victim is breathing, place in RECOVERY POSITION (see page 449).
- 3. If victim not breathing, give two ventilations (1–1.5 s). If unable to ventilate, perform the **FOREIGN BODY OBSTRUCTED AIRWAY SEQUENCE** (see page 448).
- 4. Check for circulation (breathing, coughing, movement). Palpate the carotid artery for no more than 10 s to determine presence of a pulse. If pulse is present, perform rescue breathing using pocket mask or bag-mask device (20 breaths/min).
- 5. If no pulse, or if pulse is <60 bpm and perfusion is poor, begin cardiac compressions at five compressions to one ventilation at rate of 100/min. Depth of compressions less than for an adult (1–1.5 in. or one third to one half the depth of chest). Use the heel of one hand at the lower half of the sternum. Pause compressions for ventilations until patient is intubated.</p>
- Check for return of pulse and spontaneous breathing after 20 cycles (approximately 1 min).
- 7. Resume cycles with one ventilation (1-1.5 s each), then resume compressions.

Infant CPR

(Victim's age, ≤1 y)

- 1. Determine unresponsiveness, and shout for help. Activate EMS system (call code or 911).
- Open airway (head-tilt, chin-lift). Do not hyperextend head; however, create adequate head-tilt to accomplish chest rise with breath. If neck trauma suspected, use jaw thrust. If victim is breathing, place in the RECOVERY POSITION (see page 449).
- If patient is not breathing, give two ventilations (1-1.5 s) using pocket mask or bagmask device. If unable to ventilate, perform the FOREIGN BODY OBSTRUCTED AIRWAY SEQUENCE using back blows and chest thrusts as noted on page 448.
- 4. Check for circulation (breathing, coughing, movement). Palpate the femoral or brachial artery for no more than 10 s to determine presence of a pulse. If pulse is present, continue rescue breathing (20 breaths/min).
- 5. If no pulse or if pulse is <60 bpm and perfusion is poor, begin cardiac compressions. Draw an imaginary line between the nipples and identify where this line crosses the sternum (intermammary line). The site of compression is one finger breadth below this intersection. Use a compression depth of ½-1 in., using the middle and ring fingers. Use five compressions to one ventilation (rate of compression is 100/min or 120 min for newborns).</p>
- Use the mnemonic: ("1 & 2 & 3 & 4 & 5 & pause, head-tilt, chin-lift, ventilatecontinue compressions"). When patient is intubated, no need to pause.
- 7. Check for return of pulse and spontaneous breathing after 20 cycles (1 min).

Neonatal CPR

- 1. The newborn should be dried, placed head down, gently suctioned and stimulated.
- Supplemental oxygen is useful. If baby is not breathing, ventilate 40–60 breaths/min with gentle puff of air or with bag mask.

- 3. Check apical pulse. If absent or if <60 bpm and perfusion is poor, compress at a rate of 120/min. Wrap your hands around infant's chest and compress ½2-¾ in. with thumbs side by side at the midsternum.</p>
- The compression/ventilation ratio is 3:1 for intubated newborn with two rescuers. Discontinue compressions when rate reaches 80 bpm or greater.

Foreign Body Obstructed Airway Sequence

Adult (≥ 8) and Child (1–8 y)

- A. Conscious victim can cough, speak, breath. Do not interfere and reassure patient. Stand by and allow patient to clear partial obstruction.
- B. Conscious victim cannot cough, speak, breath.
 - Ask "Are you choking" or "Can you speak?" Observe for "universal distress signal" for choking (hands clutched at neck).
 - Give abdominal thrusts/Heimlich maneuver. Stand behind victim. Using arms wrapped around victim, place thumb side of fist above umbilicus but below xiphoid. Give up to five subdiaphragmatic thrusts (Heimlich maneuver).
 - Reassess victim's status, repeat Heimlich maneuvers as needed. If not improved by 1 min, activate EMS.

C. Victim becomes unconscious.

- Place in supine (face up) position. Activate EMS or if second rescuer becomes available have that person activate EMS.
- Open airway with tongue-jaw lift; finger sweep to clear airway, open airway (head-tilt, chin-lift).
- 3. Give five abdominal thrusts/Heimlich maneuver astride victim.

D. Victim found unconscious: Cause unknown

- 1. Determine unresponsiveness, call for help (activate EMS).
- 2. Open airway (head-tilt, chin-lift), determine breathlessness (look, listen, feel).
- 3. Attempt to ventilate. If unsuccessful, reposition head and reattempt.
- 4. If unsuccessful:
 - a. Perform up to five Heimlich maneuvers astride victim.
 - **b.** Open mouth (tongue-jaw lift); finger sweep; open airway (head-tilt, chin-lift)
- Attempt to ventilate, if unsuccessful, repeat sequence until ventilations are effective.

Infant

(Victim's age, <1 y)

Victim conscious

- 1. Verify airway obstruction (ineffective cough, no strong cry).
- Hold child with head lower than body, give five back blows or five gentle abdominal thrusts. Repeat until victim becomes responsive.

Victim becomes unconscious

- 1. If second rescuer is available, have that person activate EMS.
- Open airway with tongue-jaw lift, remove foreign body if visualized. Attempt to ventilate.
- If still obstructed, reposition head and attempt to ventilate. Give five back blows and five abdominal thrusts. Repeat step 2 until ventilation is effective.
- 4. If obstruction still not relieved after 1 min, activate EMS system.

Recovery Position

Place an unconscious person who is still breathing and who has not suffered a traumatic neck injury in this position.

- 1. Kneel alongside the victim and straighten the legs.
- Place victim's arm that is closest to you in the "waving goodbye" position and place the other arm across the victim's chest.
- Grasp the far side leg above the knee and pull the thigh up toward the body. With the other hand, grasp the shoulder on the same side as the thigh.
- 4. Gently roll the patient toward you. Adjust the leg you are holding until both the thigh and knee are at right angles to the body. Tilt the patient's head back and use the patient's uppermost hand to support the head and maintain a head-tilt position.
- 5. Continue to monitor for breathing, and call for EMS.
- 6. If patient stops breathing, roll on back and follow basic CPR guidelines.

ADVANCED CARDIAC LIFE SUPPORT AND EMERGENCY CARDIAC CARE

ACLS includes the use of advanced airway management (See Endotracheal Intubation, Chapter 13, page 268), defibrillation, and drugs along with basic CPR. Most cardiac arrests are due to VF and are unwitnessed outside the hospital setting. ACLS protocols incorporating all these emergency cardiac care techniques are reviewed in the following algorithms for adults:

- Universal/International ACLS algorithm (Figure 21-1)
- Comprehensive emergency cardiac care algorithm (Figure 21–2)
- Ventricular fibrillation and pulseless VT algorithm (Figure 21–3)
- Pulseless electrical activity algorithm (Figure 21–4)
- Asystole: The silent heart algorithm (Figure 21–5)
- Bradycardia algorithm (Figure 21-6)
- · Tachycardia overview algorithm (Figure 21-7)
- Narrow complex SVT algorithm (Figure 21–8)
- Stable VT algorithm (Figure 21–9)
- Acute coronary syndromes algorithm (Figure 21–10)
- Acute pulmonary edema, hypotension, and shock (Figure 21–11)

Advanced Cardiac Life Support Drugs

The most commonly used agents are listed on the inside covers for quick reference.

ACE Inhibitors

INDICATIONS: These agents improve the outcome in post-MI patients.

Enalapril (Enalaprilat IV)

SUPPLIED: Tabs 2.5, 5, 10, 20 mg; IV 1.25 mg/mL (1- and 2-mL vial)

DOSAGE: .2.5 mg PO single dose, increase to 20 mg PO bid; 1.25 mg IV over 5 min, then 1.25–5.0 mg IV q6h

Captopril

SUPPLIED: Caps 12.5, 25, 50, 100 mg

DOSAGE: 6.25 mg PO, increase to 25 mg tid and the 50 mg PO tid as tolerated

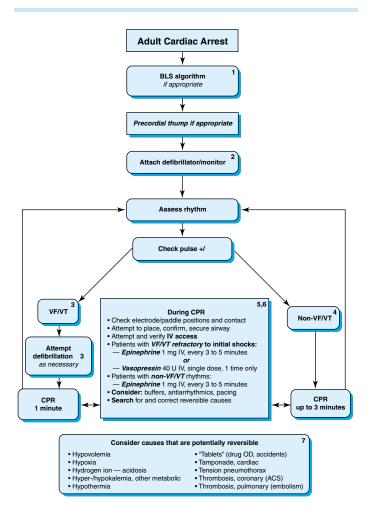


FIGURE 21–1 Universal/international advanced cardiac life support algorithm. Abbreviations: VF = ventricular fibrillation; VT = ventricular tachycardia; BLS = basic life support. (Reproduced, with permission, from: *Circulation* 2000;**102** supplement 1, part 6.)

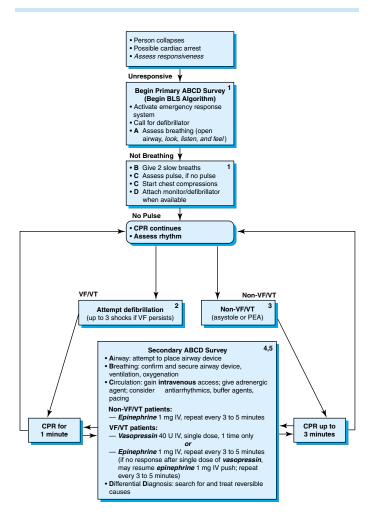


FIGURE 21-2 Comprehensive emergency cardiac care (ECC) algorithm. Abbreviations: VF = ventricular fibrillation; VT = ventricular tachycardia; BLS = basic life support; PEA = pulseless electrical activity. (Reproduced, with permission, from: Circulation 2000; 102 supplement 1, part 6.)

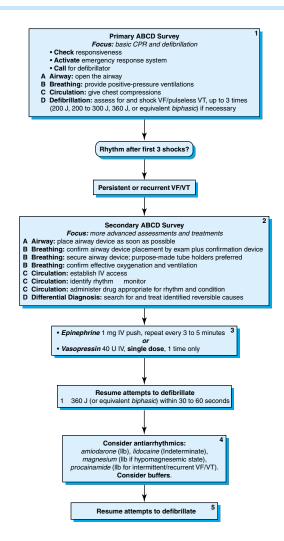


FIGURE 21–3 Ventricular fibrillation and pulseless ventricular tachycardia algorithm. *Abbreviations:* VF = ventricular fibrillation; VT = ventricular tachycardia. (Reproduced, with permission, from: *Circulation* 2000;**102** supplement 1, part 6.)

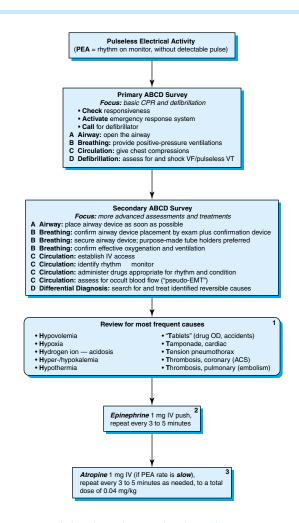


FIGURE 21-4 Pulseless electrical activity algorithm. *Abbreviations*: VF = ventricular fibrillation; VT = ventricular tachycardia; EMT = emergency medical treatment; ACS = acute coronary syndrome; PEA = pulseless electrical activity. (Reproduced, with permission, from: *Circulation* 2000; **102** supplement 1, part 6.)

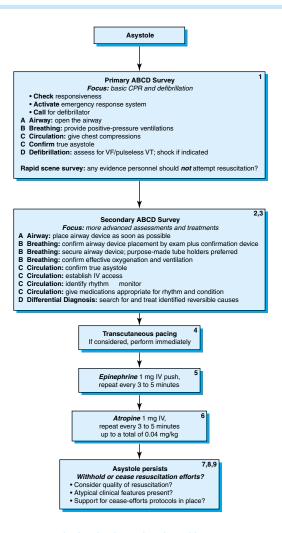


FIGURE 21-5 Asystole: the silent heart algorithm. *Abbreviations:* VF = ventricular fibrillation; VT = ventricular tachycardia. (Reproduced with permission from Circulation 2000;**102** supplement 1, part 6)

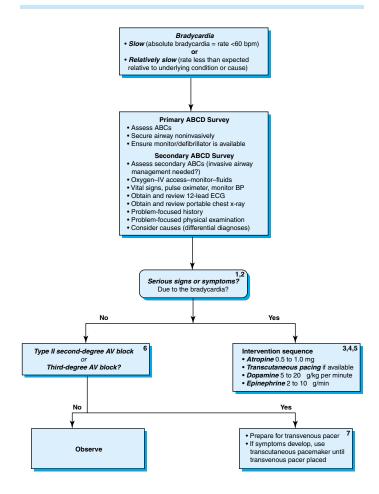


FIGURE 21-6 Bradycardia algorithm. Abbreviations: BP = blood pressure; ECG = electrocardiogram; AV = atrioventricular. (Reproduced, with permission, from: *Circulation* 2000;**102** supplement 1, part 6.)

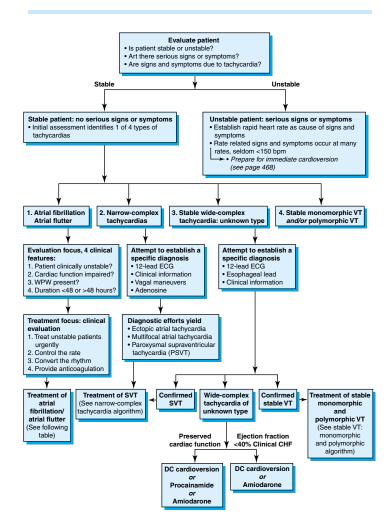


FIGURE 21-7 Tachycardia overview algorithm. *Abbreviations:* VF = ventricular fibrillation; ECG = electrocardiogram; PSVT = paroxysmal supraventricular tachycardia; SVT = supraventricular tachycardia. (Reproduced, with permission, from: *Circulation* 2000;**102** supplement 1, part 6.)

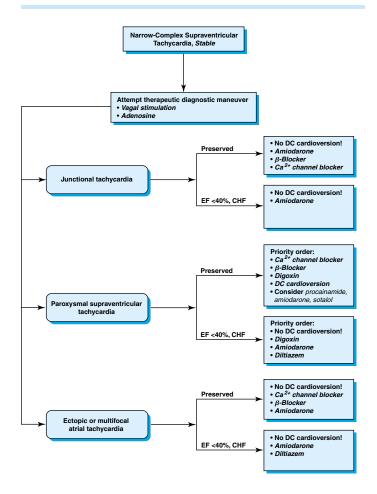


FIGURE 21-8 Narrow complex SVT algorithm. *Abbreviations*: EF = ejection fraction; CHF = congestive heart failure. (Reproduced, with permission, from: *Circulation* 2000;**102** supplement 1, part 6.)

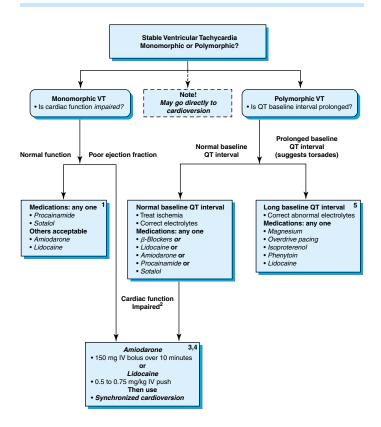


FIGURE 21-9 Stable supraventricular tachycardia algorithm. *Abbreviations*: VT = ventricular tachycardia. (Reproduced, with permission, from: *Circulation* 2000;**102** supplement 1, part 6.)

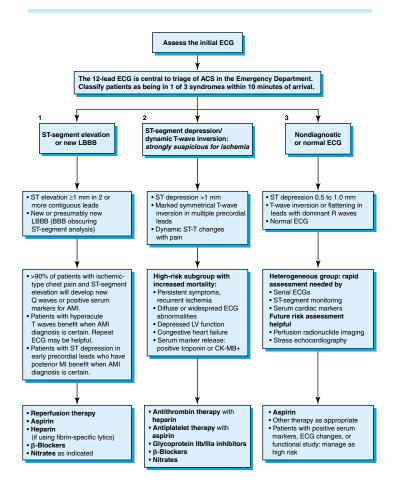


FIGURE 21–10 Acute coronary syndromes algorithm. *Abbreviations:* ECG = electrocardiogram; LBBB = left bundle branch block; BBB = bundle branch block; AMI = acute myocardial infarction; MI = myocardial infarction; LV = left ventricle; CK-MB+ = positive for myocardial muscle creatine kinase isoenzyme. (Reproduced, with permission, from: *Circulation* 2000; **102** supplement 1, part 6.)

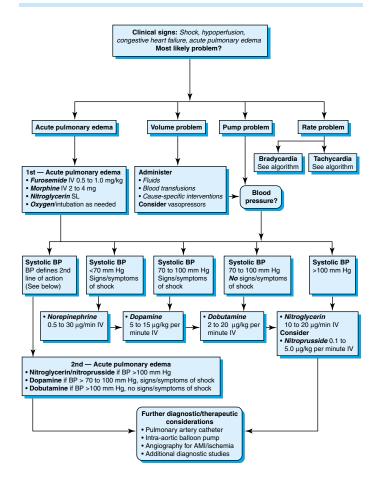


FIGURE 21–11 Acute pulmonary edema, hypotension and shock. *Abbreviations*: BP = blood pressure; AMI = acute myocardial infarction. (Reproduced, with permission, from: *Circulation* 2000;**102** supplement 1, part 7)

Lisinopril

SUPPLIED: Caps 2.5, 5, 10, 20, 30, 40 mg

DOSAGE: 5 mg PO within 24 h of symptoms, 5 mg after 24 h, then 10 mg over 48 h, then 10 mg PO daily for 6 wk

Ramipril

SUPPLIED: Caps 1.25, 2.5, 5, 10 mg

DOSAGE: 2.5 mg PO single dose, increase to 5 mg PO bid

Adenosine (Adenocard)

INDICATIONS: First drug for narrow-complex PSVT (not for AF or VT)

SUPPLIED: 2 mg/mL in 2-mL vial

DOSAGE: Adults. Put patient in reverse Trendelenburg position before administering dose; initial 6 mg over 1–3 s followed by NS bolus of 20 mL, then elevate extremity. Repeat 12 mg in 1–2 min PRN. A third dose of 12 mg in 1–2 min PRN. Peds. 0.1 mg/kg rapid IV push with continuous ECG monitoring. Follow with >5 mL NS flush. May double (0.2 mg/kg for second dose). Max: first dose: 6 mg; second dose:12 mg; single dose:12 mg

Amiodarone

INDICATIONS: Atrial and ventricular tachyarrhythmias and for rate control of rapid atrial arrhythmias in patients with impaired LV function when digoxin is ineffective

SUPPLIED: 50 mg/mL in 3-mL vial

DOSAGE: Adults. Max cumulative dose: 2.2 g IV/24 h. Cardiac arrest. 300 mg IV push. Consider repeating 150 mg IV push in 3–5 min. Wide-complex tachycardia (stable): Rapid inf: 150 mg IV over 10 min (15 mg/min), every 15 min PRN. Slow inf: 360 mg IV over 6 h (1 mg/min) Maintenance inf: 540 mg IV over 18 h (0.5 mg/min). Peds. Refractory pulseless VT, VF: 5 mg/kg rapid IV bolus. Perfusing supraventricular and ventricular arrhythmias: Loading dose: 5 mg/kg IV/IO over 20–60 min (repeat, max 15 mg/kg/day).

Amrinone

INDICATIONS: CHF refractory to conventional agents

SUPPLIED: 0.5 mg/mL in 20-mL vial

DOSAGE: Adults. 0.75 mg/kg, over 10–15 min (Do NOT mix with dextrose.). Then 5–15 µg/kg/min titrated to effect. Hemodynamic monitoring preferred. *Peds.* Loading dose: 0.75–1.0 mg/kg IV over 5 min; may repeat twice (Max: 3 mg/kg). Cont inf: 5–10 µg/kg/min IV

Aspirin

INDICATIONS: In the acute setting, administer to all patients with acute coronary syndrome (ACS)

SUPPLIED: Tabs 160, 325 mg

DOSAGE: 160–325 mg PO (chewing preferred ASAP onset of ACS)

Atropine Sulfate

INDICATIONS: First drug for symptomatic bradycardia (but not Mobitz II). Second drug (after epinephrine or vasopressin) for asystole or bradycardic PEA

SUPPLIED: 0.1 mg/mL in 10-mL syringe (total = 1 mg).

DOSAGE: Adults. Asystole or PEA: 1 mg IV push. Repeat every 3–5 min (if asystole persists) to 0.03–0.04 mg/kg max. Bradycardia: 0.5–1.0 mg IV every 3–5 min as needed; max 0.03–0.04 mg/kg. Endotracheal administration: 2–3 mg in 10 mL NS. Peds. IV administration: 0.02 mg/kg. Min single dose: 0.1 mg, max: 0.5 mg. Max adolescent single dose: 1.0 mg. May double for second IV dose. Max child total dose: 1.0 mg. Max adolescent total dose: 2.0 mg. Endotracheal administration: 0.02 mg/kg (larger doses than IV may be required)

Beta Blockers

INDICATIONS: All patients with suspected MI; may reduce chance of VF and reduce damage. Second line agents after adenosine, diltiazem, or digoxin to slow ventricular response in supraven-

tricular tachyarrhythmias. Antihypertensive for hemorrhagic and ischemic stroke. Do NOT administer along with calcium channel blockers due to risk of hypotension.

Metoprolol (Lopressor)

SUPPLIED: 1 mg/mL in 5-mL vial

DOSAGE: Adults. 5 mg slow IV q 5 min, total 15 mg

Atenolol (Tenormin)

SUPPLIED: 0.5 mg/mL in 10-mL amp

DOSAGE: Adults. 5 mg slow IV (over 5 min). In 10 min, second dose 5 mg slow IV. In 10 min, if tolerated, start 50 mg PO, then 50 mg PO bid

Propanolol (Inderal)

SUPPLIED: 1.0 mg/mL in 1 amp, 4 mg/mL in 5-mL

DOSAGE: Adults. 0.1 mg/kg slow IV push, divided 3 equal doses 2–3 min intervals, max 1 mg/min. Repeat after 2 min, PRN

• Esmolol (Brevibloc)

SUPPLIED: 10 mg/mL in 10-mL amp

DOSAGE: Adults. 0.5 mg/kg over 1 min, then 0.05 mg/kg/min

Labetalol

SUPPLIED: 5 mg/mL (Amps 20, 40, 60 mL)

DOSAGE: 10 mg IV push over 1–2 min. Repeat or double dose every 10 min (max: 150 mg); or initial bolus, then 2–8 µg/min

Calcium Chloride

INDICATIONS: Known/suspected hyperkalemia, hypocalcemia (eg, multiple transfusions), antidote for calcium channel blocker overdose, prophylactically before IV calcium channel blockers (prevent hypotension)

SUPPLIED: 100 mg/mL in 10-mL vial (total = 1 g; 10% solution)

DOSAGE: Adults. 8–16 mg/kg (usually 5–10 mL) IV slow push for hyperkalemia and calcium channel blocker overdose. 2–4 mg/kg (usually 2 mL) IV before IV calcium blockers. **Peds.** 20 mg/kg (0.2–0.25 mL/kg) slow push. Repeat PRN

Calcium Gluconate

SUPPLIED: 10% = 100 mg/10 mL = 9 mg/mL Ca

DOSAGE: *Peds.* 60–100 mg/kg (0.6–1.0 mL/kg) IV slow push. Repeat for documented conditions

Digibind

Digoxin-specific antibody therapy

INDICATIONS: Digoxin toxicity with uncontrolled life-threatening arrhythmias, shock, CHF; hyper-kalemia >5 mEq/L with serum dig levels above 10–15 ng/mL

SUPPLIED: 40-mg vial (each vial binds about 0.6 mg digoxin)

DOSAGE: Adults. Chronic intoxication: 3–5 vials may be effective. Acute overdose: See Chapter 22; based on dose ingested (average dose is 10 vials (400 mg), but may require up to 20 vials (800 mg).

Digoxin

SUPPLIED: 0.15 mg/mL or 0.1 mg/mL in 1- or 2-mL amp

INDICATIONS: Slow ventricular response in AF or atrial flutter. Second-line for PSVT

DOSAGE: Adults. Loading 10-15 µg/kg. Maintenance dose see Chapter 22.

0.

Diltiazem (Cardizem)

INDICATIONS: Control ventricular rate in AF and atrial flutter. Use after adenosine to treat refractory PSVT in patients with narrow QRS complex and adequate BP.

SUPPLIED: 5 mg/mL in 5- or 10-mL vial (total = 25 or 50 mg)

DOSAGE: Adults. Acute rate control: 15–20 mg (0.25 mg/kg) IV over 2 min. Repeat in 15 min at 20–25 mg (0.35 mg/kg) over 2 min. Maintenance: 5–15 mg/h, titrated to heart rate

Dobutamine (Dobutrex)

INDICATIONS: Pump problems with BP 70-100 mm Hg and no signs of shock

SUPPLIED: 12.5 mg/mL in 20-mL vial (total = 250 mg). IV inf: Dilute 250 mg (20 mL) in 250 mL NS or D_5W

DOSAGE: Adults. 2–20 μg/kg/min; titrate heart rate not >10% of baseline. Hemodynamic monitoring recommended. **Peds.** Cont IV inf: Titrate to effect (initial dose 5–10 μg/kg/min). Typical inf dose: 2–20 μg/kg/min

Dopamine (Intropin)

INDICATIONS: Second line for symptomatic bradycardia. Hypotension (BP <70–100 mm Hg) with signs of symptoms of shock

SUPPLIED: 40 mg/mL or 160 mg/mL. IV inf: Mix 400-800 mg in 250 mL NS or D5W.

DOSAGE: Adults. Titrate to response. Low: 1–5 µg/kg/min ("renal doses"). Moderate: 5–10 µg/kg/min ("cardiac doses"). High: 10–20 µg/kg/min ("vasopressor doses"). Peds. Titrate to effect. Initial, 5–10 µg/kg/min; typical: 2–20 µg/kg/min

Note: If >20 μg/kg/min is required, consider use of alternative adrenergic agent (eg, epinephrine)

Epinephrine

INDICATIONS: Cardiac arrest: VF, pulseless VT, asystole, PEA. Symptomatic bradycardia: After atropine and transcutaneous pacing. Anaphylaxis, severe allergic reactions: Combine with large fluid volumes, corticosteroids, antihistamines.

SUPPLIED: 1.0 mg/10 mL in preloaded 10-mL syringe (total = 1 mg), 1 mg/mL in glass 1-mL amp (total = 1 mg)

DOSAGE: Adults. Cardiac arrest: IV dose: 1.0 mg IV push, repeat every 3–5 min; doses up to (0.2 mg/kg) if 1 mg dose fails. Inf: 30 mg epinephrine (30 mL of 1:1000 solution) to 250 mL NS or D₃W, run at 100 mL/h, titrate. Endotracheal: 2.0–2.5 mg in 20 mL NS. Profound bradycardia/hypotension: 2–10 μg/min (1 mg of 1:1000 in 500 mL NS, infuse 1–5 mL/min). Peds. Asystole, pulseless arrest: First dose: 0.1 mg/kg IV (0.1 mL/kg of 1:10,000 "standard concentration"). Second and subsequent doses: 0.1 mg/kg IV (0.1 mL/kg of 1:1000 "High" concentration. Administer every 3–5 min during arrest; up to 0.2 mg/kg may be effective. Endotracheal: 0.1 mg/kg (0.1 mL/kg of 1:1000) ["high"] concentration continue q3–5 min of arrest until IV access is achieved; then begin with first IV dose. Symptomatic bradycardia: 0.01 mg/kg IV (0.1 mL/kg of 1:1000 ["standard"] concentration). Endotracheal doses: 0.1 mg/kg (0.1 mL/kg of 1:1000 ["high"] concentration). Cont IV inf: Begin with rapid infusion; then titrate to response. Typical inf: 0.1–1.0 μg/kg/min (Higher doses may be effective)

Flumazenil (Romazicon)

INDICATIONS: Reverse benzodiazepine toxicity (do NOT use in tricyclic overdose or in unknown poisoning)

SUPPLIED: 0.1 mg/mL in 5- and 10-mL vials

DOSAGE: Adults. 0.2 mg IV over 15 s then 0.3 mg IV over 30 s, if no response, give third dose. Third dose: 0.5 mg IV given over 30 s, repeat once per min until response, or total of 3 mg.

Furosemide (Lasix)

INDICATIONS: Acute pulmonary edema in BP >90–100. Hypertensive emergencies or increased intracranial pressure

SUPPLIED: 10 mg/mL in 2-, 4-, and 10-mL amp or vials

DOSAGE: Adults. 0.5-1.0 mg/kg over 1-2 min. If no response, double the dose to 2.0 mg/kg over 1-2 min

Glucagon

INDICATIONS: Reverse effects of calcium channel blocker or beta-blocker

SUPPLIED: 1- and 10-mg vials

DOSAGE: Adults. 1-5 mg over 2-5 min

Glucoprotein IIb/IIIa inhibitors

INDICATIONS: Acute coronary syndromes without ST elevation. Do NOT use with history of active bleeding or surgery within 30 d or if platelets <150,000/mm³. Note that optimum dosing and duration not established; check package insert.

Abciximab (ReoPro)

SUPPLIED: 2 mg/mL in 5-mL vial

DOSAGE: ACS with planned PCI within 24 h: 0.25 mg/kg IV bolus up to 1 h before procedure, then 0.125 µg/kg/IV; must use with heparin. Platelet recovery within 48 h; redosing may cause hypersensitivity reaction.

· Eptifibatide (Integrilin)

SUPPLIED: 0.75 and 2 mg/mL in 10-mL vial

DOSAGE: ACS: 180 μg/kg IV bolus then 2 μg/kg/min infusion

PCI: 135 μg/kg IV bolus then 0.5 μg/kg/min infusion; repeat bolus in 10 min.

· Tirofiban (Aggrastat)

SUPPLIED: 250 µg/mL in 50 mL or premixed 50 µg/mL

DOSAGE: ACS or PCI: 0.4 µg/kg/min IV for 30 min, then 0.1 µg/kg/min inf

Heparin (Unfractionated)

INDICATIONS: Adjuvant therapy in AMI. Begin heparin with fibrinolytics.

SUPPLIED: 0.5-1.0 mL amp, vials, and prefilled syringes. Multidose vials 1, 2, 5 and 30 mL. Concentrations range from 1000 to 40,000 IU/mL.

DOSAGE: Adults. Bolus 60 IU/kg (max bolus: 4000 IU). Continue 12 IU/kg/h (max 1000 IU/h for patients >70 kg) round to the nearest 50 IU. Adjust to maintain PTT 1.5-2.0 × control values for 48 h or until angiography.

Heparin (Low Molecular Weight) (Fragmin, Lovenox)

INDICATIONS: ACS with non-Q wave or unstable angina **SUPPLIED:** Dalteparin (Fragmin), Enoxaparin (Lovenox) DOSAGE: 1 mg/kg bid SQ for 2-8 d with aspirin

Ibutilide

INDICATIONS: Supraventricular arrhythmias (AFiB, A flutter); short-acting

SUPPLIED: 1 mg/10 mL

DOSAGE: 1 mg IV over 10 min (if <60 kg 0.01 mg/kg)

Isoproterenol (Isuprel)

INDICATIONS: Torsades de pointes unresponsive to magnesium sulfate. Temporary control of bradycardia in heart transplant patients. Class IIb at low doses for symptomatic bradycardias

SUPPLIED: 0.1 mg/mL in 1-mL vial. IV inf: Mix 1 mg in 250 mL NS or D5W.

DOSAGE: Adults. 2-10 µg/min. Titrate to effect.

Lidocaine

INDICATIONS: Cardiac arrest from VF/VT. Stable VT, wide-complex tachycardias of uncertain type, wide-complex PSVT

SUPPLIED: 20 mg/mL in preloaded 5-mL syringe, 10 mg/mL in 5-mL vial. Can be given via endotracheal tube.

DOSAGE: Adults. Cardiac arrest from VF/VT: Initial dose: 1.0–1.5 mg/kg IV. For refractory VF may give additional 0.5–0.75 mg/kg IV push, repeat in 5–10 min, max total dose is 3 mg/kg. A single dose of 1.5 mg/kg IV in cardiac arrest is acceptable. Endotracheal administration: 2–4 mg/kg. Perfusing arrhythmia: For stable VT, wide-complex tachycardia or uncertain type, significant ectopy, use as follows: 1.0–1.5 mg/kg IV push. Repeat 0.5–0.75 mg/kg every 5–10 min; max total dose, 3 mg/kg. Maintenance inf: 1–4 mg/min (30–50 µg/min)

Magnesium Sulfate

INDICATIONS: Cardiac arrest associated with torsades de pointes or suspected hypomagnesemic state, refractory VF, life-threatening ventricular arrhythmias due to digitalis toxicity, tricyclic overdose. Consider prophylactic administration in hospitalized patients with AMI.

SUPPLIED: Amps 2 and 10 mL of 50% MgSO₄ (total = 1 g and 5 g). 10 mL in preloaded syringe (total = 5 g/10 mL)

DOSAGE: Adults. Cardiac arrest: 1–2 g IV push (2–4 mL of a 50% solution) diluted in 10 mL of D_5W . AMI: Loading dose of 1–2 g, mixed in 50–100 mL of D_5W , over 5–60 min IV. Follow with 0.5–1.0 g/h IV for up to 24 h. Torsades de pointes: Loading dose of 1–2 g mixed in 50–100 mL of D_5W , over 5–60 min IV. Follow with 1–4 g/h IV (titrate dose to control the torsades).

Mannitol

INDICATIONS: Increased intracranial pressure in management of neurologic emergencies

SUPPLIED: 150-, 250-, and 1000-mL IV containers (strengths: 5%, 10%, 15%, 20%, and 25%).

DOSAGE: Adults. Administer 0.5–1.0 g/kg over 5–10 min. Additional doses of 0.25–2g/kg can be given every 4–6 h as needed. Use in conjugation with oxygenation and ventilation.

Morphine Sulfate

INDICATIONS: Chest pain and anxiety associated with AMI or cardiac ischemia, acute cardiogenic pulmonary edema (if blood pressure is adequate)

SUPPLIED: 2-10 mg/mL in a 1-mL syringe

DOSAGE: Adults. 2-4 mg IV (over 1-5 min) every 5-30 min

Naloxone (Narcan)

INDICATIONS: To reverse effects of narcotic toxicity, including respiratory depression, hypotension, and hypoperfusion

DOSAGE: Adults. 0.4–2.0 mg IV every 2 min; up to 10 mg over <30 min. **Peds.** Bolus IV dose: For total reversal of narcotic effects (smaller doses may be used if total reversal not required), as follows: **Birth-5** $\mathbf{y} \le 10$ kg): 0.1 mg/kg. ≥ 5 $\mathbf{y} (>20$ kg): 2.0 mg. May be necessary to repeat doses frequently. Cont inf: 0.04–0.16 mg/kg/h

Nitroglycerin

INDICATIONS: Chest pain of suspected cardiac origin; unstable angina; complications of AMI, including CHF, left ventricular failure; HTN crisis or urgency with chest pain

SUPPLIED: Parenteral: Amps: 5 mg in 10 mL, 8 mg in 10 mL, 10 mg in 10 mL, vials: 25 mg in 5 mL, 50 mg in 10 mL, 100 mg in 10 mL. *SL tabs*: 0.3 and 0.4 mg. Aerosol spray: 0.4 mg/dose **DOSAGE:** Adults. IV bolus: 12.5–25 µg. Infuse at 10–20 µg/min. Route of choice for emergencies. Use IV sets provided by manufacturer. *SL route*: 0.3–0.4 mg, repeat every 5 min. Aerosol spray: Spray for 0.5–1.0 s at 5-min intervals.

Nitroprusside (Sodium Nitroprusside, Nipride)

INDICATIONS: HTN crisis, reduce afterload in CHF and acute PE

SUPPLIED: 50-mg amp, mix in 250 mL D₅W only (keep covered with opaque material)

DOSAGE: $0.10 \mu g/kg/min$, titrate up to $5.0 \mu g/kg/min$. Use infusion pump; hemodynamic monitoring for optimal safety

Norepinephrine

INDICATIONS: Severe cardiogenic shock and significant hypotension. Last resort for ischemic heart disease and shock

SUPPLIED: 1 mg/mL in 4-mL amp. Mix 4 mg in 250 mL of D5W or D5NS

DOSAGE: Adults. 0.5–1.0 μg/min titrated to 30 μg/min. Peds. IV inf: Initial 0.1–2 μg/kg/min to effect. Do NOT administer with alkaline solutions.

Procainamide (Pronestyl)

INDICATIONS: Recurrent VT not controlled by lidocaine, refractory PSVT, refractory VF/pulseless VT, stable wide-complex tachycardia of unknown origin, AF with rapid rate in WPW

SUPPLIED: 100 mg/mL in 10-mL vial, 500 mg/mL in 2-mL vial

DOSAGE: Adults. Recurrent VF/VT: 20 mg/min IV (max total 17 mg/kg). In urgent situations up to 50 mg/min to a total dose of 17 mg/kg. Other indications: 20 mg/min IV until one of the following occurs: arrhythmia suppression, hypotension, QRS widens by more than 50%, total dose of 17 mg/kg is given. Maintenance: 1–4 mg/min

Sodium Bicarbonate

INDICATIONS: Specific indications for bicarbonate use are as follows: Class I (usually indicated) if known preexisting hyperkalemia. Class IIa (accepted, possibly controversial) if known preexisting bicarbonate-responsive acidosis (eg, DKA); tricyclic antidepressant overdose; alkalinize urine in aspirin overdose. Class IIb (accepted, but may not help, probably not harmful) if prolonged resuscitation with effective ventilation; on return of spontaneous circulation after long arrest interval. Class III (harmful) in hypoxic lactic acidosis (eg, cardiac arrest and CPR without intubation)

SUPPLIED: 50-mL syringe (8.4% sodium bicarbonate provides 50 mEq/50 mL)

DOSAGE: Adults. IV inf: 1 mEq/kg IV bolus. Repeat half this dose every 10 min thereafter. If rapidly available, use ABG analysis to guide therapy.

Sodium Bicarbonate (Pediatric)

INDICATIONS: Severe metabolic acidosis (documented or following prolonged arrest) unresponsive to oxygenation and hyperventilation, hyperkalemia, tricyclic antidepressant toxicity

DOSAGE: Adults. 8.4% 1 mEq/mL in 10- or 50-mL syringe, 4.2% 0.5 mEq/mL in 10-mL syringe. Peds. 1 mEq/kg. Dose may be calculated to correct $\frac{1}{4} - \frac{1}{2}$ of base deficit.

Thrombolytic Agents (Fibrinolytic Agents)

INDICATIONS: AMI in adults: ST-segment elevation of 1 mm or more in at least two contiguous leads in the setting of AMI. Adjuvant therapy: 60–325 mg aspirin chewed as soon as possible. Begin heparin immediately and continue for 48 h if alteplase is used.

· Alteplase, Recombinant

SUPPLIED: Vials 20, 50, and 100 mg, reconstituted with sterile water to 1 mg/mL

DOSAGE: Adults. Recommended dose based on patient's weight, not to exceed 100 mg. AMI: Accelerated inf: Give 15 mg bolus. Then 0.75 mg/kg over next 30 min (not to exceed 50 mg). Then 0.50 mg/kg over next 60 min (not to exceed 35 mg). 3-h inf: 60 mg in first hour (initial 6–10 mg as a bolus). Then 20 mg/h for 2 additional hours. Acute ischemic stroke: 0.9 mg/kg (max 90 mg) infused over 60 min. 10% of total dose as initial IV bolus over 1 min. Give the remaining 90% over the next 60 min.

Streptokinase

SUPPLIED: Reconstitute to 1 mg/mL

DOSAGE: Adults. 1.5 million IU in a 1-h infusion

Anistreplase APSAC

SUPPLIED: Reconstitute 30 U in 50 mL water or D_5W . Use two peripheral IV lines, one exclusively for thrombolytic administration.

DOSAGE: Adults. 30 IU IV over 2-5 min

· Reteplase, recombinant (Retavase)

SUPPLIED: 10-U vials reconstituted with sterile water to 1 U/mL
DOSAGE: Adults. 10 U IV bolus over 2 min. 30 min later, give second 10 U IV bolus over
2 min. NS flush before and after each bolus

Verapamil (Colan, Isoptin)

INDICATIONS: Second line for PSVT with narrow QRS complex and adequate BP

SUPPLIED: 2.5 mg/mL in 2-, 4-, and 5-mL vials (totals = 5, 10, and 12.5 mg)

DOSAGE: *Adults.* 2.5–5.0 mg IV over 1–2 min. Repeat 5–10 mg, if needed, in 15–30 min (30 mg max). Alternative: 5 mg bolus every 15 min to total dose of 30 mg

Electrical Defibrillation and Cardioversion

Although the defibrillator is the basic piece of equipment for both defibrillation and cardioversion, they are two distinctly different procedures. New devices include shock advisory defibrillators (automated external defibrillators). The energy level is the watt-second or joule.

Standard Defibrillation Procedure (conventional device)

- This is the primary therapy for VF or pulseless VT. Asystole is not now routinely defibrillated.
- 2. Use paste or pads on skin (see step 3 for location).
- Shout "Charging defibrillator-stand clear," synchronization switch off (if on, the defibrillator may not fire). In adults, energy levels begin at 200 J. In children, use 2 J/kg advance to 6 J/kg max.
- Place paddles as directed on the handles: one at the right upper sternum and one at the left anterior axillary line (apex).
- 5. Apply paddles with firm pressure (approximately 25 lb).
- Shout "I am going to shock on three. Stand clear!" and make sure no one is touching the patient or bed including yourself.
- 7. Shout "Clear," and visually check for other team members.
- 8. Shout three times "Everybody clear," and press both paddle buttons simultaneously to fire the unit, and observe for any change in the dysrhythmia.
- Defibrillate up to three times with increasing joules (200, >200-300, >360). If these
 fail to convert, continue full output (360 J) for all future shocks. If VT recurs, shock
 again at last energy level.
- 10. If a patient is HYPOTHERMIC (Core temperature < 30 °C) shock only three times as in step 8. Resume shocks only after temperature rises above 30 °C.</p>
- 11. If patient has automated implantable defibrillator and device is delivering shocks, wait 60 s for cycle to complete. If defibrillation attempted, place paddles several inches from the implanted pacer unit.

Automated External Defibrillator (AED)

Familiarize yourself with the features of the unit well in advance of using it. These
computerized devices "analyze" the rhythm and indicate if a shock is appropriate.

- Place the pads on the patient (upper right sternum and cardiac apex). Press the "analyze" button.
- 3. If appropriate (VT or VF), the unit charges and the "shock" sign is given.
- Announce "Shock is indicated... Stand clear," and verify that no one is touching patient. Depress "shock" button to administer shock.
- Repeat until arrhythmia is cleared ("no shock indicated" signal will flash). In general, shock in sets of three without interposing CPR. After three shocks, do 1 min of CPR.

Cardioversion

Used for VT with a pulse, atrial arrhythmias with rapid ventricular response (PAT, AF, or atrial flutter); an attempt to slow the heart or convert rhythm. Procedure is like that for defibrillation, except:

- Consider sedation because most of these patients are conscious. Agents can include diazepam, midazolam with or without a narcotic such as morphine, or fentanyl. Anesthesia support is helpful if readily available.
- Start with lower energy levels than for defibrillation. Start at 100 J and increase to 200, 300, and finally 360.
- Keep the synchronizer switch on (prevents shocking during vulnerable part of QRS complex when shock may cause VF, so-called R-on-T phenomenon). Observe for the markers on the R waves indicating that the synch mode is engaged.
- 4. Place paddles, apply pressure, and verify area is cleared as for the defibrillation steps.
- Most defibrillators default back to the unsynchronized mode to allow rapid shock in case of VF. Reset synch mode if multiple cardioversions needed.

Transcutaneous Pacing

Primarily used for hemodynamically unstable bradycardia. External pacemakers can be set in the asynchronous (nondemand or fixed mode) or demand mode in the range of 30-180 bpm with current outputs from 0-200 mA.

- 1. Place electrode pads on chest as per unit's instructions.
- 2. Turn unit on and set pacer to 80 bpm initially.
- Adjust current upward until capture is achieved (ie, wide QRS after each pacer spike on ECG for bradycardia.
- For asystole (not routinely used) begin at full output. If capture occurs, decrease to threshold and increase by 2 mA.

OTHER COMMON EMERGENCIES

The following material gives the treatment for other common emergencies. Dosages are for *adults* unless stated otherwise.

Anaphylaxis

Systolic BP <90 mm Hg

21 Epinephrine

DOSAGE: *Adults.* IV bolus: 100 μg of 1:10,000 over 5–10 min. IV inf: 1–4 μg/min. *Peds.* IV inf: 0.1–0.3 μg/kg/min, max 1.5 μg/kg/min

Systolic BP >90 mm Hg

· Epinephrine

DOSAGE: 1:1000 soln SQ. Adults. 0.3-0.5 mL. Peds. 0.01 mL/kg, max 0.5 mL

Supplemental drugs for anaphylaxis include:

· Diphenhydramine

DOSAGE: Adults. IV/IM/PO 50 mg. Peds. IV/IM/PO 1 mg/kg

Methylprednisolone

DOSAGE: 1-2 mg/kg IV

Ranitidine (Zantac)

DOSAGE: Adults. IV 50 mg over 5 min. Peds. IV 0.5 mg/kg over 5 min

· Albuterol

DOSAGE: Adults. 2.5 mg nebulized. Peds. 1.25 mg nebulized

Asthmatic Attack

Mild

Albuterol (Nebulized)

DOSAGE: Adults. 2.5-5.0 mg at 20 min for 3 doses. Peds. 1.25-2.5 mg at 20 min for 3 doses

Moderate to Severe

Ipratropium Bromide (nebulized)

DOSAGE: Adults. 0.5 mg with first albuterol treatment. Peds. 250 µg with first albuterol treatment.

Methylprednisolone

DOSAGE: Adults. 1 mg/kg IV. Peds. 2 mg/kg IV

Severe

Epinephrine

NOTE: Administer SQ or aerosolized beta agonists as for mild to moderate cases

Aminophylline

NOTE: Administer as for mild to moderate cases.

Give early consideration to

Hydrocortisone sodium

DOSAGE: 4 mg/kg IV q2-4h

or

Methylprednisolone

DOSAGE: 2-4 mg/kg IV q4h

Anticholinergic Crisis

Usually related to drug overdose. Patients present "red as a beet, mad as a hatter, hot as a furnace, dry as a bone, blind as a bat."

Physostigmine

DOSAGE: 0.5–2.0 mg IV

Note: Administer S-L-O-W-L-Y (may cause seizures if given rapidly). Have cardiac monitor attached and resuscitation equipment at the bedside.

Coma

- 1. Establish/secure airway.
- 2. Protect cervical spine.
- 3. Assess for respiratory failure and shock (ACLS).
- 4. Supply oxygen, IV access, cardiac monitor, and pulse oximetry.
- Administer 1 amp (50 mL) of D₅₀ IV manually; some recommend checking a stat glucose first
- 6. Administer 100 mg thiamine IV.
- 7. Give naloxone (Narcan) (see following section on Narcotics Overdose).
- 8. Obtain fingerstick glucose, SMA, CBC, urinalysis, and ABG.

Dental Emergencies

Not including facial fractures, there are generally two major categories of dental emergencies: toothaches with associated abscesses and avulsed (knocked-out) teeth. Most toothaches may be managed with antibiotics (usually penicillin-V 500 mg, q6h) and analgesics until proper dental attention can be obtained. Fluctuant abscesses may be drained if convenient. The exception to this rule is submandibular or infraorbital swelling. With submandibular infections, Ludwig's angina may develop, a life-threatening occurrence. These patients should be held for observation with special attention to maintaining the airway until a dental consult can be obtained. Infraorbital infections can lead to a cavernous sinus thrombosis if allowed to progress.

Avulsed teeth may or may not have an associated dentoalveolar fracture. The best treatment is to reposition the displaced tooth back in the socket within 30 min or as soon as possible. If the tooth root is dirty, wash it gently with sterile saline. Do not scrub or scrape the root. Get a dental consult to arrange to have the tooth splinted back in the socket.

Hypercalcemia

See Chapter 9, page 188

Hyperkalemia

See Chapter 9, page 186

Hypertensive Crisis

- 1. Treat only if signs of end organ damage.
- 2. MAP should not be reduced more than 20–25% over 30–60 min.

$$MAP = \left[\frac{1}{3} (SBP - DBP) + DBP\right]$$

· Labetalol

DOSAGE: 20 mg IV bolus then 2 mg/min IV to target BP or

· Sodium Nitroprusside

DOSAGE: 0.5 µg /kg/min ↑ to max (10 µg/kg) min

Hypoglycemia

- Draw a STAT serum glucose. Do not wait for result before treating if hypoglycemia is strongly suspected. A finger Dextro stick can usually be quickly checked.
- Give orange juice with sugar if the patient is awake and alert; if not, give 1 amp of D₅₀ IV (*Peds.* 1 mL/kg).
- 3. If IV access is not possible, give glucagon 1 mg IM or SC.

Narcotics Overdose

Naloxone (Narcan)

DOSAGE: Adults. 0.4–0.8 mg IV or IM, repeat as needed. (*Note:* if you suspect the patient is a narcotic addict give 0.4 mg instead and repeat as needed to avoid precipitating severe withdrawal. **Peds.** 0.01–0.02 mg/kg IV or IM, repeat as needed. Observe patient for at least 6 h after treatment.

Poisoning

Support airway, respiration, and circulation, as needed.

Determine ingested substance; give specific antidote, if available. The following is a list of some common poisons with their antidotes (Dosages for adults, unless otherwise specified):

Acetaminophen N-acetylcysteine, 140 mg/kg

Anticholinesterases Atropine 0.5–2 mg IV; may need up to

(organophosphates, physostigmine) 5 mg IV q 15 min if severe, then 70 mg/kg

× 17 more doses; 0.05 mg/kg IV

in children

Benzodiazepines Flumazenil (see page 463)

Beta-blockers Glucagon 0.05 mg/kg IV bolus for BP

<90, then infusion of 75-150 mg/kg/h

Carbon monoxide High-flow oxygen

Calcium channel blockers Calcium chloride 10–20 mL/kg of

1% solution then 20 mg/kg/h

Cyanide Amyl nitrate pearls inhale every 2 min then

sodium nitrite 10 mL 3% IV over 3 min (0.33 mL/kg of 3% solution in children) or sodium thiosulfate 50 mL of 25% solution

over 10 min or 1.65 mL/kg in children

Cyclic antidepressants NaHCO₃ 3 amps (50 mg/50 mL) in

1 L D₅W @ 2–3 mL/kg/h Digoxin-specific Fab

Digoxin Digoxin-specific Fa

Number of vials =

Serum digoxin level $\times \frac{\text{Patient' s weight (kg)}}{}$

00

Methanol, ethylene glycol Loading dose 1 g/kg of a 10% solution slowly

IV, followed by an infusion of 130 mg/kg/h. If patient is on dialysis give 250–300 mg/kg/h

to maintain levels.

Opiates, narcotics Naloxone see page 465.

21

Unconscious Patient

- · Protect airway with an endotracheal tube.
- Lavage with an Ewald tube or 28 French or larger NG tube, if ingestion occurred, 1 h.
- Use 300 mL NS boluses at a time through the NG or Ewald tube for adults and 20 mL/kg in children.
- · Activated charcoal can be added, unless an oral antidote is to be given.
- · Cathartics (sorbitol or magnesium citrate) promote GI elimination.

Conscious Patient

- Activated charcoal 1 g/kg, Contraindicated for iron, lithium, lead, alkali, acid. Also give 70% sorbitol solution (2 mL/kg body weight). Anyone given sorbitol should be monitored for hypokalemia and hypomagnesemia.
- · Attempt to promote excretion through IV hydration.
- Alkalinization (0.5-1 mEq/kg/L in IV fluids) for salicylates, barbiturates, tricyclics

Shock

See also Chapter 20, page 431, and this chapter, page 460.

Hypovolemic: Initially, use isotonic fluids such as NS or lactated Ringer's, blood, albumin, Plasmanate, or hetastarch.

Seizures/Status Epilepticus

Status epilepticus refers to >1 min of continuous seizure activity or back-to-back seizures without recovery in between.

Initial Supportive Care

- · Maintain airway with C-spine precautions.
- · Deliver oxygen by nasal cannula.
- · Monitor ECG and blood pressure.
- · Maintain normal temperature.

Pharmacologic Therapy

See Table 21-1

- · Establish IV.
- · Administer thiamine 100 mg IV.
- Administer 1 amp of D₅₀ IV in an adult (2 mL/kg D₂₅ in children) unless obviously hyperglycemic.
- Administer lorazepam or diazepam initially (see Table 21–1) (midazolam 0.2 mg/kg) can be given IM in children if no IV.
- If seizures persist, give fosphenytoin or phenytoin (see Table 21–1).
- If seizures persist, administer phenobarbital, paraldehyde.
- If still no response, obtain emergency neurosurgical and anesthesiology consultation.

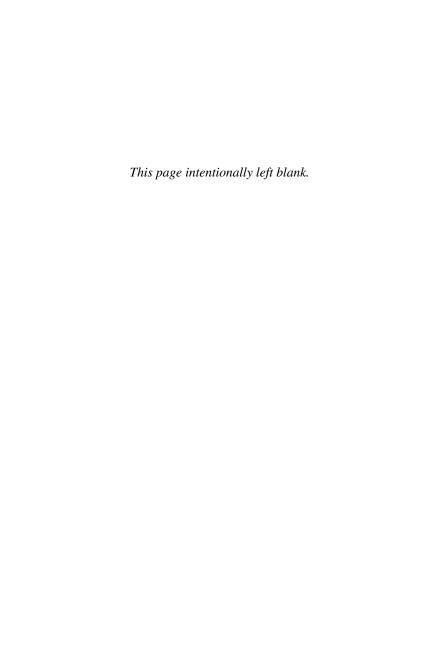
TABLE 21–1
Drugs for the Emergency Treatment of Seizures

Drug	Pediatric Dose (mg/kg)	Adult Dose	Maximum Rate (mg/min)
Diazepam (Valium)	0.10-0.20 IV	5-10 mg IV (up to 30 mg)	3–5
Fosphenytoin	N/A	20 mg/kg IV	150
Paraldehyde	0.15-0.3 mL/kg PR*	30 mL PR*	NA
Phenytoin (Dilantin)†	15 IV	Same as for child	50
Phenobarbital [‡]	10 IV or IM	120-140 mg IV	100

^{*}When given rectally, mix 2:1 with cottonseed or olive oil.

[†]When given IV, use a maximum dose of 50 mg/min and monitor ECG and vital signs closely. Can cause severe hypotension and bradycardia. Mix with NS to prevent precipitation.

[‡]Indicated when the patient is allergic to phenytoin. Patients may require intubation.



COMMONLY USED MEDICATIONS

Introduction Classification

Allergy Treatments

Antidotes

Antimicrobial Agents

Antineoplastic Agents

Cardiovascular Agents

Central Nervous System Agents

Dermatologic Agents

Dietary Supplements

Ear (Otic) Agents

Endocrine System

Eye (Ophthalmic) Agents

Gastrointestinal Agents

Hematologic Agents

Immune System Agents

Musculoskeletal Agents OB/GYN Agents

Pain Relievers

Respiratory Agents

Urinary/Genitourinary Agents

Wound Care

Miscellaneous Agents

Generic Drug Listing and Data

Aminoglycoside Dosing

Immunization Schedule

INTRODUCTION

This section is a quick reference of commonly used medications with selected key data listed for each drug. Be familiar with all the indications, contraindications, adverse effects, and drug interactions of any medication you prescribe. Such detailed information is beyond the scope of this manual but can be found in the package insert, the *Physicians' Desk Reference (PDR)*, or from the American Hospital Formulary Service.

Medications are listed by class, and then the individual medications are listed in alphabetical order by generic name. Some of the more common trade names are listed (in parentheses after the generic name) for each medication. Because many medications are used to treat various conditions based on the medical literature and not listed in their package insert, we list common uses of the medication rather than the official "labeled indications" (FDA approved). If no pediatric dosage is provided, we assume the agent is not well established for this age group.

Medications under the control of the U.S. Drug Enforcement Agency (Schedule I–V controlled substances) are indicated by the symbol [C]. The following is a general description for the schedules of controlled substances:

- Schedule I: All nonresearch use forbidden (eg, heroin, LSD, mescaline, etc)
- Schedule II: High addictive potential; medical use accepted. No telephone call-in
 prescriptions; no refills. Some states require special prescription form (eg, cocaine,
 morphine, methadone)
- Schedule III: Low to moderate risk of physical dependence, high risk of psychological dependence; prescription must be rewritten after 6 months or five refills (eg, actaminophen plus codeine)

- Schedule IV: Limited potential for dependence; prescription rules same as for Schedule III (eg, benzodiazepines)
- Schedule V: Very limited abuse potential; prescribing regulations often same as for uncontrolled medications, some states have additional restrictions

CLASSIFICATION

Allergy Treatments

Antihistamines

Cetirizine Cyproheptadine Hydroxyzine Chlorpheniramine Diphenhydramine Loratadine Clemastine fumarate Fexofenadine

Miscellanous Agents

Budesonide Cromolyn

Antidotes

Acetylcysteine Digoxin immune FAB Naloxone
Amifostine Flumazenil Physostigmine
Charcoal Ipecac syrup Succimer
Dexrazoxane Mesna

Antimicrobial Agents

Antibiotics

Aminoglycosides

Amikacin Neomycin Tobramycin Gentamicin Streptomycin

Cephalosporins, First-Generation

CefadroxilCephalexinCephapirinCefazolinCephalothinCephradine

Cephalosporins, Second-Generation

 Cefaclor
 Cefotetan
 Cefuroxime

 Cefmetazole
 Cefoxitin
 Loracarbef

 Cefonicid
 Cefprozil

Cephalosporins, Third-Generation

 Cefdinir
 Cefotaxime
 Ceftizoxime

 Cefixime
 Cefpodoxime
 Ceftriaxone

 Cefoperazone
 Ceftazidime

Cephalosporins, Fourth-Generation

Cefepime

Fluoroquinolones

Ciprofloxacin Lomefloxacin Ofloxacin

Gatifloxacin Moxifloxacin Levofloxacin Norfloxacin

Macrolides

Azithromycin Dirithromycin Erythromycin and sulfi-

Clarithromycin Erythromycin soxazole

Penicillins

Amoxicillin Mezlocillin Penicillin V Amoxicillin-clavulanate Nafcillin Piperacillin

Amoxicillin-clavulanate Nafcillin Piperacillin
Amoicillin Oxacillin Piperacillin-tazobactam

Ampicillin-sulbactam Penicillin G aqueous Ticarcillin

Cloxacillin Penicillin G benzathine Ticarcillin-clavulanate

Dicloxacillin Penicillin G procaine

Tetracyclines

Doxycycline Tetracycline

Miscellaneous agents

Aztreonam Linezolid Trimethoprim-sulfamethoxa-Clindamycin Meropenem zole (co-trimoxazole)

Fosfomycin Metronidazole Vancomycin

Imipenem-cilastatin Quinupristin/dalfopristin

Antifungals

Amphotericin B Clotrimazole and betametha- Miconazole Amphotericin B cholesteryl sone Nystatin

Amphotericin B lipid com- Econazole Terbinafine

plex Fluconazole Triamcinolone and nystatin
Amphotericin B liposomal Itraconazole

Amphotericin B liposomal Itraconazole Clotrimazole Ketoconazole

Antimycobacterials

Clofazimine Isoniazid Rifampin Dapsone Pyrazinamide Rifapentine

Ethambutol Rifabutin

Antiretrovirals

Abacavir Indinavir Saquinavir Amprenavir Lamivudine Stavudine Delavirdine Nelfinavir Zalcitabine Didanosine Nevirapine Zidovudine

Efavirenz Ritonavir Zidovudine and lamivudine

Antivirals

Acyclovir Ganciclovir Ribavirin
Amantadine Interferon Alfa-2b and ribCidofovir avirin combination Valacyclovir
Famciclovir Oseltamiyir Zanamiyir

Foscarnet Penciclovir

Miscellaneous Agents

Atovaquone Pentamidine Trimetrexate

Permethrin

Antineoplastic Agents

Alkylating Agents

Altretamine Carboplatin Procarbazine

Busulfan Cisplatin Triethylene-triphosphoramide

Nitrogen Mustards

Chlorambucil Ifosfamide Melphalan

Cyclophosphamide Mechlorethamine

Nitrosoureas

Carmustine Lomustine Streptozocin

Antibiotics

Bleomycin sulfate Doxorubicin Pentostatin
Dactinomycin Idarubicin Plicamycin
Daunorubicin Mitomycin Valrubicin

Antimetabolites

Cytarabine Fludarabine Mercaptopurine
Cytarabine liposomal Fluorouracil (5-FU) Methotrexate
Floxuridine Gemcitabine 6-Thioguanine

Hormones

Anastrozole Flutamide Nilutamide
Bicalutamide Goserelin Tamoxifen acetate

Estramustine phosphate Leuprolide acetate Fluoxymesterone Megestrol acetate

Mitotic Inhibitors

Etoposide Vinblastine Vinorelbine
Teniposide Vincristine

Miscellaneous Agents

Aldesleukin BCG (bacillus CalmetteAltretamine Guérin) Hydroxyurea
Aminoglutethimide Cladribine Interferon Alfa
L-Asparaginase Dacarbazine Irinotecan

Letrozole Mitoxantrone Procarbazine Levcovorin Paclitaxel Topotecan

Levamisole Pentostatin Tretinoin (retinoic acid)

Mitotane

Cardiovascular Agents

α_1 -(Alpha) Blockers

Doxazosin Prazosin Terazosin

Angiotensin-converting Enzyme Inhibitors

Benazepril Lisinopril Ramipril Captopril Moexipril Trandolapril

Enalapril and enalaprilat Perindopril Fosinopril Quinapril

Angiotensin II Receptor Antagonist

CandesartanIrbesartanTelmisartanEprosartanLosartanValsartan

Antiarrhythmic Agents

Esmolol Moricizine Adenosine Amiodarone Flecainide Procainamide Atropine Ibutilide Propafenone Bretvlium Lidocaine Ouinidine Digoxin Methoxamine Sotalol Disopyramide Mexiletine Tocainide

β-(Beta) Blockers

Acebutolol Carteolol Penbutolol
Atenolol Carvedilol Pindolol
Atenolol and chlorthalidone Labetalol Propranolol
Betaxolol Metoprolol Timolol
Bisoprolol Nadolol

Calcium Channel Antagonists

Amlodipine Isradipine Nisoldipine
Bepridil Nicardipine Verapamil

Diltiazem Nifedipine Felodipine Nimodipine

Centrally Acting Antihypertensive Agents

Clonidine Guanadrel Guanfacine Guanabenz Guanethidine Methyldopa

Diuretics

Acetazolamide Ethacrynic acid Hydrochlorothiazide and Amiloride Furosemide spironolactone Bumetanide Hydrochlorothiazide Hydrochlorothiazide Hydrochlorothiazide and tri-

Chlorothiazide Hydrochlorothiazide and the Hydrochlorothia

Indapamide

Chlorthalidone amiloride

Mannitol Spironolactone Triamterene

Metolazone Torsemide

Inotropic/Pressor Agents

Amrinone Epinephrine Norepinephrine Digoxin Isoproterenol Phenylephrine

Methoxamine Dobutamine Dopamine Milrinone

Lipid-Lowering Agents

Atorvastatin Colestipol Lovastatin Cerivastatin Fenofibrate Niacin Cholestyramine Fluvastatin Prayastatin Colesevelam Gemfibrozil Simvastatin

Vasodilators

Alprostadil Isosorbide dinitrate Nitroprusside Epoprostenol Isosorbide mononitrate Tolazoline

Fenoldopam Minoxidil Hydralazine Nitroglycerin

Central Nervous System Agents

Antianxiety

Alprazolam Diazepam Meprobamate Buspirone Doxepin Oxazepam Chlordiazepoxide Hydroxyzine Prazepam

Clorazepate Lorazepam

Anticonvulsants

Carbamazepine Lamotrigine Phenytoin Clonazepam Levetiracetam Tiagabine Diazepam Lorazepam **Topiramate** Ethosuximide Oxcarbazepine Valproic acid Fosphenytoin Pentobarbital Zonisamide

Gabapentin Phenobarbital

Antidepressants

Fluoxetine

Amitriptyline Fluvoxamine Phenelzine Amoxapine Imipramine Sertraline Trazodone Bupropion Maprotiline Citalopram Mirtazapine Trimipramine Desipramine Nefazodone Venlafaxine Doxepin Nortriptyline

Paroxetine

Antiparkinson Agents

Carbidopa/levodopa

Amantadine Entacapone Selegiline Benztropine Pergolide Trihexyphenidyl Bromocriptine Pramipexole Procyclidine

Antipsychotics

Chlorpromazine Mesoridazine Quetiapine
Clozapine Molindone Risperidone
Fluphenazine Olanzapine Thioridazine
Haloperidol Perphenazine Thiothixene
Lithium carbonate Prochlorperazine Trifluoperazine

Sedative Hypnotics

Chloral hydrate Midazolam Secobarbital
Diphenhydramine Pentobarbital Temazepam
Estazolam Phenobarbital Triazolam
Flurazepam Propofol Zaleplon
Hydroxyzine Quazepam Zolpidem

Miscellaneous Agents

Nimodipine Rivastigmine Tacrine

Dermatologic Agents

Acitretin Clotrimazole and betametha-

Acyclovir sone Nystatin and triamcinolone
Amphotericin B Dibucaine Oxiconazole
Anthralin Doxepin Penciclovir
Bacitracin Econazole Permethrin

Bacitracin Econazole Permethrin Bacitracin, topical Erythromycin, topical Pramoxine

Bacitracin, neomycin and polymyxin B, topical Finasteride Pramoxine and hydrocorti-

Bacitracin, neomycin, Haloprogin Podophyllin polymyxin B and hydro- Imiquimod Selenium sulfide

cortisone, topical Isotretinoin (13-cis retinoic Silver sulfadiazine Bacitracin, neomycin, acid) Steroids, topical (Table 22-6,

polymyxin B and lidocaine, topical Lactic acid and ammonium Tazarotene

Bacitracin and polymyxin B, topical Lindane Tolnaftate
Calcipotriene Metronidazole Tretinoin, topical (retinoic

Capsaicin Miconazole acid)
Ciclopirox Minoxidil Witch hazel
Ciprofloxacin Mupirocin

Naftifine

Dietary Supplements

Cyanocobalamin (vitamin B₁₂)

Clindamycin, topical

Calcium acetate Ferric gluconate complex Phytonadione (vitamin K) Calcium glubionate Ferrous gluconate Potassium supplements Calcium gluceptate Ferrous sulfate (Table 22-4, page 626) Calcium salts (chloride and gluconate) Folic acid Pyridoxine (vitamin B_6) Fron daytran Sodium bicarbonate (bicar

Calcium sans (chorde and Folic acid Fyritozinie (vitainin B_6) gluconate) Iron dextran Sodium bicarbonate (bicar-Cholecalciferol Magnesium oxide bonate)

Magnesium sulfate

Thiamine (vitamin B₁)

Nystatin

Ear (Otic) Agents

Acetic acid and aluminum ac-

Benzocaine and antipyrine

Ciprofloxacin and hydrocorti-

Neomycin, colistin, and hy-

drocortisone

Neomycin, colistin, hydrocortisone, and thonzonium

Neomycin, polymyxin, and hydrocortisone

Polymyxin B and hydrocorti-

Sulfacetamide and prednisolone

Triethanolamine

Pioglitazone

Repaglinide

Tolazamide Tolbutamide

Prednisolone

Prednisone

Vasopressin

Rosiglitazone

Endocrine System

Antidiabetic Agents

Acarbose Glyburide Acetohexamide Insulins (Table 22-2, page

Chlorpropamide 622)Metformin Glimepiride Glipizide Miglitol

Hormone and Synthetic Substitutes

Calcitonin Fludrocortisone acetate Calcitriol Glucagon Cortisone Hydrocortisone Desmopressin Methylprednisolone

Dexamethasone Metyrapone

Hypercalcemia Agents

Etidronate Pamidronate Gallium nitrate Plicamycin

Obesity

Sibutramine

Osteoporosis Agents

Alendronate Raloxifene Risedronate

Thyroid/Antithyroid

Levothyroxine Methimazole Liothyronine Propylthiouracil

Miscellanous Agents

Diazoxide Demeclocycline Metyrosine

Eye (Ophthalmic) Agents

Glaucoma Agents

Acetazolamide Brinzolamide Dorzolamide and timolol Apraclonidine Carteolol Echothiophate iodine Betaxolol Dipivefrin Latanoprost Brimonidine Dorzolamide Levobunolol

Levocabastine Metipranolol Lodoxamide Timolol

Ophthalmic Antibiotics

Bacitracin Bacitracin, neomycin and polymyxin B

Bacitracin, neomycin, polymyxin B and hydrocortisone

Bacitracin and polymyxin B Ciprofloxacin

Erythromycin

Gentamicin Neomycin and dexametha-

Neomycin, polymyxin B and

dexamethasone

Neomycin, polymyxin B and prednisolone

Ofloxacin Silver nitrate Sulfacetamide

Sulfacetamide and prednisolone

Tobramycin

Tobramycin and dexametha-Trifluridine

Other Agents

Artificial tears Cromolvn Cyclopentolate Dexamethasone (ophthalmic) Ketorolac Naphazoline and antazoline

Naphazoline and pheniramine

Gastrointestinal Agents

Antacids

Alginic acid Aluminum carbonate Aluminum hydroxide Aluminum hydroxide with magnesium carbonate

Aluminum hydroxide with magnesium hydroxide Aluminum hydroxide with magnesium hydroxide and simethicone

Aluminum hydroxide with magnesium trisilicate Calcium carbonate Magaldrate Simethicone

Antidiarrheal

Bismuth subsalicylate Diphenoxylate with atropine

Kaolin/pectin

Lactobacillus Loperamide Octreotide

Paregoric

Antiemetic Buclizine

Chlorpromazine Dimenhydrinate Dolasetron Dronabinol

Droperidol Granisetron Meclizine Metoclopramide Ondansetron

Prochlorperazine Promethazine Scopolamine Thiethylperazine Trimethobenzamide

Antiulcer

Cimetidine Famotidine Lansoprazole Nizatidine Omeprazole Pantoprazole Rabeprazole Ranitidine Sucralfate

Cathartics/Laxatives

Bisacodyl Docusate calcium Docusate potassium Docusate sodium Glycerin suppositories Lactulose Magnesium citrate Magnesium hydroxide Mineral oil

Polyethylene glycol-electrolyte (PEG) solution Psvllium Sorbitol

Enzymes

Pancreatin Pancrelipase

Miscellaneous Agents

Alosetron Infliximab Propantheline
Dexpanthenol Mesalamine Sulfasalazine
Dibucaine Metoclopramide Vasopressin

Dicyclomine Misoprostol
Hydrocortisone, rectal Olsalazine
Hyoscyamine Pramoxine

Hyoscyamine, atropine, Pramoxine with hydrocorti-

scopolamine, and phenobarbital sone

Hematologic Agents

Anticoagulants

Ardeparin Enoxaparin Protamine Dalteparin Heparin Warfarin

Antiplatelet Agents

Abciximab Eptifibatide Ticlopidine Aspirin Dipyridamole Tirofiban

Clopidogrel Reteplase

Antithrombic Agents

Alteplase, recombinant (TPA) Aprotinin Streptokinase
Aminocaproic acid Dextran 40 Tenecteplase
Anistreplase Reteplase Urokinase

Hemopoietic Stimulants

Epoetin alfa (erythropoietin) Oprelvekin Filgrastim (G-CSF) Sargramostim (GM-CSF)

Volume Expanders

Albumin Hetastarch

Dextran 40 Plasma protein fraction

Miscellaneous Agents

Antihemophilic factor VIII Lepirudin
Desmopressin Pentoxifylline

Immune System Agents

Immunomodulators

Interferon alfa Interferon beta-1b
Interferon alfacon-1 Interferon gamma-1b

Immunosuppressive Agents

Antithymocyte globulin Cyclosporine Sirolimus

(ATG) Dacliximab Steroids, systemic (See Table Azathioprine Muromonab-CD3 22–5, page 627

Basiliximab Mycophenolate mofetil Tacrolimus

Vaccine/Serums/Toxoids

CMV Immune globulin Immune globulin Pneumococcal 7-valent con-Haemophilus B conjugate Influenza vaccine jugate jugate Tetanus immune globulin Hepatitis B immune globulin Pneumococcal vaccine, poly-Hepatitis B vaccine valent Varicella virus vaccine

Musculoskeletal Agents

Antigout Agents

Allopurinol Probenecid Colchicine Sulfinpyrazone

Muscle Relaxants

BaclofenCyclobenzaprineMetaxaloneCarisoprodolDantroleneMethocarbamolChlorzoxazoneDiazepamOrphenadrine

Neuromuscular Blockers

Atracurium Pancuronium Succinylcholine
Mivacurium Pipecuronium Vecuronium

Miscellaneous Agents

Edrophonium Leflunomide Methotrexate

OB/GYN Agents

Contraceptives

Levonorgestrel implants
Oral contraceptives biphasic
Oral contraceptives
(Table 22–3, pages 623–625)

pages 623–625)
Oral contraceptives progestin
Only (Table 22–3, pages
Oral contraceptives progestin

Estrogen Supplementation

Esterified estrogens Estradiol transdermal Estrogen, conjugated with Esterified estrogens with Estrogen, conjugated methyltestosterone estrogen, conjugated with Estradiol methylprogesterone

Vaginal Preparations

Amino-Cerv pH 5.5 cream Nystatin Tioconazole
Miconazole Terconazole

Miscellaneous Agents

Gonadorelin Medroxyprogesterone Oxytocin Leuprolide Methylergonovine Terbutaline

Magnesium sulfate Mifepristone (RU486)

Pain Relievers

Local Anesthetics

Benzocaine and antipyrine Cocaine Lidocaine and prilocaine

Bupivacaine Dibucaine Pramoxine

Capsaicin Lidocaine

Migraine Headache Agents

Acetaminophen with butalbital ±/- caffeine Rizatriptan Aspirin with butalbital and caffeine Zolmitriptan

Narcotics

Acetaminophen with codeine Hydrocodone and aspirin

Alfentanil Hydrocodone and ibuprofen Aspirin with codeine Hydromorphone

Buprenorphine Levorphanol Butorphanol Meperidine

Codeine Methadone Dezocine Morphine Fentanyl Nalbuphine

Fentanyl transdermal Oxycodone

Fentanyl transmucosal Oxycodone and aceta-Hydrocodone and acetaminophen

minophen

Oxycodone and aspirin Oxymorphone

Pentazocine Propoxyphene

Propoxyphene and acetaminophen

Propoxyphene and aspirin

Sufentanil

Nonnarcotic Agents

Acetaminophen Tramadol

Nonsteroidal Antiinflammatory Agents

Aspirin Ibuprofen Naproxen sodium Celecoxib Indomethacin Oxaprozin Diclofenac Ketoprofen Piroxicam Diflunisal Ketorolac Rofecoxib Etodolac Meloxicam Sulindac Fenoprofen Nabumetone Tolmetin Flurbiprofen Naproxen

Miscellanous Agents

Amitriptyline Imipramine Tramadol

Respiratory Agents

Antitussives and Decongestants

Acetylcysteine Guaifenesin and dex-Benzonatate tromethorphan Gudeine Hydrocodone and guaifenesin Dextromethorphan Hydrocodone and homat-

Guaifenesin ropine

Guaifenesin and codeine Hydrocodone and pseudo-

ephedrine

Hydrocodone, chlorpheniramine, phenylephrine, acetaminophen, and caffeine

Pseudoephedrine

acid

Bronchodilators

Ephedrine

Albuterol Epinephrine Pirbuterol
Albuterol and ipratropium Isoetharine Salmeterol
Aminophylline Isoproternol Terbutaline
Bitolterol Levalbuterol Theophylline

Metaproterenol

Respiratory Inhalants

Acetylcysteine Colfosceril palmitate Fluticasone, oral, nasal Beclomethasone Cromolyn sodium Ipratropium Beractant Dexamethasone, nasal Nedocromil Calfactant Flunisolide Triamcinolone

Miscellanous Agents

Alpha₁ protease inhibitor Montelukast Zileuton
Dornase alfa Zafirlukast

Urinary/Genitourinary Agents

Alprostadil intracavernosal Hyoscyamine Phenazopyridine
Alprostadil urethral supposi- Methenamine Potassium citrate
tory Nalidixic acid Potassium citrate and citric

Ammonium aluminum sul- Neomycin–polymyxin blad-

fate (alum) der irrigant Sildenafil
Belladonna and opium supp Nitrofurantoin Sodium citrate
Bethanechol Oxybutynin Trimethoprim
Dimethyl sulfoxide (DMSO) Pentosan polysulfate Tolterodine

Flavoxate

Benign Prostatic Hyperplasia

Doxazosin Tamsulosin Finasteride Terazosin

Wound Care

Silver nitrate Becaplermin

Miscellaneous Agents

 Megestrol acetate
 Nicotine gum
 Potassium iodide

 Metaraminol
 Nicotine nasal spray
 Sodium polystyrene sulfonate

Naltrexone Nicotine transdermal Triethanolamine

GENERIC DRUG LISTING AND DATA

Abacavir (Ziagen)

COMMON USES: HIV infection

ACTIONS: Nucleoside reverse transcriptase inhibitor **DOSAGE:** *Adults.* 300 mg bid. *Peds.* 8 mg/kg bid

SUPPLIED: Tabs 300 mg; soln 20 mg/mL

NOTES: Fatal hypersensitivity reactions possibly manifested as respiratory symptoms. Discontinue immediately if hypersensitivity symptoms arise (fever, skin rash, fatigue, nausea, vomiting, diarrhea or abdominal pain). Lactic acidosis and hepatomegaly with steatosis also possible

Abciximab (ReoPro)

COMMON USES: Prevent acute ischemic complications in PTCA

ACTIONS: Inhibits platelet aggregation (GPII b/IIIa inhibitor)

DOSAGE: 0.25 mg/kg bolus 10–60 min prior to PTCA, then 0.125 μ g/kg/min (max = 10 μ g/min) cont inf for 12 h

SUPPLIED: Inj 2 mg/mL

NOTES: Used with heparin; allergic reactions possible

Acarbose (Precose)

COMMON USES: Type 2 DM

ACTIONS: α-Glucosidase inhibitor; delays digestion of carbohydrates, resulting in lower plasma

glucose levels

DOSAGE: 25–100 mg PO tid at the start of each main meal

SUPPLIED: Tabs 25, 50, 100 mg **NOTES:** May be taken with sulfonylureas

Acebutolol (Sectral)

COMMON USES: HTN

ACTIONS: Competitively blocks β -adrenergic receptors, β_1 and ISA

DOSAGE: 200–800 mg/d **SUPPLIED:** Caps 200, 400 mg

Acetaminophen (Tylenol, others)

COMMON USES: Mild pain, headache, and fever

ACTIONS: Nonnarcotic analgesic; inhibits synthesis of prostaglandins in the CNS and inhibits hy-

pothalamic heat-regulating center

DOSAGE: Adults. 650 mg PO or PR q4—6h or 1000 mg PO q6h; do not exceed 4 g/24h. Peds <12 y. 10–15 mg/kg/dose PO or PR q4—6h; do not exceed 2.6 g/24h. See quick dosing information in Table 22–1 (page 621).

SUPPLIED: Tabs 160, 325, 500, 650 mg; chewable tabs 80, 160 mg; liq 100 mg/mL, 120 mg/2.5 mL, 120 mg/5 mL, 160 mg/5 mL, 167 mg/5 mL, 325 mg/5 mL, 500 mg/5 mL; gtt 48 mg/mL, 60 mg/0.6 mL; supp 80, 120, 125, 300, 325, 650 mg

NOTES: No antiinflammatory or platelet-inhibiting action; \downarrow dose with alcohol use; overdose causes hepatotoxicity, which is treated with N-acetylcysteine; charcoal not usually recommended

Acetaminophen + Butalbital +/- Caffeine (Fioricet, Medigesic, Repan, Sedapap-10, Two-Dyne, Triapin, Axocet, Phrenilin Forte, others) [C-III]

COMMON USES: Mild pain; headache, especially associated with stress

ACTIONS: Nonnarcotic analgesic with barbiturate

DOSAGE: 1-2 tabs or caps PO q4-6h PRN

SUPPLIED: Caps *Medigesic, Repan, Two-Dyne:* Butalbital 50 mg, caffeine 40 mg, + acetaminophen 325 mg. Caps *Axocet, Phrenilin Forte:* Butalbital 50 mg and acetaminophen 650 mg; *Triaprin:* Butalbital 50 mg + acetaminophen 325 mg. Tabs *Esgic, Fioricet, Repan:* Butalbital 50 mg, caffeine

40 mg, + acetaminophen 325 mg; *Phrenilin:* Butalbital 50 mg and acetaminophen 325 mg; *Seda-pap-10:* Butalbital 50 mg + acetaminophen 650 mg

NOTES: Butalbital habit-forming

Acetaminophen + Codeine (Tylenol No. 1, No. 2, No. 3, No. 4) [C-II]

COMMON USES: No. 1, No. 2, and No. 3 for mild to moderate pain; No. 4 for moderate to severe pain **ACTIONS:** Combined effects of acetaminophen and a narcotic analgesic

DOSAGE: Adults. 1–2 tabs q3–4h PRN. (Max dose acetaminophen = 4 g/d). Peds. Acetaminophen 10–15 mg/kg/dose; codeine 0.5–1.0 mg/kg dose q4–6h (useful dosing guide: 3–6 y, 5 mL/dose; 7–12 y, 10 mL/dose)

SUPPLIED: Tabs 300 mg of APAP + codeine; caps 325 mg of APAP + codeine; liq acetaminophen 120 mg + codeine 12 mg/5 mL

NOTES: Codeine in No. 1 = 7.5 mg, No. 2 = 15 mg, No. 3 = 30 mg, No. 4 = 60 mg

Acetazolamide (Diamox)

COMMON USES: Diuresis, glaucoma, acute mountain sickness, and refractory epilepsy

ACTIONS: Carbonic anhydrase inhibitor; ↓ renal excretion of hydrogen ions, and ↑ renal excretion of sodium, potassium, bicarbonate, and water

DOSAGE: Adults. Diuretic: 250–375 mg IV or PO q24h. Glaucoma: 250–1000 mg PO q24h in ÷ doses. Epilepsy: 8–30 mg/kg/d PO in ÷ doses. Altitude sickness: 250 mg PO q8–12h or SR 500 mg PO q12–24h. Peds. Epilepsy: 8–30 mg/kg/24h PO in ÷ doses; max 1 g/d. Diuretic: 5 mg/kg/24h PO or IV. Alkalinization of urine: 5 mg/kg/dose PO bid–tid. Glaucoma: 5–15 mg/kg/24h PO in ÷ doses; max 1 g/d.

SUPPLIED: Tabs 125, 250 mg; SR caps 500 mg; inj 500 mg/vial

NOTES: Contra in renal and hepatic failure, sulfa hypersensitivity; follow Na⁺ and K⁺; watch for metabolic acidosis; SR dosage forms not recommended for use in epilepsy

Acetic Acid And Aluminum Acetate (Otic Domeboro)

COMMON USES: Otitis externa **ACTIONS:** Antiinfective **DOSAGE:** 4–6 gtt in ear(s) q2–3h

SUPPLIED: Otic soln

Acetohexamide (Dymelor)

COMMON USES: Type 2 DM

ACTION: Sulfonylurea. Stimulates release of insulin from pancreas; increases insulin sensitivity at peripheral sites; reduces glucose output from liver

DOSAGE: 250–1500 mg/d **SUPPLIED:** Tabs 250, 500 mg

Acetylcysteine (Mucomyst, Mucosil)

COMMON USES: Mucolytic agent as adjuvant Rx for chronic bronchopulmonary diseases and CF; antidote to acetaminophen hepatotoxicity within 24 h of ingestion

ACTIONS: Splits disulfide linkages between mucoprotein molecular complexes; protects the liver by restoring glutathione levels in acetaminophen overdose

DOSAGE: Adults & Peds. Nebulizer: 3–5 mL of 20% soln diluted with an equal vol of water or NS tid–qid. Antidote: PO or NG: 140 mg/kg loading dose, then 70 mg/kg q4h for 17 doses. Dilute 1:3 in carbonated beverage or orange juice

SUPPLIED: Soln 10%, 20%

NOTES: Watch for bronchospasm when used by inhalation in asthmatics; activated charcoal adsorbs acetylcysteine when given PO for acute APAP ingestion

Acitretin (Soriatane)

COMMON USES: Severe psoriasis and other keratinization disorders (lichen planus, etc)

ACTIONS: Retinoid-like activity

DOSAGE: 25–50 mg/d PO, with main meal; can ↑ if no response by 4 wk to 75 mg/d

SUPPLIED: Caps 10, 25 mg

NOTES: Teratogenic, contra in PRG; Use with caution in women of reproductive potential; check LFTs, can be hepatotoxic; response often takes 2–3 mo

Acyclovir (Zovirax)

COMMON USES: Herpes simplex and herpes zoster viral infections

ACTIONS: Interferes with viral DNA synthesis

DOSAGE: Adults. Oral: Initial genital herpes: 200 mg PO q4h while awake, total of 5 caps/d for 10 d or 400 mg PO tid for 7–10 d. Chronic suppression: 400 mg PO bid. Intermittent Rx: As for initial treatment, except treat for 5 d, or 800 mg PO bid, initiated at the earliest prodrome. Herpes zoster: 800 mg PO 5×/d for 7–10 d. IV. 5–10 mg/kg/dose IV q8h. Topical initial herpes genitalis: Apply q3h (6×/d) for 7 d. **Peds.** 5–10 mg/kg/dose IV or PO q8h or 750 mg/m²/24h ÷ q8h. Chickenpox: 20 mg/kg/dose PO qid

SUPPLIED: Caps 200 mg; tabs 400, 800 mg; susp 200 mg/5 mL; inj 500 mg/vial; oint 5% **NOTES:** Adjust dose in renal insufficiency; oral better than topical for herpes genitalis

Adenosine (Adenocard)

Used for emergency cardiac care (see Chapter 21).

COMMON USES: PSVT, including that associated with Wolff-Parkinson-White syndrome

ACTIONS: Class IV antiarrhythmic; slows conduction time through the AV node

DOSAGE: Adults. 6 mg rapid IV bolus; may be repeated in 1–2 min; max 12 mg IV. Peds. 0.05 mg/kg IV bolus; may repeat q 1–2 min to a max of 0.25 mg/kg

SUPPLIED: Inj 6 mg/2 mL

NOTES: Doses >12 mg not recommended; caffeine and theophylline antagonize effects of adenosine

Albumin (Albuminar, Buminate, Albutein, others)

COMMON USES: Plasma volume expansion for shock resulting from burns, surgery, hemorrhage, or other trauma

ACTIONS: Maintenance of plasma colloid oncotic pressure

DOSAGE: *Adults.* Initially, 25 g IV; subsequent infusions depend on clinical situation and response. No more than 250 g/48h. *Peds.* 0.5–1.0 g/kg/dose; infuse at 0.05–0.1 g/min

SUPPLIED: Soln 5%, 25%

NOTES: Contains 130-160 meg Na+/L.

Albuterol (Proventil, Ventolin)

COMMON USES: Bronchospasm in reversible obstructive airway disease; prevention of exerciseinduced bronchospasm

ACTIONS: β-Adrenergic sympathomimetic bronchodilator; relaxes bronchial smooth muscle

DOSAGE: *Adults.* 2 inhal q4–6h PRN; 1 Rotacaps inhaled q4–6h; 2–4 mg PO tid–qid; *Neb*: 1.25–5 mg (0.25–1 mL of 0.5% soln) in 2–3 mL of NS tid–qid. *Peds.* 2 inhal q4–6h; 0.1–0.2 mg/kg/dose PO; max 2–4 mg PO tid; *Neb*: 0.05 mg/kg (max 2.5 mg) in a 2–3 mL of NS tid–qid

SUPPLIED: Tabs 2, 4 mg; ER tabs 4, 8 mg; syrup 2 mg/5 mL; 90 µg/dose met-dose inhaler; Rotacaps 200 µg; soln for neb 0.083, 0.5%

Albuterol and Ipratropium (Combivent)

COMMON USES: COPD

ACTIONS: Combination of β-adrenergic bronchodilator and quaternary anticholinergic compound

DOSAGE: 2 inhal qid

SUPPLIED: Met-dose inhaler, 18 µg ipratropium/103 µg Albuterol/puff

Aldesleukin [IL-2] (Proleukin)

COMMON USES: RCC, melanoma

ACTIONS: Acts via IL-2 receptor; numerous immunomodulatory effects

DOSAGE: 600,000 IU/kg q8h for 14 doses (FDA-approved dose/schedule for RCC). Multiple cont inf and SCSC dosing schedules (including "high-dose" therapy with 24×10^6 IU/m² IV q8h on d 1–5 and 12–16)

SUPPLIED: Inj 1.1 mg/mL $(22 \times 10^6 \text{ IU})$

NOTES: Toxicity symptoms: flu-like syndrome (malaise, fever, chills), nausea and vomiting, diarrhea, and increased serum bilirubin. Capillary leak syndrome with hypotension, pulmonary edema, fluid retention, and weight gain. Renal toxicity and mild hematologic toxicity (anemia, thrombocytopenia, leukopenia) and secondary eosinophilia. Cardiac toxicity (myocardial ischemia, atrial arrhythmias). Neurologic toxicity (CNS depression, somnolence, rarely coma, delirium). Pruritic skin rashes, urticaria, and erythroderma common. Cont inf schedules less likely in severe hypotension and fluid retention

Alendronate (Fosamax)

COMMON USES: Rx and prevention of osteoporosis, Rx of glucocorticoid-induced osteoporosis and

Paget's disease

ACTIONS: Inhibits normal and abnormal bone resorption

DOSAGE: Osteoporosis: Rx: 10 mg/d PO. Glucocorticoid-induced osteoporosis: Rx: 5 mg/d PO. Prevention: 5 mg/d PO. Paget's disease: 40 mg/d PO

SUPPLIED: Tabs 5, 10, 40 mg

NOTES: Take first thing in AM with plain water (8 oz) at least 30 min prior to the first food or beverage of the day. Do not lie down for 30 min after taking. Adequate calcium and vitamin D supplement necessary

Alfentanil (Alfenta) [C]

COMMON USES: Adjunct in the maintenance of anesthesia; analgesia

ACTIONS: Short-acting narcotic analgesic

DOSAGE: Adults & Peds >12 y. 3-75 µg/kg IV inf; total dose depends on duration of procedure

SUPPLIED: Inj 500 µg/mL

Alginic Acid + Aluminum Hydroxide and Magnesium Trisilicate (Gaviscon)

COMMON USES: Heartburn; pain from hiatal hernia

ACTIONS: Forms protective layer preventing reflux of gastric acid **DOSAGE:** 2–4 tabs or 15–30 mL PO qid followed by water

SUPPLIED: Tabs, susp

Allopurinol (Zyloprim, Lopurin, Aloprim, others)

COMMON USES: Gout, hyperuricemia of malignancy, and uric acid urolithiasis

ACTIONS: Xanthine oxidase inhibitor, which decreases the production of uric acid **DOSAGE:** *Adults.* PO: Initially, 100 mg/d; usual 300 mg/d; max 800 mg/d. *IV*: 200–400 mg/m²/d (max 600 mg/24h). *Peds.* Use only for treating hyperuricemia of malignancy in children (<10 y):

 $10 \text{ mg/kg/}24\text{h PO or } 200 \text{ mg/m}^2\text{/d IV} \div \text{q6-8h (max } 600 \text{ mg/}24\text{h)}$

SUPPLIED: Tabs 100, 300 mg; inj 500 mg/30 mL

NOTES: Aggravates acute gouty attack; do not begin until acute attack resolves; administer pc. IV administration of 6 mg/mL final conc as single daily infusion or ÷ 6-, 8-, or 12-h intervals. Dosage adjustment necessary in renal impairment

Alosetron (lotronex)

COMMON USES: Irritable bowel syndrome in women, diarrhea as main symptom

ACTIONS: 5-HT₃ receptor antagonist **NOTES:** Removed from the market

α_l-Protease Inhibitor (Prolastin)

COMMON USES: Panacinar emphysema

ACTIONS: Replacement of human α_1 -protease inhibitor

DOSAGE: 60 mg/kg IV once/wk

SUPPLIED: Inj 500 mg/20 mL; 1000 mg/40 mL

Alprazolam (Xanax) [C]

COMMON USES: Anxiety and panic disorders + anxiety associated with depression

ACTIONS: Benzodiazepine; antianxiety agent

DOSAGE: Anxiety: Initially, 0.25-0.5 mg tid; \uparrow to a max of 4 mg/d in \div doses. Panic: Initially,

0.5 mg tid; may gradually ↑ to desired response

SUPPLIED: Tabs 0.25, 0.5, 1.0, 2.0 mg

NOTES: ↓ Dose in elderly and debilitated patients; avoid abrupt discontinuation after prolonged use

Alprostadil, Intracavernosal (Caverject, Edex)

COMMON USES: Erectile dysfunction due to neurogenic, vasculogenic, or mixed cause

ACTIONS: Relaxes smooth muscles, dilates cavernosal arteries, increases lacunar spaces and entrapment of blood by compressing venules against tunica albuginea

DOSAGE: 2.5-60 µg intracavernosal; adjusted to individual needs

SUPPLIED: Caverject: 6–10 or 6–20 μg vials +/– diluent syringes. Edex: 5, 10, 20, 40 μg vials + syringes

NOTES: Penile pain common side effect; dosage must be titrated at physician's office. Patients should be informed of other side effects, including priapism, penile fibrosis, and hematoma

Alprostadil [Prostaglandin E₁] (Prostin VR)

COMMON USES: Any state in which blood flow must be maintained through the ductus arteriosus to sustain either pulmonary or systemic circulation until corrective or palliative surgery can be performed (eg, pulmonary atresia, pulmonary stenosis, tricuspid atresia, transposition, severe tetralogy of Fallot)

ACTIONS: Vasodilator, platelet aggregation inhibitor. Smooth muscle of the ductus arteriosus is especially sensitive

DOSAGE: 0.05 μg/kg/min IV. ↓ Dosage to lowest rate that maintains response

SUPPLIED: Injectable forms

NOTES: Cutaneous vasodilation, seizure-like activity, jitteriness, temperature elevation, hypocalcemia, apnea, thrombocytopenia, hypotension. May cause apnea. Have an intubation kit at bedside if patient is not intubated

Alprostadil, Urethral Suppository (Muse)

COMMON USES: Erectile dysfunction

ACTIONS: Alprostadil (PGE₁) absorbed through urethral mucosa. Portion of administered dose transported to the corpus cavernosa where it acts as vasodilator and smooth muscle relaxant

DOSAGE: 125–1000 µg system 5–10 min prior to sexual activity **SUPPLIED:** 125, 250, 500, 1000 µg with a transurethral delivery system

NOTES: Hypotension, dizziness, syncope, penile pain, and priapism. Dose titration administered under physician's supervision

Alteplase, Recombinant [TPA] (Activase)

Used for emergency cardiac care (see Chapter 21)

common uses: AMI, PE, and acute ischemic stroke

ACTIONS: Results in thrombolysis; inhibits local fibrinolysis by binding to fibrin in the thrombus **DOSAGE:** *AMI and PE:* 100 mg IV over 3 h (10 mg over 2 min, then 50 mg over 1 h, then 40 mg

over 2 h). Stroke: 0.9 mg/kg (max 90 mg) infused over 60 min

SUPPLIED: Powder for inj 50, 100 mg

NOTES: May cause bleeding; give heparin to prevent reocclusion. In AMI doses of >150 mg associated with intracranial bleeding

Altretamine (Hexalen)

COMMON USES: Epithelial ovarian cancer

ACTIONS: Unknown; cytotoxic agent, possibly alkylating agent; inhibits nucleotide incorporation into DNA and RNA

DOSAGE: 260 mg/m²/d in 4 ÷ doses for 14–21 d of a 28-d treatment cycle; dose ↓ to 150 mg/m²/d

for 14 d in multiagent regimens. (Refer to specific protocols)

SUPPLIED: Caps 50, 100 mg

NOTES: Toxicity symptoms: Vomiting, diarrhea, and cramps; neurologic toxicity (peripheral neuropathy, CNS depression); minimally myelosuppressive

Aluminum Carbonate (Basaljel)

COMMON USES: Hyperacidity (peptic ulcer, GERD, etc); supplement to the Rx of hyperphosphatemia

ACTIONS: Neutralizes gastric acid; binds phosphate

DOSAGE: Adults. 2 caps or tabs or 10 mL (in water) q2h PRN. Peds. 50–150 mg/kg/24h PO ÷ a4–6h

SUPPLIED: Tabs, caps, susp

Aluminum Hydroxide (Amphojel, Alternagel)

COMMON USES: Hyperacidity (peptic ulcer, hiatal hernia, etc.); supplement to Rx of hyperphosphatemia

ACTIONS: Neutralizes gastric acid; binds phosphate

DOSAGE: Adults. 10–30 mL or 2 tabs PO q4–6h. *Peds*. 5–15 mL PO q4–6h or 50–150 mg/kg/24h

PO ÷ q4–6h (hyperphosphatemia)

SUPPLIED: Tabs 300, 600 mg; chewable tabs 500 mg; susp 320, 600 mg/5 mL

NOTES: Can be used in renal failure; may cause constipation

Aluminum Hydroxide + Magnesium Carbonate (Gaviscon)

COMMON USES: Hyperacidity (peptic ulcer, hiatal hernia, etc)

ACTIONS: Neutralizes gastric acid

DOSAGE: Adults. 15-30 PO pc and hs. Peds. 5-15 mL PO qid or PRN

SUPPLIED: Liq containing aluminum hydroxide 95 mg + magnesium carbonate 358 mg/15 mL

NOTES: Doses qid are best given pc and hs; may cause hypermagnesemia

Aluminum Hydroxide + Magnesium Trisilicate (Gaviscon, Gaviscon-2)

COMMON USES: Hyperacidity **ACTIONS:** Neutralizes gastric acid **DOSAGE:** Chew 2–4 tabs qid

SUPPLIED: Gaviscon: Aluminum hydroxide 80 mg and magnesium trisilicate 20 mg; Gaviscon

2: Aluminum hydroxide 160 mg and magnesium trisilicate 40 mg

Aluminum Hydroxide + Magnesium Hydroxide (Maalox)

COMMON USES: Hyperacidity (peptic ulcer, hiatal hernia, etc)

ACTIONS: Neutralizes gastric acid

DOSAGE: Adults. 10-60 mL or 2-4 tabs PO qid or PRN. Peds. 5-15 mL PO qid or PRN

SUPPLIED: Tabs, susp

NOTES: Doses qid best given pc and hs; may cause hypermagnesemia in renal insufficiency

Aluminum Hydroxide + Magnesium Hydroxide and Simethicone (Mylanta, Mylanta II, Maalox Plus)

COMMON USES: Hyperacidity with bloating

ACTIONS: Neutralizes gastric acid

DOSAGE: Adults. 10-60 mL or 2-4 tabs PO qid or PRN. Peds. 5-15 mL PO qid or PRN

SUPPLIED: Tabs, susp

NOTES: May cause hypermagnesemia in renal insufficiency; Mylanta II contains twice the aluminum and magnesium hydroxide of Mylanta

Amantadine (Symmetrel)

COMMON USES: Rx or prophylaxis for influenza A viral infections and Parkinsonism

ACTIONS: Prevents release of infectious viral nucleic acid into the host cell; releases dopamine from intact dopaminergic terminals

DOSAGE: Adults. Influenza A: 200 mg/d PO or 100 mg PO bid. Parkinsonism: 100 mg PO qd-bid. Peds. 1-9 y: 4.4–8.8 mg/kg/24h to a max of 150 mg/24h ÷ doses qd-bid. 10–12 y: 100–200 mg/d in 1–2 ÷ doses

SUPPLIED: Caps 100 mg; tabs 100 mg, soln 50 mg/5 mL

NOTES: ↓ in renal insufficiency

Amifostine (Ethyol)

COMMON USES: Xerostomia prophylaxis during radiation therapy for head and neck, ovarian, or non-small-cell lung cancer. Reduction of cumulative renal toxicity associated with repeated administration of cisplatin

ACTIONS: Prodrug, dephosphorylated by alkaline phosphatase to the pharmacologically active thiol metabolite

DOSAGE: 910 mg/m²/d as a 15-min IV inf 30 min prior to chemotherapy

SUPPLIED: Vials containing 500 mg of lyophilized drug with 500 mg of mannitol, reconstituted in sterile NS

NOTES: *Toxicity symptoms:* Transient hypotension in >60%, nausea and vomiting, flushing with hot or cold chills, dizziness, hypocalcemia, somnolence, and sneezing. Does not reduce the effectiveness of cyclophosphamide plus cisplatin chemotherapy

Amikacin (Amikin)

COMMON USES: Serious infections caused by gram (–) bacteria and mycobacterial infections

ACTIONS: Aminoglycoside antibiotic; inhibits protein synthesis

DOSAGE: See also page 620. *Adults & Peds.* 5–7.5 mg/kg/dose + q8–24h based on renal function. *Neonates.* <1200 g, 0–4 wk: 7.5 mg/kg/dose q12h-18h. *Postnatal age* <7 d. 1200–2000 g: 7.5 mg/kg/dose q12h. >2000 g: 10 mg/kg/dose q12h. *Postnatal age* >7 d. 1200–2000 g: 7 mg/kg/dose q8h. >2000 g: 7.5–10 mg/kg/dose q8h

SUPPLIED: Inj 100, 500 mg/2 mL

NOTES: May be effective against gram (–) bacteria resistant to gentamicin and tobramycin; monitor renal function carefully for dosage adjustments; monitor serum levels (see Table 22–7, pages 631–634)

Amiloride (Midamor)

COMMON USES: HTN and CHF

ACTIONS: K+-sparing diuretic; interferes with K+/Na+ exchange in the distal tubules

DOSAGE: Adults. 5-10 mg PO qd. Peds. 0.625 mg/kg/d

SUPPLIED: Tabs 5 mg

NOTES: Hyperkalemia possible; monitor serum K⁺ levels

Aminocaproic Acid (Amicar)

COMMON USES: Excessive bleeding resulting from systemic hyperfibrinolysis and urinary fibrinolysis

ACTIONS: Inhibits fibrinolysis via inhibition of TPA substances

DOSAGE: Adults. 5 g IV or PO (1st h) followed by 1–1.25 g/h IV or PO. Peds. 100 mg/kg IV (1st h), (Max dose/d: 30 g), then 1 g/m²/h; max 18 g/m²/d

SUPPLIED: Tabs 500 mg; syrup 250 mg/mL; inj 250 mg/mL

NOTES: Administer for 8 h or until bleeding is controlled; contra in DIC; not for upper urinary tract bleeding

Amino-Cerv pH 5.5 Cream

COMMON USES: Mild cervicitis, postpartum cervicitis/cervical tears, postcauterization, postcryosurgery, and postconization

DOSAGE: 1 applicator full intravaginally hs for 2-4 wk

SUPPLIED: Vaginal cream

NOTES: Contains 8.34% urea, 0.5% sodium propionate, 0.83% methionine, 0.35% cystine, 0.83% inositol, and benzalkonium chloride

Aminoglutethimide (Cytadren)

COMMON USES: Adrenal cortex carcinoma, Cushing's syndrome, breast cancer, and prostate

ACTIONS: Inhibits adrenal steroidogenesis and adrenal conversion of androgens to estrogens

DOSAGE: 750-1500 mg/d in ÷ doses plus hydrocortisone 20-40 mg/d

SUPPLIED: Tabs 250 mg

NOTES: *Toxicity symptoms:* Adrenal insufficiency ("medical adrenalectomy"), hypothyroidism, masculinization, hypotension, vomiting, rare hepatotoxicity, rash, myalgia, and fever

Aminophylline

Used for emergency care (see Chapter 21)

COMMON USES: Asthma and bronchospasm

ACTIONS: Relaxes the smooth muscle of the bronchi and pulmonary blood vessels

DOSAGE: Adults. Acute asthma: Load 6 mg/kg IV, then 0.4–0.9 mg/kg/h IV cont inf. Chronic asthma: 24 mg/kg/24h PO or PR ÷ q6h. Peds. Load 6 mg/kg IV, then 1.0 mg/kg/h IV cont inf

SUPPLIED: Tabs 100, 200 mg; soln 105 mg/5 mL; supp 250, 500 mg; inj 25 mg/mL

NOTES: Individualize dosage. *Toxicity symptoms:* Nausea and vomiting, irritability, tachycardia, ventricular arrhythmias, and seizures; follow serum levels carefully (as theophylline, see Table 22–7, pages 631–634); aminophylline is about 85% theophylline; erratic absorption with rectal doses

Amiodarone (Cordarone) (Pacerone)

COMMON USES: Recurrent VF or hemodynamically unstable VT

ACTIONS: Class III antiarrhythmic

DOSAGE: Adults. Loading dose: 800–1600 mg/d PO for 1–3 wk. Maintenance: 600–800 mg/d PO for 1 mo, then 200–400 mg/d IV: 15 mg/min for 10 min, followed by 1 mg/min for 6 h, then a maintenance dose of 0.5 mg/min cont inf. **Peds.** 10–15 mg/kg/24h ÷ q12h PO for 7–10 d, then 5 mg/kg/24h ÷ q12h or qd (infants and neonates may require a higher loading dose)

SUPPLIED: Tabs 200 mg; inj 50 mg/mL

NOTES: Average half-life is 53 d; potentially toxic effects leading to pulmonary fibrosis, liver failure, and ocular opacities, as well as exacerbation of arrhythmias; IV concentrations of 0.2 mg/mL administered via a central catheter

Amitriptyline (Elavil, others)

COMMON USES: Depression, peripheral neuropathy, chronic pain, and cluster and migraine headaches

ACTIONS: Tricyclic antidepressant; inhibits reuptake of serotonin and norepinephrine by the presynaptic neuronal membrane

DOSAGE: Adults. Initially, 30–50 mg PO hs; may ↑ to 300 mg hs. Peds. Not recommended for children <12 y unless for chronic pain; initially, 0.1 mg/kg PO hs, then advance over 2–3 wk to 0.5–2 mg/kg PO hs

SUPPLIED: Tabs 10, 25, 50, 75, 100, 150 mg; inj 10 mg/mL

NOTES: Strong anticholinergic side effects; may cause urine retention and sedation; overdose may be fatal

Amlodipine (Norvasc)

COMMON USES: HTN, chronic stable angina, and vasospastic angina

ACTIONS: Calcium channel-blocking agent; produces relaxation of coronary vascular smooth

muscle

DOSAGE: 2.5–10 mg/d PO **SUPPLIED:** Tabs 2.5, 5, 10 mg

NOTES: May be taken without regard to meals

Ammonium Aluminum Sulfate (Alum)

COMMON USES: Hemorrhagic cystitis when bladder irrigation fails

ACTIONS: Astringent

DOSAGE: 1-2% soln used with constant bladder irrigation with NS

SUPPLIED: Powder for reconstitution

NOTES: Can be used safely without anesthesia and in the presence of vesicoureteral reflux. Encephalopathy possible; obtain aluminum levels, especially in renal insufficiency. Alum soln often precipitates and occludes catheters

Amoxapine (Asendin)

COMMON USES: Depression and anxiety

ACTIONS: Tricyclic antidepressant; reduces reuptake of serotonin and norepinephrine

DOSAGE: Initially, 150 mg PO hs or 50 mg PO tid; ↑ to 300 mg/d

SUPPLIED: Tabs 25, 50, 100, 150 mg

NOTES: ↓ in elderly; taper slowly when discontinuing therapy

Amoxicillin (Amoxil, Polymox, others)

COMMON USES: Infections resulting from susceptible gram (+) bacteria (streptococci) and gram (-) bacteria (*H. influenzae*, *E. coli*, *P. mirabilis*)

ACTIONS: β-Lactam antibiotic; inhibits cell wall synthesis

DOSAGE: *Adults.* 250–500 mg PO tid or 500–875 mg bid. *Peds.* 25–100 mg/kg/24h PO ÷ q8h. 200–400 mg PO bid (equivalent to 125–250 mg tid)

SUPPLIED: Caps 250, 500 mg; chewable tabs 125, 200, 250, 400 mg; susp 50 mg/mL, 125, 250

mg/SmL; tabs 500, 875 mg
NOTES: Cross-hypersensitivity with penicillin; may cause diarrhea; skin rash common; many hospital strains of *E. coli* resistant

Amoxicillin and Clavulanic Acid (Augmentin)

COMMON USES: Infections caused by β -lactamase-producing strains of *H. influenzae*, *S. aureus*, and *E. coli*

ACTIONS: Combination of a β -lactam antibiotic and a β -lactamase inhibitor

DOSAGE: Adults. 250–500 mg PO q8h or 875 mg q12h. Peds. 20–40 mg/kg/d as amoxicillin PO \div q8h or 45 mg/kg/d \div q12h

SUPPLIED: (Expressed as amoxicillin/clavulanic acid) Tabs 250/125, 500/125, 875/125 mg; chewable tabs 125/31.25, 200/28.5, 250/62.5, 400/57 mg; susp 125/31.25, 250/62.5, 200/28.5, 400/57 mg/5 mL

NOTES: Do not substitute two 250-mg tabs for one 500-mg tab or an overdose of clavulanic acid will occur; may cause diarrhea and GI intolerance

Amphotericin B (Fungizone)

COMMON USES: Severe, systemic fungal infections; oral and cutaneous candidiasis

ACTIONS: Binds to ergosterol in the fungal membrane, altering membrane permeability

DOSAGE: Adults & Peds. Test dose of 1 mg in adults or 0.1 mg/kg to 1 mg in children, then 0.25–1.5 mg/kg/24h IV over 2–6 h. Doses often range from 25 to 50 mg/d or every other day. Total dose varies with indication. Oral: 1 mL qid. Topical: Apply bid–qid for 1–4 wk depending on infection

SUPPLIED: Powder for inj 50 mg/vial, oral susp 100 mg/mL, cream, lotion, oint 3%

NOTES: Monitor renal function; hypokalemia and hypomagnesemia possible from renal wasting; pretreatment with acetaminophen and antihistamines (Benadryl) help minimize adverse effects associated with IV infusion

Amphotericin B Cholesteryl (Amphotec)

COMMON USES: Refractory invasive fungal infection in persons intolerant to conventional amphotericin B

ACTIONS: Binds to sterols in the cell membrane, resulting in changes in membrane permeability **DOSAGE:** *Adults & Peds.* Test dose of 1.6–8.3 mg, over 15–20 min, followed by a dose of 3–4

mg/kg/d. Infuse at a rate of 1 mg/kg/h **SUPPLIED:** Powder for inj 50 mg, 100 mg/vial

NOTES: Do NOT use in-line filter, final concentration 0.6 mg/mL

Amphotericin B Lipid Complex (Abelcet)

COMMON USES: Refractory invasive fungal infection in persons intolerant to conventional amphotericin B

ACTIONS: Binds to sterols in the cell membrane, resulting in changes in membrane permeability **DOSAGE:** 5 mg/kg/d IV administered as a single daily dose; infuse at a rate of 2.5 mg/kg/h

SUPPLIED: Inj 5 mg/mL

NOTES: Filter soln with a 5-mm filter needle; do not mix in electrolyte-containing solns. If $\inf > 2 h$, manually mix contents of the bag

Amphotericin B Liposomal (Ambisome)

COMMON USES: Refractory invasive fungal infection in persons intolerant to conventional amphotericin B

ACTIONS: Binds to sterols in the cell membrane, resulting in changes in membrane permeability

DOSAGE: Adults & Peds. 3-5 mg/kg/d, infused over 60-120 min

SUPPLIED: Powder for inj 50 mg

Ampicillin (Amcil, Omnipen, others)

COMMON USES: Susceptible gram (-) (Shigella, Salmonella, E. coli, H. influenzae, and P. mirabilis) and gram (+) (streptococci) bacteria

ACTIONS: β-Lactam antibiotic; inhibits cell wall synthesis

DOSAGE: Adults. 500 mg to 2 g IM or IV q6h or 250–500 mg PO q6h. Peds. Neonates <7 d: 50–100 mg/kg/24h IV + q8h. Term infants: 75–150 mg/kg/24h + q6–8h IV or PO. Children > 1 mo: 100–200 mg/kg/24h + q4–6h IM or IV; 50–100 mg/kg/24h + q6h PO up to 250 mg/dose. Meningitis: 200–400 mg/kg/24h + q4–6h IV

SUPPLIED: Caps 250, 500 mg; susp 100 mg/mL (reconstituted as drops), 125 mg/5 mL, 250 mg/5 mL, 500 mg/5 mL; powder for inj 125 mg, 250 mg, 500 mg, 1 g, 2 g, 10 g/vial

NOTES: Cross-hypersensitivity with penicillin; can cause diarrhea and skin rash; many hospital strains of *E. coli* now resistant

Ampicillin-Sulbactam (Unasyn)

COMMON USES: Infections caused by β -lactamase-producing strains of *S. aureus, Enterococcus, H. influenzae, P. mirabilis, and Bacteroides* spp

ACTIONS: Combination of a β -lactam antibiotic and a β -lactamase inhibitor

DOSAGE: *Adults.* 1.5–3.0 g IM or IV q6h. *Peds.* 100–200 mg ampicillin/kg/d (150–300 mg Unasyn) q6h

SUPPLIED: Powder for inj 1.5, 3.0 g/vial

NOTES: 2:1 ratio of ampicillin: Sulbactam; adjust dose in renal failure; observe for hypersensitivity reactions

Amprenavir (Agenerase)

COMMON USES: HIV infection

ACTIONS: Protease inhibitor, prevents the maturation of the virion to a mature viral particle

DOSAGE: Adults. 1200 mg bid. Peds. 20 mg/kg bid or 15 mg/kg tid up to 2400 mg/d

SUPPLIED: Caps 50, 150 mg; soln 15 mg/mL

NOTES: Caps and soln contain vitamin E exceeding the reference daily intake amounts; avoid high-fat meals with administration; many drug interactions; life-threatening rash, hyperglycemia, and fat redistribution possible; use with caution in persons with known sulfa allergy

Amrinone (Inocor)

Used for emergency cardiac care (see Chapter 21)

COMMON USES: Short-term Rx low cardiac output states and pulmonary HTN

ACTIONS: Positive inotrope with vasodilator activity

DOSAGE: Adults & Peds. Initially, give IV bolus of 0.75 mg/kg over 2–3 min followed by a maintenance dose of 5–10 µg/kg/min

SUPPLIED: Inj 5 mg/mL

NOTES: Not to exceed 10 mg/kg/d; incompatible with dextrose-containing solns; monitor for fluid and electrolyte changes and renal function during therapy

Anastrozole (Arimidex)

COMMON USES: Breast cancer following tamoxifen

ACTIONS: Selective nonsteroidal aromatase inhibitor, ↓ circulating estradiol

DOSAGE: 1 mg/d SUPPLIED: Tabs 1 mg

NOTES: No detectable effect on adrenal corticosteroids or aldosterone; may ↑ cholesterol levels

Anistreplase (Eminase)

Used for emergency cardiac care (see Chapter 21)

COMMON USES: AMI

ACTIONS: Thrombolytic agent; activates the conversion of plasminogen to plasmin, promoting thrombolysis

inrombolysi

DOSAGE: 30 U IV over 2–5 min **SUPPLIED:** Vials containing 30 U

NOTES: May not be effective if readministered >5 d after the previous dose of anistreplase, streptokinase, or streptococcal infection because of the production of antistreptokinase antibody

Anthralin (Anthraderm, others)

COMMON USES: Psoriasis
ACTIONS: Keratolytic
DOSAGE: Apply qd

SUPPLIED: Cream, oint 0.1; 0.2; 0.25; 0.4; 0.5; 1%

Antihemophilic Factor [Factor VIII] [AHF] (Monoclate)

COMMON USES: Classic hemophilia A

ACTIONS: Provides factor VIII needed to convert prothrombin to thrombin

DOSAGE: Adults & Peds. 1 AHF unit/kg increases factor VIII conc in the body by approximately 2%. Units required = (kg) (desired factor VIII ↑ as % normal) × (0.5). Prophylaxis of spontaneous hemorrhage = 5% normal. Hemostasis following trauma or surgery = 30% normal. Head injuries, major surgery, or bleeding = 80–100% normal. Patient's % of normal level of factor VIII concentration must be ascertained prior to dosing for these calculations

SUPPLIED: Check each vial for number of units contained

NOTES: Not effective in controlling bleeding in von Willebrand's disease

Antithymocyte Globulin [ATG] (Atgam)

COMMON USES: Allograft rejection in transplant patients

ACTIONS: Reduces the number of circulating, thymus-dependent lymphocytes

DOSAGE: Adults & Peds. 10-15 mg/kg/d

SUPPLIED: Inj 50 mg/mL

NOTES: Do not administer in cases of prior history of severe systemic reaction to any other equine γ -globulin preparation; discontinue treatment with severe thrombocytopenia or leukopenia

Apraclonidine (Iodipine)

COMMON USES: Glaucoma ACTIONS: α₂-Adrenergic agonist DOSAGE: 1–2 gtt of 0.5% tid SUPPLIED: 0.5, 1.0% soln

Aprotinin (Trasylol)

COMMON USES: Reduction or prevention of blood loss in patients undergoing a CABG

ACTIONS: Protease inhibitor; antifibrinolytic

DOSAGE: *High-dose:* 2 million KIU load, 2 million KIU for the pump prime dose, followed by 500,000 KIU/h until surgery ends. *Low-dose:* 1 million KIU load, 1 million KIU for the pump prime dose, followed by 250,000 KIU/h until surgery ends. Max total dose of 7 million KIU

SUPPLIED: Inj 1.4 mg/mL (10,000 KIU/mL)

NOTES: 1000/KIU = 0.14 mg of aprotinin. Give all patients 1-mL IV test dose to assess for allergic reaction

Ardeparin (Normiflo)

COMMON USES: Prevention of DVT and PE following knee replacement

ACTIONS: Low-molecular-weight heparin

DOSAGE: 35-50 U/kg SC q12h. Begin the day of surgery and continue up to 14 d

SUPPLIED: Inj 5000, 10,000 IU/0.5 mL **NOTES:** Laboratory monitoring not necessary

Artificial Tears (Tears Naturale, others)

COMMON USES: Dry eyes ACTIONS: Ocular lubricant DOSAGE: 1–2 gtt tid–qid SUPPLIED: OTC soln

L-Asparaginase (Elspar)

COMMON USES: ALL (in combination with other agents)

ACTIONS: Protein synthesis inhibitor

DOSAGE: 500-20,000 IU/m²/d for 1-14 d. (Refer to specific protocols)

SUPPLIED: Inj 10,000 IU

NOTES: *Toxicity symptoms:* Hypersensitivity reactions in 20–35% (spectrum of urticaria to anaphylaxis), test dose recommended; rare GI toxicity (mild nausea/anorexia, pancreatitis)

Aspirin (Bayer, St. Joseph, others)

COMMON USES: Mild pain, headache, fever, inflammation, prevention of emboli, and prevention

of MI

ACTIONS: Prostaglandin inhibitor

DOSAGE: Adults. Pain, fever: 325–650 mg q4–6h PO or PR. RA: 3–6 g/d PO in + doses. Platelet inhibitory action: 325 mg PO qd. Prevention of MI: 160–325 mg PO qd. Peds. Caution: Use linked to Reye's syndrome; avoid use with viral illness in children. Antipyretic: 10–15 mg/kg/dose PO or PR q4h up to 80 mg/kg/24h. RA: 60–100 mg/kg/24h PO + q4–6h (monitor serum levels to maintain between 15 and 30 mg/dL)

SUPPLIED: Tabs 325, 500 mg; chewable tabs 81 mg; EC tabs 165, 325, 500, 650, 975 mg; SR tabs 650, 800 mg; effervescent tabs 325, 500 mg; supp 120, 200, 300, 600 mg

NOTES: GI upset and erosion common adverse reactions; discontinue use 1 wk prior to surgery to avoid postoperative bleeding complications

Aspirin and Butalbital Compound (Fiorinal, Lanorinal, others) [C]

COMMON USES: Tension headache, pain **ACTIONS:** Combination barbiturate and analgesic

DOSAGE: 1-2 PO q4h PRN, max 6 tabs/d

SUPPLIED: Caps Fiorgen PF, Fiorinal, Lanorinal, Marnal: Aspirin 325 mg/butalbital 50 mg/caffeine 40 mg. Tabs Fiorinal, Lanorinal, Marnal: Aspirin 325 mg/butalbital 50 mg/ caffeine 40 mg/caffeine 40 mg/

mg

NOTES: Butalbital habit-forming

Aspirin + Butalbital, Caffeine and Codeine (Fiorinal + Codeine) [C]

COMMON USES: Mild pain; headache, especially when associated with stress

ACTIONS: Sedative analgesic, narcotic analgesic

DOSAGE: 1–2 tabs (caps) PO q4–6h PRN

SUPPLIED: Each cap or tab contains 325 mg aspirin, 40 mg caffeine, 50 mg of butalbital, codeine:

No. 3 = 30 mg

NOTES: Significant drowsiness associated with use

Aspirin + Codeine (Empirin No. 2, No. 3, No. 4) [C]

COMMON USES: Mild to moderate pain

ACTIONS: Combined effects of aspirin and codeine

DOSAGE: Adults. 1-2 tabs PO q4-6h PRN. Peds. Aspirin 10 mg/kg/dose; codeine 0.5-1.0

mg/kg/dose q4h

SUPPLIED: Tabs 325 mg of aspirin and codeine as in Notes **NOTES:** Codeine in No. 2 = 15 mg, No. 3 = 30 mg, No. 4 = 60 mg

Atenolol (Tenormin)

Used for emergency cardiac care (see Chapter 21)

COMMON USES: HTN, angina, MI

ACTIONS: Competitively blocks β -adrenergic receptors, β_1

DOSAGE: HTN and angina: 50-100 mg/d PO. AMI: 5 mg IV ×2 over 10 min, then 50 mg PO bid if

olerated

SUPPLIED: Tabs 25, 50, 100 mg; inj 5 mg/10 mL

Atenolol and Chlorthalidone (Tenoretic)

COMMON USES: HTN

ACTION: β-Adrenergic blockade with diuretic

DOSAGE: 50-100 mg/d PO

SUPPLIED: Tenoretic 50: Atenolol 50 mg/chlorthalidone 25 mg; Tenoretic 100: Atenolol 100

mg/chlorthalidone 25 mg

Atorvastatin (Lipitor)

COMMON USES: Elevated cholesterol and triglycerides

ACTIONS: HMG-CoA reductase inhibitor

DOSAGE: Initial dose 10 mg/d, may be ↑ to 80 mg/d

SUPPLIED: Tabs 10, 20, 40, 80 mg

NOTES: May cause myopathy, monitor LFT regularly

Atovaquone (Mepron)

COMMON USES: Rx and prevention mild to moderate PCP

ACTIONS: Inhibits nucleic acid and ATP synthesis

DOSAGE: Rx: 750 mg PO bid for 21 d. Prevention: 1500 mg PO once/d

SUPPLIED: Suspension 750 mg/5 mL

NOTES: Take with meals

Atracurium (Tracrium)

COMMON USES: Adjunct to anesthesia to facilitate endotracheal intubation

ACTIONS: Nondepolarizing neuromuscular blocker

DOSAGE: Adults & Peds. 0.4–0.5 mg/kg IV bolus, then 0.08–0.1 mg/kg q 20–45 min PRN

SUPPLIED: Inj 10 mg/mL

NOTES: Patient must be intubated and on controlled ventilation. Use adequate amounts of sedation and analgesia

Atropine

Used for emergency care (see Chapter 21)

COMMON USES: Preanesthetic; symptomatic bradycardia and asystole

ACTIONS: Antimuscarinic agent; blocks acetylcholine at parasympathetic sites

DOSAGE: Adults. Emergency cardiac care, bradycardia (see Chapter 21). Preanesthetic: 0.3–0.6 mg IM. Peds. Emergency cardiac care: 0.01–0.03 mg/kg IV q 2–5 min max 1.0 mg; min dose 0.1 mg. Preanesthetic: 0.01 mg/kg/dose SC/IV (max 0.4 mg)

SUPPLIED: Tabs 0.3, 0.4, 0.6; inj 0.05, 0.1, 0.3, 0.4, 0.5, 0.8, 1.0 mg/mL

NOTES: Blurred vision, urinary retention, and dried mucous membranes

Azathioprine (Imuran)

COMMON USES: Adjunct for the prevention of rejection following organ transplantation; RA; SLE

ACTIONS: Immunosuppressive agent; antagonizes purine metabolism

DOSAGE: Adults & Peds. 1–3 mg/kg/d IV or PO

SUPPLIED: Tabs 50 mg; inj 100 mg/20 mL

NOTES: GI intolerance; inj should be handled with cytotoxic precautions. Interaction with allopurinol

Azithromycin (Zithromax)

COMMON USES: Acute bacterial exacerbations of COPD, mild community-acquired pneumonia, pharyngitis, otitis media, skin and skin structure infections, nongonococcal urethritis, and PID. Rx and prevention of MAC infections in HIV-infected persons

ACTIONS: Macrolide antibiotic; inhibits protein synthesis

POSAGE: Adults. Oral: Respiratory tract infections: 500 mg on the first day, followed by 250 mg/d PO for 4 more d. Nongonococcal urethritis: 1 g as a single dose. Prevention of MAC: 1200 mg PO once/wk. IV: 500 mg for at least 2 d, followed by 500 mg PO for total of 7–10 d. **Peds.** Otitis media: 10 mg/kg PO on day 1, then 5 mg/kg/d on days 2–5. Pharyngitis: 12 mg/kg/d PO for 5 d

SUPPLIED: Tabs 250, 600 mg; susp 1-g single-dose packet; susp 100, 200 mg/5 mL; inj 500 mg

NOTES: Take susp on an empty stomach; tabs may be taken with or without food

Aztreonam (Azactam)

COMMON USES: Infections caused by aerobic gram (-) bacteria, including Pseudomonas aeruginosa

ACTIONS: Monobactam antibiotic; inhibits cell wall synthesis

DOSAGE: Adults. 1–2 g IV/IM q6–12h. Peds. Premature infants: 30 mg/kg/dose IV q12h. Term infants, children: 30 mg/kg/dose q6–8h

SUPPLIED: Inj 500 mg, 1 g, 2 g

NOTES: Not effective against gram (+) or anaerobic bacteria; may be given to penicillin-allergic patients; adjust dose in renal impairment

Bacitracin, Topical (Baciguent)

Bacitracin and Polymyxin B, Topical (Polysporin)

Bacitracin, Neomycin and Polymyxin B, Topical (Neosporin Ointment)

Bacitracin, Neomycin, Polymyxin B and Hydrocortisone, Topical (Cortisporin)

Bacitracin, Neomycin, Polymyxin B and Lidocaine, Topical (Clomycin)

COMMON USES: Prevention and Rx of minor cuts, scrapes and burns

ACTIONS: Topical antibiotic with added effects based on components (antiinflammatory and analgesic)

DOSAGE: Apply sparingly bid-qid

SUPPLIED: Bacitracin 500 U/g oint. Bacitracin 500 U/polymyxin B sulfate 10,000 U/g oint and powder. Bacitracin 400 U/neomycin/ 3.5 mg/polymyxin B 5000 U/g oint (for Neosporin Cream, see page 576). Bacitracin 400 U/neomycin 3.5 mg/polymyxin B/10,000 U/hydrocortisone 10 mg/g oint. Bacitracin 500 U/neomycin 3.5 g/polymyxin B 5000 U/lidocaine 40 mg/g oint

NOTES: Systemic and irrigation forms of bacitracin available but not generally used due to potential toxicity. *Note:* Neosporin ointment different from cream (page 576)

Bacitracin, Ophthalmic (AK-Tracin Ophthalmic)

Bacitracin and Polymyxin B, Ophthalmic (AK Poly Bac Ophthalmic, Polysporin Ophthalmic)

Bacitracin, Neomycin and Polymyxin B, Ophthalmic (AK Spore Ophthalmic, Neosporin Ophthalmic)

Bacitracin, Neomycin, Polymyxin B and Hydrocortisone, Ophthalmic (AK Spore HC Ophthalmic, Cortisporin Ophthalmic)

COMMON USES: Blepharitis, conjunctivitis, and prophylactic treatment of corneal abrasions ACTIONS: Topical antibiotic with added effects based on components (antiinflammatory) DOSAGE: Apply q3—4h into conjunctival sac SUPPLIED: See Topical equivalents, above

Baclofen (Lioresal, others)

COMMON USES: Spasticity secondary to severe chronic disorders, eg, MS or spinal cord lesions, trigeminal neuralgia

ACTIONS: Centrally acting skeletal muscle relaxant; inhibits transmission of both monosynaptic and polysynaptic reflexes at the spinal cord

DOSAGE: Adults. Initially, 5 mg PO tid; ↑ q 3 d to max effect; max 80 mg/d. Peds. 2–7 y: 10–15 mg/d ÷ q8h; titrate to effect or max of 40 mg/d. >8 y: Max of 60 mg/d. IT: Through implantable pump

SUPPLIED: Tabs 10, 20 mg; IT inj 10 mg/20 mL, 10 mg/5 mL

NOTES: Use caution in epilepsy and neuropsychiatric disturbances, withdrawal may occur with abrupt discontinuation

Basiliximab (Simulect)

COMMON USES: Prevention of acute organ transplant rejections

ACTIONS: IL-2 receptor antagonists

DOSAGE: Adults. 20 mg IV 2 h prior to transplant, then 20 mg IV 4 d posttransplant. Peds. 12 mg/m 2 up to a max of 20 mg 2 h prior to transplant, then the same dose IV 4 d posttransplant

SUPPLIED: Inj 20 mg

NOTES: Murine/human monoclonal antibody

BCG [Bacillus Calmette-Guerin] (Theracys, TICE BCG)

COMMON USES: Bladder carcinoma, TB prophylaxis

ACTIONS: Immunomodulator

DOSAGE: Bladder cancer, contents of 1 vial prepared and instilled in bladder for 2 h. Repeat once weekly for 6 wk; repeat 3 weekly doses 3, 6, 12, 18, and 24 mo after the initial therapy

SUPPLIED: Inj 27 mg $(3.4 + 3 \times 10^8 \text{ CFU})/\text{vial (TheraCys)}$, $1-8 \times 10^8 \text{ CFU/vial (TICE BCG)}$

NOTES: Intravesical toxicity symptoms: Hematuria, urinary frequency, dysuria, and bacterial urinary tract infection. Routine adult BCG immunization in the U.S. no longer recommended. BCG vaccine occasionally used in high risk-children who are negative on the PPD skin test and cannot be given isoniazid prophylaxis.

Becaplermin (Regranex Gel)

COMMON USES: Adjunct to local wound care in diabetic foot ulcers

ACTIONS: Recombinant human PDGF, enhanced formation of granulation tissue

DOSAGE: Based on size of lesion; 11/6-in. ribbon from 2-g tube, %-in. ribbon from 7.5- or 15-g tube/in.² of ulcer; apply and cover with moist gauze; rinse after 12 h; do not reapply; repeat process 12 h later

SUPPLIED: 0.01% gel in 2-, 7.5-, 15-g tubes

NOTES: Use along with good wound care; wound must be vascularized

Beclomethasone (Beclovent Inhaler, Vanceril Inhaler Quar)

COMMON USES: Chronic asthma
ACTIONS: Inhaled corticosteroid

DOSAGE: Adults. 2–4 inhal tid–qid (max 20/d); Vanceril double strength: 2 inhal bid (max 10/d); quar 1–4 inhal bid. **Peds.** 1–2 inhal tid–qid (max 10/d); Vanceril double strength: 2 inhal bid (max 5/d)

 $\textbf{SUPPLIED:} \ \ Oral\ met-dose\ inhaler;\ 42,\ 84\ \mu g/inhal;\ quar\ HFA\ formulation\ 40,\ 80\ \mu g/inhal$

NOTES: Not effective for acute asthmatic attacks; may cause oral candidiasis

Beclomethasone (Beconase, Vancenase Nasal Inhaler)

COMMON USES: Allergic rhinitis refractory to conventional therapy with antihistamines and decongestants

ACTIONS: Inhaled corticosteroid

DOSAGE: Adults. 1 spray intranasally bid-qid; Aqueous inhal: 1–2 spays/nostril qd-bid. Peds. 6–12 y: 1 spray intranasally tid

SUPPLIED: Nasal met-dose inhaler

NOTES: Nasal spray delivers 42 µg/dose and 84 µg/dose

Belladonna and Opium Supp (B & O Supprettes) [CII]

COMMON USES: Bladder spasms; moderate to severe pain

ACTIONS: Antispasmodic

DOSAGE: Insert 1 supp PR q6h PRN. 15A = 30 mg powdered opium; 16.2 mg belladonna extract.

16A = 60 mg powdered opium; 16.2 mg belladonna extract

SUPPLIED: Supp 15A, 16A

NOTES: Anticholinergic side effects; caution patients about sedation, urinary retention, and constipation

Benazepril (Lotensin)

COMMON USES: HTN ACTIONS: ACE inhibitor DOSAGE: 10–40 mg/d PO SUPPLIED: Tabs 5, 10, 20, 40 mg

NOTES: Symptomatic hypotension in patients taking diuretics; nonproductive cough

Benzocaine and Antipyrine (Auralgan)

COMMON USES: Analgesia in severe otitis media

ACTIONS: Anesthetic and local decongestant

DOSAGE: Fill the ear and insert a moist cotton plug; repeat 1-2 h PRN

SUPPLIED: Soln

NOTES: Do not use with perforated eardrum

Benzonatate (Tessalon Perles)

COMMON USES: Symptomatic relief of cough

ACTIONS: Anesthetizes the stretch receptors in the respiratory passages

DOSAGE: Adults & Peds >10 v. 100 mg PO tid

SUPPLIED: Caps 100 mg

NOTES: May cause sedation; do not chew or puncture the caps

Benztropine (Cogentin)

COMMON USES: Parkinsonism and drug-induced extrapyramidal disorders

ACTIONS: Partially blocks striatal cholinergic receptors

DOSAGE: Adults. 0.5-6 mg PO, IM, or IV in ÷ doses/d. Peds >3 y. 0.02-0.05 mg/kg/dose 1-2/d

SUPPLIED: Tabs 0.5, 1.0, 2.0; inj 1 mg/mL

NOTES: Anticholinergic side effects

Bepridil (Vascor)

COMMON USES: Chronic stable angina **ACTIONS:** Calcium channel-blocking agent

DOSAGE: 200–400 mg/d PO **SUPPLIED:** Tabs 200, 300, 400 mg

NOTES: Agranulocytosis and serious ventricular arrhythmias, including Torsades de Pointes

Beractant (Survanta)

COMMON USES: Prevention and Rx of RDS in premature infants

ACTIONS: Replacement of pulmonary surfactant

DOSAGE: 100 mg/kg administered via endotracheal tube. May be repeated 3 more × q6h for a max

of 4 doses/48h

SUPPLIED: Suspension 25 mg of phospholipid/mL **NOTES:** Administer via 4-quadrant method

Betaxolol (Kerlone)

COMMON USES: HTN

ACTIONS: Competitively blocks β -adrenergic receptors (β_1)

DOSAGE: 10–20 mg/d SUPPLIED: Tabs 10, 20 mg

Betaxolol, Ophthalmic (Betoptic)

COMMON USES: Glaucoma

ACTIONS: Competitively blocks β-adrenergic receptors (β₁)

DOSAGE: 1 gtt bid

SUPPLIED: Soln 0.5%; susp 0.25%

Bethanechol (Urecholine, Duvoid, Various)

COMMON USES: Neurogenic atony of the bladder with urinary retention, acute postoperative and postpartum functional (nonobstructive) urinary retention

ACTIONS: Stimulates cholinergic receptors in the smooth muscle of the bladder and GI tract

DOSAGE: Adults. 10-50 mg PO tid-qid or 2.5-5 mg SC tid-qid and PRN. Peds. 0.6 mg/kg/24h

PO \div tid-qid or 0.15–2 mg/kg/d SC \div 3–4×/d

SUPPLIED: Tabs 5, 10, 25, 50 mg; inj 5 mg/mL

NOTES: Contra in bladder outlet obstruction, asthma, and CAD; do NOT administer IM or IV

Bicalutamide (Casodex)

COMMON USES: Advanced prostate cancer (in combination with GnRH agonists such as leuprolide or goserelin)

ACTIONS: Nonsteroidal antiandrogen

DOSAGE: 50 mg/d **SUPPLIED:** Caps 50 mg

NOTES: Toxicity symptoms: Hot flashes, loss of libido, impotence, diarrhea, nausea and vomiting, gynecomastia, and LFT elevation

Bicarbonate (see Sodium Bicarbonate page 602)

Bisacodyl (Dulcolax)

COMMON USES: Constipation; preoperative bowel preparation

ACTIONS: Stimulates peristalsis

DOSAGE: Adults. 5–15 mg PO or 10 mg PR PRN. Peds. <2 y: 5 mg PR PRN. >2 y: 5 mg PO or 10 mg PR PRN

SUPPLIED: EC tabs 5 mg; supp 10 mg

NOTES: Contra in acute abdomen or bowel obstruction; do NOT chew tabs; do NOT give within 1 h of antacids or milk

Bismuth Subsalicylate (Pepto-Bismol)

COMMON USES: Indigestion, nausea, and diarrhea. In combination for treatment of *H. pylori* infec-

tion

ACTIONS: Antisecretory and antiinflammatory effects

DOSAGE: Adults. 2 tabs or 30 mL PO PRN (max 8 doses/24h). *Peds.* 3–6 y: ½ tab or 5 mL PO PRN (max 8 doses/24h). 6–9 y: ½ tab or 10 mL PO PRN (max 8 doses/24h). 9–12 y: 1 tab or 15 mL PO PRN (max 8 doses/24h)

SUPPLIED: Chewable tabs 262 mg; liq 262, 524 mg/15 mL

NOTES: May turn tongue and stools black

Bisoprolol (Zebeta)

COMMON USES: HTN

ACTIONS: Competitively blocks β -adrenergic receptors (β_1)

DOSAGE: 5–10 mg/d (max dose 20 mg/d)

SUPPLIED: Tabs 5, 10 mg

Bitolterol (Tornalate)

COMMON USES: Prophylaxis and Rx of asthma and reversible bronchospasm

ACTIONS: Sympathomimetic bronchodilator; stimulates β_2 -adrenergic receptors in the lungs **DOSAGE:** *Adults & Children.* >12 y: 2 inhal q8h; acute 2 inhal 1–3 min apart, repeat × 1

SUPPLIED: Aerosol 0.8%

Bleomycin Sulfate (Blenoxane)

COMMON USES: Testicular carcinomas; Hodgkin's and non-Hodgkin's lymphomas; cutaneous lymphomas; and squamous cell carcinomas of the head and neck, larynx, cervix, skin, and penis

ACTIONS: Induces breakage (scission) of single- and double-stranded DNA **DOSAGE:** 10–20 mg (U)/m² 1–2/wk (Refer to specific protocols)

SUPPLIED: Inj 15 mg (15 U)

NOTES: Toxicity symptoms: Hyperpigmentation (skin staining) and hypersensitivity (rash to anaphylaxis); test dose of 1 mg (U) recommended, especially in lymphoma patients; fever in 50%;

lung toxicity (idiosyncratic and dose-related); pneumonitis may progress to fibrosis. Lung toxicity likely when the total dose >400 mg (U)

Bretylium

COMMON USES: Acute Rx of VF or tachycardia unresponsive to conventional therapy

ACTIONS: Class III antiarrhythmic

DOSAGE: Adults. 5 mg/kg IV rapid inj (1 min); may repeat q 15–30 min with 10 mg/kg (max 30 mg/kg); maintenance 1–2 mg/min IV infusion. **Peds.** Same as adults, except the maintenance dose is 5 mg/kg/dose q6–8h

SUPPLIED: Inj 50 mg/mL; premixed inf 1, 2, 4 mg/mL (limited availability)

NOTES: Nausea and vomiting associated with rapid IV bolus; gradually \downarrow dose and discontinue in 3–5 d; effects seen within the first 10–15 min; transient rise in BP seen initially; hypotension most frequent adverse effect and occurs within the first hours of treatment

Brimonidine (Alphagan)

COMMON USES: Open-angle glaucoma **ACTIONS:** α₂-Adrenergic agonist **DOSAGE:** 1 gtt in eye(s) tid

SUPPLIED: 0.2% soln

Brinzolamide (Azopt)

COMMON USES: Open-angle glaucoma **ACTIONS:** Carbonic anhydrase inhibitor

DOSAGE: 1 gtt in eye(s) tid **SUPPLIED:** 1.0% susp

Bromocriptine (Parlodel)

COMMON USES: Parkinson's syndrome, hyperprolactinemia

ACTIONS: Direct-acting on the striatal dopamine receptors; inhibits prolactin secretion

DOSAGE: Initially, 1.25 mg PO bid; titrate to effect

SUPPLIED: Tabs 2.5 mg; caps 5 mg **NOTES:** Nausea and vertigo common

Buclizine (Bucladin-S Softabs)

COMMON USES: Control of nausea, vomiting, and dizziness of motion sickness

ACTIONS: Centrally acting antiemetic

DOSAGE: 50 mg dissolved in the mouth bid; 50 mg PO prophylactically 30 min prior to travel

SUPPLIED: Tabs 50 mg

NOTES: NOT safe in PRG; contains tartrazine; observe the patient for allergic reactions

Budesonide (Rhinocort, Pulmicort, Pulmicort Respules)

COMMON USES: Allergic and nonallergic rhinitis, asthma

ACTIONS: Steroid

DOSAGE: Intranasal: 2 sprays/nostril bid or 4 sprays/nostril/d; Aqueous: 1 spray/nostril/d. Oral in-

haled: 1-4 inhal bid. Peds. 1-2 inhal bid; Nebulization: 0.25-1 mg given qd or bid

SUPPLIED: Met-dose Turbuhaler, nasal inhaler and aqueous spray; respules 0.25 mg/2 mL, 0.5 mg/2 mL

Bumetanide (Bumex)

COMMON USES: Edema from CHF, hepatic cirrhosis, and renal disease

ACTIONS: Loop diuretic; inhibits reabsorption of sodium and chloride in the ascending loop of Henle and the distal renal tubule

neme and the distal felial tubul

DOSAGE: *Adults.* 0.5–2.0 mg/d PO; 0.5–1.0 mg IV q8–24h (max 10 mg/d). *Peds.* 0.015–0.1 mg/kg/d PO, IV, or IM \div q6–24h

SUPPLIED: Tabs 0.5, 1, 2 mg; inj 0.25 mg/mL

NOTES: Monitor fluid and electrolyte status during treatment

Bupivacaine (Marcaine)

COMMON USES: Peripheral nerve block

ACTIONS: Local anesthetic

DOSAGE: Adults & Peds. Dose dependent on procedure, vascularity of tissues, depth of anesthesia,

and degree of muscle relaxation required (see Chapter 17)

SUPPLIED: Inj 0.25, 0.5, 0.75%

Buprenorphine (Buprenex) [C]

COMMON USES: Moderate to severe pain **ACTIONS:** Opiate agonist—antagonist

DOSAGE: 0.3–0.6 mg IM or slow IV push q6h PRN **SUPPLIED:** Inj 0.324 mg/mL (= 0.3 mg of buprenorphine)

NOTES: May induce withdrawal syndrome in opioid-dependent patients

Bupropion (Wellbutrin, Zyban)

COMMON USES: Depression, adjunct to smoking cessation

ACTIONS: Weak inhibitor of neuronal uptake of serotonin and norepinephrine; inhibits the neuronal

reuptake of dopamine

DOSAGE: Depression: 100–450 mg/d ÷ bid–tid. Smoking cessation: 150 mg/d for 3 d, then 150 mg bid for 8–12 wk

SUPPLIED: Tabs 75, 100 mg; SR tabs 100, 150 mg

NOTES: Associated with seizures; avoid use of alcohol and other CNS depressants

Buspirone (Buspar)

COMMON USES: Short-term relief of anxiety

ACTIONS: Antianxiety agent; selectively antagonizes CNS serotonin receptors

DOSAGE: 5–10 mg PO tid. ↑ dose to desired response; usual dose 20–30 mg/d; max 60 mg/d

SUPPLIED: Tabs 5, 10, 15 mg

NOTES: No abuse potential. No physical or psychological dependence

Busulfan (Myleran)

COMMON USES: CML, preparative regimens for allogeneic and ABMT in high doses

ACTIONS: Alkylating agent

DOSAGE: 4–12 mg/d for several weeks; 16 mg/kg once or 4 mg/kg/d for 4 d in conjunction with another agent in transplant regimens. Refer to specific protocol

SUPPLIED: Tabs 2 mg

NOTES: *Toxicity symptoms:* Myelosuppression, pulmonary fibrosis, nausea (high-dose therapy), gynecomastia, adrenal insufficiency, and hyperpigmentation of the skin

Butorphanol (Stadol) [C]

COMMON USES: Moderate to severe pain and headaches

ACTIONS: Opiate agonist-antagonist with central analgesic actions

DOSAGE: 1-4 mg IM or IV q 3-4 h PRN. Headaches: 1 spray in 1 nostril, may be repeated once if

pain not relieved in 60-90 min

SUPPLIED: Inj 1, 2 mg/mL; nasal spray 10 mg/mL

NOTES: May induce withdrawal syndrome in opioid-dependent patients

Calcipotriene (Dovonex)

COMMON USES: Plaque psoriasis

ACTIONS: Keratolytic

DOSAGE: Apply bid

SUPPLIED: Cream; oint; soln 0.005%

Calcitonin (Cibacalcin, Miacalcin)

COMMON USES: Paget's disease of bone; hypercalcemia; osteogenesis imperfecta, postmenopausal osteoporosis

ACTIONS: Polypeptide hormone

DOSAGE: Paget's salmon form: 100 U/d IM/SC initially, 50 U/d or 50–100 U q1–3d maintenance. Paget's human form: 0.5 mg/d initially; maintenance 0.5 mg 2–3x/wk or 0.25 mg/d, max 0.5 mg bid. Hypercalcemia salmon calcitonin: 4 U/kg IM/SC q12h; ↑ to 8 U/kg q12h, max q6h. Osteoporosis salmon calcitonin: 100 U/d IM/SC; Intranasal 200 U = 1 nasal spray/d

SUPPLIED: Spray, nasal 200 U/activation; inj, human (Cibacalcin) 0.5 mg/vial, salmon 200 U/mL

(2 mL)

NOTES: Human (Cibacalcin) and salmon forms; human only approved for Paget's bone disease

Calcitriol (Rocaltrol)

COMMON USES: Reduction of elevated parathyroid hormone levels, hypocalcemia associated with

dialysis

ACTIONS: 1,25-Dihydroxycholecalciferol, a vitamin D analogue

DOSAGE: Adults. Renal failure: 0.25 µg/d PO, ↑ 0.25 µg/d q 4–6 wk PRN; 0.5 µg 3×/wk IV, ↑ PRN. Hyperparathyroidism: 0.5–2.0 µg/d. Peds. Renal failure: 15 ng/kg/d, ↑ PRN; typical maintenance 30–60 ng/kg/d. Hyperparathyroidism: <5 y, 0.25–0.75 µg/d; >6 y, 0.5–2.0 µg/d

SUPPLIED: Inj 1, 2 μ g/mL (in 1 mL volume); caps 0.25, 0.5 μ g **NOTES:** Monitor dosing to keep calcium levels within normal range

Calcium Acetate (Calphron, Phos-Ex, PhosLo)

COMMON USES: ESRD-associated hyperphosphatemia

ACTIONS: Ca supplement to treat ESRD hypophosphatemia without aluminum

DOSAGE: 2-4 tabs PO with meals

SUPPLIED: Caps Phos-Ex 500 mg (125 mg Ca); Tabs Calphron and Phos-Lo 667 mg (169 mg Ca)

NOTES: Can cause hypercalcemia, monitor Ca levels

Calcium Carbonate (Tums, Alka-Mints)

COMMON USES: Hyperacidity associated with peptic ulcer disease, hiatal hernia, etc

ACTIONS: Neutralizes gastric acid **DOSAGE:** 500 mg-2 g PO PRN

SUPPLIED: Chewable tabs 350, 420, 500, 550, 750, 850 mg; susp

Calcium Glubionate (Neo-Calglucon) [OTC]

COMMON USES: Rx and prevention of Ca deficiency

ACTIONS: Oral Ca supplementation

DOSAGE: Adults. 6–18 g/d \div doses. Peds. 600–2000 mg/kg/d \div qid (9 g/d max)

SUPPLIED: OTC syrup 1.8 g/5 mL = Ca 115 mg/5 mL

Calcium Salts (Chloride, Gluconate, Gluceptate)

Used for emergency cardiac care (see Chapter 21)

COMMON USES: Ca replacement, VF, electromechanical dissociation, Ca blocker toxicity, Mg intoxication, tetany, hyperphosphatemia in ESRD

DOSAGE: Adults. Replacement: 1–2 g/d PO. Cardiac emergencies: CaCl 0.5–1.0 g IV q 10 min or Ca gluconate 1–2 g IV q 10 min. Tetany: 1 g CaCl over 10–30 min; repeat in 6 h PRN. Peds. Replacement: 200–500 mg/kg/24h PO or IV ÷ qid. Cardiac emergency: 100 mg/kg/dose IV of gluconate salt q 10 min. Tetany: 10 mg/kg CaCl over 5–10 min; repeat in 6 h or use inf (200 mg/kg/d max). Adult and Peds. Hypocalcemia due to citrated blood infusion: 0.45 meq Ca/100 mL citrated blood infused

SUPPLIED: CaCl inj 10% = 100 mg/mL = Ca 27.2 mg/mL = 10 mL ampule. Ca gluconate inj 10% = 100 mg/mL = Ca 9 mg/mL; tabs 500 mg = 45 mg Ca, 650 mg = 58.5 mg , 975 mg = 87.75 mg Ca, 1 g = 90 mg Ca. Ca glucoptate inj 220 mg/mL = 18 mg/mL Ca

NOTES: CaCl contains 270 mg (13.6 meq) elemental Ca/g, and calcium gluconate contains 90 mg (4.5 meq) Ca/g. RDA for Ca: Adults = 800 mg/d, Peds = <6 mo 360 mg/d, 6 mo-1 y 540 mg/d, 1-10 y 800 mg/d; 10-18 y 1200 mg/d

Calfactant (Infasurf)

COMMON USES: Prevention and Rx of RSD in infants

ACTIONS: Exogenous pulmonary surfactant

DOSAGE: 3 mL/kg instilled into lungs. May be retreated for a total of 3 doses administered 12 h

apart

SUPPLIED: Intratracheal susp 35 mg/mL

NOTES: Monitor for cyanosis and airway obstruction during administration

Candesartan (Atacand)

COMMON USES: HTN

ACTIONS: Angiotensin II receptor antagonists

DOSAGE: 2–32 mg/d, usual dose is 16 mg/d

SUPPLIED: Tabs 4, 8, 16, 32 mg

Capsaicin (Capsin, Zostrix, etc) [OTC]

COMMON USES: Pain due to postherpetic neuralgia, chronic neuralgia, arthritis, diabetic neuropathy, postoperative pain psoriasis, intractable pruritus

ACTIONS: Topical analgesic DOSAGE: Apply tid—qid

SUPPLIED: OTC creams; gel; lotions; roll-ons

Captopril (Capoten, Various)

COMMON USES: HTN, CHF, LVD, and diabetic nephropathy

ACTIONS: ACE inhibitor

DOSAGE: Adults. HTN: Initially, 25 mg PO bid-tid; ↑ to a maintenance dose q 1–2 wk by 25-mg increments/dose (max 450 mg/d) to desired effect. CHF: Initially, 6.25–12.5 mg PO tid; titrate to desired effect. LVD: 50 mg PO tid. Diabetic nephropathy: 25 mg PO tid. Peds. Infants <2 mo: 0.05–0.5 mg/kg/dose PO q8–24h. Children: Initially, 0.3–0.5 mg/kg/dose PO; ↑ to a max of 6 mg/kg/d

SUPPLIED: Tabs 12.5, 25, 50, 100 mg

NOTES: Use with caution in renal failure. Give 1 h ac; can cause rash, proteinuria, and cough; contra in 2nd or 3rd trimester of PRG.

Carbamazepine (Tegretol)

COMMON USES: Epilepsy and trigeminal neuralgia

ACTIONS: Anticonvulsant

DOSAGE: Adults. Initially, 200 mg PO bid; ↑ by 200 mg/d; usual 800–1200 mg/d in ÷ doses. Peds. <6 y: 5 mg/kg/d, ↑ to 10–20 mg/kg/d ÷ in 2–4 doses. 6–12 y: Initially, 100 mg PO bid or 10 mg/kg/24h PO ÷ qd–bid; ↑ to a maintenance dose of 20–30 mg/kg/24h ÷ tid–qid

SUPPLIED: Tabs 200 mg; chewable tabs 100 mg; XR tabs 100, 200, 400 mg; susp 100 mg/5 mL **NOTES:** Severe hematologic side effects possible; monitor CBC; monitor serum levels (see Table 22–7, pages 631–634); generic products not interchangeable

Carbidopa/Levodopa (Sinemet)

COMMON USES: Parkinson's disease **ACTIONS:** Increases CNS levels of dopamine

DOSAGE: 25/100 bid–qid; ↑ as needed (max 200/2000 mg/d)

SUPPLIED: Tabs (mg of carbidopa/mg of levodopa) 10/100, 25/100, 25/250; Tabs SR (mg of carbidopa/mg of levodopa) 25/100, 50/200

NOTES: Psychiatric disturbances, orthostatic hypotension, dyskinesias, and cardiac arrhythmias

Carboplatin (Paraplatin)

COMMON USES: Ovarian, lung (small-cell and non-small-cell), head and neck, testicular, and brain cancers, and allogeneic and ABMT in high doses

ACTIONS: DNA cross-linker; forms DNA-platinum adducts

DOSAGE: 360 mg/m² (ovarian carcinoma); AUC dosing 4–7 mg/mL (using Calvert's formula: mg = AUC × [25 + calculated GFR]); also may be adjusted based on pretreatment platelet count. CrCl. and BSA (Egorin's formula); up to 1500 mg/m² used in ABMT setting (refer to specific protocols)

SUPPLIED: Inj 50, 150, 450 mg

NOTES: Toxicity symptoms: Myelosuppression, nausea and vomiting, diarrhea, nephrotoxicity, hematuria, neurotoxicity, and hepatic enzyme elevations; physiologic dosing based on either Calvert's or Egorin's formula allows larger doses to be given with reduced toxicity

Carisoprodol (Soma)

COMMON USES: Adjunct to sleep and physical therapy for the relief of painful musculoskeletal

ACTIONS: Centrally acting muscle relaxant

DOSAGE: 350 mg PO tid-qid SUPPLIED: Tabs 350 mg

NOTES: Avoid alcohol and other CNS depressants; available in combination with aspirin or codeine

Carmustine (BCNU, BiCNU)

COMMON USES: Primary brain tumors, melanoma, Hodgkin's and non-Hodgkin's lymphomas, multiple myeloma, and preparative regimens for allogeneic and ABMT in high doses

ACTIONS: Alkylating agent; forms DNA cross-links; inhibitor of DNA synthesis

DOSAGE: 75–100 mg/m²/d for 2 d; 200 mg/m² in a single dose; 450–900 mg/m² in BMT regimens (refer to specific protocols)

SUPPLIED: Inj 100 mg; wafer: 7.7 mg

NOTES: Toxicity symptoms: Myelosuppression (especially leukocytes and platelets), phlebitis, facial flushing, hepatic and renal dysfunction, pulmonary fibrosis, and optic neuroretinitis. Hematologic toxicity may persist up to 4-6 wk after administration

Carteolol (Cartrol, Occupress Ophthalmic)

COMMON USES: HTN, increased intraocular pressure

ACTIONS: Competitively blocks β -adrenergic receptors, β_1 , β_2 , ISA

DOSAGE: PO 2.5–5 mg/; ophth 1 gtt in eye(s) bid

SUPPLIED: Tabs 2.5, 5 mg; ophth soln 1%

Carvedilol (Coreg) COMMON USES: HTN and CHF

ACTIONS: Competitively blocks β -adrenergic receptors, β_1 , β_2 , α DOSAGE: HTN: 6.25-12.5 mg bid. CHF: 3.125-25 mg bid

SUPPLIED: Tabs 3.125, 6.25, 12.5, 25 mg

NOTES: Take with food to slow absorption and reduce incidence of orthostatic hypotension

Cefaclor (Ceclor)

COMMON USES: Infections caused by susceptible bacteria involving the upper and lower respira-

tory tract, skin, bone, urinary tract, abdomen and gynecologic system **ACTIONS:** 2nd-Generation cephalosporin; inhibits cell wall synthesis DOSAGE: Adults. 250-500 mg PO tid. Peds. 20-40 mg/kg/d PO ÷ tid $\textbf{SUPPLIED:} \ Caps\ 250,\ 500\ mg;\ ER\ tabs\ 375,\ 500\ mg;\ susp\ 125,\ 187,\ 250,\ 375\ mg/5\ mL$

NOTES: Has more gram (-) activity then 1st-generation cephalosporins

Cefadroxil (Duricef, Ultracef)

COMMON USES: Infections caused by susceptible strains of *Streptococcus*, *Staphylococcus*, *E. coli*, *Proteus* and *Klebsiella* involving the skin, bone, upper and lower respiratory tract, and urinary tract **ACTIONS:** 1st-generation cephalosporin; inhibits cell wall synthesis

DOSAGE: *Adults.* 500–1000 mg PO bid–qd. *Peds.* 30 mg/kg/d ÷ bid **SUPPLIED:** Caps 500 mg; tabs 1 g; susp 125; 250, 500 mg/5 mL

Cefazolin (Ancef, Kefzol)

COMMON USES: Infections caused by susceptible strains of *Streptococcus*, *Staphylococcus*, *E. coli*, *Proteus*, and *Klebsiella* involving the skin, bone, upper and lower respiratory tract, and urinary tract **ACTIONS:** 1st-generation cephalosporin; inhibits cell wall synthesis

DOSAGE: Adults. 1–2 g IV q8h. Peds. 50–100 mg/kg/d IV ÷ q8h

SUPPLIED: Inj

NOTES: Widely used for surgical prophylaxis

Cefdinir (Omnicef)

COMMON USES: Infections caused by susceptible bacteria involving the respiratory tract, skin, bone, and urinary tract

ACTIONS: 3rd-Generation cephalosporin; inhibits cell wall synthesis

DOSAGE: Adults. 300 mg PO bid or 600 mg/d PO. Peds. 7 mg/kg PO bid or 14 mg/kg/d PO

SUPPLIED: Caps 300 mg; susp 125 mg/5 mL

Cefepime (Maxipime)

COMMON USES: UTI and pneumonia caused by susceptible S. pneumoniae, S. aureus, K. pneumoniae, E. coli, P. aeruginosa, and Enterobacter spp

ACTIONS: 4th-generation cephalosporin; inhibits cell wall synthesis

DOSAGE: 1-2 g IV q12h

SUPPLIED: Inj 500 mg, 1 g, 2 g

Cefixime (Suprax)

COMMON USES: Infections caused by susceptible bacteria involving the respiratory tract, skin, bone, and urinary tract

ACTIONS: 3rd-generation cephalosporin; inhibits cell wall synthesis

DOSAGE: Adults. 200-400 mg PO qd-bid. Peds. 8 mg/kg/d PO ÷ qd-bid

SUPPLIED: Tabs 200, 400 mg; susp 100 mg/5 mL

NOTES: Use susp to treat otitis media

Cefmetazole (Zefazone)

COMMON USES: Infections caused by susceptible bacteria involving the upper and lower respiratory tract, skin, bone, urinary tract, abdomen and gynecologic system

ACTIONS: 2nd-generation cephalosporin; inhibits cell wall synthesis

DOSAGE: Adults. 1-2 mg IV q8h

SUPPLIED: Inj

NOTES: Has more gram (−) activity than 1st-generation cephalosporins; has anaerobic activity; ↑ risk of bleeding

Cefonicid (Monocid)

COMMON USES: Susceptible bacterial infections (respiratory tract, skin, bone and joint, urinary tract, gynecologic system, sepsis)

ACTIONS: 2nd-generation cephalosporin

DOSAGE: 1 g/24h IM/IV **SUPPLIED:** Injectable forms

Cefoperazone (Cefobid)

COMMON USES: Susceptible bacterial infections (respiratory, skin, urinary tract, sepsis; as a 3rd-generation cephalosporin, cefoperazone has activity against gram (–) organisms (eg, *E. coli, Klebsiella*); variable activity against *Streptococcus* and *Staphylococcus* spp.; active against *P. aeruginosa*, but less than ceftazidime

ACTIONS: 3rd-generation cephalosporin

DOSAGE: Adults. 2-4 g/d IM/IV ÷ q12h (12 g/d max). Peds. 100-150 mg/kg/d IM/IV ÷ bid-tid

SUPPLIED: Injectable forms

Cefotaxime (Claforan)

COMMON USES: Infections caused by susceptible bacteria involving the respiratory tract, skin, bone, urinary tract, meningitis, sepsis

ACTIONS: 3rd-generation cephalosporin; inhibits cell wall synthesis **DOSAGE:** *Adults.* 1–2 g IV q4–12h. *Peds.* 100–200 mg/kg/d IV ÷ q6–8h

SUPPLIED: Ini

Cefotetan (Cefotan)

COMMON USES: Infections caused by susceptible bacteria involving the upper and lower respiratory tract, skin, bone, urinary tract, abdomen and gynecologic system

ACTIONS: 2nd-generation cephalosporin; inhibits cell wall synthesis **DOSAGE:** *Adults.* 1–2 g IV q12h. *Peds.* 40–80 mg/kg/d IV ÷ q12h

SUPPLIED: Inj

NOTES: Has more gram (-) activity than 1st-generation cephalosporins; has anaerobic activity; contains MTT side chain, which may increase risk of bleeding

Cefoxitin (Mefoxin)

COMMON USES: Infections caused by susceptible bacteria involving the upper and lower respiratory tract, skin, bone, urinary tract, abdomen and gynecologic system

ACTIONS: 2nd-generation cephalosporin; inhibits cell wall synthesis **DOSAGE**: Adults. 1–2 mg IV q6h. Peds. 80–160 mg/kg/d ÷ q4–6h

SUPPLIED: Inj

NOTES: Has more gram (-) activity than 1st-generation cephalosporins; has anaerobic activity

Cefpodoxime (Vantin)

COMMON USES: Infections caused by susceptible bacteria involving the respiratory tract, skin, and urinary tract

ACTIONS: 3rd-generation cephalosporin; inhibits cell wall synthesis **DOSAGE:** *Adults.* 200–400 mg PO q12h. *Peds.* 10 mg/kg/d PO ÷ bid

SUPPLIED: Tabs 100, 200 mg; susp 50, 100 mg/5 mL

NOTES: Drug interactions with agents increasing gastric pH

Cefprozil (Cefzil)

COMMON USES: Infections caused by susceptible bacteria involving the upper and lower respiratory tract, skin, and urinary tract

ACTIONS: 2nd-generation cephalosporin; inhibits cell wall synthesis

DOSAGE: Adults. 250-500 mg PO qd-bid. Peds. 7.5-15 mg/kg/d PO ÷ bid

SUPPLIED: Tabs 250, 500 mg; susp 125, 250 mg/5 mL

NOTES: Has more gram (–) activity then 1st-generation cephalosporins; use higher doses for otitis and pneumonia

Ceftazidime (Fortaz, Ceptaz, Tazidime, Tazicef)

COMMON USES: Infections caused by susceptible bacteria involving the respiratory tract, skin,

bone, urinary tract, meningitis, and septicemia

ACTIONS: 3rd-generation cephalosporin; inhibits cell wall synthesis **DOSAGE:** *Adults.* 1–2 g IV q8h. *Peds.* 30–50 mg/kg/d IV ÷ q8h

SUPPLIED: Inj

Ceftibutin (Cedax)

COMMON USES: Infections caused by susceptible bacteria involving the respiratory tract, skin, and urinary tract

ACTIONS: 3rd-generation cephalosporin; inhibits cell wall synthesis

DOSAGE: Adults. 400 mg/d PO. Peds. 9 mg/kg/d PO

SUPPLIED: Caps 400 mg; susp 90, 180 mg/5 mL

NOTES: Take on an empty stomach; little activity against Streptococcus

Ceftizoxime (Cefizox)

COMMON USES: Infections caused by susceptible bacteria involving the respiratory tract, skin,

bone, urinary tract, meningitis, and septicemia

ACTIONS: 3rd-generation cephalosporin; inhibits cell wall synthesis **DOSAGE:** *Adults.* 1–2 g IV q 8–12h. *Peds.* 150–200 mg/kg/d IV ÷ q6–8h

SUPPLIED: Inj

Ceftriaxone (Rocephin)

COMMON USES: Infections caused by susceptible bacteria involving the respiratory tract, skin, bone, urinary tract, meningitis, and septicemia

ACTIONS: 3rd-generation cephalosporin; inhibits cell wall synthesis **DOSAGE:** *Adults.* 1–2 g IV q12–24h. *Peds.* 50–100 mg/kg/d IV ÷ q12–24h

SUPPLIED: Inj

Cefuroxime (Ceftin [oral], Zinacef [parenteral])

COMMON USES: Infections caused by susceptible bacteria involving the upper and lower respiratory tract, skin, bone, urinary tract, abdomen and gynecologic system

ACTIONS: 2nd-generation cephalosporin; inhibits cell wall synthesis

DOSAGE: Aduls. 750 mg–1.5 g IV q8h or 250–500 mg PO bid. Peds. 100–150 mg/kg/d IV ÷ q8h or 20–30 mg/kg/d PO ÷ bid

SUPPLIED: Tabs 125, 250, 500 mg; susp 125, 250 mg/5 mL; inj forms

NOTES: Has more gram (-) activity then 1st-generation cephalosporin; IV crosses the blood-brain barrier

Celecoxib (Celebrex)

COMMON USES: Osteoarthritis and RA **ACTIONS:** NSAID, inhibits the COX-2 pathway

DOSAGE: 100–200 mg/d or bid **SUPPLIED:** Caps 100, 200 mg

Cephalexin (Keflex, Keftab)

COMMON USES: Infections caused by susceptible strains of *Streptococcus, Staphylococcus, E. coli, Proteus,* and *Klebsiella* involving the skin, bone, upper and lower respiratory tract, and urinary tract

ACTIONS: 1st-generation cephalosporin; inhibits cell wall synthesis **DOSAGE:** *Adults.* 250–500 mg PO qid. *Peds.* 25–100 mg/kg/d PO ÷ qid **SUPPLIED:** Caps 250, 500 mg; tabs 250, 500, 1000 mg; susp 125; 250 mg/5 mL

Cephapirin (Cefadyl)

COMMON USES: Respiratory, skin, urinary tract, bone and joint infections, endocarditis, sepsis due to susceptible gram (+) cocci (not enterococcus); some gram (-) coverage (*E. coli, Proteus, Klebsiella*)

ACTIONS: 1st-generation cephalosporin; inhibits cell wall synthesis

DOSAGE: Adults. 1 g IM/IV q6h (12 g/d max). Peds. 10–20 mg/kg q6h (4 g/d max)

SUPPLIED: Powder for inj

Cephradine (Velosef)

COMMON USES: Various bacterial infections (includes group A β-hemolytic strep)

ACTIONS: 1st-generation cephalosporin; inhibits cell wall synthesis

DOSAGE: Adults. 2-4 g/d PO/IV ÷ qid (8 gm/d max). Peds. >9 mo: 25-100 mg/kg/d ÷ bid-qid

(4 gm/d max)

SUPPLIED: Caps: 250, 500 mg; powder for susp 125, 250 mg/5 mL, injectable

Cerivastatin (Baycol)

COMMON USES: Reduction of cholesterol, triglycerides and apolipoprotein B

ACTIONS: HMG-CoA reductase inhibitor **DOSAGE:** 0.4 mg/d in the evening **SUPPLIED:** Withdrawn by manufacturer

NOTES: May cause myopathy, monitor LFT regularly

Cetirizine (Zyrtec)

COMMON USES: Allergic rhinitis and chronic urticaria

ACTIONS: Nonsedating antihistamine

DOSAGE: Adults & Children. >6 y: 5–10 mg/d **SUPPLIED:** Tabs 5, 10 mg; syrup 5 mg/5 mL

Charcoal, Activated (Superchar, Actidose, Liqui-Char)

COMMON USES: Emergency treatment in poisoning by most drugs and chemicals

ACTIONS: Adsorbent detoxicant

DOSAGE: See also Chapter 21. Adults. Acute intoxication: 30–100 g/dose. GI dialysis: 25–50 g

q4-6h. Peds. Acute intoxication: 1-2 g/kg/dose. GI dialysis: 5-10 g/dose q4-8h

SUPPLIED: Powder, liq

NOTES: Administer with a cathartic; some liq dosage forms in sorbitol base; protect the airway in lethargic or comatose patients

Chloral Hydrate (Noctec, etc) [C]

COMMON USES: Nocturnal and preoperative sedation

ACTIONS: Sedative hypnotic

DOSAGE: Adults. Hypnotic: 500 mg-1 g PO or PR 30 min prior to hs or procedure. Sedative: 250 mg PO or PR tid. Peds. Hypnotic: 20–40 mg/kg/24h PO or PR 30 min prior to hs or procedure.

Sedative: $25-50 \text{ mg/kg/d} \div q6-8h$

SUPPLIED: Caps 500 mg; syrup 250, 500 mg/5 mL; supp 324, 500, 648 mg

NOTES: Mix syrup in a glass of water or fruit juice

Chlorambucil (Leukeran)

COMMON USES: CLL, Hodgkin's disease, Waldenström's macroglobulinemia

ACTIONS: Alkylating agent

DOSAGE: 0.1–0.2 mg/kg/d for 3–6 wk or 0.4 mg/kg q 2 wk (Refer to specific protocol)

SUPPLIED: Tabs 2 mg

NOTES: *Toxicity symptoms:* Myelosuppression, CNS stimulation, nausea and vomiting, drug fever, skin rash, chromosomal damage that can result in secondary leukemias, alveolar dysplasia, and pulmonary fibrosis

Chlordiazepoxide (Librium) [C]

COMMON USES: Anxiety, tension, alcohol withdrawal, and preoperative apprehension

ACTIONS: Benzodiazepine; antianxiety agent

DOSAGE: Adults. Mild anxiety: 5–10 mg PO tid–qid or PRN. Severe anxiety: 25–50 mg IM, IV, or PO 3–4×/d or PRN. Alcohol withdrawal: 50–100 mg IM or IV; repeat in 2–4 h if needed, up to 300 mg in 24 h; gradually taper the daily dosage. **Peds.** >6 y: 0.5 mg/kg/24h PO or IM ÷ q6–8h

SUPPLIED: Caps 5, 10, 25 mg; tabs 10, 25 mg; inj 100 mg

NOTES: ↓ Dose in the elderly; absorption of IM doses can be erratic

Chlorothiazide (Diuril)

COMMON USES: HTN, edema, and CHF

ACTIONS: Thiazide diuretic

DOSAGE: Adults. 500 mg-1.0 g PO or IV qd-bid. Peds. 20-30 mg/kg/24h PO ÷ bid

SUPPLIED: Tabs 250, 500 mg; susp 250 mg/5 mL; inj 500 mg/vial

NOTES: Contra in anuria

Chlorpheniramine (Chlor-Trimeton, etc)

COMMON USES: Allergic reactions

ACTIONS: Antihistamine

DOSAGE: Adults. 4 mg PO q4-6h or 8-12 mg PO bid of SR. Peds. 0.35 mg/kg/24h PO ÷ q4-6h or

0.2 mg/kg/24h SR

SUPPLIED: Tabs 4 mg; chewable tabs 2 mg; SR tabs 8, 12 mg; syrup 2 mg/5 mL; inj 10, 100 mg/mL **NOTES:** Anticholinergic side effects and sedation common

Chlorpromazine (Thorazine)

COMMON USES: Psychotic disorders, apprehension, intractable hiccups, and control of nausea and vomiting

ACTIONS: Phenothiazine antipsychotic; antiemetic

DOSAGE: Adults. Psychosis: 10–25 mg PO or PR bid–tid. (Usual dose 30–800 mg/d in ÷ doses). Children. Psychosis & N+V: 0.5–1 mg/kg/dose PO q or IM/IV q6–8h. Severe symptoms: 25 mg IM; can repeat in 1 h; then 25–50 mg PO or PR tid. Hiccups: 25–50 mg PO bid–tid

SUPPLIED: Tabs 10, 25, 50, 100, 200 mg; SR caps 30, 75, 150 mg; syrup 10 mg/5 mL; conc 30, 100 mg/mL; supp 25, 100 mg; inj 25 mg/mL

ing/inc, supp 23, 100 ing, inj 23 ing/inc

NOTES: Beware of extrapyramidal side effects and sedation; has α-adrenergic-blocking properties

Chlorpropamide (Diabinese)

COMMON USES: Type 2 DM

ACTION: Sulfonylurea. Stimulates the release of insulin from the pancreas; increases insulin sensitivity at peripheral sites; reduces glucose output from the liver

DOSAGE: 100–500 mg/d **SUPPLIED:** Tabs 100, 250 mg

NOTES: Use with caution in renal insufficiency

Chlorthalidone (Hygroton, others)

COMMON USES: HTN, edema associated with CHF

ACTIONS: Thiazide diuretic

DOSAGE: Adults. 50-100 mg/d PO qd. Peds. 2 mg/kg/dose PO 3×/wk or 1-2 mg/kg/d PO

SUPPLIED: Tabs 15, 25, 50, 100 mg **NOTES:** Contra in anuric patients

Chlorzoxazone (Paraflex, Parafon Forte DSC, others)

COMMON USES: Adjunct to rest and physical therapy for the relief of discomfort associated with acute, painful musculoskeletal conditions

ACTIONS: Centrally acting skeletal muscle relaxant

DOSAGE: Adults. 250–500 mg PO tid-qid. Peds. 20 mg/kg/d in 3–4 ÷ doses

 $\textbf{SUPPLIED:} \ Tabs\ 250,\,500\ mg;\ caps\ 250,\,500\ mg$

Cholecalciferol [Vitamin D₃] (Delta-D)

COMMON USES: Dietary supplement for treatment of vitamin D deficiency

ACTIONS: Enhances intestinal calcium absorption

DOSAGE: 400–1000 IU/d PO **SUPPLIED:** Tabs 400, 1000 IU

NOTES: 1 mg of cholecalciferol = 40,000 IU of vitamin D activity

Cholestyramine (Questran)

COMMON USES: Adjunctive therapy for the reduction of serum cholesterol in patients with primary

hypercholesterolemia; Rx pruritus associated with partial biliary obstruction **ACTIONS:** Binds bile acids in the intestine to form insoluble complexes

DOSAGE: Adults. Individualize the dose:4 g/d-bid (↑ to max 24 g/d and 6 doses/d). Peds. 240

mg/kg/d in 3 ÷ doses

SUPPLIED: 4 g of cholestyramine resin/9 g of powder; with aspartame: 4 g resin/5 g of powder

NOTES: Mix 4 g of cholestyramine in 2–6 oz of noncarbonated beverage; take other medications 1–2 h before or 6 h after cholestyramine

Ciclopirox (Loprox)

COMMON USES: Tinea pedis, tinea cruris, tinea corporis, cutaneous candidiasis, tinea versicolor

ACTIONS: Antifungal antibiotic

DOSAGE: Adults & Peds. >10: Massage into affected area bid

SUPPLIED: Cream; gel; lotion 1%

Cidofovir (Vistide)

COMMON USES: CMV retinitis

ACTIONS: Selective inhibition of viral DNA synthesis

DOSAGE: Rx: 5 mg/kg IV once/wk for 2 wk; administered with probenecid. Maintenance: 5 mg/kg IV once/2 wk; administered with probenecid: 2 g PO 3 h prior to Cidofovir, and then

1 g PO at 2 h and 8 h after Cidofovir

SUPPLIED: Inj 75 mg/mL

NOTES: Dose adjust in renal impairment, hydrate patient with NS prior to each infusion; causes renal toxicity

Cimetidine (Tagamet, others)

COMMON USES: Duodenal ulcer; ulcer prophylaxis in hypersecretory states, eg, trauma, burns, surgery, ZE; and GERD

ACTIONS: Histamine-2 receptor antagonist

DOSAGE: Adults. Active ulcer: 2400 mg/d IV cont inf or 300 mg IV q6; 400 mg PO bid or 800 mg hs. Maintenance therapy: 400 mg PO hs. GERD: 800 mg PO bid; maintenance 800 mg PO hs. Peds. Infants: 10–20 mg/kg/24h PO or IV ÷ q6–12h. Children: 20–40 mg/kg/24h PO or IV ÷ q6h

SUPPLIED: Tabs 200, 300, 400, 800 mg; liq 300 mg/5 mL; inj 300 mg/2 mL **NOTES:** Extend dosing interval with renal insufficiency; ↓ dose in the elderly

Ciprofloxacin (Cipro)

COMMON USES: Broad-spectrum activity against a variety of gram (+) and gram (-) aerobic bacteria

ACTIONS: Quinolone antibiotic; inhibits DNA gyrase

DOSAGE: Adults. 250–750 mg PO q12h or 200–400 mg IV q12h. Peds. NOT recommended for children <18 y old

SUPPLIED: Tabs 100, 250, 500, 750 mg; susp 5 g/100 mL, 10 g/100 mL; inj 200, 400 mg

NOTES: Little activity against streptococci; drug interactions with theophylline, caffeine, sucralfate, and antacids; nausea, vomiting, and abdominal discomfort common side effects; contra in PRG

Ciprofloxacin, Ophthalmic (Ciloxan)

COMMON USES: Rx and prevention of ocular infections eg, conjunctivitis, blepharitis, corneal abra-

ACTIONS: Quinolone antibiotic; inhibits DNA gyrase, antiinflammatory

DOSAGE: Instill 1-2 gtt in eye(s) q2h while awake for 2 d, then 1-2 gtt q4h while awake for 5 more d

SUPPLIED: Soln 3.5 mg/mL

Ciprofloxacin, Otic (Cipro HC Otic)

COMMON USES: Otitis externa

ACTIONS: Quinolone antibiotic; inhibits DNA gyrase **DOSAGE**: *Adult and Peds* > *1 mo.* 1–2 gtt in ear(s) bid for 7 d **SUPPLIED:** Susp ciprofloxacin 0.2% and hydrocortisone 1%

Cisplatin (Platinol)

COMMON USES: Testicular, small-cell and non-small-cell lung, bladder, ovarian, breast, head and neck, and penile cancers; osteosarcoma; and pediatric brain tumors

ACTIONS: DNA-binding; intrastrand cross-linking; formation of DNA adducts

DOSAGE: 20 mg/m²/d for 5 d q 3 wk; 120 mg/m² q 3–4 wk; 100 mg/m² on days 1 and 8 q 20 d. (Refer to specific protocols)

SUPPLIED: Inj 1 mg/mL

NOTES: Toxicity symptoms: Allergic reactions, nausea and vomiting, nephrotoxicity (exacerbated by concurrent administration of other nephrotoxic drugs and minimized by saline infusion and mannitol diuresis), high-frequency hearing loss in approximately 30%, peripheral "stocking glove":type neuropathy, cardiotoxicity (ST-T-wave changes), hypomagnesemia, mild myelosuppression, and hepatotoxicity. Renal impairment is dose-related and cumulative

Citalopram (Celexa)

COMMON USES: Depression

ACTIONS: SSRI

DOSAGE: Initial 20 mg/d, may be ↑ to 40 mg/d

SUPPLIED: Tabs 20, 40 mg

Cladribine (Leustatin)

COMMON USES: HCL

ACTIONS: Induces DNA strand breakage and interference with DNA repair enzymes and DNA synthesis

DOSAGE: 0.09 mg/kg/d cont IV inf for 7 d. (Refer to specific protocols)

SUPPLIED: Inj 1 mg/mL

NOTES: *Toxicity symptoms:* Myelosuppression; T-lymphocyte suppression may be prolonged (26–34 wk). Fever occur in 46% (probably related to tumor lysis); infections common (especially at lung and IV catheter sites); rash common (50%) in patients treated for HCL

Clarithromycin (Biaxin)

COMMON USES: Upper and lower respiratory tract infections, skin and skin structure infections, *H. pylori* infections, and infections caused by nontuberculosis (atypical) *Mycobacterium*. Prevention of MAC infections in HIV-infected individuals.

ACTIONS: Macrolide antibiotic; inhibits protein synthesis

DOSAGE: Adults. 250–500 mg PO bid or 1000 mg (2×500 mg ER tab)/d. Mycobacterium: 500-1000 mg PO bid. Peds. 7.5 mg/kg/dose PO bid

SUPPLIED: Tabs 250, 500 mg; susp 125, 250 mg/5 mL; 500 mg ER tab

NOTES: Increases theophylline and carbamazepine levels; avoid concurrent use with cisapride; causes metallic taste

Clemastine Fumarate (Tavist)

COMMON USES: Allergic rhinitis

ACTIONS: Antihistamine

DOSAGE: Adults & Peds. >12 y: 1.34 mg bid to 2.68 mg tid; max 8.04 mg/d. <12 y: 0.4 mg PO bid

SUPPLIED: Tabs 1.34, 2.68 mg; syrup 0.67 mg/5 mL

Clindamycin (Cleocin, Cleocin-T)

COMMON USES: Susceptible strains of streptococci, pneumococci, staphylococci, and gram (+) and gram (-) anaerobes; no activity against gram (-) aerobes and bacterial vaginosis; topical for severe acne and vaginal infections

ACTIONS: Bacteriostatic; interferes with protein synthesis

DOSAGE: Adults. 150–450 mg PO qid; 300–600 mg IV q6h or 900 mg IV q8h. Vaginal: 1 applicatorful hs for 7 d. Topical: Apply 1% get, lotion, or soln bid. Peds. Neonates: 10–15 mg/kg/24h ÷ q8–12h. Children >1 mo: 10–30 mg/kg/24h ÷ q6–8h, to a max of 1.8 g/d oral or 4.8 g/d IV. Topical: Apply 1%, get, lotion, or soln bid

SUPPLIED: Caps 75, 150, 300 mg; susp 75 mg/5 mL; inj 300 mg/2 mL; vaginal cream 2%

NOTES: Beware of diarrhea that may represent pseudomembranous colitis caused by Clostridium difficile

Clofazimine (Lamprene)

COMMON USES: Leprosy and as part of combination therapy for MAC in AIDS patients

ACTIONS: Bactericidal; inhibits DNA synthesis

DOSAGE: Adults. 100-300 mg PO qd. Peds. 1 mg/kg/d

SUPPLIED: Caps 50 mg

NOTES: Take with meals; may change skin pigmentation pink to brownish black; may cause skin dryness and GI intolerance

Clonazepam (Klonopin) [C]

COMMON USES: Lennox-Gastaut syndrome, akinetic and myoclonic seizures, and absence seizures

ACTIONS: Benzodiazepine; anticonvulsant

DOSAGE: Adults. 1.5 mg/d PO in 3 ÷ doses; ↑ by 0.5-1.0 mg/d q 3 d PRN up to 20 mg/d. Peds.

0.01-0.03 mg/kg/24h PO ÷ tid; ↑ to 0.1-0.2 mg/kg/24h ÷ tid

SUPPLIED: Tabs 0.5, 1.0, 2.0 mg

NOTES: CNS side effects, including sedation

Clonidine, Oral (Catapres)

COMMON USES: HTN; opioid and tobacco withdrawal **ACTIONS:** Centrally acting α -adrenergic stimulant

DOSAGE: Adults. 0.10 mg PO bid adjusted daily by 0.1- to 0.2-mg increments (max 2.4 mg/d).

Peds. 5–10 μ g/kg/d ÷d q8–12h (max 0.9 mg/d)

SUPPLIED: Tabs 0.1, 0.2, 0.3 mg

NOTES: Dry mouth, drowsiness, and sedation frequent; more effective for HTN when combined with diuretics; rebound HTN can occur with abrupt cessation of doses >0.2 mg bid. (See TD dose.)

Clonidine, Transdermal (Catapres TTS)

COMMON USES: HTN

ACTIONS: Centrally acting α-adrenergic stimulant

DOSAGE: Apply 1 patch q 7 d to a hairless area on the upper arm or torso; titrate according to indi-

vidual therapeutic requirements

SUPPLIED: TTS-1, TTS-2, TTS-3 (programmed to deliver 0.1, 0.2, 0.3 mg, respectively, of clonidine/d for 1 wk)

NOTES: Doses >2 TTS-3 usually not associated with increased efficacy

Clopidogrel (Plavix)

COMMON USES: Reduction of atherosclerotic events

ACTIONS: Inhibits platelet aggregation

DOSAGE: 75 mg/d **SUPPLIED:** Tabs 75 mg

NOTES: Prolongs bleeding time, use with caution in persons at risk of bleeding from trauma, etc

Clorazepate (Tranxene) [C]

COMMON USES: Acute anxiety disorders, acute alcohol withdrawal symptoms, and adjunctive therapy in partial seizures

ACTIONS: Benzodiazepine; antianxiety agent

DOSAGE: Adults. 15–60 mg/d PO in single or + doses. Elderly and debilitated patients: Initiate therapy at 7.5–15 mg/d in + doses. Alcohol withdrawai: Day 1: Initially, 30 mg; followed by 30–60 mg in + doses. Day 2: 45–90 mg in + doses. Day 3: 22.5–45 mg in + doses. Day 4: 15–30 mg in + doses. Peds. 3.75–7.5 mg/dose bid, to a max of 60 mg/d + bid-tid

SUPPLIED: Tabs 3.75, 7.5, 11.25, 15, 22.5 mg

NOTES: Monitor patients with renal and hepatic impairment because drug may accumulate; CNS depressant effects

Clotrimazole (Lotrimin, Mycelex)

COMMON USES: Candidiasis and tinea infections

ACTIONS: Antifungal agent; alters cell wall permeability

DOSAGE: Oral: One troche dissolved slowly in the mouth 5 (times)/d for 14 d. Vaginal: Cream 1 applicatorful hs for 7–14 d. Tabs 100 mg vaginally hs for 7 d or 200 mg (2 tabs) vaginally hs for 3 d or 500-mg tabs vaginally hs once. Topical: Apply bid for 10–14 d

SUPPLIED: 1% cream; soln; lotion; troche 10 mg; vaginal tabs 100, 500 mg; vaginal cream 1%

NOTES: Oral prophylaxis commonly used in immunosuppressed patients

Clotrimazole and Betamethasone (Lotrisone)

COMMON USES: Fungal skin infections

ACTIONS: Imidazole antifungal and antiinflammatory

DOSAGE: Apply and gently massage into the area bid from 2-4 wk

SUPPLIED: Cream 15, 45 g

NOTES: Contra in children and varicella

Cloxacillin (Cloxapen, Tegopen)

COMMON USES: Infections caused by susceptible strains of *S. aureus* and *Streptococcus*

ACTIONS: Bactericidal; inhibits cell wall synthesis

DOSAGE: Adults. 250-500 mg PO qid. Peds. 50-100 mg/kg/d ÷ qid

SUPPLIED: Caps 250, 500 mg; soln 125 mg/5 mL

NOTES: Take on an empty stomach

Clozapine (Clozaril)

COMMON USES: Refractory severe schizophrenia **ACTIONS:** Tricyclic "atypical" antipsychotic agent

DOSAGE: Initially, 25 mg qd–bid; ↑ dose to 300–450 mg/d over 2 wk. Maintain the patient at the

lowest dose possible

SUPPLIED: Tabs 25, 100 mg

NOTES: Monitor blood counts frequently (weekly for the first 6 mo; then every other week) because of the risk of agranulocytosis. Drowsiness and seizures possible

Cocaine [C]

COMMON USES: Topical anesthetic for mucous membranes **ACTIONS:** Narcotic analgesic, local vasoconstrictor

DOSAGE: Apply topically lowest amount of topical soln that provides relief; 1 mg/kg max **SUPPLIED:** Topical soln and viscous preparations 4, 10% powder, soluble tabs (135 mg) for soln

Codeine [C-II]

COMMON USES: Mild to moderate pain; symptomatic relief of cough

ACTIONS: Narcotic analgesic; depresses cough reflex

DOSAGE: Adults. Analgesic: 15–60 mg PO or IM qid PRN. Antitussive: 10–20 mg PO q4h PRN; max 12 mg/d. **Peds.** Analgesic: 0.5–1.0 mg/kg/dose PO or IM q4–6h PRN. Antitussive: 1.0–1.5 mg/kg/24h PO ÷ q4h; max 30 mg/24h

SUPPLIED: Tabs 15, 30, 60 mg; soln 15 mg/5 mL; inj 30, 60 mg/mL

NOTES: Most often combined with acetaminophen for pain or with agents, eg, terpin hydrate as an antitussive; 120 mg IM = to 10 mg of morphine IM

Colchicine

COMMON USES: Acute gout

ACTIONS: Inhibits migration of leukocytes; reduces production of lactic acid by leukocytes

DOSAGE: *Initially:* 0.5–1.2 mg PO, then 0.5–0.6 mg q 1–2 h until relief or GI side effects develop (max 8 mg/d). Do not repeat for 3 d. IV: 1–3 mg, then 0.5 mg q6h until relief (max 4 mg/d) do not repeat for 7 d. *Prophylaxis:* PO: 0.5–0.6 mg/d or 3–4 d/wk

SUPPLIED: Tabs 0.5, 0.6 mg; inj 1 mg/2 mL

NOTES: Use caution in elderly and in renal impairment. Colchicine 1–2 mg IV within 24–48 h of an acute attack can be diagnostic and therapeutic in monoarticular arthritis

Colesevelam (Welchol)

COMMON USES: Reduction of LDL and total cholesterol

ACTIONS: Bile acid sequestrant

DOSAGE: 3 tabs PO bid with meals

SUPPLIED: Tabs 625 mg

Colestipol (Colestid)

COMMON USES: Adjunctive for \downarrow serum cholesterol in primary hypercholesterolemia

ACTIONS: Binds bile acids in the intestine to form an insoluble complex **DOSAGE:** Granules: $5-30 \text{ g/d} \div \text{into } 2-4 \text{ doses}$; tabs: 2-16 g/d qd-bid

SUPPLIED: Tabs 1 g; granules

NOTES: Do not use dry powder; mix with beverages, soups, cereals, etc

Colfosceril Palmitate (Exosurf Neonatal)

COMMON USES: Prophylaxis and Rx for RSD in infants

ACTIONS: Synthetic lung surfactant

DOSAGE: 5 mL/kg/dose administered through the endotracheal tube as soon after birth as possible

and again at 12 and 24 h

SUPPLIED: Suspension 108 mg

NOTES: Monitor pulmonary compliance and oxygenation carefully. Pulmonary hemorrhage possi-

ble in infants weighing <700 g at birth. Mucous plugging of endotracheal tube possible

Cortisone

See Steroids pages 628–630. (See Table 22–5, page 627 and Table 22–6, page 627.)

Cromolyn Sodium (Intal, Nasalcrom, Opticrom)

COMMON USES: Adjunct to the Rx of asthma; prevention of exercise-induced asthma; allergic rhinitis; ophth allergic manifestations

ACTIONS: Antiasthmatic; mast cell stabilizer

DOSAGE: Adults & Children >12 y. Inhal: 20 mg (as powder in caps) inhaled qid or met-dose inhaler 2 puffs qid. Oral: 200 mg qid 15–20 min ac, up to 400 mg qid. Nasal instillation: Spray once

in each nostril 2–6 ×/d. *Ophth*: 1–2 gtt in each eye 4–6×/d. *Peds*. Inhal: 2 puffs qid of met-dose inhaler. *Oral: Infants* <2 y: 20 mg/kg/d in 4 ÷ doses. 2–12 y: 100 mg qid ac

SUPPLIED: Oral conc 100 mg/5 mL; soln for neb 20 mg/2 mL; met-dose inhaler; nasal soln 40 mg/mL; ophth soln 4%

NOTES: No benefit in acute situations; may require 2-4 wk for maximal effect in perennial allergic disorders

Cyanocobalamin [Vitamin B₁₂]

COMMON USES: Pernicious anemia and other vitamin B₁₂ deficiency states

ACTIONS: Dietary supplement of vitamin B₁₂

DOSAGE: *Adults.* $100 \mu g$ IM or SC qd for 5-10 d, then $100 \mu g$ IM $2 \times /wk$ for 1 mo, then $100 \mu g$ IM

monthly. **Peds.** $100 \mu g/d$ IM or SC for 5-10 d, then $30-50 \mu g$ IM q 4 wk **SUPPLIED:** Tabs $25, 50, 100, 250, 500, 1000 \mu g$; inj $30, 100, 1000 \mu g/mL$

NOTES: Oral absorption highly erratic, altered by many drugs and not recommended; for use with hyperalimentation (see Chapter 12)

Cyclobenzaprine (Flexeril)

COMMON USES: Adjunct to rest and physical therapy for the relief of muscle spasm associated with acute painful musculoskeletal conditions

ACTIONS: Centrally acting skeletal muscle relaxant; reduces tonic somatic motor activity DOSAGE: 10 mg PO 2–4×/d SUPPLIED: Tabs 10 mg

NOTES: Do not use for longer than 2–3 wk; has sedative and anticholinergic properties

Cyclopentolate (Cyclogyl)

COMMON USES: Diagnostic procedures requiring cycloplegia and mydriasis

ACTIONS: Cycloplegia and mydriatic agent (can last up to 24 h)

DOSAGE: 1 gtt followed by another in 5 min

SUPPLIED: Soln, 0.5, 1, 2%

Cyclophosphamide (Cytoxan, Neosar)

COMMON USES: Hodgkin's and non-Hodgkin's lymphomas, multiple myeloma, breast and ovarian cancers, mycosis fungoides, neuroblastoma, retinoblastoma, acute leukemias, small-cell lung cancer, and allogeneic and ABMT in high doses; severe rheumatologic disorders

ACTIONS: Converted to acrolein and phosphoramide mustard, the active alkylating moieties

DOSAGE: $500-1500 \text{ mg/m}^2$ as a single dose at 2–4-wk intervals; 1.8 g/m² to 160 mg/kg (or \approx 12 g/m² in a 75-kg individual) in the BMT setting. (Refer to specific protocols)

SUPPLIED: Tabs 25, 50 mg; inj 100 mg

NOTES: Toxicity symptoms: Myelosuppression (leukopenia and thrombocytopenia); sterile hemorrhagic cystitis, SIADH, alopecia, and anorexia; nausea and vomiting common. Hepatotoxicity and rarely interstitial pneumonitis possible. Irreversible testicular atrophy possible. Cardiotoxicity rare. Second malignancies (bladder cancer and acute leukemias); cumulative risk of 3.5% at 8 y, 10.7% at 12 y. Preventive measures to avoid hemorrhagic cystitis often applied in high-dose regimens and may include continuous bladder irrigation and MESNA uroprotection (see page 567)

Cyclosporine (Sandimmune, Neoral)

COMMON USES: Organ rejection in kidney, liver, heart, and BMT in conjunction with adrenal corticosteroids

ACTIONS: Immunosuppressant; reversible inhibition of immunocompetent lymphocytes

DOSAGE: Adults & Peds. Oral: 15 mg/kg/d beginning 12 h prior to transplant; after 2 wk, taper the dose by 5 mg/wk to 5-10 mg/kg/d. IV: If the patient is unable to take the drug orally, give ½ the oral dose IV

SUPPLIED: Caps 25, 50 mg, 100 mg; oral soln 100 mg/mL; inj 50 mg/mL

NOTES: May elevate BUN and creatinine, which may be confused with renal transplant rejection; should be administered in glass containers; many drug interactions; Neoral and Sandimmune not interchangeable. (See Table 22–7 pages 631–634.)

Cyproheptadine (Periactin)

COMMON USES: Allergic reactions; especially good for itching

ACTIONS: Phenothiazine antihistamine

DOSAGE: Adults. 4–20 mg PO ÷ q8h; max 0.5 mg/kg/d. Peds. 2–6 y: 2 mg bid–tid (max 12

mg/24h). 7-14 y: 4 mg bid-tid

SUPPLIED: Tabs 4 mg; syrup 2 mg/5 mL

NOTES: Anticholinergic side effects and drowsiness common; may stimulate appetite in some patients

Cytarabine [Ara-C] (Cytosar-U)

COMMON USES: Acute leukemias, CML, non-Hodgkin's lymphoma; IT administration for leukemic meningitis or prophylaxis

ACTIONS: Antimetabolite; interferes with DNA synthesis

DOSAGE: 100–150 mg/m²/d for 5–10 d (low-dose); 3 g/m² q12h for 8–12 doses (high-dose); 1 mg/kg 1–2x/wk (SC maintenance regimens); 5–70 mg/m² up to 3x/wk IT. (Refer to specific protocols)

SUPPLIED: Inj 100 mg, 500 mg, 1 g, 2 g

NOTES: Toxicity symptoms: Myelosuppression, nausea and vomiting, diarrhea, stomatitis, flu-like syndrome, rash of the palms and soles of the feet, and hepatic dysfunction. Toxicity of high-dose regimens (conjunctivitis) ameliorated by corticosteroid ophth soln, cerebellar dysfunction, and noncardiogenic pulmonary edema

Cytarabine Liposomal (Depocyt)

COMMON USES: Lymphomatous meningitis

ACTIONS: Antimetabolite; interferes with DNA synthesis

DOSAGE: 50 mg IT q 14 d for 5 doses; followed by 50 mg IT q 28 d for 4 doses

SUPPLIED: IT inj 50 mg/5 mL

Cytomegalovirus Immune Globulin [CMV-GIV] (Cytogam)

COMMON USES: Attenuation of primary CMV disease associated with transplantation

ACTIONS: Provides exogenous IgG antibodies to CMV

DOSAGE: Administered for 16 wk posttransplant, 15 mg/kg/hr, ↑Q30 min to 60 mg/kg/hr, max 75

mL/hr IV

SUPPLIED: Inj 50±10 mg/mL

Dacarbazine (DTIC-Dome)

COMMON USES: Melanoma, Hodgkin's disease, sarcoma

ACTIONS: Alkylating agent; antimetabolite activity as a purine precursor; inhibits synthesis of protein, RNA, and especially DNA

DOSAGE: 2–4.5 mg/kg/d for 10 consecutive d or 250 mg/m²/d for 5 d. (Refer to specific protocols)

SUPPLIED: Inj 100, 200, 500 mg

NOTES: Toxicity symptoms: Moderate myelosuppression, severe nausea and vomiting, hepatotoxicity, flu-like syndrome, hypotension with high-dose therapy, photosensitivity, alopecia, facial flushing, facial paresthesias, urticaria, and phlebitis at the inj site

Daclizumab (Zenapax)

COMMON USES: Prevention of acute organ rejection

ACTIONS: IL-2 receptor antagonists

DOSAGE: 1 mg/kg IV/dose; first dose before transplant then 4 doses 14 d apart posttransplant

SUPPLIED: Inj 5 mg/mL

Dactinomycin (Cosmegen)

COMMON USES: Choriocarcinoma, Wilms' tumor, Kaposi's sarcoma, Ewing's sarcoma, rhabdomyosarcoma, testicular cancer

ACTIONS: DNA intercalating agent

DOSAGE: 0.5 mg/d for 5 d; 2 mg/wk for 3 consecutive wk; $15 \mu\text{g/kg}$ or $0.45 \text{ mg/m}^2/\text{d}$ (max 0.5 mg) for 5 d q 3-8 wk in pediatric sarcoma. (Refer to specific protocols)

SUPPLIED: Inj 0.5 mg

NOTES: Toxicity symptoms: Myelosuppression, immunosuppression, nausea and vomiting, alopecia, acne-form skin changes and hyperpigmentation, radiation recall phenomenon, phlebitis and tissue damage with extravascular extravasation, and hepatotoxicity

Dalteparin (Fragmin)

COMMON USES: Unstable angina, non-Q-wave MI, prevention of ischemic complications due to clot formation in patients on concurrent aspirin, prevention of DVT following surgery

ACTIONS: Low-molecular-weight heparin

DOSAGE: Angina/MI: 120 IU/kg (max 10,000 IU) SC q12h with aspirin. *DVT prophylaxis*: 2500–5000 IU SC 1–2 h prior to surgery, then qd for 5–10 d. *Systemic anticoagulation*: 200 IU/kg/d SC or 100 IU/kg bid SC

SUPPLIED: Inj 2500 IU (16 mg/0.2 mL), 5000 IU (32 mg/0.2 mL), 10,000 (64 mg/mL) **NOTES:** Predictable antithrombotic effects eliminates need for laboratory monitoring

Dantrolene (Dantrium)

COMMON USES: Clinical spasticity resulting from upper motor neuron disorders, eg, spinal cord injuries, strokes, CP, or MS; Rx of malignant hyperthermic crisis

ACTIONS: Skeletal muscle relaxant

DOSAGE: Adults. Spasticity: Initially, 25 mg PO qd; ↑ to effect by 25 mg to a max dose of 100 mg PO qid PRN. Peds. Initially, 0.5 mg/kg/dose bid; ↑ by 0.5 mg/kg to effectiveness to a max dose of 3 mg/kg/dose qid PRN. Adults & Peds. Malignant hyperthermia: Treatment: Continuous rapid IV push beginning at 1 mg/kg until symptoms subside or 10 mg/kg is reached. Postcrisis follow-up: 4-8 mg/kg/d in 3-4 + doses for 1-3 d to prevent recurrence

SUPPLIED: Caps 25, 50, 100 mg; powder for inj 20 mg/vial

NOTES: Monitor ALT and AST closely

Dapsone [DDS] (Avlosulfon)

COMMON USES: Rx and prevention of PCP; toxoplasmosis prophylaxis; leprosy

ACTIONS: Unknown; bactericidal

DOSAGE: Adults. Prophylaxis of PCP 50–100 mg/d PO. Rx of PCP 100 mg/d PO with TMP 5 mg/kg for 21 d. Peds. Prophylaxis of PCP 1–2 mg/kg/24h PO qd; max 100 mg/d

SUPPLIED: Tabs 25 mg, 100 mg

NOTES: Absorption enhanced by an acidic environment; leprosy therapy in combination with rifampin and other agents

Daunorubicin (Daunomycin, Cerubidine)

COMMON USES: Acute leukemias

ACTIONS: DNA intercalating agent; inhibits topoisomerase II; generates oxygen free radicals **DOSAGE:** 45–60 mg/m²/d for 3 consecutive d; 25 mg/m²/wk. (Refer to specific protocols)

SUPPLIED: Inj 20 mg

NOTES: Toxicity symptoms: Myelosuppression, mucositis, nausea and vomiting, alopecia, radiation recall phenomenon, hepatotoxicity (hyperbilirubinemia), tissue necrosis on extravascular extravasation, and cardiotoxicity (1–2% risk of CHF with a cumulative dose of 550 mg/m²)

Delavirdine (Rescriptor)

COMMON USES: HIV infection

ACTION: Nonnucleoside reverse transcriptase inhibitor

DOSAGE: 400 mg PO tid **SUPPLIED:** Tabs 100 mg

NOTES: Inhibits cytochrome P-450 enzymes. Numerous drug interactions

Demeclocycline (Declomycin)

COMMON USES: SIADH

ACTIONS: Antagonizes the action of ADH on renal tubules

DOSAGE: 300-600 mg PO q12h

SUPPLIED: Caps 150 mg; tabs 150, 300 mg **NOTES:** ↓ Dose in renal failure. DI possible

Desipramine (Norpramin)

COMMON USES: Endogenous depression, chronic pain, and peripheral neuropathy

ACTIONS: Tricyclic antidepressant; increases synaptic concentration of serotonin or norepinephrine

in CNS

DOSAGE: 25–200 mg/d in single or ÷ doses; usually as a single hs dose. (Max 300 mg/d)

SUPPLIED: Tabs 10, 25, 50, 75, 100, 150 mg; caps 25, 50 mg

NOTES: Many anticholinergic side effects, including blurred vision, urinary retention, and dry

mouth

Desmopressin (DDAVP, Stimate)

COMMON USES: DI (intranasal and parenteral); bleeding caused by hemophilia A and type I von Willebrand's disease (parenteral), nocturnal enuresis

ACTIONS: Synthetic analogue of vasopressin, a naturally occurring human ADH; increases factor

VIII

DOSAGE: DI: Intranasal: Adults. 0.1–0.4 mL (10–40 μg)/d in 1–4 ÷ doses. Peds 3 mo–12 y. 0.05–0.3 mL/d in 1 or 2 doses. Parenteral: Adults. 0.5–1 mL (2–4 μg)/d in 2 ÷ doses. If converting from intranasal to parenteral dosing, use ½0 of the intranasal dose. Oral: Adults. 0.05 mg bid; may be ↑ to max of 1.2 mg. Hemophilia A and von Willebrand's disease (type I): Adults. & Peds >10 kg. 0.3 μg/kg diluted to 50 mL with NS infused slowly over 15–30 min. Peds <10 kg. Same as above with dilution to 10 mL with NS. Nocturnal enuresis: Peds >6 y. 20 μg intranasally hs.

SUPPLIED: Tabs 0.1, 0.2 mg; inj 4 µg/mL; nasal soln 0.1, 1.5 mg/mL

NOTES: In very young and old patients adjust fluid intake to avoid water intoxication and hyponatremia

NOTES: Must be used in conjunction with a glucocorticoid

Dexamethasone, Nasal (Dexacort Phosphate Turbinaire)

COMMON USES: Chronic nasal inflammation or allergic rhinitis

ACTIONS: Antiinflammatory corticosteroid

DOSAGE: Adult and Peds > 12 y. 2 sprays/nostril bid-tid, max 12 sprays/d. Peds 6-12 y. 1-2

sprays/nostril, bid, max 8 sprays/d **SUPPLIED:** Aerosol, 84 μg/activation

Dexamethasone, Ophthalmic (AK-DEX Ophthalmic, Decadron Ophthalmic, others)

COMMON USES: Inflammatory or allergic conjunctivitis

ACTIONS: Antiinflammatory corticosteroid

DOSAGE: Instill 1-2 gtt tid-qid

SUPPLIED: Susp and soln 0.1%; oint 0.05%

Dexamethasone, Systemic, Topical (Decadron)

Dexpanthenol (Ilopan-Choline Oral, Ilopan)

COMMON USES: Minimize paralytic ileus, Rx postop distention

ACTIONS: Cholinergic agent

DOSAGE: Adults. Relief of gas: 2–3 tabs PO tid. Prevention of postop ileus: 250–500 mg IM stat, repeat in 2 h, then q6h PRN. Ileus: IM: 500 mg stat, repeat in 2 h, followed by doses q6h, if needed

SUPPLIED: Inj; tabs 50 mg; cream

NOTES: Do NOT use if obstruction is suspected

Dexrazoxane (Zinecard)

COMMON USES: Prevention of anthracycline-induced (doxorubicin) cardiomyopathy in metastatic breast cancer and other therapies

ACTIONS: Chelates heavy metals; binds intracellular iron and prevents anthracycline-induced freeradical generation

DOSAGE: 10:1 ratio of dexrazoxane to doxorubicin, 30 min prior to each dose of anthracycline

SUPPLIED: Inj 10 mg/mL

NOTES: Toxicity symptoms: Myelosuppression (especially leukopenia), fever, infection, stomatitis, alopecia, diarrhea, and nausea and vomiting. Mild elevations of hepatic transaminases and local pain at injection site less frequent

Dextran 40 [Low Molecular Weight Dextran] (Rheomacrodex)

COMMON USES: Plasma expander for adjunctive therapy in shock, prophylaxis of DVT and thromboembolism, adjunct in peripheral vascular surgery

ACTIONS: Expands plasma volume; ↓ blood viscosity

DOSAGE: Shock: 10 mL/kg infused rapidly with a max dose of 20 mL/kg in the first 24 h; max dosage beyond 24 h not to exceed 10 mL/kg; discontinue after 5 d. *Prophylaxis of DVT and throm-boembolism*: 10 mL/kg IV on day of surgery followed by 500 mL/d IV for 2–3 d, then 500 mL IV q 2–3 d based on the patient's risk factors for up to 2 wk

SUPPLIED: 10% dextran 40 in 0.9% NaCl or 5% dextrose

NOTES: Observe for hypersensitivity reactions; monitor renal function and electrolytes

Dextromethorphan (Mediquell, Benylin DM, Pediacare 1)

COMMON USES: Controlling nonproductive cough **ACTIONS:** Depresses the cough center in the medulla

DOSAGE: Adults. 10-30 mg PO q4h PRN. Peds. 7 mo-1 y: 2-4 mg q6-8h; 2-6 y: 2.5-7.5 mg

q4-8h (max 30 mg/24h). 7-12 y: 5-10 mg q4-8h (max 60 mg/24/h)

 $\label{eq:supplied:caps 30 mg; lozenges 2.5, 5, 7.5, 15 mg; syrup 15 mg/15 mL, 10 mg/5 mL; liq 10 mg/15 mL, 3.5, 7.5, 15 mg/5 mL; sustained-action liq 30 mg/5 mL$

NOTES: May be found in combination products with guaifenesin

Dezocine (Dalgan)

COMMON USES: Moderate to severe pain **ACTIONS:** Narcotic agonist—antagonist

DOSAGE: 5-20 mg IM or 2.5-10 mg IV q2-4h PRN

SUPPLIED: Inj 5, 10, 15 mg/mL

NOTES: Withdrawal symptoms possible in patients dependent on narcotics. NOT recommended for patients <18 y

Diazepam (Valium, others) [C_{IV}]

COMMON USES: Anxiety, alcohol withdrawal, muscle spasm, status epilepticus, panic disorders, amnesia, and preoperative sedation

ACTIONS: Benzodiazepine

DOSAGE: Adults. Status epilepticus: 5–10 mg q 10–20 min to max dose of 30 mg in 8-h period. Anxiety, muscle spasm: 2–10 mg PO bid–qid or IM/IV q3–4h PRN. Preop: 5–10 mg PO or IM 20–30 min before procedure; can be given IV just prior to procedure. Alcohol withdrawal: Initially,

2–5 mg IV, then 5–10 mg q 5–10 min, not to exceed 100 mg in 1 h. May require up to 1000 mg in 24-h period for severe withdrawal symptoms. Titrate to agitation; avoid excessive sedation; may lead to aspiration or respiratory arrest. *Peds.* Status epilepticus: <5 y: 0.05–0.3 mg/kg/dose IV q 15–30 min up to a max of 5 mg. >5 y: May administer up to a max of 10 mg. *Sedation, muscle relaxation*: 0.04–0.3 mg/kg/dose q2–4h IM or IV up to a max of 0.6 mg/kg in 8 h, or 0.12–0.8 mg/kg/24h PO ÷ tid–qid

SUPPLIED: Tabs 2, 5, 10 mg; soln 1, 5 mg/mL; inj 5 mg/mL; gel for rectal delivery 5 mg/mL **NOTES:** Do NOT exceed 5 mg/min IV in adults or 1–2 mg/min in peds, as respiratory arrest possible; absorption of IM dose may be erratic

Diazoxide (Hyperstat, Proglycem)

COMMON USES: Hypoglycemia caused by hyperinsulinism

ACTIONS: Inhibits pancreatic insulin release

DOSAGE: Adults & Peds. 3–8 mg/kg/24h PO ÷ q8–12h. Neonates. 8–15 mg/kg/24h ÷ in 3 equal doses; maintenance 8–10 mg/kg/24h PO in 2–3 equal doses

SUPPLIED: Inj 15 mg/mL; caps 50 mg; oral susp 50 mg/mL

NOTES: Sodium retention and hyperglycemia frequent; possible thiazide diuretic cross-hypersensitivity; cannot be titrated

Dibucaine (Nupercainal)

COMMON USES: Hemorrhoids and minor skin conditions

ACTIONS: Topical anesthetic

DOSAGE: Insert PR with applicator bid and after each bowel movement; apply sparingly to skin

SUPPLIED: 1% Oint with rectal applicator; 0.5% cream

Diclofenac (Cataflam, Voltaren)

COMMON USES: Arthritis and pain

ACTIONS: NSAID

DOSAGE: 50-75 mg PO bid

SUPPLIED: Tabs 50 mg; tabs DR 25, 50, 75, 100 mg

Dicloxacillin (Dynapen, Dycill)

COMMON USES: Infections caused by susceptible strains of S. aureus and Streptococcus

ACTIONS: Bactericidal; inhibits cell wall synthesis

DOSAGE: Adults. 250–500 mg qid. Peds <40 kg. 12.5–25 mg/kg/d ÷ qid

SUPPLIED: Caps 125, 250, 500 mg; soln 62.5 mg/5 mL

NOTES: Take on an empty stomach

Dicyclomine (Bentyl)

COMMON USES: Functional irritable bowel syndromes

ACTIONS: Smooth muscle relaxant

DOSAGE: Adults. 20 mg PO qid; ↑ to a max dose of 160 mg/d or 20 mg IM q6h. Peds. Infants >6

mo: 5 mg/dose tid-qid. Children: 10 mg/dose tid-qid

SUPPLIED: Caps 10, 20 mg; tabs 20 mg; syrup 10 mg/5 mL; inj 10 mg/mL

NOTES: Anticholinergic side effects may limit dose

Didanosine [DDI] (Videx)

COMMON USES: HIV infection in zidovudine-intolerant patients

ACTIONS: Nucleoside antiretroviral agent

DOSAGE: Adults. >60 kg: 400 mg/d PO or 200 mg PO bid. <60 kg: 250 mg/d PO or 125 mg PO

bid. Peds. Dose by following table

BSA (m ²)	Tablets (mg)	Powder (mg)	
1.1–1.4	100 mg bid	125 mg bid	
0.8–1	75 mg bid	94 mg bid	
0.5–0.7	50 mg bid	62 mg bid	
<0.4	25 mg bid	31 mg bid	

SUPPLIED: Chewable tabs 25, 50, 100, 150, 200 mg; powder packets 100, 167, 250, 375 mg; powder for soln 2, 4 g

NOTES: Reconstitute powder with water; side effects include pancreatitis, peripheral neuropathy, diarrhea, and headache; adults should take 2 tabs/administration. Dose adjust in renal impairment; do not mix powder with fruit juice or other acidic beverages

Diflunisal (Dolobid)

COMMON USES: Mild to moderate pain; osteoarthritis

ACTIONS: NSAID

DOSAGE: Pain: 500 mg PO bid. Osteoarthritis: 500-1500 mg PO in 2-3 ÷ doses

SUPPLIED: Tabs 250, 500 mg **NOTES:** May prolong bleeding time

Digoxin (Lanoxin, Lanoxicaps)

Used for emergency cardiac care (see Chapter 21)

COMMON USES: CHF, AF and flutter, and PAT

ACTIONS: Positive inotrope; increases the refractory period of the AV node

DOSAGE: Adults. PO digitalization: 0.50–0.75 mg PO, then 0.25 mg PO q6–8h to total 1.0–1.5 mg. IV or IM digitalization: 0.25–0.50 mg IM or IV, then 0.25 mg q4–6h to total =1 mg. Daily maintenance: 0.125–0.500 mg/d PO, IM, or IV (average daily dose 0.125–0.250 mg). **Peds.** Preterm infants: Digitalization: 30 μg/kg PO or 25 μg/kg IV; give ½ of dose initially, then ½ of dose at 8–12-h intervals for 2 doses. Maintenance: 5–7.5 μg/kg/24h PO or 4–6 μg/kg/24h IV + q12h. Term infants: Digitalization: 25–35 μg/kg PO or 20–30 μg/kg IV; give ½ the dose initially, then ½ of the dose at 8–12 h. Maintenance: 6–10 μg/kg/24h PO or 5–8 μg/kg/24h + q12h. I mo–2 y: Digitalization: 35–60 μg/kg PO or 30–50 μg/kg IV; give ½ the dose initially, then ½ of the dose at 8–12h in tervals for 2 doses. Maintenance: 10–15 μg/kg/24h PO or 7.5–15 μg/kg/24h IV + q12h. 2–10 y: Digitalization: 30–40 μg/kg PO or 25 μg/kg IV; give ½ dose initially, then ½ of the dose at 8–12-h intervals for 2 doses. Maintenance: 8–10 μg/kg/24h PO or 6–8 μg/kg/24h IV + q12h. >10 y: Same as for adults

SUPPLIED: Caps 0.05, 0.1, 0.2 mg; tabs 0.125, 0.25, 0.5 mg; elixir 0.05 mg/mL; inj 0.1, 0.25 mg/mL **NOTES:** Can cause heart block; low potassium can potentiate toxicity; ↓ in renal failure. *Toxicity symptoms:* Nausea and vomiting, headache, fatigue, visual disturbances (yellow-green halos around lights), and cardiac arrhythmias; IM inj can be painful and has erratic absorption (See Drug Levels, Table 22–7, pages 631–634)

Digoxin Immune Fab (Digibind)

Used for emergency cardiac care (see Chapter 21)

COMMON USES: Life-threatening digoxin intoxication

ACTIONS: Antigen-binding fragments bind digoxin, rendering it inactive

DOSAGE: Adults & Peds. Based on serum level and patient's weight. See dosing charts provided with the drug

SUPPLIED: Inj 38 mg/vial

NOTES: Each vial binds ≅0.6 mg of digoxin; in renal failure, may require redosing in several days because of breakdown of the immune complex

Diltiazem (Cardizem, Dilacor, Tiazac)

Used for emergency cardiac care (see Chapter 21)

COMMON USES: Angina pectoris, prevention of reinfarction, HTN, AF or flutter, and PAT

ACTIONS: Calcium channel-blocker

DOSAGE: Oral: Initially, 30 mg PO qid; \uparrow to 180–360 mg/d in 3–4 + doses PRN. SR: 60–120 mg PO bid; \uparrow to effect to max dose 360 mg/d. CD: 120–360 mg/d (max 480 mg/d). IV: 0.25 mg/kg IV bolus over 2 min; may repeat the dose in 15 min at 0.35 mg/kg. May begin cont inf of 5–15 mg/h **SUPPLIED:** Tabs 30, 60, 90, 120 mg; SR caps 60, 90, 120 mg; CD caps 120, 180, 240, 300, 360 mg, 420 mg; inj 5 mg/mL

NOTES: Contra in sick sinus syndrome, AV block, and hypotension; Cardizem CD, Dilacor XR, and Tiazac not interchangeable

Dimenhydrinate (Dramamine, other)

COMMON USES: Prevention and Rx of nausea, vomiting, dizziness, or vertigo of motion sickness

ACTIONS: Antiemetic

DOSAGE: Adults. 50–100 mg PO q4–6h to a max of 400 mg/d; 50 mg IM/IV PRN. Peds. 5

mg/kg/24h PO or IV \div qid (max 300 mg/d)

SUPPLIED: Tabs 50 mg; chewable tabs 50 mg; liq 12.5 mg/4 mL, 12.5 mg/5 mL, 15.62 mg/5 mL; inj 50 mg/mL

30 mg/mL

NOTES: Anticholinergic side effects

Dimethyl Sulfoxide [DMSO] (Rimso-50)

COMMON USES: Interstitial cystitis

ACTIONS: Unknown

DOSAGE: Intravesical, 50 mL, retain for 15 min; repeat q 2 wk until relief

SUPPLIED: 50 % soln in 50 mL

Diphenhydramine (Benadryl, others)

COMMON USES: Allergic reactions, motion sickness, potentiate narcotics, sedation, cough suppression, and treatment of extrapyramidal reactions

ACTIONS: Antihistamine, antiemetic

DOSAGE: Adults. 25–50 mg PO, IV, or IM bid–tid. Peds. 5 mg/kg/24h PO or IM ÷ q6h (max 300 mg/d)

SUPPLIED: Tabs and caps 25, 50 mg; chewable tabs 12.5 mg; elixir 12.5 mg/5 mL; syrup 12.5 mg/5 mL; liq 6.25 mg/5 mL, 12.5 mg/5 mL; inj 50 mg/mL

NOTES: Anticholinergic side effects, including dry mouth and urinary retention; causes sedation;

↑ interval in moderate to severe renal failure

Diphenoxylate + Atropine (Lomotil) [C]

COMMON USES: Diarrhea

ACTIONS: Constipating meperidine congener

DOSAGE: Adults. Initially, 5 mg PO tid-qid until under control, then 2.5–5.0 mg PO bid. Peds >2 y: 0.3–0.4 mg/kg/24h (of diphenoxylate) ÷ bid-qid

SUPPLIED: Tabs 2.5 mg of diphenoxylate/0.025 mg of atropine; liq 2.5 mg diphenoxylate/0.025 mg atropine/5 mL

NOTES: Atropine-type side effects

Dipivefrin (Propine)

COMMON USES: Open-angle glaucoma ACTIONS: α-Adrenergic agonist DOSAGE: 1 gtt into eye q12h SUPPLIED: 0.1% soln

Dirithromycin (Dynabac)

COMMON USES: Bronchitis, community-acquired pneumonia, and skin and skin structure infec-

ACTIONS: Macrolide antibiotic **DOSAGE:** 500 mg/d PO

SUPPLIED: Tabs 250 mg **NOTES:** Absorption enhanced when taken with food

Disopyramide (Norpace, Napamide)

COMMON USES: Suppression and prevention PVC

ACTIONS: Class 1A antiarrhythmic

DOSAGE: Adults. 400–800 mg/d ÷ q6h for regular-release products and q12h for SR products. Peds. <1 y: 10–30 mg/kg/24h PO (÷ qid). 1–4 y: 10–20 mg/kg/24h PO (÷ qid). 4–12 y: 10–15 mg/kg/24h PO (÷ qid). 12–18 y: 6–15 mg/kg/24h PO (÷ qid)

SUPPLIED: Caps 100, 150 mg; SR caps 100, 150 mg

NOTES: Anticholinergic side effects (urinary retention); negative inotropic properties may induce CHF; ↓ in impaired hepatic function and renal dysfunction. (See Table 22–7, pages 631–634, for levels.)

Dobutamine (Dobutrex)

Used for emergency cardiac care (see Chapter 21)

COMMON USES: Short-term use in cardiac decompensation secondary to depressed contractility

ACTIONS: Positive inotropic agent

DOSAGE: Adults & Peds. Cont IV inf of 2.5–15 μg/kg/min; rarely, 40 μg/kg/min may be required; titrate according to response

SUPPLIED: Inj 250 mg/20 mL

NOTES: Monitor ECG for ↑ heart rate, BP, and ectopic activity; monitor PWP and cardiac output if possible. (See also Table 20–10, page 637.)

Docetaxel (Taxotere)

COMMON USES: Breast (anthracycline-resistant), ovarian, and lung cancers

ACTIONS: Antimitotic agent; promotes microtubular aggregation; semisynthetic taxoid

DOSAGE: 100 mg/m² by 1-h IV infusion q 3 wk. Start dexamethasone 8 mg bid prior to docetaxel and continue for 3-4 d. (Refer to specific protocols.)

SUPPLIED: Inj 20, 40, 80 mg/mL

NOTES: Toxicity symptoms: Myelosuppression, neuropathy, and nausea and vomiting; fluid retention syndrome cumulative doses of $300-400 \text{ mg/m}^2$ without corticosteroid preparation and post-reatment and $600-800 \text{ mg/m}^2$ with corticosteroid preparation. Hypersensitivity reactions possible, but only rarely with corticosteroid preparation. \downarrow Dose with \uparrow bilirubin levels

Docusate Calcium (Surfak, others)/Docusate Potassium (Dialose)/Docusate Sodium (Doss, Colace, others)

COMMON USES: Constipation; adjunct to painful anorectal conditions (hemorrhoids)

ACTIONS: Stool softener

DOSAGE: Adults. 50–500 mg PO ÷ qd–qid. Peds. Infants–3 y: 10–40 mg/24h ÷ qd–qid. 3–6 y: 20–60 mg/24h ÷ qd–qid.6–12 y: 40–150 mg/24h ÷ qd–qid

SUPPLIED: Ca: Caps 50, 240 mg. K: Caps 100, 240 mg. Na: Caps 50, 100 mg; syrup 50, 60 mg/15 mL; liq 150 mg/15 mL; soln 50 mg/mL

NOTES: No significant side effects; no laxative action

Dolasetron (Anzemet)

COMMON USES: Prevention of nausea and vomiting associated with chemotherapy

ACTIONS: 5-HT₃ receptor antagonists

DOSAGE: Adults & Peds. 1.8 mg/kg IV as a single dose 30 min prior to chemotherapy. Adults. 100 mg PO as a single dose. 1 h prior to chemotherapy. Peds. 1.8 mg/kg PO to max 100 mg as a single dose

SUPPLIED: Tabs 50, 100 mg; Inj 20 mg/mL

NOTES: May prolong QT interval

Dopamine (Intropin, Dopastat)

Used for emergency cardiac care (see Chapter 21)

COMMON USES: Short-term use in cardiac decompensation secondary to decreased contractility; increases organ perfusion

ACTIONS: Positive inotropic agent with dose-related response. 2–10 μ g/kg/min β -effects (increases cardiac output and renal perfusion). 10–20 μ g/kg/min α -effects (peripheral vasoconstriction, pressor). >20 μ g/kg/min peripheral and renal vasoconstriction

DOSAGE: Adults & Peds. 5 µg/kg/min by cont inf, ↑ increments of 5 µg/kg/min to a max of 50 µg/kg/min based on effect

SUPPLIED: Inj 40, 80, 160 mg/mL

NOTES: Dosage >10 μ g/kg/min may \downarrow renal perfusion; monitor urinary output; monitor ECG for \uparrow in heart rate, BP, and ectopic activity; monitor PCWP and cardiac output if possible. (See also Table 20–10, page 637.)

Dornase Alfa (Pulmozyme)

COMMON USES: \$\precedef\$ Frequency of respiratory infections in patients with CF

ACTIONS: Enzyme that selectively cleaves DNA

DOSAGE: Inhal 2.5 mg/d

SUPPLIED: Soln for inhalation 1 mg/mL **NOTES:** Use with recommended nebulizer

Dorzolamide (Trusopt)

COMMON USES: Glaucoma

ACTIONS: Carbonic anhydrase inhibitor

DOSAGE: 1 gtt in eye(s) tid

SUPPLIED: 2% soln

Dorzolamide and Timolol (Cosopt)

COMMON USES: Glaucoma

ACTIONS: Carbonic anhydrase inhibitor with β-adreneric blocker

DOSAGE: 1 gtt in eye(s) bid

SUPPLIED: Soln dorzolamide 2% and timolol 0.5%

Doxazosin (Cardura)

COMMON USES: HTN and BPH

ACTIONS: α₁-Adrenergic blocker; relaxation of bladder neck smooth muscle fibers

DOSAGE: HTN: Initially 1 mg/d PO; may be ↑ to 16 mg/d PO. BPH: Initially 1 mg/d PO, may be ↑

to 8 mg/d PO

SUPPLIED: Tabs 1, 2, 4, 8 mg

NOTES: Doses >4 mg ↑ likelihood of excessive postural hypotension, asthenia, retrograde ejaculation

Doxepin (Sinequan, Adapin)

COMMON USES: Depression, anxiety, and chronic pain

ACTIONS: Tricyclic antidepressant; increases the synaptic concentrations of serotonin or norepi-

nephrine in CNS

DOSAGE: 25–150 mg/d PO, usually hs, but can be in ÷ doses

SUPPLIED: Caps 10, 25, 50, 75, 100, 150 mg; oral conc 10 mg/mL

NOTES: Anticholinergic, CNS, and cardiovascular side effects

Doxepin Topical (Zonalon)

COMMON USES: Short-term Rx pruritus (atopic dermatitis or lichen simplex chronicus)

ACTIONS: Tricyclic antidepressant; increases synaptic concentrations of serotonin or norepineph-

rine

DOSAGE: Apply thin coating qid for max 8 d

SUPPLIED: 5% cream

NOTES: Apply to limited areas to avoid systemic toxicity (anticholinergic, CNS, and cardiovascular side effects)

Doxorubicin (Adriamycin, Rubex)

COMMON USES: Acute leukemias; Hodgkin's and non-Hodgkin's lymphomas; breast cancer; soft tissue and osteosarcomas; Ewing's sarcoma; Wilms' tumor; neuroblastoma; bladder, ovarian, gastric, thyroid, and lung cancers

ACTIONS: DNA intercalating agent; inhibitor of DNA topoisomerases I and II

DOSAGE: 60–75 mg/m² q 3 wk; reduced cardiotoxicity with weekly (20 mg/m²/wk) or cont inf (60–90 mg/m² over 96 h) schedules. (Refer to specific protocols)

SUPPLIED: Inj 10, 20, 50, 75, 200 mg

NOTES: Toxicity symptoms: Myelosuppression; extravasation leads to tissue damage; venous streaking and phlebitis, nausea and vomiting, diarrhea, mucositis, and radiation recall phenomenon. Cardiomyopathy rare but dose-related; limit of 550 mg/m² cumulative dose (400 mg/m² if prior history of mediastinal irradiation)

Doxycycline (Vibramycin)

COMMON USES: Broad-spectrum antibiotic, including activity against *Rickettsia* spp., *Chlamydia*, and *M. pneumoniae*

ACTIONS: Tetracycline; interferes with protein synthesis

DOSAGE: Adults. 100 mg PO q12h on 1st day, then 100 mg PO qd-bid or 100 mg IV q12h. Peds >8

y. 5 mg/kg/24h PO, to a max of 200 mg/d ÷ qd-bid

SUPPLIED: Tabs 50, 100 mg; caps 20, 50, 100 mg; syrup 50 mg/5 mL; susp 25 mg/5 mL; inj 100, 200 mg/vial

NOTES: Useful for chronic bronchitis; tetracycline of choice for patients with renal impairment

Dronabinol (Marinol) [C]

COMMON USES: Nausea and vomiting; appetite stimulation

ACTIONS: Antiemetic; inhibits the vomiting center in the medulla

DOSAGE: Adults & Peds. Antiemetic: 5–15 mg/m²/dose q4–6h PRN. Adults. Appetite: 2.5 mg PO

before lunch and dinner **SUPPLIED:** Caps 2.5, 5, 10 mg

NOTES: Principal psychoactive substance present in marijuana; many CNS side effects

Droperidol (Inapsine)

COMMON USES: Nausea and vomiting; premedication for anesthesia

ACTIONS: Tranquilization, sedation, and antiemetic

DOSAGE: Adults. Nausea: 2.5-5 mg IV or IM q3-4h PRN. Premed: 2.5-10 mg IV, 30-60 min

preop. Peds. Premed: 0.1-0.15 mg/kg/dose

SUPPLIED: Inj 2.5 mg/mL

NOTES: Drowsiness, moderate hypotension, and occasional tachycardia

Econazole (Spectazole)

COMMON USES: Most tinea, cutaneous Candida, and tinea versicolor infections

ACTIONS: Topical antifungal

DOSAGE: Apply to affected areas bid (qd for tinea versicolor) for 2-4 wk

SUPPLIED: Topical cream 1%

NOTES: Relief of symptoms and clinical improvement may be seen early in treatment, but carry out course of therapy to avoid recurrence

Echothiophate Iodine (Phospholine Ophthalmic)

COMMON USES: Glaucoma ACTIONS: Cholinesterase inhibitor **DOSAGE:** 1 gtt eve(s) bid with one dose hs

SUPPLIED: Powder to reconstitute 1.5 mg/0.03%; 3 mg/0.06%; 6.25 mg/0.125%; 12.5 mg/0.25%

Edrophonium (Tensilon)

COMMON USES: Diagnosis of MyG; acute myasthenic crisis; curare antagonist

ACTIONS: Anticholinesterase

DOSAGE: Adults. Test for MvG: 2 mg IV in 1 min; if tolerated, give 8 mg IV; a positive test is a brief increase in strength. Peds. Test for MyG: Total dose of 0.2 mg/kg. Give 0.04 mg/kg as a test dose. If no reaction occurs, give the remainder of the dose in 1-mg increments to max of 10 mg

SUPPLIED: Inj 10 mg/mL

NOTES: Can cause severe cholinergic effects; keep atropine available

Efavirenz (Sustiva)

COMMON USES: HIV infections

ACTIONS: Antiretroviral agent, nonnucleoside reverse transcriptase inhibitor DOSAGE: Adults. 600 mg/d PO. Peds. Refer to product information for dosing chart **SUPPLIED:** Caps 50, 100, 200 mg

NOTES: Take hs, may cause somnolence, vivid dreams, dizziness; may cause rash

Enalapril (Vasotec) ACTIONS: ACE inhibitor

COMMON USES: HTN, CHF, and asymptomatic LVD

DOSAGE: Adults. 2.5–5 mg/d PO \uparrow by effect to 10–40 mg/d as 1–2 ÷ doses, or 1.25 mg IV q6h.

Peds. 0.05-0.08 mg/kg/dose PO q12-24h

SUPPLIED: Tabs 2.5, 5, 10, 20 mg; inj 1.25 mg/mL

NOTES: Initial dose can produce symptomatic hypotension, especially with concomitant diuretics; discontinue diuretic for 2-3 d prior to initiation if possible; monitor closely for ↑ in serum potassium; may cause a nonproductive cough

Enoxaparin (Lovenox)

COMMON USES: Prevention and Rx of DVT; Rx PE; unstable angina and non-Q-wave MI

ACTIONS: Low-molecular-weight heparin

DOSAGE: Prevention: 30 mg bid SC or 40 mg SC q24h. DVT/PE: 1 mg/kg SC q12h or 1.5 mg/kg

SC q24h. Angina: 1 mg/kg SC q12h

SUPPLIED: Inj 10 mg/0.1 mL (30-, 40-, 60-, 80-, 100-mg syringes)

NOTES: Does not significantly affect bleeding time, platelet function, PT, or APTT

Entacapone (Comtan)

COMMON USES: Parkinson's disease

ACTION: Selective and reversible inhibitor of COMT

DOSAGE: 200 mg administered concurrently with each levodopa/carbidopa dose to a max of 8×/d

SUPPLIED: Tabs 200 mg

Ephedrine

COMMON USES: Acute bronchospasm, nasal congestion, hypotension, narcolepsy, enuresis, and

ACTIONS: Sympathomimetic that stimulates both α - and β -receptors

DOSAGE: Adults. 25–50 mg IM or IV q 10 min to a max of 150 mg/d or 25–50 mg PO q3–4h PRN.

Peds. 0.2-0.3 mg/kg/dose IM or IV q4-6h PRN

SUPPLIED: Inj 25, 50 mg/mL; caps 25, 50 mg; syrup 11, 20 mg/5 mL

Epinephrine (Adrenalin, Sus-Phrine, others)

Used for emergency cardiac care (see Chapter 21)

COMMON USES: Cardiac arrest, anaphylactic reactions, and acute asthma

ACTIONS: β -Adrenergic agonist with some α -effects

DOSAGE: Adults. Emergency cardiac care: 0.5–1.0 mg (5–10 mL of 1:10,000) IV q 5 min to response. Anaphylaxis: 0.3–0.5 mL of 1:1000 dilution SC; may repeat q 10–15 min to a max of 1 mg/dose and 5 mg/d. Asthma: 0.3–0.5 mL of 1:1000 dilution SC, repeated at 20-min–4-h intervals or 1 inhal (met-dose) repeated in 1–2 min or susp 0.1–0.3 mL SC for extended effect. **Peds**. Emergency cardiac care: 0.1 mL/kg of 1:10,000 dilution IV q 3–5 min to response

SUPPLIED: Inj 1:1000, 1:2000, 1:10,000, 1:100,000; susp for inj 1:200; aerosol; soln for inhal

NOTES: Sus-Phrine offers sustained action. In acute cardiac settings, can be given via endotracheal tube if central line not available

Epoetin Alfa [Erythropoietin] (Epogen, Procrit)

COMMON USES: Anemia associated with CRF, zidovudine treatment in HIV-infected patients, and patients receiving cancer chemotherapy; reduction in transfusions associated with surgery

ACTIONS: Erythropoietin supplementation

DOSAGE: Adults & Peds. 50–150 U/kg 3×/wk; adjust the dose q 4–6 wk as needed. Surgery: 300

U/kg/d for 10 d prior to surgery

SUPPLIED: Inj 2000, 3000, 4000, 10,000, 20,000 U/mL

NOTES: May cause HTN, headache, tachycardia, nausea, and vomiting; store in refrigerator

Epoprostenol (Flolan)

COMMON USES: Pulmonary HTN

ACTIONS: Dilates the pulmonary and systemic arterial vascular beds; inhibits platelet aggregation **DOSAGE:** 4 ng/kg/min IV cont inf; make dosage adjustments based on clinical status and package insert guidelines

SUPPLIED: Inj 0.5, 1.5 mg

NOTES: Availability through PBM

Eprosartan (Teveten)

COMMON USES: HTN

ACTIONS: Angiotensin II receptor antagonist **DOSAGE:** 400–800 mg/d as single dose or bid

SUPPLIED: Tabs 400, 600 mg
NOTES: Avoid use during PRG

Eptifibatide (Integrilin)

COMMON USES: Acute coronary syndrome **ACTIONS:** Glycoprotein IIb/IIIa inhibitor

DOSAGE: 180 µg/kg IV bolus, followed by 2 µg/kg/min cont inf

SUPPLIED: Inj 0.75, 2 mg/mL

Erythromycin (E-mycin, Ilosone, Erythrocin, others)

COMMON USES: Infections caused by group A streptococci (S. pyrogenes), α-hemolytic streptococci, and Neisseria gonorrhoeae infections in penicillin-allergic patients, S. pneumoniae, M. pneumoniae, and Legionella infections

ACTIONS: Bacteriostatic; interferes with protein synthesis

DOSAGE: Adults. 250–500 mg PO qid or 500 mg–1 g IV qid. **Peds.** 30–50 mg/kg/24h PO or IV ÷ a6h to a may of 2 g/d.

q6h, to a max of 2 g/d

SUPPLIED: Powder for inj as lactobionate and gluceptate salts: 500 mg, 1 g; Base: Tabs 250, 333, 500 mg; caps 250 mg; Estolate: Tabs 500 mg; caps 250 mg; susp 125, 250 mg per 5 mL; Stearate: Tabs 250, 500 mg; Ethylsuccinate: Chewable tabs 200 mg; tabs 400 mg; susp 200, 400 mg/5 mL **NOTES:** Frequent mild GI disturbances; estolate salt associated with cholestatic jaundice; erythromycin base not well absorbed from the GI tract; some forms better tolerated with respect to GI irritation; lactobionate salt contains benzyl alcohol, so use with caution in neonates; used as part of the Condon bowel prep

Erythromycin and Benzoyl Peroxide (Benzamycin)

COMMON USES: Topical control of acne vulgaris

ACTIONS: Macrolide antibiotic with keratolytic

DOSAGE: Apply bid (AM & PM)

SUPPLIED: Gel erythromycin 30 mg/benzoyl peroxide 50 mg/g

Erythromycin and Sulfisoxazole (Eryzole, Pediazole)

COMMON USES: Bacterial infections of the upper and lower respiratory tract; otitis media in children due to *H. influenzae*; other infections in penicillin-allergic patients

ACTIONS: Macrolide antibiotic with sulfonamide

DOSAGE: Based on erythromycin content. *Adults*. 400 mg erythromycin/1200 mg sulfisoxazole PO q6h. *Peds* >2 *mo*. 40–50 mg/kg/d of erythromycin PO ÷ tid–qid; max 2 g erythromycin or 6 g sulfisoxazole/d or estimated dose of 1.25 mL/kg/d ÷ tid–qid

SUPPLIED: Susp erythromycin ethylsuccinate 200 mg/sulfisoxazole 600 mg/5 mL

Erythromycin, Ophthalmic (Ilotycin Ophthalmic)

COMMON USES: Conjunctival infections

ACTIONS: Macrolide antibiotic

DOSAGE: Apply q6h **SUPPLIED:** 0.5% Oint

Erythromycin, Topical (Akne-Mycin Topical, Del-Mycin Topical, Emgel Topical, Staticin Topical, others)

COMMON USES: Acne

ACTIONS: Macrolide antibiotic

DOSAGE: Wash and dry area, apply 2% product over area bid **SUPPLIED:** Soln 1.5, 2%;gel; impregnated pads and swabs 2%

Esmolol (Brevibloc)

Used for emergency cardiac care (see Chapter 21)

COMMON USES: SVT and noncompensatory sinus tachycardia **ACTIONS:** β -Adrenergic blocking agent; class II antiarrhythmic

DOSAGE: Adults & Peds. Initiate treatment with 500 µg/kg load over 1 min, then 50 µg/kg/min for 4 min; if inadequate response, repeat the loading dose and follow with maintenance infusion of 100 µg/kg/min for 4 min; continue the titration process by repeating the loading dose followed by incremental \uparrow in the maintenance dose of 50 µg/kg/min for 4 min until the desired heart rate is reached or BP decreases; average dose 100 µg/kg/min

SUPPLIED: Inj 10, 250 mg/mL

NOTES: Monitor closely for hypotension; ↓ or discontinuing infusion reverses hypotension in ≅30 min

Estazolam (Prosom) [C]

COMMON USES: Insomnia ACTIONS: Benzodiazepine DOSAGE: 1–2 mg PO hs PRN SUPPLIED: Tabs 1, 2 mg

Esterified Estrogens (Estratab, Menest)

COMMON USES: Vasomotor symptoms, atrophic vaginitis, or kraurosis vulvae associated with menopause; female hypogonadism

ACTIONS: Estrogen supplementation

DOSAGE: Menopause: 0.3-1.25 mg/d, administered cyclically 3 wk on and 1 wk off. Hypogo-

nadism: 2.5 mg PO qd-tid

SUPPLIED: Tabs 0.3, 0.625, 1.25, 2.5 mg

Esterified Estrogens + Methyltestosterone (Estratest)

COMMON USES: Moderate to severe vasomotor symptoms associated with menopause; postpartum breast engorgement

ACTIONS: Estrogen and androgen supplementation

DOSAGE: 1 tab/d for 3 wk, then 1 wk off

SUPPLIED: Tabs (estrogen/methyltestosterone) 0.625 mg/1.25 mg, 1.25 mg/2.5 mg

Estradiol, (Estrace)

COMMON USES: Atrophic vaginitis and kraurosis vulvae associated with menopause, vasomotor symptoms

ACTIONS: Estrogen supplementation

DOSAGE: Oral: 1-2 mg/d, adjust dose as necessary to control symptoms. Vaginal cream: 2-4 g/d

for 2 wk, then 1 g 1-3×/wk

SUPPLIED: Tabs 0.5, 1, 2 mg; vaginal cream

Estradiol, Transdermal (Estraderm, others)

COMMON USES: Severe vasomotor symptoms associated with menopause; female hypogonadism

ACTIONS: Estrogen supplementation

DOSAGE: 0.1 mg/d patch 1–2×/wk depending on product; adjust dose as necessary to control symptoms

SUPPLIED: TD patches (delivers mg/24h) 0.025, 0.0375, 0.05, 0.075, 0.1

Estramustine Phosphate (Estracyte, Emcyt)

COMMON USES: Advanced prostate cancer

ACTIONS: Antimicrotubule agent; weak estrogenic and antiandrogenic activity

DOSAGE: $14 \text{ mg/kg/d in } 3\text{--}4 \div \text{doses}$

SUPPLIED: Caps 140 mg

NOTES: Toxicity symptoms: Nausea and vomiting, exacerbation of preexisting CHF, gynecomastia in 20–100%

Estrogen, Conjugated (Premarin)

COMMON USES: Moderate to severe vasomotor symptoms associated with menopause; atrophic vaginitis; palliative therapy of advanced prostatic carcinoma; prevention of estrogen deficiency-induced osteoporosis

ACTIONS: Hormonal replacement

DOSAGE: 0.3–1.25 mg/d PO cyclically; prostatic carcinoma requires 1.25–2.5 mg PO tid

SUPPLIED: Tabs 0.3, 0.625, 0.9, 1.25, 2.5 mg; inj 25 mg/mL

NOTES: Do NOT use in PRG; associated with an increased risk of endometrial carcinoma, gallbladder disease, thromboembolism, and possibly breast cancer; generic products not equivalent

Estrogen, Conjugated + Methylprogesterone (Premarin + Methylprogesterone)

COMMON USES: Vasomotor symptoms associated with menopause

ACTIONS: Estrogen and androgen combination

DOSAGE: 1 tab/d

SUPPLIED: Tabs containing 0.625 mg of estrogen, conjugated, and 5 mg of methylprogesterone

Estrogen, Conjugated + Methyltestosterone (Premarin + Methyltestosterone)

COMMON USES: Moderate to severe vasomotor symptoms associated with menopause; postpartum

breast engorgement

ACTIONS: Estrogen and androgen combination **DOSAGE:** 1 tab/d for 3 wk, then 1 wk off

SUPPLIED: Tabs (estrogen/methyltestosterone) 0.625 mg/5 mg, 1.25 mg/10 mg

Ethacrynic Acid (Edecrin)

COMMON USES: Edema, CHF, and ascites; any time rapid diuresis is desired

ACTIONS: Loop diuretic; inhibits reabsorption of sodium and chlorine in the ascending loop of

Henle and the distal renal tubule

DOSAGE: Adults. 50-200 mg PO qd or 50 mg IV PRN. Peds. 1 mg/kg/dose IV. Repeated doses

NOT recommended

SUPPLIED: Tabs 25, 50 mg; powder for inj 50 mg **NOTES:** Contra in anuria; severe side effects reported

Ethambutol (Myambutol)

COMMON USES: Pulmonary TB and other mycobacterial infections

ACTIONS: Inhibits cellular metabolism

DOSAGE: Adults & Peds >12 y. 15-25 mg/kg/d PO as a single dose

SUPPLIED: Tabs 100, 400 mg

NOTES: May cause vision changes and GI upset

Ethinyl Estradiol (Estinyl, Feminone)

COMMON USES: Vasomotor symptoms associated with menopause; female hypogonadism

ACTIONS: Estrogen supplementation **DOSAGE:** $0.02-1.5 \text{ mg/d} \div \text{qd-tid}$ **SUPPLIED:** Tabs 0.02, 0.05, 0.5 mg

Ethosuximide (Zarontin)

COMMON USES: Seizures

ACTIONS: Anticonvulsant; increases the seizure threshold

DOSAGE: Adults. Initially, 500 mg PO ÷ bid; ↑ by 250 mg/d q 4–7 d PRN (max 1500 mg/d) Peds.

20–40 mg/kg/24h PO ÷ bid to a max of 1500 mg/d **SUPPLIED:** Caps 250 mg; syrup 250 mg/5 mL

NOTES: Blood dyscrasias as well as CNS and GI side effects may occur; use caution in renal or hepatic impairment. (See Table 27–7, pages 631–634, for levels.)

Etidronate Disodium (Didronel)

COMMON USES: Hypercalcemia of malignancy and hypertropic ossification

ACTIONS: Inhibition of normal and abnormal bone resorption

DOSAGE: 5-20 mg/kg/d, may be given in ÷ doses. (Duration of therapy 3-6 mo) 7.5 mg/kg/d IV in-

fusion over 2 h

SUPPLIED: Tabs 200, 400 mg; inj 50 mg/mL

NOTES: GI intolerance may be \downarrow by \div oral daily doses

Etodolac (Lodine)

COMMON USES: Arthritis and pain

ACTIONS: NSAID

DOSAGE: 200–400 mg PO bid–qid (max 1200 mg/d)

SUPPLIED: Tabs 400, 500 mg; ER tabs 400, 500, 600 mg; caps 200, 300 mg

Etoposide [VP-16] (Vepesid)

COMMON USES: Testicular cancer, non-small-cell lung cancers, Hodgkin's and non-Hodgkin's lymphomas, pediatric ALL, and allogeneic and autologous BMT in high doses

ACTIONS: Topoisomerase II inhibitor

DOSAGE: 50 mg/m²/d IV for 3–5 d; 50 mg/m²/d PO for 21 d (bioavailability of the oral formulation ≈50% of the IV form); 2–6 g/m² or 25–70 mg/kg used in BMT. (Refer to specific protocols)

SUPPLIED: Caps 50 mg; inj 20 mg/mL

NOTES: *Toxicity symptoms:* Myelosuppression, nausea and vomiting, and alopecia; hypotension may occur if infused too rapidly; anaphylaxis or lesser hypersensitivity reactions (wheezing) rare; potential for secondary leukemias

Famciclovir (Famvir)

COMMON USES: Acute herpes zoster (shingles) and genital herpes infections

ACTIONS: Inhibits viral DNA synthesis

DOSAGE: Zoster: 500 mg PO q8h. Simplex: 125-250 mg PO bid

SUPPLIED: Tabs 125, 250, 500 mg

Famotidine (Pepcid)

COMMON USES: Short-term Rx of active duodenal ulcer and benign gastric ulcer; maintenance

therapy for duodenal ulcer, hypersecretory conditions, GERD, and heartburn

ACTIONS: H₂-antagonist; inhibits gastric acid secretion

DOSAGE: Adults. Ulcer: 20–40 mg PO hs or 20 mg IV q12h. Hypersecretion: 20–160 mg PO q6h. GERD: 20 mg PO bid; maintenance 20 mg PO hs. Heartburn: 10 mg PO PRN heartburn; Peds. 1–2 mg/kg/d

SUPPLIED: Tabs 10, 20, 40 mg; chewable tabs 10 mg; susp 40 mg/5 mL; inj 10 mg/mL

NOTES: ↓ Dose in severe renal insufficiency

Felodipine (Plendil)

COMMON USES: HTN and CHF ACTIONS: Ca channel-blocker DOSAGE: 5–20 mg PO qd SUPPLIED: ER tabs 2.5, 5, 10 mg

NOTES: Closely monitor BP in elderly and in impaired hepatic function; do NOT use doses >10 mg

in these patients; bioavailability is ↑ when administered with grapefruit juice

Fenofibrate (Tricor)

COMMON USES: Hypertriglyceridemia **ACTIONS:** Inhibits triglyceride synthesis

DOSAGE: Initially 67 mg/d, ↑ to 67 mg tid or 200 mg/d

SUPPLIED: Caps 67, 200 mg

NOTES: Take with meals to increase bioavailability; May cause cholecystitis; monitor LFTs

Fenoldopam (Corlopam)

COMMON USES: Hypertensive emergency **ACTIONS:** Rapid acting vasodilator

DOSAGE: Initial dose 0.03–0.1 μg/kg/min IV cont inf, titrate to effect q 15 min with 0.05–0.1

μg/kg/min increments **SUPPLIED:** Ini 10 mg/mL

NOTES: Avoid concurrent use with β-blockers

Fenoprofen (Nalfon)

COMMON USES: Arthritis and pain

ACTIONS: NSAID

DOSAGE: 200–600 mg q4–8h, to a max of 3200 mg/d

SUPPLIED: Caps 200, 300 mg; tabs 600 mg

Fentanyl (Sublimaze) [C-II]

COMMON USES: Short-acting analgesic used in conjunction with anesthesia

ACTIONS: Narcotic

DOSAGE: Adults & Peds. 0.025-0.15 mg/kg IV/IM titrated to effect

SUPPLIED: Inj 0.05 mg/mL

NOTES: Causes significant sedation; 0.1 mg of fentanyl = 10 mg of morphine IM

Fentanyl, Transdermal (Duragesic) [C-II]

COMMON USES: Chronic pain

ACTIONS: Narcotic

DOSAGE: Apply a patch to the upper torso q72h. Dose calculated from the narcotic requirements

for the previous 24 h

SUPPLIED: TD patches deliver 25, 50, 75, $100 \mu g/h$ **NOTES:** 0.1 mg of fentanyl = 10 mg of morphine IM

Fentanyl, Transmucosal System (Actiq, Fentanyl Oralet) [C-II]

COMMON USES: Induction of anesthesia and breakthrough cancer pain

ACTIONS: Narcotic

DOSAGE: Adults & Peds. Anesthesia: 5-15 µg/kg. Pain: 200 µg consumed over 15 min, titrate to

appropriate effect

SUPPLIED: Lozenges 100, 200, 300, 400 µg; lozenges on stick 200, 400, 600, 800, 1200, 1600 µg

Ferric Gluconate Complex (Ferrlecit)

COMMON USES: Iron deficiency in patients receiving supplemental erythropoietin therapy

ACTIONS: Supplemental iron

DOSAGE: Give test dose of 2 mL (25 mg Fe) infused over 1 h. If no reaction, 125 mg (10 mL) IV over 1 h until favorable hematocrit achieved. Usual cumulative dose 1 g Fe administered over 8 sessions.

sions

SUPPLIED: Inj 12.5 mg/mL Fe

NOTES: Dosage is expressed as mg Fe; may be infused during dialysis

Ferrous Gluconate (Fergon, others)

COMMON USES: Fe deficiency anemia and Fe supplementation

ACTIONS: Dietary supplementation **DOSAGE:** *Adults.* 100–200 mg Fe/d

SUPPLIED: Tabs 240 (27 mg Fe), 325 mg (36 mg Fe) **NOTES:** 12% Fe; may turn stool and urine dark

Ferrous Sulfate

COMMON USES: Fe deficiency anemia and Fe supplementation

ACTIONS: Dietary supplementation

DOSAGE: Adults. 300 mg PO bid-tid. Peds. 1-4 mg/kg/24h ÷ qd-bid

SUPPLIED: Tabs 187, 200, 324 mg; SR caplets and tabs 160 mg; gtt 75 mg/0.6 mL; elixir 220 mg/5

mL; syrup 90 mg/5 mL

NOTES: May turn stools and urine dark; can cause GI upset and constipation; vitamin C taken with ferrous sulfate ↑ absorption of Fe, especially in patients with atrophic gastritis

Fexofenadine (Allegra)

COMMON USES: Relief of allergic rhinitis

ACTIONS: Antihistamine

DOSAGE: Adults & Peds >12 y. 60 mg bid or 180 mg/d

SUPPLIED: Caps 60 mg, 180 mg tabs; also available in combination with pseudoephedrine (60 mg fexoferadine/120 mg pseudoephedrine)

Filgrastim [G-CSF] (Neupogen)

COMMON USES: Decrease incidence of infection in febrile neutropenic patients, and Rx chronic neutropenia

ACTIONS: Recombinant G-CSF

DOSAGE: Adults & Peds. 5 µg/kg/d SC or IV as a single daily dose

SUPPLIED: Inj 300 μg/mL

NOTES: May cause bone pain. Discontinue therapy when ANC >10,000

Finasteride (Proscar, Propecia)

COMMON USES: BPH and androgenetic alopecia

ACTIONS: Inhibits 5α reductase

DOSAGE: BPH: 5 mg/d PO [Proscar]. Alopecia: 1 mg/d PO [Propecia]

SUPPLIED: Tabs 1, 5 mg

NOTES: Decreases PSA levels; may take 3-6 mo to see effect on urinary symptoms

Flavoxate (Urispas)

COMMON USES: Symptomatic relief of dysuria, urgency, nocturia, suprapubic pain, urinary frequency, and incontinence

ACTIONS: Counteracts smooth muscle spasm of the urinary tract

DOSAGE: 100-200 mg PO tid-qid

SUPPLIED: Tabs 100 mg

NOTES: May cause drowsiness, blurred vision, and dry mouth

Flecainide (Tambocor)

COMMON USES: Prevention of PAF/flutter and PSVT, Rx life-threatening ventricular arrhythmias

ACTIONS: Class 1C antiarrhythmic

DOSAGE: Adults. 100 mg PO q12h; ↑ in increments of 50 mg q12h q 4 d to a max of 400 mg/d.

Peds. 3–6 mg/kg/d in 3 ÷ doses **SUPPLIED:** Tabs 50, 100, 150 mg

NOTES: May cause new or worsened arrhythmias; therapy should be initiated in the hospital; may dose q8h if the patient is intolerant or uncontrolled at 12-h intervals; drug interactions with propranolol, digoxin, verapamil, and disopyramide; may cause CHF

Floxuridine (FUDR)

COMMON USES: Colon carcinoma, pancreatic carcinoma, liver cancer, biliary tract cancers, and adenocarcinoma of the GI tract metastatic to the liver

ACTIONS: Inhibitor of thymidylate synthase; interferes with DNA synthesis (S phase-specific)

DOSAGE: 0.1-0.6 mg/kg/d for 1-6 wk

SUPPLIED: Inj 500 mg

NOTES: Toxicity symptoms: Myelosuppression, nausea and vomiting, anorexia, abdominal cramps, diarrhea, mucositis, alopecia, skin rash, and hyperpigmentation; rare neurotoxicity (blurred vision, depression, nystagmus, vertigo, and lethargy). Intraarterial catheter-related problems (ischemia, thrombosis, bleeding, and infection)

Fluconazole (Diflucan)

COMMON USES: Oropharyngeal and esophageal candidiasis; cryptococcal meningitis; *Candida* infections of the lungs, peritoneum, and urinary tract; prevention of candidiasis in BMT patients on chemotherapy or radiation; and candidal vaginitis

ACTIONS: Antifungal; inhibits fungal cytochrome P-450 sterol demethylation

DOSAGE: Adults. 100–400 mg/d PO or IV. Vaginitis: 150 mg PO as a single dose. Peds. 3–6 mg/kg/d PO or IV

SUPPLIED: Tabs 50, 100, 150, 200 mg; susp 10, 40 mg/mL; inj 2 mg/mL

NOTES: Adjust dose in renal insufficiency; oral dosing produces the same blood levels as IV dosing, so use oral route whenever possible

Fludarabine Phosphate (Fludara)

COMMON USES: CLL, low-grade lymphoma, and mycosis fungoides

ACTIONS: Inhibits ribonucleotide reductase; blocks DNA polymerase-induced DNA repair **DOSAGE:** 18–30 mg/m²/d for 5 d, given as a 30-min inf (Refer to specific protocols)

SUPPLIED: Inj 50 mg

NOTES: Toxicity symptoms: Myelosuppression, nausea and vomiting, diarrhea, and hepatic transaminase elevations; severe CNS toxicity rare in leukemic patients and pulmonary toxicity

Fludrocortisone Acetate (Florinef)

COMMON USES: Partial treatment for adrenocortical insufficiency

ACTIONS: Mineralocorticoid replacement

DOSAGE: Adults. 0.05-0.2 mg/d PO. Peds. 0.05-0.1 mg/d PO

SUPPLIED: Tabs 0.1 mg

NOTES: For adrenal insufficiency, must be used in conjunction with a glucocorticoid supplement; dosage changes based on plasma renin activity

Flumazenil (Romazicon)

Used for emergency (see Chapter 21)

COMMON USES: For complete or partial reversal of the sedative effects of benzodiazepines (diazepam, etc)

ACTIONS: Benzodiazepine receptor antagonist

DOSAGE: Adults. 0.2 mg IV over 15 s; dose may be repeated if the desired level of consciousness is not obtained, to a max dose of 1 mg. Peds. 0.01 mg/kg to a max of 0.2 mg IV over 15 s. Repeat doses 0.005 mg/kg at 1-min intervals

SUPPLIED: Inj 0.1 mg/mL

NOTES: Does NOT reverse narcotics

Flunisolide (Aerobid, Nasalide)

COMMON USES: Control of bronchial asthma in patients requiring chronic corticosteroid therapy; relief of seasonal or perennial allergic rhinitis

ACTIONS: Topical steroid

DOSAGE: Adults. 2–4 inhal bid. Nasal: 2 sprays/nostril bid. Peds >6 y. 2 inhal bid. Nasal: 1–2 sprays/nostril bid

SUPPLIED: Met-dose aerosol 250 mg; nasal spray 0.025%

NOTES: May cause oral candidiasis; NOT for acute asthma attack

Fluorouracil [5-FU] (Adrucil)

COMMON USES: Colorectal, bladder, gastric, pancreatic, anal, head and neck, and breast cancers; topical application for basal cell carcinoma of the skin

ACTIONS: Inhibitor of thymidylate synthetase (interferes with DNA synthesis, S phase-specific)

DOSAGE: 370–1000 mg/m²/d for 1–5 d; intravenously as IV push to 24-h cont inf; protracted venous infusion of 200–300 mg/m²/d. (See specific protocols.)

SUPPLIED: Inj 50 mg/mL

NOTES: Toxicity symptoms: Stomatitis, esophagopharyngitis, diarrhea, anorexia, and nausea and vomiting. Myelosuppression (leukocytopenia, thrombocytopenia, and anemia); rash, dry skin, and photosensitivity frequent. Tingling in the hands and feet followed by pain (palmar-plantar erythrodysesthesia); phlebitis and discoloration at inj sites

Fluorouracil, Topical [5-FU] (Efudex)

common uses: Basal cell carcinoma of the skin, actinic and solar keratosis

ACTIONS: Inhibitor of thymidylate synthetase (interferes with DNA synthesis, S phase-specific)

DOSAGE: Apply 5% cream bid for 4–6 wk **SUPPLIED:** Cream 1, 5%; soln 1, 2, 5%

NOTES: Toxicity symptoms: Rash, dry skin, and photosensitivity

Fluoxetine (Prozac, Sarafem)

COMMON USES: Depression, OCD, bulimia, PMDD

ACTIONS: SSRI

DOSAGE: Initially, 20 mg/d PO; ↑to a max of 80 mg/24h; ÷ doses of >20 mg/d. Bulimia: 60 mg/d

in AM. PMDD: 20 mg/d

SUPPLIED: Caps 10, 20 mg; tabs 10 mg; soln 20 mg/5 mL

NOTES: May cause nausea, nervousness, and weight loss; hepatic failure dosage adjustment

Fluoxymesterone (Halotestin)

COMMON USES: Androgen-responsive metastatic breast cancer

ACTIONS: Inhibition of secretion of LH and FSH by feedback inhibition

DOSAGE: 10–40 mg/d

SUPPLIED: Tabs 2, 5, 10 mg

NOTES: *Toxicity symptoms:* Virilization, amenorrhea and menstrual irregularities, hirsutism, alopecia and acne, nausea, and cholestasis. *Hematologic toxicity symptoms:* Suppression of clotting factors II, V, VII, and X and polycythemia. ↑ libido, headache, and anxiety

Fluphenazine (Prolixin, Permitil)

COMMON USES: Psychotic disorders

ACTIONS: Phenothiazine antipsychotic; blocks postsynaptic mesolimbic dopaminergic receptors in the brain

DOSAGE: 0.5–10 mg/d in ÷ doses PO q6–8h; average maintenance 5.0 mg/d or 1.25 mg IM ini-

tially, then 2.5–10 mg/d in ÷ doses q6–8h PRN **SUPPLIED:** Tabs 1, 2.5, 5, 10; cone 5 mg/mL; elixir 2.5 mg/5 mL; inj 2.5 mg/mL; depot inj 25

mg/mL

NOTES: ↓ Dose in elderly; monitor LFT; may cause drowsiness; do NOT administer conc with caffeine, tannic acid, or pectin-containing products

Flurazepam (Dalmane) [C]

COMMON USES: Insomnia ACTIONS: Benzodiazepine

DOSAGE: Adults & Peds >15 y. 15-30 mg PO hs PRN

SUPPLIED: Caps 15, 30 mg **NOTES:** ↓ Dose in elderly

Flurbiprofen (Ansaid)

COMMON USES: Arthritis

DOSAGE: 50-100 mg bid-qid, to a max of 300 mg/d

SUPPLIED: Tabs 50, 100 mg

Flutamide (Eulexin)

COMMON USES: Advanced prostate cancer (in combination with GnRH agonists, eg, leuprolide or goserelin) with or without radiation for localized prostate cancer

ACTIONS: Nonsteroidal antiandrogen **DOSAGE:** 250 mg PO tid (750 mg total)

SUPPLIED: Caps 125 mg

NOTES: Toxicity symptoms: Hot flashes, loss of libido, impotence, diarrhea, nausea and vomiting, and gynecomastia; follow LFT

Fluticasone Nasal (Flonase)

COMMON USES: Seasonal allergic rhinitis

ACTIONS: Topical steroid

DOSAGE: Adults & adolescents. 100-250 µg bid. Nasal: 1-2 sprays/nostril/d. Peds 4-11 y. 50 µg

bid. Nasal: 1–2 sprays/nostril/d SUPPLIED: Nasal spray 50 µg/actuation

Fluticasone Oral (Flovent, Flovent Rotadisk)

COMMON USES: Chronic treatment of asthma

ACTIONS: Topical steroid

DOSAGE: Adults & adolescents. 2-4 puffs bid. Peds 4-11 y. 50 µg bid

 $\textbf{SUPPLIED:} \ \ Multidose \ inhaler \ 44, \ 110, \ or \ 220 \ \mu\text{g/activation}; \ Rotadisk \ dry \ powder \ 50, \ 100, \ and \ 250$

μg/activation; risk of thrush

NOTES: Counsel patients carefully on use of device

Fluvastatin (Lescol)

COMMON USES: Adjunct to diet in the treatment of elevated total cholesterol

ACTIONS: HMG-CoA reductase inhibitor DOSAGE: 20–40 mg PO hs, may be ↑ to 80 mg/d SUPPLIED: Caps 20, 40 mg

NOTES: Avoid concurrent use with gemfibrozil

Fluvoxamine (Luvox)

COMMON USES: OCD

ACTIONS: SSRI

DOSAGE: Initial 50 mg as single hs dose, may be ↑ to 300 mg/d in ÷ doses

SUPPLIED: Tabs 25, 50, 100 mg

NOTES: + doses of >100 mg; numerous drug interactions

Folic Acid

COMMON USES: Megaloblastic anemia

ACTIONS: Dietary supplementation

DOSAGE: Adults. Supplement: 0.4 mg/d PO. PRG: 0.8 mg/d PO. Folate deficiency: 1.0 mg PO qd-tid. Peds. Supplement: 0.04–0.4 mg/24h PO, IM, IV, or SC. Folate deficiency: 0.5–1.0 mg/24h PO. IM. IV, or SC

SUPPLIED: Tabs 0.1, 0.4, 0.8, 1.0 mg; inj 5 mg/mL

NOTES: Recommended for all women of childbearing age; \downarrow incidence of fetal neural tube defects by 50%

Foscarnet (Foscavir)

COMMON USES: CMV; acyclovir-resistant herpes infections

ACTIONS: Inhibits viral DNA polymerase and reverse transcriptase

DOSAGE: Induction: 60 mg/kg IV q8h for 14-21 d. Maintenance: 90-120 mg/kg/d IV

(Monday-Friday)

SUPPLIED: Inj 24 mg/mL

NOTES: Dosage must be adjusted for renal function; nephrotoxic; monitor ionized calcium closely (causes electrolyte abnormalities); administer through a central line

Fosfomycin (Monurol)

COMMON USES: Uncomplicated UTI
ACTIONS: Inhibits bacterial cell wall synthesis

DOSAGE: 3 g PO dissolved in 90-120 mL of water as single dose

SUPPLIED: Granule packets 3 g

NOTES: May take 2-3 d for symptoms to improve

Fosinopril (Monopril)

ACTIONS: ACE inhibitor

COMMON USES: HTN and heart failure

DOSAGE: Initially, 10 mg/d PO; may be ↑ to a max of 80 mg/d PO ÷ qd-bid

SUPPLIED: Tabs 10, 20, 40 mg

NOTES: ↓ Dose in elderly; may cause nonproductive cough and dizziness

Fosphenytoin (Cerebyx)

COMMON USES: Status epilepticus

ACTION: Inhibits seizure spread in the motor cortex

DOSAGE: Dosed as phenytoin equivalents (PE) Loading 15–20 mg PE/kg, maintenance 4–6 mg

PE/kg/d

SUPPLIED: Inj; 150 mg (= phenytoin 100 mg); 750 mg (= phenytoin 500 mg)

NOTES: Requires 15 min to convert the prodrug fosphenytoin to phenytoin; administer at <150 mg PE/min to prevent hypotension; administer with BP monitoring; dosage adjustment/plasma monitoring may be necessary in hepatic impairment

Furosemide (Lasix)

Used for emergency cardiac care (see Chapter 21)

COMMON USES: Edema, HTN, and CHF

ACTIONS: Loop diuretic; inhibits Na and Cl reabsorption in the ascending loop of Henle and the

distal renal tubule

DOSAGE: Adults. 20–80 mg PO or IV qd–bid. Peds. 1 mg/kg/dose IV q6–12h; 2 mg/kg/dose PO q12h–24h

SUPPLIED: Tabs 20, 40, 80 mg; soln 10 mg/mL, 40 mg/5 mL; inj 10 mg/mL

NOTES: Monitor for hypokalemia; use with caution in hepatic disease; high doses of the IV form may cause ototoxicity

Gabapentin (Neurontin)

COMMON USES: Adjunctive therapy in the treatment of partial seizures

ACTIONS: Anticonvulsant

DOSAGE: 900-1800 mg/d PO in 3 ÷ doses

SUPPLIED: Caps 100, 300, 400 mg

NOTES: Not necessary to monitor serum gabapentin levels; dosage adjustment in renal impairment

Gallium Nitrate (Ganite)

COMMON USES: Hypercalcemia of malignancy; bladder cancer

ACTIONS: Inhibits resorption of Ca from the bones

DOSAGE: Hypercalcemia: 10–200 mg/m²/d for 5 d. Cancer: 350 mg/m² cont inf for 5 d to 700

mg/m² rapid IV inf q 2 wk in antineoplastic settings

SUPPLIED: Inj 25 mg/mL

NOTES: Can cause renal insufficiency; may cause hypocalcemia, hypophosphatemia, and decreased bicarbonate; <1% of patients developed acute optic neuritis; for bladder cancer, use in combination with vinblastine and ifosfamide

Ganciclovir (Cytovene, Vitrasert)

COMMON USES: Rx and prevention of CMV retinitis and prevention of CMV disease in transplant

recipients

ACTIONS: Inhibits viral DNA synthesis

DOSAGE: Adults & Peds. IV: 5 mg/kg IV q12h for 14—21 d, then maintenance of 5 mg/kg/d IV for 7 d/wk or 6 mg/kg/d IV for 5 d/wk. Ocular implant: One implant q 5–8 mo. Adults. PO: Following induction, 1000 mg PO tid. Prevention: 1000 mg PO tid

SUPPLIED: Caps 250, 500 mg; inj 500 mg; ocular implant 4.5 mg

NOTES: NOT a cure for CMV; granulocytopenia and thrombocytopenia are major toxicities; injection should be handled with cytotoxic precautions; take caps with food; implant confers no systemic benefit; dosage adjustment in renal impairment

Gatifloxacin (Tequin)

COMMON USES: Acute exacerbation of chronic bronchitis, sinusitis, community acquired pneumo-

nia, UTI

ACTIONS: Quinolone antibiotic, inhibits DNA-gyrase

DOSAGE: 400 mg/d PO or IV **SUPPLIED:** Tabs 200, 400 mg; inj

NOTES: Avoid use with antacids; do NOT use in children <18 y, pregnant or lactating women; reliable activity against *S. pneumoniae*; dosage adjustment in renal impairment

Gemcitabine (Gemzar)

COMMON USES: Pancreatic cancer, gastric cancer, and lung cancer

ACTIONS: Antimetabolite; inhibits ribonucleotide reductase; produces false nucleotide base-inhibit-

ing DNA synthesis

DOSAGE: 1000 mg/m² as a 1-h IV inf weekly for 3–4 wk or 6–8 wk

SUPPLIED: Inj 20 mg/mL

NOTES: Toxicity symptoms: Myelosuppression, nausea and vomiting, diarrhea, drug fever, and skin

rash

Gemfibrozil (Lopid)

COMMON USES: Hypertriglyceridemia, and reduction of CHD risk

ACTIONS: Lipid-regulating agent

DOSAGE: 1200 mg/d PO in 2 ÷ doses 30 min ac AM and PM

SUPPLIED: Tabs 600 mg; caps 300 mg

NOTES: Monitor AST, ALT, LDH, alkaline phosphatase, and serum lipids during therapy; cholelithiasis may occur secondary to treatment; may enhance the effect of warfarin; avoid concurrent use with the HMG-CoA reductase inhibitors

Gentamicin (Garamycin, others)

COMMON USES: Serious infections caused by susceptible *Pseudomonas, Proteus, E. coli, Klebsiella, Enterobacter,* and *Serratia,* and for initial treatment of gram (–) sepsis

ACTIONS: Bactericidal; inhibits protein synthesis

DOSAGE: See also Aminoglycoside dosing (page 620). *Adults*. 3–5 mg/kg/24h IV \div q8–24h. *Peds*. Infants <7 d <1200 g: 2.5 mg/kg/dose q18–24h. >1200 g: 2.5 mg/kg/dose q12–18h. *Infants* >7 d: 2.5 mg/kg/dose IV q8–12h. *Children:* 2.5 mg/kg/d IV q8h

SUPPLIED: Inj 10, 40 mg/mL, IT preservative-free 2 mg/mL

NOTES: Nephrotoxic and ototoxic; ↓ dose with renal insufficiency; monitor CrCl and serum concentration for dosage adjustments (see Table 22–7, pages 631–634). Daily dosing becoming popular

Gentamicin, Ophthalmic (Garamycin, Genoptic, Gentacidin, others)

COMMON USES: Conjunctival infections

ACTIONS: Bactericidal; inhibits protein synthesis

DOSAGE: Oint apply bid or tid; soln: 1–2 gtt q2–4h, up to 2 gtt/h for severe infections

SUPPLIED: Soln and oint 0.3%

Gentamicin, Topical (Garamycin, G-Myticin)

COMMON USES: Skin infections caused by susceptible organisms

ACTIONS: Bactericidal; inhibits protein synthesis **DOSAGE:** *Adult and Peds* > 1 y. Apply tid–qid

SUPPLIED: Cream; oint; soln 0.3%

Gentamicin and Prednisolone, Ophthalmic (Pred-G Ophthalmic)

COMMON USES: Steroid-responsive ocular and conjunctival infections sensitive to gentamicin (eg, Staphylococcus, E. coli, H. influenzae, Klebsiella, Neisseria, Pseudomonas, Proteus, and Serratia spn)

ACTIONS: Bactericidal; inhibits protein synthesis

DOSAGE: Oint apply bid or tid; Soln: 1–2 gtt q2–4h, up to 2 gtt/h for severe infections

SUPPLIED: Oint, ophth: Prednisolone acetate 0.6% and gentamicin sulfate 0.3% (3.5 g); Susp, ophth: Prednisolone acetate 1% and gentamicin sulfate 0.3% (2 mL, 5 mL, 10 mL); Soln and oint 0.3%

Glimepiride (Amaryl)

COMMON USES: Type 2 DM

ACTION: Sulfonylurea. Stimulates the release of insulin from the pancreas; increases insulin sensitivity at peripheral sites; reduces glucose output from the liver

DOSAGE: 1-4 mg/d, up to max of 8 mg

SUPPLIED: Tabs 1, 2, 4 mg

Glipizide (Glucotrol)

COMMON USES: Type 2 DM

ACTION: Sulfonylurea. Stimulates the release of insulin from the pancreas; increases insulin sensitivity at peripheral sites; reduces glucose output from the liver

DOSAGE: 5-15 mg qd-bid

SUPPLIED: Tabs 5, 10 mg; ER tabs 5, 10 mg

Glucagon

Emergency care (see Chapter 21)

COMMON USES: Severe hypoglycemic reactions in diabetic patients with sufficient liver glycogen stores or β -blocker overdose

ACTIONS: Accelerates liver gluconeogenesis

DOSAGE: Adults. 0.5–1.0 mg SC, IM, or IV; repeat after 20 min PRN. β-Blocker overdose: 3–10 mg IV; repeat in 10 min PRN; may be given as cont inf. **Peds.** Neonates: 0.3 mg/kg/dose SC, IM, or IV q4h PRN. Children: 0.025–0.1 mg/kg/dose SC, IM, or IV; repeat after 20 min PRN

SUPPLIED: Inj 1 mg

NOTES: Administration of glucose IV necessary; ineffective in states of starvation, adrenal insufficiency, or chronic hypoglycemia

Glyburide (Diaßeta, Micronase Glynase Prestab)

COMMON USES: Type 2 DM

ACTION: Sulfonylurea. Stimulates the release of insulin from the pancreas; increases insulin sensitivity at peripheral sites; reduces glucose output from the liver

DOSAGE: Nonmicronized: 1.25–10 mg qd–bid. Micronized: 1.5–6 mg qd–bid

SUPPLIED: Tabs 1.25, 2.5, 5 mg; micronized tabs [Glynase] 1.5, 3, 4.5, 6 mg

NOTES: NOT recommended in renal impairment

Glycerin Suppository

COMMON USES: Constipation
ACTIONS: Hyperosmolar laxative

DOSAGE: Adults. 1 adult supp PR PRN. Peds. 1 infant supp PR qd-bid PRN

SUPPLIED: Supp (adult, infant); liq 4 mL/applicatorful

Gonadorelin (Lutrepulse)

COMMON USES: Primary hypothalamic amenorrhea

ACTIONS: Stimulates the pituitary to release the gonadotropins LH and FSH

DOSAGE: $5-20~\mu g$ IV q 90 min for 21 d using a reservoir and pump

SUPPLIED: Inj 0.8 mg, 3.2 mg

NOTES: Risk of multiple pregnancies

Goserelin (Zoladex)

COMMON USES: Advanced prostate cancer and with radiation for localized prostate cancer; endometriosis

ACTIONS: Slow-release form of LHRH agonist, thereby inhibiting the release of gonadotropin, decreasing testosterone levels

DOSAGE: 3.6 mg SC (implant) q 28 d or 10.8 mg SC q 3 mo

SUPPLIED: Subcutaneous implant 3.6, 10.8 mg

NOTES: Toxicity symptoms: Hot flashes, ↓ libido, gynecomastia, and transient exacerbation of cancer-related bone pain ("flare reaction" 7–10 d after 1st dose)

Granisetron (Kytril)

COMMON USES: Prevention of nausea and vomiting

ACTIONS: Serotonin receptor antagonist

DOSAGE: Adults & Peds. 10 mg/kg IV 30 min prior to initiation of chemotherapy. Adults. 1 mg PO

1 h prior to chemotherapy, then 12 h later SUPPLIED: Tabs 1 mg; inj 1 mg/mL

Guaifenesin (Robitussin, others)

COMMON USES: Symptomatic relief of dry, nonproductive cough

ACTIONS: Expectorant

DOSAGE: Adults. 200–400 mg (10–20 mL) PO q4h. Peds. <2 y: 12 mg/kg/d in 6 ÷ doses. 2–5 y:

50-100 mg (2.5-5 mL) PO q4h. 6-11 y: 100-200 mg (5-10 mL) PO q4h

 $\textbf{SUPPLIED:}\ \ Tabs\ 100,\ 200,\ 1200\ \ mg;\ SR\ tabs\ 600\ \ mg;\ caps\ 200\ \ mg;\ SR\ caps\ 300\ \ mg;\ liq\ 100,\ 200\ \ mg/5\ \ mL$

Guaifenesin and Codeine (Robitussin A-C, Brontex, others) [C]

COMMON USES: Symptomatic relief of dry, nonproductive cough

ACTIONS: Antitussive with expectorant

DOSAGE: Adults. 10 mL or 1 tab PO q6-8h. Peds. 2-6 y: 1-1.5 kg/kg codeine/d ÷ dose q4-6h; 6-12 y: 5 mL q4h; >12 y: 10 mL q4h, max 60 mL/24h

0=12 y. 3 IIIE q4II, >12 y. 10 IIIE q4II, IIIax 00 IIIE/24II

SUPPLIED: Brontex tab contains 10 mg codeine; Brontex liq 2.5 mg codeine/5 mL; others 10 mg codeine/5 mL

Guaifenesin and Dextromethorphan (Many OTC Brands)

COMMON USES: Cough due to upper respiratory irritation

ACTIONS: Antitussive with expectorant

DOSAGE: *Adults & Peds* >*12 y.* 10 mL PO q6h. *Peds*. 2–6 y: 2.5 mL q6–8h, 10 mL/d max; 6–*12 y*: 5 mL q6–8h, 20 mL max/d

Guanabenz (Wytensin)

COMMON USES: HTN

ACTIONS: Central α-adrenergic agonist

DOSAGE: Adults. Initially, 4 mg PO bid; ↑ by 4 mg/d increments at 1–2-wk intervals up to 32 mg bid. Peds >12 y. Initially, 0.5–4 mg/d; ↑ by increments of 0.5–2 mg/d at 1-wk intervals up to 24 mg/d ÷ bid

SUPPLIED: Tabs 4, 8 mg

NOTES: Sedation, dry mouth, dizziness, and headache common

Guanadrel (Hylorel)

COMMON USES: HTN

ACTIONS: Inhibits norepinephrine release from peripheral storage sites

DOSAGE: Initially, 5 mg PO bid: ↑ by 10 mg/d increments at 1-wk intervals up to 75 mg PO bid

SUPPLIED: Tabs 10, 25 mg

NOTES: Interactions with tricyclic antidepressants; lower incidence of orthostatic changes and impotence than guanethidine; dosage adjustment in renal impairment

Guanethidine (Ismelin)

COMMON USES: Moderate to severe HTN or renal HTN

ACTIONS: Inhibits release of norepinephrine from peripheral storage sites

DOSAGE: Adults. Initially, 10–25 mg PO qd; ↑ the dose based on response. Peds. Initially, 0.2

mg/kg/24h PO; ↑ by 0.2 mg/kg/24h increments q 7-10 d to a max of 3 mg/kg/24h

SUPPLIED: Tabs 10, 25 mg

NOTES: May produce profound orthostatic hypotension, especially with diuretic use; may potentiate the effects of vasopressor agents; increased bowel movements and explosive diarrhea possible; interaction with tricyclic antidepressants reduces effectiveness

Guanfacine (Tenex)

COMMON USES: HTN

ACTIONS: Centrally acting α-adrenergic agonist

DOSAGE: Initially, 1 mg hs; ↑ by 1 mg/24h increments to a max of 3 mg/24h; split the dose bid if BP increases at the end of the dosing interval

SUPPLIED: Tabs 1, 2 mg

NOTES: Use with a thiazide diuretic recommended; sedation and drowsiness common; rebound HTN possible with abrupt cessation of therapy

Haemophilus B Conjugate Vaccine (Prohibit, Comvax, others)

COMMON USES: Routine immunization of children against diseases caused by *H. influenzae* type B

ACTIONS: Active immunization against *Haemophilus B*

DOSAGE: Peds. 0.5 mL (25 mg) IM in deltoid or vastus lateralis

SUPPLIED: Inj 7.5, 10, 15, 25 µg/0.5 mL

NOTES: Booster NOT required; observe for anaphylaxis. (See Table 22–9, page 636.)

Haloperidol (Haldol)

COMMON USES: Psychotic disorders, agitation, Tourette's disorders, and hyperactivity in children **ACTIONS:** Antipsychotic, neuroleptic

DOSAGE: Adults. Moderate symptoms: 0.5–2.0 mg PO bid-tid. Severe symptoms or agitation: 3–5 mg PO bid-tid or 1-5 mg IM q4h PRN (max 100 mg/d). Peds. 3-6 y: 0.01-0.03 mg/kg/24h PO qd. 6-12 y: Initially, 0.5-1.5 mg/24h PO; ↑ by increments of 0.5 mg/24h to maintenance of 2-4 mg/24h (0.05-0.1 mg/kg/24h) or 1-3 mg/dose IM q4-8h to a max of 0.1 mg/kg/24h; Tourette's syndrome may require up to 15 mg/24h PO

SUPPLIED: Tabs 0.5, 1, 2, 5, 10, 20 mg; conc liq 2 mg/mL; inj 5 mg/mL; decanoate inj 50, 100 mg/mL

NOTES: Can cause extrapyramidal symptoms and hypotension; ↓ dose in elderly

Haloprogin (Halotex)

COMMON USES: Topical treatment of tinea pedis, tinea cruris, tinea corporis, tinea manus

ACTIONS: Topical antifungal

DOSAGE: Adults. Apply bid for up to 2 wk; intertriginous may require up to 4 wk

SUPPLIED: 1% Cream; soln

Heparin

Used for emergency cardiac care (see Chapter 21)

COMMON USES: Rx and prevention of DVT and PE, AF with emboli formation, and acute arterial occlusion

ACTIONS: Acts with antithrombin III to inactivate thrombin and inhibit thromboplastin formation

DOSAGE: Adults. Prophylaxis: 3000–5000 U SC q8–12h. Thrombosis Rx: Loading dose of 50–75 U/kg IV, then 10–20 U/kg IV qh (adjust based on PTT). Peds. Infants: Loading dose 50 U/kg IV bolus, then 20 U/kg/h IV by cont inf. Children: Loading dose 50 U/kg IV, then 15–25 U/kg cont inf or 100 U/kg/dose q4h IV intermittent bolus

SUPPLIED: Inj 10, 100, 1000, 2000, 2500, 5000, 7500, 10,000, 20,000, 40,000 U/mL

NOTES: Follow PTT, thrombin time, or activated clotting time to assess effectiveness; heparin has little effect on the prothrombin time; with proper dose, PTT is about $1.5-2 \times$ the control; can cause thrombocytopenia; follow platelet counts

Hepatitis A Vaccine (Havrix, Vaqta)

COMMON USES: Prevention of hepatitis A in individuals at high risk, eg, travelers, those in certain professions, or those practicing high-risk behavior

ACTIONS: Provides active immunity

DOSAGE: (Expressed as ELISA units [EL.U]) *Havrix: Adults.* 1440 EL.U. as a single IM dose. *Peds* >2 y. 720 EL.U. as a single IM dose. *Vaqta: Adults.* 50 U as a single IM dose. *Peds.* 25 U as a single IM dose

SUPPLIED: Inj 720 EL.U./0.5 mL, 1440 EL.U./1 mL.; 50 U/mL

NOTES: Booster is recommended 6–12 mo after primary vaccination

Hepatitis B Immune Globulin [HBIG] (BayhepB, NAbi-HB)

COMMON USES: Exposure to HBsAg-positive materials, eg, blood, plasma, or serum (accidental needle-stick, mucous membrane contact, or oral ingestion)

ACTIONS: Passive immunization

DOSAGE: Adults & Peds. 0.06 mL/kg IM to a max of 5 mL; within 24 h of needle-stick or percutaneous exposure; within 14 d of sexual contact; repeat 1 and 6 mo after exposure

SUPPLIED: Inj

NOTES: Administered in gluteal or deltoid muscle; if exposure continues, the patient should also receive the hepatitis B vaccine

Hepatitis B Vaccine (Engerix-B, Recombivax HB)

COMMON USES: Prevention of hepatitis B

ACTIONS: Active immunization

DOSAGE: Adults. 3 IM doses of 1 mL each, the first 2 doses given 1 mo apart, the 3rd 6 mo after the first. *Peds.* 0.5 mL IM given on the same schedule as for adults (see Table 22–9, page 636)

SUPPLIED: Engerix-B: Inj 20 μg/mL; Ped inj 10 μg/0.5 mL. Recombivax HB: Inj 10 and 40 μg/mL;

Ped inj 5 µg/0.5 mL

NOTES: Administer IM injections for adults and older Peds in the deltoid; in other Peds, administer in the anterolateral thigh; may cause fever, inj site soreness; derived from recombinant DNA technology

Hetastarch (Hespan)

COMMON USES: Plasma volume expansion as an adjunct in the treatment of shock and leukaphere-

ACTIONS: Synthetic colloid with actions similar to those of albumin

DOSAGE: 500–1000 mL (do not exceed 1500 mL/d) IV at a rate not to exceed 20 mL/kg/h. *Leuka-pheresis:* 250–700 mL

SUPPLIED: Inj 6 g/100 mL

NOTES: NOT a substitute for blood or plasma; contra in patients with severe bleeding disorders, severe CHF, or renal failure with oliguria or anuria

Hydralazine (Apresoline, others)

COMMON USES: Moderate to severe HTN

ACTIONS: Peripheral vasodilator

DOSAGE: Adults. Begin at 10 mg PO qid, then ↑ to 25 mg qid to max of 300 mg/d. Peds. 0.75–3

mg/kg/24h PO \div q12–6h

SUPPLIED: Tabs 10, 25, 50, 100 mg; inj 20 mg/mL

NOTES: Use caution with impaired hepatic function and CAD; compensatory sinus tachycardia can be eliminated with the addition of propranolol; chronically high doses can cause SLE-like syndrome and Vitamin B_6 deficiency; SVT can occur following IM administration; dosage adjustment in renal impairment

Hydrochlorothiazide (Hydrodiuril, Esidrix, others)

COMMON USES: Edema, HTN, and CHF

ACTIONS: Thiazide diuretic; inhibits Na reabsorption in the distal tubule

DOSAGE: Adults. 25–100 mg/d PO in single or ÷ doses. Peds. <6 mo: 2–3 mg/kg/d in 2 ÷ doses. >6

mo: 2 mg/kg/d in 2 ÷ doses

SUPPLIED: Tabs 25, 50, 100 mg; caps 12.5 mg; oral soln 50 mg/5 mL

NOTES: Hypokalemia frequent; hyperglycemia, hyperuricemia, hyperlipidemia, and hyponatremia common

Hydrochlorothiazide and Amiloride (Moduretic)

COMMON USES: HTN; adjunctive therapy for CHF

ACTIONS: Combined effects of a thiazide diuretic and a potassium-sparing diuretic

DOSAGE: 1-2 tabs/d PO

SUPPLIED: Tabs (amiloride/hydrochlorothiazide) 5 mg/50 mg **NOTES:** Do NOT give to diabetics or patients with renal failure

Hydrochlorothiazide and Spironolactone (Aldactazide)

COMMON USES: Edema (CHF, cirrhosis) and HTN

ACTIONS: Combined effects of a thiazide diuretic and a K-sparing diuretic

DOSAGE: 25–200 mg each component/d in ÷ doses

SUPPLIED: Tabs (hydrochlorothiazide/spironolactone) 25 mg/25 mg, 50 mg/50 mg

Hydrochlorothiazide and Triamterene (Dyazide, Maxzide)

COMMON USES: Edema and HTN

ACTIONS: Combined effects of a thiazide diuretic and a K-sparing diuretic

DOSAGE: Dyazide: 1–2 caps PO qd–bid. Maxzide: 1 tab/d PO

SUPPLIED: (triamterene/HCTZ) 37.5 mg/25 mg, 50 mg/25 mg, 75 mg/50 mg

NOTES: HCTZ component in Maxzide more bioavailable than Dyazide; can cause hyperkalemia as well as hypokalemia; follow serum K levels

Hydrocodone and Acetaminophen (Lorcet, Vicodin, others) [C-III]

COMMON USES: Moderate to severe pain; hydrocodone has antitussive properties

ACTIONS: Narcotic analgesic with nonnarcotic analgesic

DOSAGE: 1-2 caps or tabs PO q4-6h PRN

SUPPLIED: Many different combinations; specify hydrocodone/acetaminophen dose. Caps 5/500; tabs 2.5/500, 5/400, 5/500, 7.5/400, 10/400, 7.5/500, 7.5/650, 7.5/750, 10/325, 10/400, 10/500, 10/650; elixir and soln (fruit punch flavor) 2.5 mg hydrocodone/167 mg acetaminophen/5 mL

Hydrocodone and Aspirin (Lortab ASA, others) [C-III]

COMMON USES: Moderate-to-severe pain **ACTIONS:** Narcotic analgesic with NSAID

DOSAGE: 1-2 PO q4-6h PRN

SUPPLIED: 5 mg hydrocodone/500 mg aspirin/tab

Hydrocodone and Guaifenesin (Hycotuss Expectorant, others) [C-III]

COMMON USES: Nonproductive cough associated with respiratory infection

ACTIONS: Expectorant plus cough suppressant

DOSAGE: Adults & Peds. >12 y: 5 mL q4h, pc and hs. Peds. <2 y: 0.3 mg/kg/d ÷ qid; 2–12 y: 2.5

mL q4h pc and hs

SUPPLIED: Hydrocodone 5 mg/guaifenesin 100 mg/5 mL

Hydrocodone and Homatropine (Hycodan, others) [C-III]

COMMON USES: Relief of cough **ACTIONS:** Combination antitussive

DOSAGE: Dose based on hydrocodone. Adults. 5-10 mg q4-6h. Peds. 0.6 mg/kg/d ÷ tid-qid

SUPPLIED: Syrup 5-mg hydrocodone/5 mL; tabs 5-mg hydrocodone

Hydrocodone and Ibuprofen (Vicoprofen) [C-III]

COMMON USES: Moderate to severe pain (<10 d)

ACTIONS: Narcotic with NSAID DOSAGE: 1–2 tabs q4–6h PRN

SUPPLIED Tabs 7.5 mg hydrocodone/200 mg ibuprofen

Hydrocodone and Pseudoephedrine (Entuss-D, Histussin-D, others) [C-III]

COMMON USES: Cough and nasal congestion

ACTIONS: Narcotic cough suppressant with decongestant

DOSAGE: 5 mL qid, PRN

SUPPLIED: Entuss-D 5-mg hydrocodone/30 mg pseudoephedrine/5 mL; Histussin-D 5-mg hy-

drocodone/60 mg pseudoephedrine/5 mL

Hydrocodone, Chlorpheniramine, Phenylephrine, Acetaminophen, and Caffeine (Hycomine Compound) [C-III]

COMMON USES: Cough and symptoms of upper respiratory infections **ACTIONS:** Narcotic cough suppressant with decongestants and analgesic

DOSAGE: 1 PO, q4h, PRN

SUPPLIED: Hydrocodone 5 mg/chlorpheniramine/2 mg/phenylephrine/10 mg/acetaminophen 250

mg/caffeine 30 mg/tab

Hydrocortisone

See Steroids (topical Table 22–6, pages 628–630, systemic, Table 22–5, page 627)

Hydrocortisone, Rectal (Anusol-HC Suppository, C Ortifoam Rectal, Proctocort others)

COMMON USES: Adjunct to painful anorectal conditions; radiation proctitis, management of ulcerative colitis

ACTIONS: Antiinflammatory steroid

DOSAGE: Adults. Ulcerative colitis 10–100 mg rectally qd–bid 2–3 wk 1–2×/d for 2–3 wk

SUPPLIED: Hydrocortisone acetate: Rectal aerosol 90 mg/applicator; supp 25 mg; Hydrocortisone base: Rectal 1%; rectal susp: 100 mg/60 mL

Hydrocortisone, Topical (see also Table 22–6, pages 628–630) Hydromorphone (Dilaudid) [C-II]

COMMON USES: Moderate to severe pain

ACTIONS: Narcotic analgesic

DOSAGE: 1-4 mg PO, IM, IV, or PR q4-6h PRN; 3 mg PR q6-8h PRN

SUPPLIED: Tabs 1, 2, 3, 4, 8 mg; liq 5 mg/mL; inj 1, 2, 4, 10 mg/mL; supp 3 mg

NOTES: 1.5 mg IM = 10 mg of morphine IM

Hydroxyurea (Hydrea, Droxia)

COMMON USES: CML, head and neck cancer, ovarian cancer, melanoma, colon cancer, acute leukemia, and sickle cell anemia, HIV

ACTIONS: Probable inhibitor of the ribonucleotide reductase system

DOSAGE: 50–75 mg/kg for WBC counts of >100,000 cells/mL; 20–30 mg/kg in refractory CML. *HIV*: 1000–1500 mg/d in single or ÷ doses

SUPPLIED: Caps 200, 300, 400, 500 mg

NOTES: Toxicity symptoms: Myelosuppression (primarily leukopenia), nausea and vomiting, rashes, facial erythema, radiation recall reactions, and renal dysfunction; dosage adjustment in renal dysfunction

Hydroxyzine (Atarax, Vistaril)

COMMON USES: Anxiety, tension, sedation, itching

ACTIONS: Antihistamine, anxiety

DOSAGE: Adults. Anxiety or sedation: 50–100 mg PO or IM qid or PRN (max 600 mg/d). Itching: 25–50 mg PO or IM tid–qid. Peds. 0.5–1.0 mg/kg/24h PO or IM q6h

SUPPLIED: Tabs 10, 25, 50, 100 mg; caps 25, 50, 100 mg; syrup 10 mg/5 mL; susp 25 mg/5 mL; inj 25, 50 mg/mL

NOTES: Useful in potentiating effects of narcotics; NOT for IV use; drowsiness and anticholinergic effects common

Hyoscyamine (Anaspaz, Cystospaz, Levsin, others)

COMMON USES: Spasm associated with GI and bladder disorders

DOSAGE: Adults. 0.125-0.25 mg (1-2 tabs) SL 3-4/×/d, pc and hs; 1 SR caps q12h

SUPPLIED: Caps SR [Cystospaz-M, Levsinex])

Hyoscyamine, Atropine, Scopolamine, and Phenobarbital (Donnatal, others)

COMMON USES: Irritable bowel, spastic colitis, peptic ulcer, spastic bladder

DOSAGE: 0.125–0.25 mg (1–2 tabs) 3–4×/d, 1 cap q12h (SR), 5–10 mL elixir 3–4×/d or q8h

Ibuprofen (Motrin, Rufen, Advil, others)

COMMON USES: Arthritis and pain

ACTIONS: NSAID

DOSAGE: Adults. 200-800 mg PO bid-qid. Peds. 30-40 mg/kg/d in 3-4 ÷ doses

SUPPLIED: Tabs 100, 200, 400, 600, 800 mg; chewable tabs 50, 100 mg; caps 200 mg; susp 100 mg/2.5 mL, 100 mg/5 mL, 40 mg/mL

Ibutilide (Corvert)

COMMON USES: Rapid conversion of Afib or flutter

ACTIONS: Class III antiarrhythmic agent

DOSAGE: 0.01 mg/kg (max 1 mg) IV inf over 10 min. May be repeated once

SUPPLIED: Inj 0.1 mg/mL

NOTES: Do NOT administer Class I or III antiarrhythmics concurrently or within 4 h of ibutilide inf

Idarubicin (Idamycin)

COMMON USES: AML (in combination with cytarabine), CML in blast crisis, and ALL

ACTIONS: DNA intercalating agent; inhibits of DNA topoisomerases I and II

DOSAGE: 10–12 mg/m²/d for 3–4 d

SUPPLIED: Inj 1 mg/mL (5-, 10-, 20-mg vials

NOTES: Toxicity symptoms: Myelosuppression, cardiotoxicity, nausea and vomiting, mucositis, alopecia, and irritation at sites of IV administration; rare changes in renal and hepatic function; dosage adjustment in renal or hepatic dysfunction

Ifosfamide (Ifex, Holoxan)

COMMON USES: Lung cancer (small-cell and non-small-cell), soft tissue sarcoma, testicular cancer, and non-Hodgkin's lymphoma

ACTIONS: Alkylating agent

DOSAGE: 1.2 g/m²/d for 5 d by bolus or cont inf; 2.4 g/m²/d for 3 d; with MESNA uroprotection (see MESNA)

SUPPLIED: Inj 1, 3 g

NOTES: Toxicity symptoms: Hemorrhagic cystitis, nephrotoxicity, nausea and vomiting, mild to moderate leukopenia, lethargy and confusion, alopecia, and hepatic enzyme elevations; dosage adjustment in renal impairment

Imipenem-Cilastatin (Primaxin)

COMMON USES: Serious infections caused by a wide variety of susceptible bacteria; inactive against *S. aureus*, group A and B streptococci, etc

ACTIONS: Bactericidal; interferes with cell wall synthesis

DOSAGE: Adults. 250-500 mg (imipenem) IV q6h. Peds. 60-100 mg/kg/24h IV ÷ q6h

SUPPLIED: Inj (imipenem/cilastatin) 250 mg/250 mg, 500 mg/500 mg

NOTES: Seizures may occur if drug accumulates; ↓ dosage for renal insufficiency to avoid drug accumulation if calculated CrCl is <70 mL/min

Imipramine (Tofranil)

COMMON USES: Depression, enuresis, and chronic pain

ACTIONS: Tricyclic antidepressant; ↑ synaptic conc of serotonin or norepinephrine in the CNS

DOSAGE: Adults. Hospitalized: Start at 100 mg/24h PO in + doses; can ↑ over several weeks to

250–300 mg/24h. Outpatient: Maintenance of 50–150 mg PO hs, not to exceed 200 mg/24h. Peds.

Antidepressant: 1.5–5.0 mg/kg/24h + 1–4×/d. Enuresis: >6 y: 10–25 mg PO hs; ↑ by 10–25 mg at

1–2-wk intervals; treat for 2–3 mo, then taper

SUPPLIED: Tabs 10, 25, 50 mg; caps 75, 100, 125, 150 mg

NOTES: Do NOT use with MAO inhibitors; less sedation than with amitriptyline

Imiquimod Cream, 5% (Aldara)

COMMON USES: External genital warts

ACTIONS: Exact mechanism unknown; may induce cytokines

DOSAGE: Applied 3×/wk; leave on skin for 6–10 h, continue therapy for a max of 16 wk

SUPPLIED: Single-dose packets (250 mg of the cream)

NOTES: Local skin reactions common

Immune Globulin, Intravenous (Gamimmune N, Sandoglobulin, Gammar IV)

COMMON USES: IgG antibody deficiency disease states (eg, congenital agammaglobulinemia), CVH, and BMT; and ITP

e vii, and Bivii, and iii

ACTIONS: IgG supplementation

DOSAGE: Adults & Peds. Immunodeficiency: 100–200 mg/kg/mo IV at a rate of 0.01–0.04

mL/kg/min to a max of 400 mg/kg/dose. ITP: 400 mg/kg/dose IV qd for 5 d. BMT: 500 mg/kg/wk

SUPPLIED: Inj

NOTES: Adverse effects associated mostly with rate of infusion

Indapamide (Lozol)

COMMON USES: HTN and CHF

ACTIONS: Thiazide diuretic; enhances Na, Cl, and water excretion in the proximal segment of the

distal tubule

DOSAGE: 1.25–5.0 mg/d PO **SUPPLIED:** Tabs 1.25, 2.5 mg

NOTES: Doses >5 mg do NOT have additional effects on lowering BP

Indinavir (Crixivan)

COMMON USES: HIV infection when antiretroviral therapy is indicated

ACTIONS: Protease inhibitor; inhibits maturation of immature noninfectious virions to mature in-

fectious virus

DOSAGE: 800 mg PO q8h SUPPLIED: Caps 200, 400 mg

NOTES: Use in combination with other antiretroviral agents; take on an empty stomach; may cause nephrolithiasis; drink six 8-oz glasses of water/d; numerous drug interactions; dosage adjustment in

hepatic impairment

Indomethacin (Indocin)

COMMON USES: Arthritis and closure of the ductus arteriosus; tocolytic

ACTIONS: Inhibits prostaglandin synthesis

DOSAGE: Adults. 25–50 mg PO bid-tid, to a max of 200 mg/d. SR dosed 1–2 × day *Tocolysis*: 50–100 10 PR, then 25 mg PO/PR q4–6h/× 48h. *Infants*: 0.2–0.25 mg/kg/dose IV; may be repeated in 12–24 h for up to 3 doses

SUPPLIED: Inj 1 mg/vial; caps 25, 50 mg; SR caps 75 mg; supp 50 mg; susp 25 mg/5 mL

NOTES: Monitor renal function carefully

Infliximab (Remicade)

COMMON USES: Moderate to severe Crohn's disease; RA (in combination with methotrexate)

ACTIONS: IgG1κ neutralizes biologic activity of TNFα

DOSAGE: Crohn's disease: 5 mg/kg IV inf, may follow with subsequent doses given at 2 and 6 wk after initial inf. RA: 3 mg/kg IV inf at 0, 2, 6 wk, followed by q 8 wk

SUPPLIED: Inj

NOTES: May cause hypersensitivity reaction, made up of human constant and murine variable regions; patients are predisposed to infection

Influenza Vaccine (Fluzone, Fluogen, Flushield, Flu-immune)

COMMON USES: Prevention of influenza in high-risk populations (chronic medical conditions, eg, heart disease, lung disease, or diabetes; children with asthma; residents of chronic care facilities; and any person >50 y). Health care workers or members of households who may come into contact with these patients also encouraged to be immunized

ACTIONS: Active immunization to inactivated virus grown in eggs

DOSAGE: 0.5 mL/dose IM in adults. Optimal time for vaccination in the U.S. is October–November because protection begins 1-2 wk after vaccination and lasts up to 6 mo

SUPPLIED: Each year, specific vaccines manufactured based on predictions of the strains likely to be active in the influenza season. The flu season generally December–Spring in the U.S. (Fluimmune = surface antigen, Fluogen = split virus, Flurone = whole virus)

NOTES: Soreness at the inj site and fever or malaise common after inj; severe reactions rare. Whole or split virus usually given to adults; give children <13 y split virus or purified surface antigen form to decrease febrile reactions

Insulin

COMMON USES: DM refractory to diet change or oral hypoglycemic agents; adjunct to the management of acute life-threatening hyperkalemia

ACTIONS: Insulin supplementation

DOSAGE: Based on serum glucose levels; usually given SC but can also be given IV or IM (only regular insulin can be given IV)

SUPPLIED: See Table 22–2 (page 622)

NOTES: Highly purified insulins ↑ free insulin; monitor patients closely for several weeks when changing doses

Interferon Alfa (Roferon-A, Intron A)

COMMON USES: HCL, Kaposi's sarcoma, multiple myeloma, CML, renal cell carcinoma, bladder cancer, melanoma, and chronic hepatitis C

ACTIONS: Direct antiproliferative action against tumor cells; modulation of the host immune re-

DOSAGE: Dictated by treatment protocol. *Alfa-2a (Roferon)*: 3 million IU/d for 16–24 wk SC or IM. *Alfa-2b (Intron A)*: 2 million IU/m² IM or SC 3×/wk for 2–6 mo; intravesical 50–100 million IU in 50 mL/wk NS × 6

SUPPLIED: Injectable forms

NOTES: May cause flu-like symptoms; fatigue common; anorexia occurs in 20–30% of patients; neurotoxicity may occur at high doses; neutralizing antibodies can occur in up to 40% of patients receiving prolonged therapy

Interferon Alfa-2B and Ribavirin Combination (Rebetron)

COMMON USES: Chronic hepatitis C in patients with compensated liver disease who have relapsed following α -interferon therapy

ACTIONS: Combination antiviral agents

DOSAGE: 3 million U Intron A SC 3×/wk with 1000–1200 mg of Rebtrol PO ÷ bid dose for 24 wk;

Patients <75 kg: 1000 mg of Rebetrol/d

SUPPLIED: Patients <75 $\bar{k}g$: Combination pack; 6 vials Intron A (3 million U/0.5 mL) with 6 syringes and alcohol swabs; 70 Rebtrol caps. One 18-million-U multidose vial of Intron A inj (22.8 million U/3.8 mL; 3 million U/0.5 mL) and 6 syringes and alcohol swabs; 70 Rebetrol caps. One 18 million IU Intron A inj multidose pen (22.5 million IU/1.5 mL; 3 million IU/0.2 mL) and 6 disposable needles and alcohol swabs 70 Rebetrol caps. Patients >75 kg: Identical except for 84 Rebetrol caps/pack

NOTES: Instruct patients in self-administration of SC Intron A

Interferon Alfacon-1 (Infergen)

COMMON USES: Management of chronic hepatitis C

ACTIONS: Biologic response modifier

DOSAGE: $9 \mu g SC 3 \times /wk$ **SUPPLIED:** Inj 9, $15 \mu g$

NOTES: At least 48 h between inj

Interferon β -1B (Betaseron)

COMMON USES: Management of MS **ACTIONS:** Biologic response modifier

DOSAGE: 0.25 mg SC qod

SUPPLIED: Powder for inj 0.3 mg **NOTES:** May cause flu-like syndrome

Interferon Gamma-1B (Actimmune)

COMMON USES: Chronic granulomatous disease

ACTIONS: Biologic response modifier **DOSAGE:** 50 mg/m² SC 3×/wk

SUPPLIED: Inj 100 mg

NOTES: 100 mg = 3 million U; may cause flu-like syndrome

Ipecac Syrup

See also Chapter 21

COMMON USES: Drug overdose and certain cases of poisoning

ACTIONS: Irritation of the GI mucosa; stimulation of the chemoreceptor trigger zone

DOSAGE: Adults. 15–30 mL PO, followed by 200–300 mL of water; if no emesis occurs in 20 min, may repeat once. **Peds.** Children 6–12 mo: 5–10 mL PO, followed by 10–20 mL/kg of water; if no

emesis occurs in 20 min, may repeat once. Children 1–12 y: 15 mL PO followed by 10–20 mL/kg of water; if no emesis occurs in 20 min, may repeat once

SUPPLIED: Syrup 15, 30 mL

NOTES: Do NOT use for ingestion of petroleum distillates or strong acid, base, or other corrosive or caustic agents; NOT for use in comatose or unconscious patients; caution in CNS depressant overdose

Ipratropium (Atrovent)

COMMON USES: Bronchospasm associated with COPD, bronchitis, and emphysema; rhinorrhea

ACTIONS: Synthetic anticholinergic agent similar to atropine

DOSAGE: Adults & Peds >12 y. 2-4 puffs qid. Nasal: 2 sprays/nostril bid-tid

SUPPLIED: Met-dose inhaler 18 µg/dose; soln for inhal 0.02%; nasal spray 0.03%, 0.06%

NOTES: Not for initial treatment of acute episodes of bronchospasm

Irbesartan (Avapro)

COMMON USES: HTN

ACTIONS: Angiotensin II receptor antagonists **DOSAGE:** 150 mg/d PO, may be ↑ to 300 mg/d

SUPPLIED: Tabs 75, 150, 300 mg

Irinotecan (Camptosar)

COMMON USES: Advanced colorectal cancer; lung cancer

ACTIONS: Topoisomerase I inhibitor; interferes with DNA synthesis

Dose: 125–250 mg/m² weekly to every other week

SUPPLIED: Inj 20 mg/mL

NOTES: *Toxicity symptoms:* Myelosuppression, diarrhea (acute or subacute), nausea and vomiting, abdominal cramping, and alopecia. Diarrhea dose-limiting in many studies; acute diarrhea associated with crampy abdominal pain successfully treated with atropine; subacute diarrhea treated with Imodium or loperamide. Diarrhea correlated to levels of metabolite SN-38

Iron Dextran (Dexferrum, InFeD)

COMMON USES: Iron deficiency when oral supplementation not possible

ACTIONS: Parenteral iron supplementation

DOSAGE: Based on estimate of iron deficiency, given IM/IV. A 0.5-mL test dose (0.25 mL in infants) prior to starting iron dextran. Total replacement dose (mL) = $0.0476 \times$ weight (kg) × [desired hemoglobin (g/dL) – measured hemoglobin (g/dL)] + 1 mL/5 kg weight (max 14 mL). Max daily dose: Adults >50 kg. 100 mg Fe. Peds <5 kg. 25 mg Fe, 5–10 kg: 50 mg Fe, 0–50 kg: 100 mg Fe

SUPPLIED: Inj 50 mg (Fe)/mL

NOTES: Use test dose because anaphylaxis common; may be given deep IM using the "Z-track" technique, although IV route preferred

Isoetharine (Bronkosol, Bronkometer)

COMMON USES: Bronchial asthma and reversible bronchospasm

ACTIONS: Sympathomimetic bronchodilator

DOSAGE: Adults. 0.25–1.0 mL diluted 1:3 with saline q4–6h. **Peds.** 0.01 mL/kg; min dose 0.1 mL; max dose 0.5 mL; dilute with saline q4–6h

SUPPLIED: Soln for inhal; aerosol

Isoniazid (INH)

COMMON USES: Treatment and prophylaxis of *Mycobacterium* spp infections

ACTIONS: Bactericidal; interferes with mycolic acid synthesis, thus disrupting the bacterial cell wall

DOSAGE: Adults. Active TB: 5 mg/kg/24h PO or IM (usually 300 mg/d). Prophylaxis: 300 mg/d PO for 6–12 mo. **Peds**. Active TB: 10–20 mg/kg/24h PO or IM to a max of 300 mg/d. Prophylaxis: 10 mg/kg/24h PO

SUPPLIED: Tabs 50, 100, 300 mg; syrup 50 mg/5 mL; inj 100 mg/mL

NOTES: Can cause severe hepatitis; given with other antituberculous drugs for active TB; consult *MMWR* for the latest recommendations on the treatment and prophylaxis of TB; IM route rarely used; to prevent peripheral neuropathy, give pyridoxine 50–100 mg/d; dosage adjustment in hepatic impairment

Isoproterenol (Isuprel, Medihaler-Iso)

Used for emergency cardiac care (see Chapter 21)

COMMON USES: Shock, cardiac arrest, and AV nodal block; antiasthmatic

ACTIONS: β_1 - and β_2 -receptor stimulant

DOSAGE: Adults. For emergency cardiac care, also see Chapter 21. Shock: 1–4 mg/min IV inf; titrate to effect. AV nodal block: 20–60 mg IV push; may repeat q 3–5 min; maintenance 1–5 mg/min IV inf. Inhalation: 1–2 inhal 4–6×/d. **Peds.** For emergency cardiac care, also see Chapter 21. Inhal: 1–2 inhal 4–6×/d

SUPPLIED: Metered inhaler; soln for neb 0.5%, 1%; inj 0.02 mg/mL, 0.2 mg/mL

NOTES: Contra in tachycardia; pulse >130 may induce ventricular arrhythmias. (See Table 20–10, page 637.)

Isosorbide Dinitrate (Isordil, Sorbitrate)

COMMON USES: Rx and prevention of angina pectoris **ACTIONS:** Relaxation of vascular smooth muscle

ACTIONS: Relaxation of vascular smooth muscle

DOSAGE: Acute angina: 5–10 mg PO (chewable tabs) q2–3h or 2.5–10 mg SL PRN q 5–10 min; >3 doses should not be given in a 15–30-min period. Angina prophylaxis: 5–60 mg PO tid

SUPPLIED: Tabs 5, 10, 20, 30, 40 mg; SR tabs 40 mg; SL tabs 2.5, 5, 10 mg; chewable tabs 5, 10 mg; SR caps 40 mg

NOTES: Do NOT give nitrates on a chronic q6h or qid basis because of development of tolerance; can cause headaches; higher oral dose usually needed to achieve same results as SL forms

Isosorbide Mononitrate (Ismo, Imdur)

COMMON USES: Prevention of angina pectoris

ACTIONS: Causes relaxation of the vascular smooth muscle

DOSAGE: 20 mg PO bid, with the 2 doses given 7 h apart or ER (Imdur) 30-120 mg/d PO

SUPPLIED: Tabs 10, 20 mg; ER 30, 60, 120 mg

Isotretinoin [13-cis Retinoic Acid] (Accutane)

COMMON USES: Refractory severe acne ACTIONS: Retinoic acid derivative DOSAGE: 0.5–2 mg/kg/d PO ÷ bid SUPPLIED: Caps 10, 20, 40 mg

NOTES: Contra in PRG and lactation; isolated reports of depression, psychosis, suicidal thoughts;

dosage adjustment in hepatic impairment

Isradipine (Dyna-Circ)

COMMON USES: HTN and CHF ACTIONS: Ca channel-blocker DOSAGE: 2.5–10 mg PO bid

SUPPLIED: Caps 2.5, 5.0 mg; tabs CR 5, 10 mg

Itraconazole (Sporanox)

COMMON USES: Systemic fungal infections caused by *Aspergillus, Blastomycosis*, and *Histoplasma* **ACTIONS:** Inhibits synthesis of ergosterol

DOSAGE: 200 mg PO or IV qd-bid

SUPPLIED: Caps 100 mg; soln 10 mg/mL; inj 10 mg/mL

NOTES: Administer with meals or cola; do NOT use concurrently with H₂-antagonist, omeprazole, antacids, terfenadine, astemizole, or cisapride; numerous other interactions

Kaolin-Pectin (Kaodene, Kao-Spen, Kapectolin)

COMMON USES: Diarrhea

ACTIONS: Adsorbent demulcent

DOSAGE: Adults. 60-120 mL PO after each loose stool or q3-4h PRN. Peds. 3-6 y: 15-30

mL/dose PO PRN. 6-12 v: 30-60 mL/dose PO PRN

SUPPLIED: Multiple OTC forms

NOTES: Also available with opium (Parepectolin [C-V])

Ketoconazole (Nizoral)

COMMON USES: Systemic fungal infections (candidiasis, chronic mucocutaneous candidiasis, blastomycosis, coccidioidomycosis, histoplasmosis, and paracoccidioidomycosis); topical cream for localized fungal infections due to dermatophytes and yeast; short-term treatment of prostate cancer when rapid reduction of testosterone needed (ie, spinal cord compression)

ACTIONS: Inhibits fungal cell wall synthesis

DOSAGE: Adults. Oral: 200 mg PO qd; ↑ to 400 mg PO qd for serious infections; prostate cancer 400 mg PO tid (short term). Topical: Apply to the affected area qd (cream or shampoo). Peds >2 y. 5–10 mg/kg/24h PO ÷ q12–24h

SUPPLIED: Tabs 200 mg; topical cream 2%; shampoo 2%

NOTES: Systemic use associated with hepatotoxicity; monitor LFT; drug interaction with any agent † gastric pH prevents absorption of ketoconazole; avoid concurrent use with cisapride; may enhance oral anticoagulants; may react with alcohol to produce a disulfiram-like reaction; numerous other drug interactions

Ketoprofen (Orudis, Oruvail)

COMMON USES: Arthritis and pain

ACTIONS: NSAID; inhibits prostaglandin synthesis **DOSAGE:** 25–75 mg PO tid–qid, to a max of 300 mg/d

SUPPLIED: Tabs 12.5 mg; caps 50, 75 mg; caps, SR 100, 150, 200 mg

Ketorolac (Toradol)

COMMON USES: Arthritis and pain

ACTIONS: NSAID; inhibits prostaglandin synthesis DOSAGE: 15–30 mg IV/IM q6h or 10 mg PO qid SUPPLIED: Tabs 10 mg; inj 15 mg/mL, 30 mg/mL

NOTES: Do NOT use for longer than 5 d; adjust dose for age and renal dysfunction

Ketorolac Ophthalmic (Acular)

COMMON USES: Relief of ocular itching caused by seasonal allergic conjunctivitis

ACTIONS: NSAID
DOSAGE: 1 gt qid
SUPPLIED: Soln 0.5%

Labetalol (Trandate, Normodyne)

COMMON USES: HTN and hypertensive emergencies

ACTIONS: α- and β-Adrenergic blocking agent

DOSAGE: Adults. HTN: Initially, 100 mg PO bid; then 200–400 mg PO bid. Hypertensive emergency: 20–80 mg IV bolus, then 2 mg/min IV influsion, titrated to effect. Peds. Oral: 3–20 mg/kg/d

in ÷ doses. Hypertensive emergency: 0.4-3 mg/kg/h IV cont inf

SUPPLIED: Tabs 100, 200, 300 mg; inj 5 mg/mL. (See Table 22–10, page 637.)

Lactic Acid and Ammonium Hydroxide [Ammonium Lactate] (Lac-Hydrin)

COMMON USES: Severe xerosis and ichthyosis

ACTIONS: Emollient moisturizer

DOSAGE: Apply bid

SUPPLIED: Lactic acid 12% with ammonium hydroxide

Lactobacillus (Lactinex Granules)

COMMON USES: Control of diarrhea, especially after antibiotic therapy

ACTIONS: Replaces normal intestinal flora

DOSAGE: Adult and Peds >3 y. 1 packet, 2 caps, or 4 tabs with meals or liqs tid-qid

SUPPLIED: Tabs; caps; EC caps; powder in packets

Lactulose (Chronulac, Cephulac)

COMMON USES: Hepatic encephalopathy; laxative

ACTIONS: Acidifies the colon, allowing ammonia to diffuse into the colon

DOSAGE: Adults. Acute hepatic encephalopathy: 30–45 mL PO q1h until soft stools are observed, then tid-qid. Chronic laxative therapy: 30–45 mL PO tid-qid; adjust the dosage q 1–2 d to produce 2–3 soft stools/d. Rectally: 200 g diluted with 700 mL of water instilled PR. Peds. Infants: 2.5–10 mL/24h + tid-qid. Children: 40–90 mL/24h + tid-qid

SUPPLIED: Syrup 10 g/15 mL **NOTES:** Can cause severe diarrhea

Lamivudine (Epivir, Epivir-HBV)

COMMON USES: HIV infection when therapy warranted based on clinical or immunologic evidence of disease progression, and chronic hepatitis B

ACTIONS: Inhibits HIV reverse transcriptase, resulting in viral DNA chain termination

DOSAGE: HIV: Adults & Peds >12 y. 150 mg PO bid. Peds <12 y. 4 mg/kg bid. HBV: 100 mg/d

SUPPLIED: Tabs 100, 150 mg; soln 5 mg/mL, 10 mg/mL

NOTES: Use in combination with zidovudine; use with caution in pediatric patients because of an increased incidence of pancreatitis; adjust dose for renal dysfunction

Lamotrigine (Lamictal)

COMMON USES: Partial seizures **ACTIONS:** Phenyltriazine antiepileptic

DOSAGE: Adults. Initial dose 50 mg/d PO, followed by 50 mg PO bid for 2 wk, then maintenance dose of 300-500 mg/d in $2 \div$ doses. *Peds.* 0.15 mg/kg in $1-2 \div$ doses for weeks 1 and 2, then 0.3 mg/kg for weeks 3 and 4, then maintenance dose of 1 mg/kg/d in $1-2 \div$ doses

SUPPLIED: Tabs 25, 100, 150, 200 mg; chewable tabs 5, 25 mg

NOTES: May cause rash and photosensitivity; value of therapeutic monitoring not established; interacts with other antiepileptics

Lansoprazole (Prevacid)

COMMON USES: Duodenal ulcers, H. pylori infection, erosive esophagitis, and hypersecretory con-

ditions

ACTIONS: Proton pump inhibitor DOSAGE: 15–30 mg/d PO SUPPLIED: Caps 15, 30 mg

Latanoprost (Xalatan)

COMMON USES: Refractory glaucoma

ACTIONS: Prostaglandin
DOSAGE: 1 gtt

SUPPLIED: 0.005% Soln

NOTES: May darken light irides

Leflunomide (Arava)

COMMON USES: Active RA

ACTIONS: Inhibits pyrimidine synthesis

DOSAGE: Initial 100 mg/d for 3 d, followed by 10-20 mg/d

SUPPLIED: Tabs 10, 20, 100 mg

NOTES: PRG category X DO NOT USE; monitor serum transaminase levels during initial

therapy

Lepirudin (Refludan)

COMMON USES: Heparin-induced thrombocytopenia

ACTIONS: Direct inhibitor of thrombin

DOSAGE: Bolus 0.4 mg/kg IV, followed by 0.15 mg/kg cont inf

SUPPLIED: Inj 50 mg

NOTES: Adjust dose based on aPTT ratio; maintain aPTT ratio of 1.5-2.0

Letrozole (Femara)

COMMON USES: Advanced breast cancer

ACTIONS: Nonsteroidal inhibitor of the aromatase enzyme system

DOSAGE: 2.5 mg/d

SUPPLIED: Tabs 2.5 mg

NOTES: Requires periodic CBC, thyroid function, electrolyte, LFT, and renal monitoring

Leucovorin (Wellcovorin)

COMMON USES: Overdose of folic acid antagonist; augmentation of 5-FU

ACTIONS: Reduced folate source; circumvents the action of folate reductase inhibitors (ie,

methotrexate)

DOSAGE: Adults & Peds. MTX rescue: 10 mg/m²/dose IV or PO q6h for 72 h until MTX level <010-8. 5-FU: 200 mg/m²/d IV 1-5 d during daily 5-FU treatment or 500 mg/m²/wk with weekly 5-FU therapy. Adjunct to antimicrobials: 5-15 mg/d PO

SUPPLIED: Tabs 5, 15, 25 mg; inj

NOTES: Many different dosing schedules for leucovorin rescue following MTX therapy

Leuprolide (Lupron, Viadur)

COMMON USES: Prostate cancer, endometriosis, and CPP

ACTIONS: LHRH agonist; paradoxically inhibits release of gonadotropin, resulting in decreased LH

and testosterone levels

DOSAGE: Adults. Prostate: 7.5 mg IM q 28 d or 22.5 mg IM q 3 mo of depot. Endometriosis (depot only): 3.75 mg IM as a single monthly dose. Viadur: SQ implant 1 × year **Peds**. CPP: 50 mg/kg/d as a daily SC inj. ↑ by 10 mg/kg/d until total down-regulation achieved. Depot: <25 kg: 7.5 mg IM q 4 wk. >37.5 kg: 15 mg IM

SUPPLIED: Inj 5 mg/mL; depot forms 3.75, 7.5, 11.25, 15, 22.5, 30 mg; Viadur 12 mo implant

NOTES: Toxicity symptoms: Hot flashes, gynecomastia, nausea and vomiting, constipation, anorexia, dizziness, headache, insomnia, paresthesias, peripheral edema, and bone pain (transient "flare reaction" at 7–14 d after the first dose due to testosterone surge)

Levalbuterol (Xopenex)

COMMON USES: Rx and prevention of bronchospasm

ACTIONS: Sympathomimetic bronchodilator

DOSAGE: 0.63 mg neb q6–8h

SUPPLIED: Soln for inhal 0.63, 1.25 mg/3mL

NOTES: Therapeutically active *R*-isomer of albuterol

Levamisole (Ergamisol)

COMMON USES: Adjuvant therapy of Dukes C colon cancer (in combination with 5-FU)

ACTIONS: Multiple poorly understood immunostimulatory effects

DOSAGE: 50 mg PO q8h for 3 d q 14 d during 5-FU therapy

SUPPLIED: Tabs 50 mg

NOTES: Toxicity symptoms: Nausea and vomiting, diarrhea, abdominal pain, taste disturbance, and vomiting, diarrhea, abdominal pain, taste disturbance, and consider the pression, fatigue, fever, and conjunctivitis

Levetiracetam (Keppra)

COMMON USES: Partial onset seizures

ACTIONS: Unknown

DOSAGE: 500 mg PO bid, may be ↑ to a max of 3000 mg/d

SUPPLIED: Tabs 250, 500, 750 mg

NOTES: May cause dizziness and somnolence; may impair coordination; adjust dosage in renal impairment

Levobunolol (Betagan, Liquidfilm Ophthalmic)

COMMON USES: Glaucoma

ACTIONS: β-Adrenergic blocker

DOSAGE: 1-2 gtt/d 0.5% or 1-2 gtt 0.25% bid

SUPPLIED: Soln 0.25, 0.5%

Levocabastine (Livostin)

COMMON USES: Allergic seasonal conjunctivitis

ACTIONS: Antihistamine

DOSAGE: 1 gtt in eye(s) qid up to 4 wk

SUPPLIED: 0.05% soln

Levofloxacin (Levaquin)

COMMON USES: Lower respiratory tract infections, sinusitis, and UTI

ACTIONS: Quinolone antibiotic, inhibits DNA gyrase **DOSAGE:** 250–500 mg/d PO or IV

SUPPLIED: Tabs 250, 500 mg; inj 5, 25 mg/mL

NOTES: Reliable activity against S. pneumoniae, drug interactions with cation-containing products;

renal dosage adjustment

Levonorgestrel Implant (Norplant)

COMMON USES: Contraceptive (Progestin)

DOSAGE: Implant 6 caps in the midforearm during first 7 days of menses **SUPPLIED:** Kits containing 6 implantable caps, each containing 36 mg

NOTES: Prevents pregnancy for up to 5 y; caps may be removed if pregnancy desired

Levorphanol (Levo-Dromoran) [C-II]

COMMON USES: Moderate to severe pain

ACTIONS: Narcotic analgesic

DOSAGE: 2 mg PO or SC PRN q6-8h **SUPPLIED:** Tabs 2 mg; inj 2 mg/mL

Levothyroxine (Synthroid)

COMMON USES: Hypothyroidism
ACTIONS: Supplementation of L-thyroxine

DOSAGE: Adults. Initially, 25–50 μg/d PO or IV; ↑ by 25–50 μg/d every month; usual dose 100–200 μg/d. Peds. 0–1 y: 8–10 μg/kg/24h PO or IV. *1–5 y:* 4–6 μg/kg/24h PO or IV. >5 y: 3–4 μg/kg/24h PO or IV

SUPPLIED: Tabs 25, 50, 75, 88, 100, 112, 125, 150, 175, 200, 300 µg; inj 200, 500 µg

NOTES: Titrate dosage based on clinical response and thyroid function tests; can ↑ dosage more rapidly in young to middle-aged patients

Lidocaine (Anestacon Topical, Xylocaine, others)

Used for emergency cardiac care (see Chapter 21)

COMMON USES: Local anesthetic; treatment of cardiac arrhythmias

ACTIONS: Anesthetic; class IB antiarrhythmic

DOSAGE: Adults. Antiarrhythmic, endotracheal: 5 mg/kg; follow with 0.5 mg/kg in 10 min if effective. IV Load: 1 mg/kg/dose bolus over 2-3 min; repeat in 5-10 min up to 200-300 mg/h; cont inf of 20-50 μg/kg/min or 1-4 mg/min. Peds. Antiarrhythmic, endotracheal, Loading dose: 1 mg/kg; repeat in 10-15 min max total dose of 5 mg/kg; then IV inf 20-50 μg/kg/min. Topical: Apply max 3 mg/kg/dose. Local inj anesthetic: Max 4.5 mg/kg; See Chapter 17.

SUPPLIED: Inj (*Local*) 0.5, 1, 1.5, 2, 4, 10, 20%; (*Inj IV*) 1% (10 mg/mL, 2% 20 mg/mL); admixture 4, 10, 20%; (*IV inf*) 0.2%, 0.4%; cream 2%; gel 2, 2.5%; oint 2.5, 5%; liq 2.5%; soln 2, 4%; viscous 2%. (For infusion, see Table 20–10, page 637.)

NOTES: Endotracheal doses should be diluted to 1–2 mL with NS; epinephrine may be added for local anesthesia to prolong effect and help decrease bleeding; do NOT use lidocaine with epinephrine on the digits, ears, or nose because vasoconstriction may cause necrosis; for IV forms, ↓ dose with liver disease or CHF; dizziness, paresthesias, and convulsions associated with toxicity; see Table 22–7 (pages 631–634) for drug levels

Lidocaine/Prilocaine (EMLA)

COMMON USES: Topical anesthetic; adjunct to phlebotomy or invasive dermal procedures

ACTIONS: Topical anesthetic

DOSAGE: Adults. EMLA cream and anesthetic disc (1 g/10 cm²): Apply thick layer of cream 2–2.5 g to intact skin and cover with an occlusive dressing (eg. Tegaderm) for at least 1 h. Anesthetic disc: 1 g/10 cm² for at least 1 h. Peds. Max dose: ≤ 3 mo or ≤ 5 kg: 1 g/10 cm² for 1 h. 3–12 mo and ≤ 5 kg: 2 g/20 cm² for 4 h. 1–6 y and ≤ 10 kg: 10 g/100 cm² for 4 h. 7–12 y and ≤ 20 kg: 20 g/200 cm² for 4 h.

SUPPLIED: Cream 2.5% lidocaine/2.5% prilocaine; anesthetic disc (1 g)

NOTES: Not for ophth use; use with caution when risk of methemoglobinemia; longer contact time gives greater effect

Lindane (Kwell)

COMMON USES: Head lice, crab lice, scabies

ACTIONS: Ectoparasiticide and ovicide

DOSAGE: Adults & Peds. Cream or lotion: Apply thin layer after bathing and leave in place for 8–12h (6–8 h for children, 6 h for infants), pour on laundry. Shampoo: Apply 30 mL and develop a lather with warm water for 4 min; comb out nits

SUPPLIED: Lotion 1%; shampoo 1%

NOTES: Caution with overuse; may be absorbed into blood; repeat in 7 d if necessary

Linezolid (Zyvox)

COMMON USES: Infections caused by gram+ bacteria, including vancomycin-resistant and methicillin-resistant strains

ACTIONS: Unique action, binds ribosomal bacterial RNA; bacteriocidal for strep, bacteriostatic for enterococci and staph

DOSAGE: 400-600 mg IV or PO q12h

SUPPLIED: Inj 2 mg/mL; tabs 400, 600 mg; susp 100 mg/5 mL

NOTES: Reversible MAO inhibitor; avoid foods containing tyramine; avoid cough and cold products containing pseudoephedrine

Liothyronine (Cytomel)

COMMON USES: Hypothyroidism

ACTIONS: T₃ replacement

DOSAGE: Adults. Initial dose of 25 μg/24h, then titrate q 1–2 wk according to clinical response and TFT to maintenance of 25–100 μg/d PO. Myxedema coma: 25–50 μg IV. Peds. Initial dose of 5 μg/24h, then titrate by 5 μg/24h increments at 1–2-wk intervals; maintenance 25–75 μg/24h PO qd **SUPPLIED:** Tabs 5, 25, 50 μg; inj 10 μg/mL

NOTES: ↓ Dose in elderly; monitor TFT

Lisinopril (Prinivil, Zestril)

COMMON USES: HTN, heart failure, and AMI

ACTIONS: ACE inhibitor

DOSAGE: 5-40 mg/24h PO qd-bid. AMI: 5 mg within 24h of MI, followed by 5 mg after 24h, 10

mg after 48 h, then 10 mg/d

SUPPLIED: Tabs 2.5, 5, 10, 20, 30, 40 mg

NOTES: Dizziness, headache, and cough common side effects; Do NOT use in PRG

Lithium Carbonate (Eskalith, others)

COMMON USES: Manic episodes of bipolar illness; maintenance therapy in recurrent disease

ACTIONS: Effects shift toward intraneuronal metabolism of catecholamines

DOSAGE: Adults. Acute mania: 600 mg PO tid or 900 mg SR bid. Maintenance: 300 mg PO

tid-qid. Peds 6-12 y. 15-60 mg/kg/d in 3-4 ÷ doses

SUPPLIED: Caps 150, 300, 600 mg; tabs 300 mg; SR tabs 300, 450 mg; syrup 300 mg/5 mL

NOTES: Dosage must be titrated; follow serum levels (Table 22–7, pages 631–634); common side effects polyuria and tremor; contra in patients with severe renal impairment; Na retention or diuretic use may potentiate toxicity

Lodoxamide (Alomide Ophthalmic)

COMMON USES: Seasonal allergic conjunctivitis

ACTIONS: Stabilizes mast cells

DOSAGE: Adults & Peds >2 y. 1-2 gtt in eye(s) qid up to 3 mo

SUPPLIED: Soln 0.1%

Lomefloxacin (Maxaquin)

COMMON USES: UTI and lower respiratory tract infections caused by gram-bacteria; prophylaxis

in transurethral procedures

ACTIONS: Quinolone antibiotic; inhibits DNA gyrase

DOSAGE: 400 mg/d PO SUPPLIED: Tabs 400 mg

NOTES: May cause photosensitivity; renal dosage adjustment

Lomustine (CCNU, CeeNu)

COMMON USES: Hodgkin's lymphoma and primary brain tumors

ACTIONS: Nitrosourea alkylating agent

DOSAGE: 130 mg/m² single dose repeated q 6 wk

SUPPLIED: Caps 10, 40, 100 mg; dose pack

NOTES: Toxicity symptoms: Myelosuppression, renal injury, anorexia, nausea and vomiting, stomatitis, pulmonary fibrosis, and hepatotoxicity. High lipid solubility translates into excellent penetration into the CNS

Loperamide (Imodium)

COMMON USES: Diarrhea

ACTIONS: Slows intestinal motility

DOSAGE: Adults. Initially, 4 mg PO; then 2 mg after each loose stool, up to 16 mg/d. Peds. 0.4–0.8

 $mg/kg/24h PO \div q6-12h$ until diarrhea resolves or for 7 d max **SUPPLIED:** Caps 2 mg; tabs 2 mg; liq 1 mg/5 mL, 1 mg/mL

NOTES: Do NOT use in acute diarrhea caused by Salmonella, Shigella, or C. difficile

Loracarbef (Lorabid)

COMMON USES: Infections caused by susceptible bacteria involving the upper and lower respiratory tract, skin, bone, urinary tract, abdomen, and gynecologic system

ACTIONS: 2nd-generation cephalosporin; inhibits cell wall synthesis **DOSAGE:** *Adults.* 200–400 mg PO bid. *Peds.* 7.5–15 mg/kg/d PO ÷ bid

SUPPLIED: Caps 200, 400 mg; susp 125, 250 mg/5 mL

NOTES: More gram (-) activity than 1st-generation cephalosporins

Loratadine (Claritin)

COMMON USES: Allergic rhinitis **ACTIONS:** Nonsedating antihistamine

DOSAGE: 10 mg/d PO

SUPPLIED: Tabs 10 mg; syrup 1 mg/mL **NOTES:** Take on an empty stomach

Lorazepam (Ativan, others) [C-IV]

COMMON USES: Anxiety and anxiety mixed with depression; preop sedation; control of status epilepticus; antiemetic

ACTIONS: Benzodiazepine; antianxiety agent

DOSAGE: Adults. Anxiety: 1–10 mg/d PO in 2–3 ÷ doses. Preop sedation: 0.05 mg/kg to a max of 4 mg IM 2 h before surgery. Insomnia: 2–4 mg PO hs. Status epilepticus: 4 mg/dose IV may be repeated at 10–15-min intervals; usual total dose 8 mg. Antiemetic: 0.5–2 mg IV or PO q4–6h PRN. **Peds.** Status epilepticus: 0.05 mg/kg/dose IV repeated at 1–20-min intervals × 2 PRN. Antiemetic, 2–15 y old: 0.05 mg/kg (to 2 mg/dose) prior to chemotherapy

SUPPLIED: Tabs 0.5, 1, 2 mg; soln, oral conc 2 mg/mL; inj 2, 4 mg/mL

NOTES: ↓ Dose in elderly; do NOT administer IV faster than 2 mg/min or 0.05 mg/kg/min; may take up to 10 min to see effect when given IV

Losartan (Cozaar)

COMMON USES: HTN

ACTIONS: Angiotensin II antagonist **DOSAGE:** 25–50 mg PO qd–bid **SUPPLIED:** Tabs 25, 50, 100 mg

NOTES: Do NOT use in PRG; symptomatic hypotension may occur in patients on diuretics; dosage

adjustment in elderly or hepatic impairment

Lovastatin (Mevacor)

COMMON USES: Hypercholesterolemia; to slow the progression of atherosclerosis

ACTIONS: HMG-CoA reductase inhibitor

DOSAGE: 20 mg/d PO with PM meal; may ↑ at 4-wk intervals to a max of 80 mg/d taken with meals

SUPPLIED: Tabs 10, 20, 40 mg

NOTES: Patient must maintain standard cholesterol-lowering diet throughout treatment; monitor LFT q 6 wk during the 1st year of therapy; headache and GI intolerance common; patient should promptly report any unexplained muscle pain, tenderness, or weakness; avoid concurrent use with gemfibrozil

Lyme Disease Vaccine (Lymerix)

COMMON USE: Prevention of Lyme disease

ACTION: Provides active immunity against *Borrelia burgdorferi*

DOSAGE: 30 µg/0.5 mL IM administered at 0, 1, and 12 mo

SUPPLIED: Vaccine 0.3 µg/0.5 mL

Magaldrate (Riopan, Lowsium)

COMMON USES: Hyperacidity associated with peptic ulcer, gastritis, and hiatal hernia

ACTIONS: Low-Na antacid

DOSAGE: 5-10 mL PO between meals and hs

SUPPLIED: Susp

NOTES: <0.3 mg Na/tab or tsp; do NOT use in renal insufficiency due to Mg content

Magnesium Citrate

COMMON USES: Vigorous bowel preparation; constipation

ACTIONS: Cathartic laxative

DOSAGE: Adults. 120-240 mL PO PRN. Peds. 0.5 mL/kg/dose, to a max of 200 mL PO

SUPPLIED: Effervescent soln

NOTES: Do NOT use in renal insufficiency or intestinal obstruction

Magnesium Hydroxide (Milk of Magnesia)

COMMON USES: Constipation

ACTIONS: Saline laxative

DOSAGE: Adults. 15-30 mL PO PRN. Peds. 0.5 mL/kg/dose PO PRN

SUPPLIED: Tabs 311 mg, liq 400 mg/5 mL, 800 mg/5 mL

NOTES: Do NOT use in renal insufficiency or intestinal obstruction

Magnesium Oxide (Mag-Ox 400, others)

COMMON USES: Replacement for low plasma levels

ACTIONS: Mg supplementation

DOSAGE: $400-800 \text{ mg/d} \div \text{qd-qid.}$ (See Chapter 9)

SUPPLIED: Caps 140 mg; tabs 400 mg

NOTES: May cause diarrhea

Magnesium Sulfate

Used for emergency cardiac care (see Chapter 21)

COMMON USES: Replacement for low plasma levels; refractory hypokalemia and hypocalcemia;

preeclampsia and premature labor

ACTIONS: Mg supplement

DOSAGE: Adults. Supplement: 1–2 g IM or IV; repeat dosing based on response and continued hypomagnesemia. (See also Chapter 9.) Preeclampsia, premature labor: 4 g load then 1–4 g/h IV infusion. Peds. 25–50 mg/kg/dose IM or IV q4–6h for 3–4 doses; may repeat if hypomagnesemia persists

SUPPLIED: Inj 100, 125, 250, 500 mg/mL; oral soln 500 mg/mL; granules 40 meq/5 g

NOTES: ↓ Dose with low urine output or renal insufficiency

Mannitol

Used for emergency care (see Chapter 21)

COMMON USES: Cerebral edema, oliguria, anuria, myoglobinuria

ACTIONS: Osmotic diuretic

DOSAGE: Adults. Diuresis: 0.2 g/kg/dose IV over 3–5 min; if no diuresis within 2 h, discontinue. Peds. Diuresis: 0.75 g/kg/dose IV over 3–5 min; if no diuresis within 2 h, discontinue. Adults & Peds. Cerebral edema: 0.25 g/kg/dose IV push, repeated at 5-min intervals PRN; ↑ incrementally to 1 g/kg/dose PRN for increased intracranial pressure

SUPPLIED: Inj 5%, 10%, 15%, 20%, 25%

NOTES: Caution with CHF or volume overload

Maprotiline (Ludiomil)

COMMON USES: Depressive neurosis, bipolar illness, major depressive disorder, and anxiety associated with depression

ACTIONS: Tetracyclic antidepressant

DOSAGE: 75-150 mg/d hs, to a max of 300 mg/d

SUPPLIED: Tabs 25, 50, 75 mg

NOTES: Contra with MAO inhibitors or seizure history; patients >60 y, give only 50–75 mg/d; anticholinergic side effects

Mechlorethamine (Mustargen)

COMMON USES: Hodgkin's and non-Hodgkin's lymphoma, cutaneous T-cell lymphoma (mycosis fungoides), lung cancer, CLL, CML, and malignant pleural effusions

ACTIONS: Alkylating agent (bifunctional)

DOSAGE: 0.4 mg/kg single dose or 0.1 mg/kg/d for 4 d; 6 mg/m² 1–2 ×/mo

SUPPLIED: Inj 10 mg

NOTES: Toxicity symptoms: Myelosuppression, thrombosis, or thrombophlebitis at inj site; tissue damage with extravasation (Na thiosulfate may be used topically to treat); nausea and vomiting; skin rash; amenorrhea; and sterility. High rates of sterility (especially in men) and secondary leukemia in patients treated for Hodgkin's disease. Highly volatile; must be administered within 30–60 min of preparation

Meclizine (Antivert)

COMMON USES: Motion sickness; vertigo associated with diseases of the vestibular system

ACTIONS: Antiemetic, anticholinergic, and antihistaminic properties

DOSAGE: Adults & Peds >12 y. 25 mg PO tid-qid PRN

SUPPLIED: Tabs 12.5, 25, 50 mg; chewable tabs 25 mg; caps 25, 30 mg

NOTES: Drowsiness, dry mouth, and blurred vision common

Medroxyprogesterone (Provera, Depot Provera, Cycrin)

COMMON USES: Secondary amenorrhea and abnormal uterine bleeding caused by hormonal imbalance; endometrial cancer

ACTIONS: Progestin supplement

DOSAGE: Secondary amenorrhea: 5–10 mg/d PO for 5–10 d. Abnormal uterine bleeding: 5–10 mg/d PO for 5–10 d beginning on the 16th or 21st d of the menstrual cycle. Endometrial cancer: 400–1000 mg/wk IM

SUPPLIED: Tabs 2.5, 5, 10 mg; depot inj 100, 150, 400 mg/mL

NOTES: Contra with past thromboembolic disorders or with hepatic disease

Megestrol Acetate (Megace)

COMMON USES: Breast and endometrial cancers; appetite stimulant in cancer and HIV-related

cachexia

ACTIONS: Hormone; progesterone analogue

DOSAGE: Cancer: 40-320 mg/d PO in ÷ doses. Appetite: 800 mg/d PO

SUPPLIED: Tabs 20, 40 mg; soln 40 mg/mL

NOTES: May induce DVT; do NOT abruptly discontinue therapy

Meloxicam (Mobic)

COMMON USES: Osteoarthritis ACTIONS: NSAID agent DOSAGE: 7.5–15 mg/d PO SUPPLIED: Tabs 7.5 mg

NOTES: ↓ Dose in renal impairment

Melphalan [L-PAM] (Alkeran)

COMMON USES: Multiple myeloma, breast cancer, testicular cancer, ovarian cancer, melanoma, and allogenic and ABMT in high doses

ACTIONS: Alkylating agent (bifunctional)

DOSAGE: (Per protocol) 9 mg/m² or 0.25 mg/kg/d for 4–7 d, repeated at 4–6-wk intervals, or 1 mg/kg single dose once q 4–6 wk; 0.15 mg/kg/d for 5 d q 6 wk. *High dose for high-risk multiple myeloma*; Single dose 140 mg/m².*ABMT*: 140–240 mg/m² IV

SUPPLIED: Tabs 2 mg; inj 50 mg

NOTES: *Toxicity symptoms:* Myelosuppression (leukopenia and thrombocytopenia), secondary leukemia, alopecia, dermatitis, stomatitis, and pulmonary fibrosis; very rare hypersensitivity reactions

Meperidine (Demerol) [C-II]

COMMON USES: Relief of moderate to severe pain

ACTIONS: Narcotic analgesic

DOSAGE: Adults. 50-150 mg PO or IM q3-4h PRN. Peds. 1-1.5 mg/kg/dose PO or IM q3-4h

PRN, up to 100 mg/dose

SUPPLIED: Tabs 50, 100 mg; syrup 50 mg/mL; inj 10, 25, 50, 75, 100 mg/mL

NOTES: 75 mg IM = 10 mg of morphine IM; beware of respiratory depression; do NOT use in renal failure; \downarrow dose in elderly and renal impairment

Meprobamate (Equanil, Miltown) [C-IV]

COMMON USES: Short-term relief of anxiety

ACTIONS: Mild tranquilizer; antianxiety

DOSAGE: Adults. 400 mg PO tid-qid up to 2400 mg/d; SR 400-800 mg PO bid. Peds 6-12 y.

100-200 mg bid-tid; SR 200 mg bid

SUPPLIED: Tabs 200, 400, 600 mg; SR caps 200, 400 mg

NOTES: May cause drowsiness; adjust dose for renal impairment

Mercaptopurine [6-MP] (Purinethol)

COMMON USES: Acute leukemias of children and adults, 2nd-line Rx of CML and non-Hodgkin's lymphoma, maintenance therapy of ALL in children, and immunosuppressant therapy for autoimmune diseases (Crohn's disease)

ACTIONS: Antimetabolite; mimics hypoxanthine

DOSAGE: 80–100 mg/m²/d or 2.5–5 mg/kg/d; maintenance 1.5–2.5 mg/kg/d

SUPPLIED: Tabs 50 mg

NOTES: Toxicity symptoms: Mild hematologic toxicity; uncommon GI toxicity, except mucositis, stomatitis, and diarrhea. Rash, fever, eosinophilia, jaundice, and hepatitis. Concurrent allopurinol therapy requires a $67-75\% \downarrow of 6-MP$ because of interference with metabolism by xanthine oxidase

Meropenem (Merrem)

COMMON USES: Serious infections caused by a wide variety of bacteria including intraabdominal and polymicrobial; bacterial meningitis

ACTIONS: Carbapenem; inhibition of cell wall synthesis, a β-lactam

DOSAGE: Adults. 1 g IV q8h. Peds. 20-40 mg/kg IV q8h

SUPPLIED: Inj

NOTES: Adjust dose for renal function; less seizure potential than imipenem; beware of possible anaphylaxis

Mesalamine [5-Amino salicylic acid] (Rowasa, Asacol, Pentasa)

COMMON USES: Mild to moderate distal ulcerative colitis, proctosigmoiditis, or proctitis

ACTIONS: Unknown; may topically inhibit prostaglandins

DOSAGE: Retention enema qd hs or insert 1 supp bid. Oral: 800–1000 mg PO 3–4×/d

SUPPLIED: Tabs 400 mg; caps 250 mg; supp 500 mg; rectal susp 4 g/60 mL

Mesna (Mesnex)

COMMON USES: ↓ Incidence of ifosfamide and cyclophosphamide-induced hemorrhagic cystitis

ACTIONS: Antidote

DOSAGE: 20% of the ifosfamide dose (+/-) or cyclophosphamide dose IV at 15 min prior to and

4 and 8 h after chemotherapy SUPPLIED: Inj 100 mg/mL

Mesoridazine (Serentil)

COMMON USES: Schizophrenia, acute and chronic alcoholism, and chronic brain syndrome

ACTIONS: Phenothiazine antipsychotic

DOSAGE: Initially, 25–50 mg PO or IV tid; \uparrow to a max of 300–400 mg/d **SUPPLIED:** Tabs 10, 25, 50, 100 mg; oral conc 25 mg/mL; inj 25 mg/mL

NOTES: Low incidence of extrapyramidal side effects

Metaproterenol (Alupent, Metaprel)

COMMON USES: Bronchodilator for asthma and reversible bronchospasm

ACTIONS: Sympathomimetic bronchodilator

DOSAGE: Adults. Inhal: 1–3 inhal q3–4h to a max of 12 inhal/24h; allow at least 2 min between inhal. Oral: 20 mg q6–8h. Peds. Inhal: 0.5 mg/kg/dose to a max of 15 mg/dose inhaled q4–6h by neb or 1–2 puffs q4–6h. Oral: 0.3–0.5 mg/kg/dose q6–8h

SUPPLIED: Aerosol 75, 150 mg; soln for inhal 0.4%, 0.6% 5%; tabs 10, 20 mg; syrup 10 mg/5 mL.

NOTES: Fewer β_1 -effects than isoproterenol and longer acting

Metaraminol (Aramine)

COMMON USES: Prevention and Rx of hypotension due to spinal anesthesia

ACTIONS: α-Adrenergic agent

DOSAGE: Adults. Prevention: 2–10 mg IM q10–15min PRN. Rx: 0.5–5 mg IV bolus followed by IV inf of 1–4 mg/kg/min titrated to effect. **Peds.** Prevention: 0.1 mg/kg/dose IM PRN. Rx: 0.01 mg/kg IV bolus followed by IV inf of 5 mg/kg/min titrated to effect

SUPPLIED: Injectable forms

NOTES: Allow 10 min for max effect; employ other shock management techniques, eg, fluid resuscitation as needed; may cause cardiac arrhythmias

Metaxalone (Skelaxin)

COMMON USES: Relief of painful musculoskeletal conditions

ACTIONS: Centrally acting skeletal muscle relaxant

DOSAGE: $800 \text{ mg PO } 3\text{--}4\text{\times/}d$ **SUPPLIED:** Tabs 400 mg

Metformin (Glucophage)

COMMON USES: Type 2 DM

ACTIONS: Decreases hepatic glucose production; ↓ intestinal absorption of glucose; improves in-

sulin sensitivity

DOSAGE: Initial dose of 500 mg PO bid; may ↑ to max dose 2500 mg/d

SUPPLIED: Tabs 500, 850 mg

NOTES: Administer with the AM and PM meals; may cause lactic acidosis; do NOT use if SCr >1.3 in females or >1.4 in males; withhold prior to and following IV contrast studies; contra in hypoxemic conditions, including acute CHF and sepsis

Methadone (Dolophine) [C-II]

COMMON USES: Severe pain; detoxification and maintenance of narcotic addiction

ACTIONS: Narcotic analgesic

DOSAGE: Adults. 2.5-10 mg IM q 3-8 h or 5-15 mg PO q8h; titrate as needed. Peds. 0.7 mg/kg/24 h PO or IM \div q8h

SUPPLIED: Tabs 5, 10, 40 mg; oral soln 5, 10 mg/5 mL; oral conc 10 mg/mL; inj 10 mg/mL

NOTES: Equianalgesic with parenteral morphine; long half-life; ↑ slowly to avoid respiratory depression

Methenamine (Hiprex, Urex, others)

COMMON USES: Suppression or elimination of bacteriuria associated with chronic and recurrent UTI

DOSAGE: Adults. Hippurate: 1 g bid, mandelate: 1 g qid pc and hs. Peds 6–12 y. Hippurate: 25–50 mg/kg/d ÷ bid. Mandelate: 50–75 mg/kg/d ÷ qid

SUPPLIED: Methenamine hippurate (Hiprex, Urex): 1-g tabs. Methenamine mandelate: 500 mg/1 g EC tabs

NOTES: Contra in patients with renal insufficiency, severe hepatic disease, and severe dehydration

Methimazole (Tapazole)

COMMON USES: Hyperthyroidism and preparation for thyroid surgery or radiation

ACTIONS: Blocks the formation of T3 and T4

DOSAGE: Adults. Initial: 15–60 mg/d PO + tid. Maintenance: 5–15 mg PO qd. Peds. Initial: 0.4–0.7 mg/kg/24h PO + tid. Maintenance: ½–½ of the initial dose PO qd

SUPPLIED: Tabs 5, 10 mg

NOTES: Follow patient clinically and with TFT

Methocarbamol (Robaxin)

COMMON USES: Relief of discomfort associated with painful musculoskeletal conditions

ACTIONS: Centrally acting skeletal muscle relaxant

DOSAGE: *Adults.* 1.5 g PO qid for 2–3 d, then 1 g PO qid maintenance therapy; IV form rarely indicated. *Peds.* 15 mg/kg/dose may be repeated if necessary. (Recommended for tetanus only) **SUPPLIED:** Tabs 500, 750 mg; inj 100 mg/mL

NOTES: Can discolor urine; may cause drowsiness or GI upset; contra with MyG

Methotrexate (Folex, Rheumatrex)

COMMON USES: ALL and AML, leukemic meningitis, trophoblastic tumors (chorioepithelioma, choriocarcinoma, chorioadenoma destruens, hydatidiform mole), breast cancer, Burkitt's lymphoma, mycosis fungoides, osteosarcoma, head and neck cancer, Hodgkin's and non-Hodgkin's lymphoma, lung cancer; psoriasis; and RA

ACTIONS: Inhibits dihydrofolate reductase-mediated generation of tetrahydrofolate

DOSAGE: Cancer, "conventional dose": 15–30 mg PO or IV 1–2×/wk q 1–3 wk. "Intermediate dose": 50–240 mg or 0.5–1 g/m² IV once q 4 d to 3 wk. "High dose": 1–12 g/m² IV once q 1–3 wk; 12 mg/m² (max 15 mg) IT, weekly until the CSF cell count returns to normal. RA: 7.5 mg/wk PO as a single dose or 2.5 mg q12h PO for 3 doses/wk

SUPPLIED: Tabs 2.5 mg; inj 2.5, 25 mg/mL; preservative-free inj 25 mg/mL

NOTES: Toxicity symptoms: Myelosuppression, nausea and vomiting, anorexia, mucositis, diarrhea, hepatotoxicity (transient and reversible; may progress to atrophy, necrosis, fibrosis, rashes, dizziness, malaise, blurred vision, renal failure, pneumonitis, and, rarely, pulmonary fibrosis. Chemical arachnoiditis and headache with IT delivery. High-dose therapy requires leucovorin rescue to prevent severe hematologic and mucosal toxicity (see page 559); monitor blood counts and MTX levels carefully

Methoxamine (Vasoxyl)

COMMON USES: Support, restoration, or maintenance of blood pressure during anesthesia; for termination of some episodes of PSVT

ACTIONS: α-Adrenergic

DOSAGE: Adults. Anesthesia: 10–15 mg IM; if emergency, 3–5 mg slow IV push. PSVT: 10 mg by slow IV push. Peds. 0.25 mg/kg/dose IM or 0.08 mg/kg/dose slow IV push

SUPPLIED: Injectable forms

NOTES: IM dose requires 15 min to act; use 5–10 mg phentolamine locally in case of extravasation; interaction with MAO inhibitors and tricyclic antidepressants to potentiate methoxamine effect

Methyldopa (Aldomet)

COMMON USES: Essential HTN

ACTIONS: Centrally acting antihypertensive

DOSAGE: Adults. 250–500 mg PO bid-tid (max 2–3 g/d) or 250 mg-1 g IV q6-8h. Peds. 10 mg/kg/24h PO in 2–3 + doses (max 40 mg/kg/24h + q6-12h) or 5–10 mg/kg/dose IV q6-8h to total dose of 20–40 mg/kg/24h

SUPPLIED: Tabs 125, 250, 500 mg; oral susp 50 mg/mL; inj 50 mg/mL

NOTES: Do NOT use in the presence of liver disease; can discolor urine; initial transient sedation or drowsiness frequent

Methylergonovine (Methergine)

COMMON USES: Prevention and Rx postpartum hemorrhage caused by uterine atony

ACTIONS: Ergotamine derivative

DOSAGE: 0.2 mg IM after delivery of placenta, may repeat at 2–4-h intervals or 0.2–0.4 mg PO q6–12h for 2–7 d

SUPPLIED: Injectable forms, 0.2 mg tabs

NOTES: IV doses should be given over a period of not less than 1 min with frequent BP monitoring

Methylprednisolone (Solu-Medrol)

See Steroids (Table 22-5, see page 627).

Metoclopramide (Reglan, Clopra, Octamide)

COMMON USES: Relief of diabetic gastroparesis; symptomatic GERD; relief of cancer chemotherapy-induced nausea and vomiting

ACTIONS: Stimulates motility of the upper GI tract and blocks dopamine in the chemoreceptor trigger zone

DOSAGE: Adults. Diabetic gastroparesis: 10 mg PO 30 min ac and hs for 2–8 wk PRN; or same dose given IV for 10 d, then switch to PO. Reflux: 10–15 mg PO 30 min ac and hs. Antiemetic: 1–3 mg/kg/dose IV 30 min prior to antineoplastic agent, then q2h for 2 doses, then q3h for 3 doses. Peds. Reflux: 0.1 mg/kg/dose PO qid. Antiemetic: 1–2 mg/kg/dose IV on the same schedule as for adults

SUPPLIED: Tabs 5, 10 mg; syrup 5 mg/5 mL; soln 10 mg/mL; inj 5 mg/mL

NOTES: Dystonic reactions common with high doses; can be treated with IV diphenhydramine; can also be used to facilitate small bowel intubation and radiologic evaluation of the upper GI tract

Metolazone (Mykrox, Zaroxolyn)

COMMON USES: Mild to moderate essential HTN and edema of renal disease or cardiac failure

ACTIONS: Thiazide-like diuretic; inhibits reabsorption of sodium in the distal tubules

DOSAGE: *Adults.* HTN: 2.5–5 mg/d PO. *Edema:* 5–20 mg/d PO. *Peds.* 0.2–0.4 mg/kg/d PO ÷ q12h–qd

SUPPLIED: Tabs 0.5, 2.5, 5, 10 mg

NOTES: Monitor fluid and electrolyte status during treatment

Metoprolol (Lopressor, Toprol XL)

Used for emergency cardiac care (see also Chapter 21)

COMMON USES: HTN, angina, and AMI

ACTIONS: Competitively blocks β -adrenergic receptors, β_1 .

DOSAGE: Angina: 50-100 mg PO bid. HTN: 100-450 mg/d PO. AMI: $5 \text{ mg IV} \times 3 \text{ doses, then } 50 \text{ mg PO q6h} \times 48 \text{ h, then } 100 \text{ mg PO bid}$

ing FO don × 48 ii, then 100 ing FO bid

SUPPLIED: Tabs 50, 100 mg; ER tabs 50, 100, 200 mg; inj 1 mg/mL

Metronidazole (Flagyl, Metrogel)

COMMON USES: Amebiasis, trichomoniasis, *C. difficile, H. pylori*, anaerobic infections, and bacterial vaginosis

ACTIONS: Interferes with DNA synthesis

DOSAGE: Adults. Anaerobic infections: 500 mg IV q6–8h. Amebic dysentery: 750 mg/d PO for 5–10 d. Trichomoniasis: 250 mg PO tid for 7 d or 2 g PO in a single dose. C. difficile infection: 500 mg PO or IV q8h for 7–10 d. Naginosis: 1 applicatorful intravaginally bid or 500 mg PO bid for 7 d. Acne rosacea and skin: Apply bid. **Peds.** Anaerobic infections: 15 mg/kg/24h PO or IV + q6h. Amebic dysentery: 35–50 mg/kg/24h PO in 3 + doses for 5–10 d

SUPPLIED: Tabs 250, 500 mg; ER tabs 750 mg; caps 375 mg; topical lotion and gel 0.75%; gel, vaginal 0.75% (5 g/applicator 37.5 mg in 70 g tube)

NOTES: For Trichomonas infections, also treat patient's partner; \downarrow in hepatic failure; no activity against aerobic bacteria; use in combination in serious mixed infections; may cause a disulfiramlike reaction; adjust dose in renal failure

Metyrapone (Metopirone)

COMMON USES: Diagnostic test for hypothalamic-pituitary ACTH function **ACTIONS:** Inhibits adrenocortical synthesis by blocking 11b-hydroxylase

DOSAGE: Metyrapone test: Day 1: Control period, collect 24 h urine to measure 17-OHCS or 17-KSG. Day 2: ACTH test, administer 50 U of ACTH infused over 8 h and measure 24-h urinary steroids. Days 3-4: Rest period. Day 5: Administer metyrapone with milk or a snack. Adults. 750 mg PO q4h for 6 doses. **Peds.** 15 mg/kg q4h for 6 doses (min 250-mg dose). Day 6: Determine 24-h urinary steroids

SUPPLIED: Tabs 250 mg (Limited availability in U.S.)

NOTES: Normal 24-h urine 17-OHCS is 3–12 mg; following ACTH, it ↑ to 15–45 mg/24h; normal response to metyrapone is 2-fold to 4-fold increase in 17-OHCS excretion; drug interactions with phenytoin, cyproheptadine, and estrogens may lead to subnormal response

Metyrosine (Demser)

COMMON USES: Pheochromocytoma; short-term preop and long-term when surgery contraindi-

ACTIONS: Tyrosine hydroxylase inhibitor

DOSAGE: Adults & Peds >12 y. 250 mg PO qid, ↑ by 250–500 mg/d up to 4 g/d. Maintenance dose: 2–3 g/d ÷ qid

SUPPLIED: 250 mg caps

NOTES: Administer at least 5-7 d preop

Mexiletine (Mexitil)

COMMON USES: Suppression of symptomatic ventricular arrhythmias; diabetic neuropathy

ACTIONS: Class IB antiarrhythmic

DOSAGE: Administer with food or antacids; 200-300 mg PO q8h; do not exceed 1200 mg/d

SUPPLIED: Caps 150, 200, 250 mg

NOTES: Do NOT use in cardiogenic shock or 2nd- or 3rd-degree AV block if no pacemaker; may worsen severe arrhythmias; monitor LFT during therapy; drug interactions with hepatic enzyme inducers and suppressors requiring dosage changes

Mezlocillin (Mezlin)

COMMON USES: Infections caused by susceptible strains of gram (–) bacteria (including *Klebsiella, Proteus, E. coli, Enterobacter, P. aeruginosa*, and *Serratia*) involving the skin, bone, respiratory tract, urinary tract, abdomen, and septicemia

ACTIONS: Bactericidal; inhibits cell wall synthesis

DOSAGE: *Adults.* 3 mg IV q4–6h. *Peds.* 200–300 mg/kg/d \div q4–6h

SUPPLIED: Inj

NOTES: Often used in combination with aminoglycoside; adjust dosage for renal impairment

Miconazole (Monistat, others)

COMMON USES: Severe systemic fungal infections, including coccidioidomycosis, candidiasis, *Cryptococcus*, etc; various tinea forms; cutaneous candidiasis; vulvovaginal candidiasis; tinea versicolor

ACTIONS: Fungicidal; alters permeability of the fungal cell membrane

DOSAGE: Adults. Apply to affected area bid for 2–4 wk. Candidiasis: 600–1800 mg/day ÷ Q8h Intravaginally: Insert 1 applicatorful or supp hs for 7 d

SUPPLIED: Topical cream 2%; lotion 2%; powder 2%; spray 2%; vaginal supp 100, 200 mg; vaginal cream 2%, IU forms

NOTES: Antagonistic to amphotericin B in vivo; rapid IV infusion may cause tachycardia or arrhythmias; may potentiate warfarin drug activity

Midazolam (Versed) [C-IV]

COMMON USES: Preoperative sedation, conscious sedation for short procedures, and induction of general anesthesia

ACTIONS: Short-acting benzodiazepine

DOSAGE: Adults. 1–5 mg IV or IM; titrate dose to effect. *Peds*. Conscious sedation: 0.08 mg/kg IM in a single dose. *General anesthesia*: 0.15 mg/kg IV followed by 0.05 mg/kg/dose q 2 min for 1–3 doses as needed to induce anesthesia

SUPPLIED: Inj 1, 5 mg/mL; syrup 2 mg/mL

NOTES: Monitor for respiratory depression; may produce hypotension in conscious sedation

Mifepristone [RU 486] (Mifeprex)

COMMON USES: Termination of intrauterine pregnancies of <49 d

ACTIONS: Antiprogestin; increases prostaglandins, resulting in uterine contraction

DOSAGE: Must be administered with 3 office visits: Day 1, three 200-mg tablets, PO; Day 3 if no abortion has occurred, give two 200-µg misoprostol PO; on or about day 14, verify termination of pregnancy

SUPPLIED: Tabs 200 mg

NOTES: Must be administered under physician supervision; can cause abdominal pain and 1–2 wk of uterine bleeding

Miglitol (Glyset)

COMMON USES: Type 2 DM

ACTIONS: α-Glucosidase inhibitor; delays digestion of ingested carbohydrates

DOSAGE: Initial 25 mg PO tid taken at the first bite of each meal; maintenance 50-100 mg tid with meals

SUPPLIED: Tabs 25, 50, 100 mg

NOTES: May be used alone or in combination with sulfonylureas

Milrinone (Primacor)

COMMON USES: CHF

ACTIONS: Positive inotrope and vasodilator, with little chronotropic activity **DOSAGE:** Loading dose of 50 µg/kg, followed by cont inf of 0.375–0.75 µg/kg/min

SUPPLIED: Ini 1 ug/mL

NOTES: Carefully monitor fluid and electrolyte status; dosage adjustment in renal impairment

Mineral Oil

COMMON USES: Constipation **ACTIONS:** Emollient laxative

DOSAGE: Adults. 5-45 mL PO PRN. Peds >6 y. 5-20 mL PO bid

SUPPLIED: Liq

Minoxidil (Loniten, Rogaine)

COMMON USES: Severe HTN; male and female pattern baldness

ACTIONS: Peripheral vasodilator; stimulates vertex hair growth

DOSAGE: Adults. Oral: 2.5–10 mg PO bid–qid. Topical: [Rogaine] Apply bid to the affected area.

Peds. 0.2–1 mg/kg/24h ÷ PO q12–24h

SUPPLIED: Tabs 2.5, 10 mg; topical soln (Rogaine) 2%

NOTES: Pericardial effusion and volume overload may occur with oral use; hypertrichosis after

chronic use

Mirtazapine (Remeron)

COMMON USES: Depression

ACTIONS: Tetracyclic antidepressant, unrelated to tricyclics or MAOIs.

DOSAGE: 15 mg PO hs, up to 45 mg/d hs

SUPPLIED: Tabs 15, 30, 45 mg

NOTES: Do NOT ↑ dose at intervals of less than 1–2 wk; may cause agranulocytosis

Misoprostol (Cytotec)

COMMON USES: Prevention of NSAID-induced gastric ulcers

ACTIONS: Synthetic prostaglandin with both antisecretory and mucosal protective properties

DOSAGE: $200 \ \mu g$ PO qid with meals

SUPPLIED: Tabs $100, 200 \mu g$

NOTES: Do NOT take during PRG; can cause miscarriage with potentially dangerous bleeding; GI

side effects common

Mitomycin C (Mutamycin)

COMMON USES: Adenocarcinomas of the stomach, pancreas, colon, and breast; non-small-cell lung cancer; head and neck cancer; cervical cancer; squamous cell carcinoma of the anus; and bladder cancer (intravesically)

ACTIONS: Alkylating agent; may also generate oxygen free radicals, which induce DNA strand

DOSAGE: 20 mg/m² q 6–8 wk or 10 mg/m² in combination with other myelosuppressive drugs; bladder cancer 20–40 mg in 40 mL of NS via a urethral catheter once/wk for 8 wk, followed by monthly treatments for 1 y

SUPPLIED: Ini

NOTES: Toxicity symptoms: Myelosuppression, which may persist up to 3–8 wk after a dose and may be cumulative (minimized by a lifetime dose <50–60 mg/m²), nausea and vomiting, anorexia, stomatitis, and renal toxicity. Microangiopathic hemolytic anemia (similar to hemolytic-uremic syndrome) with progressive renal failure. Venoocclusive disease of the liver, interstitial pneumonia, and alopecia (rare); extravasation reactions can be severe. Adjust dose in renal impairment

Mitotane (Lysodren)

COMMON USES: Palliative treatment of inoperable adrenal cortex carcinoma

ACTIONS: Exact action unclear; induces mitochondrial injury in adrenocortical cells

DOSAGE: 8–10 g/d in 3–4 ÷ doses (begin at 2 g/d with full glucocorticoid replacement therapy)

SUPPLIED: Tabs 500 mg

NOTES: Toxicity symptoms: Anorexia, nausea and vomiting, and diarrhea. Acute adrenal insufficiency may be precipitated by physical stresses (shock, trauma, infection), in which case corticosteroid replacement necessary. Allergic reactions (rare), visual disturbances, hemorrhagic cystitis, albuminuria, hematuria, HTN or hypotension, minor aches, and fever

Mitoxantrone (Novantrone)

COMMON USES: AML (with cytarabine), ALL, CML, breast and prostate cancer, non-Hodgkin's lymphoma

ACTIONS: DNA-intercalating agent; inhibitor of DNA topoisomerase II

DOSAGE: 12 mg/m²/d for 3 d (ANLL induction), 12–14 mg/m² q 3 wk (advanced solid tumors)

SUPPLIED: Inj 20, 25, 30 mg

NOTES: Toxicity symptoms: Myelosuppression, nausea and vomiting, stomatitis, alopecia (infrequent), cardiotoxicity; cumulative dose not to exceed 160 mg/m² in patients receiving mediastinal radiation therapy or 120 mg/m² in patients receiving prior anthracycline therapy; dosage adjustment for hepatic failure may be warranted

Mivacurium (Mivacron)

COMMON USES: Adjunct to general anesthesia or mechanical ventilation

ACTIONS: Nondepolarizing neuromuscular blocker

DOSAGE: Adults. 0.15 mg/kg/dose IV; may need to repeat at 15-min intervals. **Peds.** 0.2

mg/kg/dose IV; may need to repeat at 10-min interval

SUPPLIED: Inj 0.5, 2 mg/mL

NOTES: Dosage adjustment in renal impairment

Moexipril (Univasc)

COMMON USES: HTN ACTIONS: ACE inhibitor

DOSAGE: 7.5-30 mg in $1-2 \div$ doses administered 1 h ac **SUPPLIED:** Tabs 7.5, 15 mg; adjust dose in renal impairment

Molindone (Moban)

COMMON USES: Psychotic disorders **ACTIONS:** Piperazine phenothiazine

DOSAGE: Adults. 50-75 mg/d, \uparrow to 225 mg/d if necessary. Peds. 3-5 y: 1-2.5 mg/d in 4 ÷ doses.

 $5-12 \text{ y: } 0.5-1.0 \text{ mg/kg/d in } 4 \div \text{doses}$

SUPPLIED: Tabs 5, 10, 25, 50, 100 mg; conc 20 mg/mL

Montelukast (Singulair)

COMMON USES: Prophylaxis and Rx of chronic asthma

ACTIONS: Leukotriene receptor antagonist

DOSAGE: Adults >15 y. 10 mg/d PO taken in PM. Peds. 6-14 y: 5 mg/d PO taken in PM. 2-5 y: 4

mg/d PO taken in PM

SUPPLIED: Tabs 10 mg; chewable tabs 4, 5 mg

NOTES: NOT for acute asthma attacks

Moricizine (Ethmozine)

COMMON USES: Ventricular arrhythmias

ACTIONS: Class I antiarrhythmic DOSAGE: 200–300 mg PO tid SUPPLIED: Tabs 200, 250, 300 mg

Morphine (Roxanol, Duramorph, MS Contin, others) [C-II]

Used for emergency cardiac care (see Chapter 21)

COMMON USES: Relief of severe pain

ACTIONS: Narcotic analgesic

DOSAGE: Adults. Oral: 10–30 mg q4h PRN; SR tabs 30–60 mg q8–12h. IV/IM: 2.5–15 mg q2-6h. Peds. 0.1–0.2 mg/kg/dose IM/IV q2–4h PRN, to a max of 15 mg/dose

SUPPLIED: Tabs 10, 15, 30 mg; SR tabs 15, 30, 60 mg; soln 10, 20, 100 mg; supp 5, 10, 20 mg; inj 2, 4, 5, 8, 10, 15 mg/mL; preservative-free inj 0.5, 1 mg/mL

NOTES: Large number of narcotic side effects; may require scheduled dosing to relieve severe chronic pain. Duramorph and MS Contin commonly used SR forms

Moxifloxacin (Avelox)

COMMON USES: Acute sinusitis, acute bronchitis, and community acquired pneumonia

ACTIONS: Quinolone; inhibits DNA gyrase

DOSAGE: 400 mg/d once **SUPPLIED:** Tabs 400 mg

NOTES: Active against gram (–) bacteria and *S. pneumoniae*; interactions with Mg, Ca, Al and Fe containing products and Class IA and III antiarrhythmic agents

Mupirocin (Bactroban)

COMMON USES: Impetigo; eradication of MRSA nasal carrier state

ACTIONS: Inhibits bacterial protein synthesis

DOSAGE: Topical: Apply small amount to affected area. Nasal: Apply bid in the nostrils

SUPPLIED: Oint 2%; cream 2%

NOTES: Do NOT use concurrently with other nasal products

Muromonab-CD3 [OKT3] (Orthoclone OKT3)

COMMON USES: Acute rejection following organ transplantation

ACTIONS: Blocks T-cell function

DOSAGE: Adults. 5 mg/d IV for 10-14 d. Peds. 0.1 mg/kg/d for 10-14 d

SUPPLIED: Inj 5 mg/5 mL

NOTES: Murine antibody; may cause significant fever and chills after the first dose; requires close

patient monitoring for anaphylaxis B or pulmonary edema

Mycophenolate (CellCept)

COMMON USES: Prevention of organ rejection following transplantation **ACTIONS:** Inhibits immunologically mediated inflammatory responses

DOSAGE: 1 g PO bid

SUPPLIED: Caps (as Mofetil) 250, 500 mg, inj 500 mg

NOTES: Used in conjunction with corticosteroids and cyclosporine

Nabumetone (Relafen)

COMMON USES: Arthritis and pain

ACTIONS: NSAID; inhibits prostaglandin synthesis

DOSAGE: $1000-2000 \text{ mg/d} \div \text{qd-bid}$ **SUPPLIED:** Tabs 500, 750 mg

Nadolol (Corgard)

COMMON USES: HTN and angina

ACTIONS: Competitively blocks β -adrenergic receptors (β_1 and β_2)

DOSAGE: 40-80 mg/d; up to 240 mg/d (angina) or 320 mg/d (HTN) may be needed

SUPPLIED: Tabs 20, 40, 80, 120, 160 mg

Nafcillin (Nallpen)

COMMON USES: Infections caused by susceptible strains of *Staphylococcus* and *Streptococcus*

ACTIONS: Bactericidal; inhibits cell wall synthesis

DOSAGE: Adults. 1-2 g IV q4-6h. Peds. 50-200 mg/kg/d ÷ q4-6h

SUPPLIED: Ini

NOTES: No adjustments for renal function

Naftifine (Naftin)

COMMON USES: Tinea cruris and tinea corporis

ACTIONS: Antifungal antibiotic

DOSAGE: Apply bid **SUPPLIED:** 1% cream; gel

Nalbuphine (Nubain)

COMMON USES: Moderate to severe pain; preop and obstetrical analgesia

ACTIONS: Narcotic agonist-antagonist; inhibits ascending pain pathways

DOSAGE: Adults. 10–20 mg IM or IV q4–6h PRN; max of 160 mg per d; single max dose, 20 mg.

Peds. 0.2 mg/kg IV or IM to a max dose of 20 mg

SUPPLIED: Inj 10, 20 mg/mL

NOTES: Causes CNS depression and drowsiness; use with caution in patients receiving opiates

Nalidixic Acid (NegGram)

COMMON USES: UTI caused by susceptible strains of *Proteus, Klebsiella, Enterobacter,* and *E. coli,* but not *Pseudomonas*

ACTIONS: Inhibits bacterial RNA and DNA synthesis

DOSAGE: Adults. 1 g PO qid. Suppressive: 500 mg PO qid. Peds. 55 mg/kg/24h in 4 ÷ doses. Suppressive: 33 mg/kg/d in 4 ÷ doses

SUPPLIED: Tabs 250 mg, 500 mg, 1 g; oral susp 250 mg/5 mL

NOTES: Resistance emerges within 48 h in a significant percentage of trials; may enhance the effect of oral anticoagulants; may cause CNS adverse effects that reverse on discontinuation; decreased effect with concurrent use of antacids

Naloxone (Narcan)

Used for emergency care (see also Chapter 21)

COMMON USES: Reversal of narcotic effect **ACTIONS:** Competitive narcotic antagonist

DOSAGE: Adults. 0.4–2.0 mg IV, IM, or SC q 5 min; max total dose of 10 mg. Peds. 0.01–1.0

mg/kg/dose IV, IM, or SC; may repeat IV q 3 min for 3 doses PRN **SUPPLIED:** Inj 0.4, 1.0 mg/mL; neonatal inj 0.02 mg/mL

NOTES: May precipitate acute withdrawal in addicts; if no response after 10 mg, suspect nonnarcotic cause

Naltrexone (Revia)

COMMON USES: Alcoholism and narcotic addiction **ACTIONS:** Competitively binds to opioid receptors

DOSAGE: 50 mg/d PO

SUPPLIED: Tabs 50 mg

NOTES: May cause hepatotoxicity; do NOT give until opioid-free for 7–10 d

Naphazoline and Antazoline (Albalon-A Ophthalmic, others) Naphazoline and Pheniramine Acetate (Naphcon A)

COMMON USES: Temporary relief from ocular redness and itching caused by allergy

ACTIONS: Vasoconstrictor and antihistamine

DOSAGE: 1-2 gtt up to 4×/d

SUPPLIED: Soln 15 mL

NOTES: Contra in those with glaucoma, children <6 y, and with contact lens use

Naproxen (Aleve [OTC], Naprosyn, Anaprox)

COMMON USES: Arthritis and pain

ACTIONS: NSAID; inhibits prostaglandin synthesis

DOSAGE: Adults & Peds >12 y. 200-500 mg bid-tid, to a max of 1500 mg/d

SUPPLIED: Tabs 200 [OTC], 250, 375, 500 mg; DR tabs 375, 500 mg; susp 125 mg/5 mL

NOTES: ↓ Dose in hepatic impairment

Naratriptan (Amerge)

COMMON USES: Acute migraine attacks **ACTIONS:** Serotonin 5-HT₁ receptor antagonist

DOSAGE: 1-2.5 mg PO once; may be repeated once in 4 h

SUPPLIED: Tabs 1, 2.5 mg

NOTES: Contra in persons with severe renal impairment; adjust dose in renal dysfunction; avoid in angina, ischemic heart disease, uncontrolled HTN, and ergot administration

Nedocromil (Tilade)

COMMON USES: Mild to moderate asthma
ACTIONS: Antiinflammatory agent

DOSAGE: 2 inhal 4×/d
SUPPLIED: Met-dose inhaler

Nefazodone (Serzone)

COMMON USES: Depression

ACTIONS: Inhibits neuronal uptake of serotonin and norepinephrine

DOSAGE: Initially, 100 mg PO bid; usual effective range is 300–600 mg/d in 2 ÷ doses

SUPPLIED: Tabs 100, 150, 200, 250 mg

NOTES: May cause postural hypotension and allergic reactions

Nelfinavir (Viracept)

COMMON USES: HIV infection

ACTIONS: Protease inhibitor; results in formation of immature, noninfectious virion **DOSAGE:** *Adults.* 750 mg PO tid or 1250 mg PO bid. *Peds.* 20–30 mg/kg PO tid

SUPPLIED: Tabs 250 mg; oral powder

NOTES: Food necessary to increase absorption; interacts with St. John's wort

Neomycin, Bacitracin and Polymyxin B (Neosporin Ointment) (see Bacitracin, Neomycin and Polymyxin, page 502)

Neomycin, Colistin, and Hydrocortisone (Cortisporin-TC Otic Drops) Neomycin, Colistin, Hydrocortisone, and Thonzonium (Cortisporin-TC Otic Suspension)

COMMON USES: External otitis, infections of mastoidectomy and fenestration cavities

ACTIONS: Antibiotic and antiinflammatory

DOSAGE: Adults.4-5 gtt in the ear(s) tid-qid. Peds. 3-4 gtt in ear(s) tid-qid

SUPPLIED: Otic gtt and susp

Neomycin and Dexamethasone (Neo-Dexameth Ophthalmic, NeoDecadron Ophthalmic)

COMMON USES: Steroid responsive inflammatory conditions of the cornea, conjunctiva, lid, and anterior segment

ACTIONS: Antibiotic with antiinflammatory corticosteroid

DOSAGE: 1–2 gtt in eye(s) q3–4h or thin coat tid-qid until response observed, then reduce dose

to qd

SUPPLIED: Cream neomycin 0.5%/dexamethasone 0.1%; oint neomycin 0.35%/dexamethasone 0.05%; soln neomycin 0.35%/dexamethasone 0.1%

Neomycin, Polymyxin B (Neosporin Cream)

COMMON USES: Infection in minor cuts, scrapes, and burns

ACTIONS: Bactericidal antibiotic

DOSAGE: Apply bid-qid

SUPPLIED: Cream neomycin 3.5 mg/polymyxin B 10,000 U/g **NOTES:** Different from Neosporin oint (See page 502)

Neomycin, Polymyxin-B and Dexamethasone, (Maxitrol)

COMMON USES: Steroid-responsive ocular conditions with bacterial infection

ACTIONS: Antibiotic with antiinflammatory corticosteroid **DOSAGE:** 1–2 gtt in eye(s) q4–6h; apply oint in eye(s) 3–4×/d

SUPPLIED: Oint neomycin sulfate 3.5 mg/ polymyxin B sulfate 10,000 U/dexamethasone 0.1%/g; susp identical/5 mL

NOTES: Should be used under supervision of ophthalmologist

Neomycin, Polymyxin Bladder Irrigant

COMMON USES: Continuous irrigant for prophylaxis against bacteriuria and gram- bacteremia associated with indwelling catheter use

ACTIONS: Bactericidal antibiotic

DOSAGE: 1-mL irrigant added to 1 L of 0.9% NaCl; continuous irrigation of the bladder with 1–2 L

of soln/24h

SUPPLIED: Ampules 1, 20 mL

NOTES: Potential for bacterial or fungal superinfection; slight possibility for neomycin-induced

ototoxicity or nephrotoxicity

Neomycin, Polymyxin, and Hydrocortisone (Cortisporin Ophthalmic and Otic)

COMMON USES: Ocular and otic bacterial infections

ACTIONS: Antibiotic and antiinflammatory

DOSAGE: Otic: 3–4 gtt in the ear(s) 3–4×/d. Ophth: Apply a thin layer to the eye(s) or 1 gt 1–4×/d

SUPPLIED: Otic susp; ophth soln; ophth oint

Neomycin, Polymyxin-B and Prednisolone (Poly-Pred Opthalmic)

COMMON USES: Steroid-responsive ocular conditions with bacterial infection

ACTIONS: Antibiotic and antiinflammatory

DOSAGE: 1–2 gtt in eye(s) q4–6h; apply oint in eye(s) 3–4×/d

SUPPLIED: Susp, neomycin 0.35%/polymyxin B 10,000 U/prednisolone 0.5%/mL

NOTES: Should be used under supervision of ophthalmologist

Neomycin Sulfate

COMMON USES: Hepatic coma and preoperative bowel preparation

ACTIONS: Aminoglycoside; suppresses GI bacterial flora

DOSAGE: Adults. 3–12 g/24h PO in 3–4 ÷ doses. Peds. 50–100 mg/kg/24h PO in 3–4 ÷ dose

SUPPLIED: Tabs 500 mg; oral soln 125 mg/5 mL

NOTES: Part of the Condon bowel prep

Nevirapine (Viramune)

COMMON USES: HIV infection

ACTIONS: Nonnucleoside reverse transcriptase inhibitor

DOSAGE: Adults. Initially 200 mg/d for 14 d; then 200 mg bid. Peds. <8 y: 4 mg/kg/d for 14 d; then

7 mg/kg bid. >8 y: 4 mg/kg/d for 14 d; then 4 mg/kg bid

SUPPLIED: Tabs 200 mg; susp 50 mg/5 mL

NOTES: May cause life-threatening rash; give without regard to food

Niacin (Nicolar)

COMMON USES: Adjunctive therapy in patients with significant refractory hyperlipidemia

ACTIONS: Inhibits lipolysis; decreases esterification of triglycerides; increases lipoprotein lipase activity

DOSAGE: 1-6 g tid; max of 9 g/d

500, 750 mg; elixir 50 mg/5 mL

NOTES: Upper body and facial flushing and warmth following dose; may cause GI upset

Nicardipine (Cardene)

COMMON USES: Chronic stable angina and HTN; prophylaxis of migraine

ACTIONS: Ca channel-blocker

DOSAGE: Oral: 20–40 mg PO tid. SR: 30–60 mg PO bid. IV: 5 mg/h IV cont inf; ↑ by 2.5 mg/h q

15 min to max 15 mg/h

SUPPLIED: Caps 20, 30 mg; SR caps 30, 45, 60 mg; inj 2.5 mg/mL

NOTES: Oral-to-IV conversion: 20 mg tid = 0.5 mg/h, 30 mg tid = 1.2 mg/h, 40 mg tid = 2.2 mg/h; adjust dose in renal or hepatic impairment

Nicotine Gum (Nicorette, Nicorette DS)

COMMON USES AND ACTIONS: See Nicotine, Transdermal

DOSAGE: 9-12 pieces/d PRN. Max 30 pieces/d

SUPPLIED: 2 mg (96 pieces/box); Nicorette DS has 4 mg/piece

NOTES: Patients must stop smoking and perform behavior modification for max effect

Nicotine Nasal Spray (Nicotrol NS)

COMMON USES: Aid to smoking cessation for the relief of nicotine withdrawal

ACTIONS: Provides systemic delivery of nicotine

DOSAGE: 0.5 mg/actuation; 1–2 sprays/h, not to exceed 10 sprays/h.

SUPPLIED: Nasal inhaler 10 mg/mL

NOTES: Patients must stop smoking and perform behavior modification for max effect

Nicotine, Transdermal (Habitrol, Nicoderm, Nicotrol, Prostep)

COMMON USES: Aid to smoking cessation for the relief of nicotine withdrawal

ACTIONS: Provides systemic delivery of nicotine

DOSAGE: Individualized to the patient's needs; apply 1 patch (14–22 mg/d), and taper over 6 wk **SUPPLIED:** Habitrol and Nicoderm 7, 14, 21 mg of nicotine/24h; Nicotrol 5, 10, 15 mg/24h; ProStep 11, 22 mg/24h

NOTES: Nicotrol to be worn for 16 h to mimic smoking patterns; others worn for 24 h; patients must stop smoking and perform behavior modification for max effect

Nifedipine (Procardia, Procardia XI, Adalat, Adalat CC)

COMMON USES: Vasospastic or chronic stable angina and HTN; tocolytic

ACTIONS: Ca channel-blocker

DOSAGE: Adults. SR tabs 30–90 mg/d. Tocolysis: 10–20 mg PO q4–6h. Peds. 0.6–0.9 mg/kg/24h ÷

tid-qid

SUPPLIED: Caps 10, 20 mg; SR tabs 30, 60, 90 mg

NOTES: Headaches common on initial treatment; reflex tachycardia may occur with regular release dosage forms; Adalat CC and Procardia XL are NOT interchangeable; SL administration NOT advisable

Nilutamide (Nilandron)

COMMON USES: Combination with surgical castration for the treatment of metastatic prostate can-

cer

ACTIONS: Nonsteroidal antiandrogen

DOSAGE: 300 mg/d in ÷ doses for the first 30 d, then 150 mg/d

SUPPLIED: 50-, 150-mg tabs

NOTES: Toxicity symptoms: Hot flashes, loss of libido, impotence, diarrhea, nausea, vomiting, gynecomastia, hepatic dysfunction (follow LFTs), and interstitial pneumonitis

Nimodipine (Nimotop)

COMMON USES: Prevention of vasospasm following subarachnoid hemorrhage

ACTIONS: Ca channel-blocker **DOSAGE:** 60 mg PO q4h for 21 d

SUPPLIED: Caps 30 mg

NOTES: Contents of caps may be extracted and administered down a NG tube if caps cannot be swallowed whole; dosage adjustment in hepatic failure

Nisoldipine (Sular)

COMMON USES: HTN
ACTIONS: Ca channel-blocker
DOSAGE: 10–60 mg/d PO

SUPPLIED: ER tabs 10, 20, 30, 40 mg

NOTES: Do NOT take with grapefruit juice or high-fat meal; \downarrow starting doses in elderly or hepatic impairment

Nitrofurantoin (Macrodantin, Furadantin, Macrobid)

COMMON USES: Prevention and Rx UTI

ACTIONS: Bacteriostatic; interferes with carbohydrate metabolism

DOSAGE: Adults. Suppression: 50-100 mg/d PO. Rx: 50-100 mg PO qid. Peds. 5-7 mg/kg/24h in

4 ÷ doses

SUPPLIED: Caps and tabs 50, 100 mg; SR caps [Macrobid] 100 mg; susp 25 mg/5 mL

NOTES: GI side effects common; should be taken with food, milk, or antacid; macrocrystals (Macrodantin) cause less nausea than other forms of the drug; avoid if CrCl <50 mL/min

Nitroglycerin (Nitrostat, Nitrolingual, Nitro-Bid Ointment, Nitro-Bid IV, Nitrodisc, Transderm-Nitro, others)

Used for emergency cardiac care (see Chapter 21)

COMMON USES: Angina pectoris, acute and prophylactic therapy, CHF, BP control

ACTIONS: Relaxation of vascular smooth muscle

DOSAGE: Adults. SL: 1 tab q 5 min SL PRN for 3 doses. Translingual: 1–2 met-doses sprayed onto the oral mucosa q3–5 min, max 3 doses. Oral: 2.5–9 mg tid. IV: 5–20 μg/min, titrated to effect. Topical: Apply 1–2 in. of oint to the chest wall q6h, then wipe off at night. TD: 5–20-cm patch qd. Peds. 1 μg/kg/min IV, titrated to effect

SUPPLIED: SL tabs 0.3, 0.4, 0.6 mg; translingual spray 0.4 mg/dose; SR caps 2.5, 6.5, 9, 13 mg; SR tabs 2.6, 6.5, 9,0 mg; inj 0.5, 5, 10 mg/mL; oint 2%; TD patches 2.5, 5, 7.5, 10, 15 mg/24h; buccal CR 1. 2. 3 mg

NOTES: Tolerance to nitrates develops with chronic use after 1–2 wk; can be avoided by providing a nitrate-free period each day; use shorter-acting nitrates tid, and remove long-acting patches and oint before hs to prevent development of tolerance. (See Table 20–10, page 637.)

Nitroprusside (Nitropress)

COMMON USES: Hypertensive emergency, aortic dissection, and pulmonary edema

ACTIONS: Reduces systemic vascular resistance

DOSAGE: Adults & Peds. 0.5-10 µg/kg/min IV inf, titrated to desired effect; usual dose 3

μg/kg/min

SUPPLIED: Inj 10 mg/mL, 25 mg/mL

NOTES: Thiocyanate, the metabolite, excreted by the kidney; thiocyanate toxicity occurs at plasma levels of 5–10 mg/dL; if used to treat aortic dissection; use β -blocker concomitantly. (See Table 20–10, page 637.)

Nizatidine (Axid)

COMMON USES: Duodenal ulcers, GERD, and heartburn

ACTIONS: H₂-receptor antagonist

DOSAGE: Active ulcer: 150 mg PO bid or 300 mg PO hs; maintenance 150 mg PO hs. GERD: 150

mg PO bid; maintenance PO hs. Heartburn: 75 mg PO bid

SUPPLIED: Caps 75, 150, 300 mg

NOTES: Dosage adjustment in renal impairment

Norepinephrine (Levophed)

Used for emergency cardiac care (see Chapter 21)

COMMON USES: Acute hypotensive states

ACTIONS: Peripheral vasoconstrictor acting on both the arterial and venous beds

DOSAGE: Adults. 8–12 μg/min IV, titrated to desired effect. Peds. 0.05–0.1 mg/kg/min IV, titrated to desired effect

SUPPLIED: Inj 1 mg/mL

NOTES: Correct blood volume depletion as much as possible prior to initiation of vasopressor therapy; drug interaction with tricyclic antidepressants leading to severe profound HTN; infuse into large vein to avoid extravasation; phentolamine 5–10 mg/10 mL NS injected locally as an antidote to extravasation. (See Table 20–10, page 637.)

Norfloxacin (Noroxin)

COMMON USES: Complicated and uncomplicated UTI caused by a wide variety of gram (-) bacteria, prostatitis, and infectious diarrhea

ACTIONS: Quinolone, inhibits DNA gyrase

DOSAGE: Adults. 400 mg PO bid. Gonorrhea: 800 mg as single dose. Conjunctivitis: 1-2 gtt qid

SUPPLIED: Tabs 400 mg; ophth soln 0.3%

NOTES: Do NOT use in PRG; drug interactions with antacids, theophylline, and caffeine; good concentrations in the kidney and urine, poor blood levels; do NOT use for urosepsis; dosage adjustment in renal impairment

Norgestrel (Ovrette)

COMMON USES: Contraceptive

ACTIONS: Prevent follicular maturation and ovulation

DOSAGE: 1 tab/d; begin day 1 of menses

SUPPLIED: Tabs 0.075 mg

NOTES: Progestin-only products have higher risk of failure in prevention of pregnancy

Nortriptyline (Aventyl, Pamelor)

COMMON USES: Endogenous depression

ACTIONS: Tricyclic antidepressant; increases the synaptic concentrations of serotonin and/or norep-

inephrine in the CNS

DOSAGE: Adults. 25 mg PO tid-qid; doses >150 mg/d NOT recommended. Elderly: 10-25 mg hs.

Peds. 6-7 y: 10 mg/d. 8-11 y: 10-20 mg/d. >11 y: 25-35 mg/d

SUPPLIED: Caps 10, 25, 50, 75 mg; soln 10 mg/5 mL

NOTES: Many anticholinergic side effects, including blurred vision, urinary retention, and dry

mouth; max effect seen after 2 wk of therapy

Nystatin (Mycostatin, Nilstat, others)

COMMON USES: Mucocutaneous *Candida* infections (thrush, vaginitis)

ACTIONS: Alters membrane permeability

DOSAGE: Adults. Oral: 400,000–600,000 U PO "swish and swallow" qid. Vaginal: 1 tab vaginally hs for 2 wk. Topical: Apply bid—tid to the affected area. **Peds.** Infants: 200,000 U PO q6h. Children: See Adult dosage

SUPPLIED: Oral susp 100,000 U/mL; oral tabs 500,000 U; troches 200,000 U; vaginal tabs 100,000 U; topical cream and oint 100,000 U/g

NOTES: Not absorbed orally; therefore, NOT effective for systemic infections

Octreotide (Sandostatin)

COMMON USES: Suppresses or inhibits severe diarrhea associated with carcinoid and neuroendocrine tumors of the intestinal tract; bleeding esophageal varices

ACTIONS: Long-acting peptide that mimics the natural hormone somatostatin

DOSAGE: Adults. 100–600 μ g/d SC in 2–4 ÷ doses; initiate at 50 μ g qd–bid. Peds. 1–10 μ g/kg/24h

SC in 2-4 ÷ doses

SUPPLIED: Inj 0.05, 0.1, 0.2, 0.5, 1 mg/mL

NOTES: May cause nausea, vomiting, and abdominal discomfort

Ofloxacin (Floxin, Ocuflox Ophthalmic)

COMMON USES: Infections of the lower respiratory tract, skin and skin structure, and urinary tract, prostatitis, uncomplicated gonorrhea, and *Chlamydia* infections; topical for bacterial conjunctivitis; acute otitis media in children >1 y tympanostomy tubes; otitis externa in adults and children >1 y; if perforated ear drum >12 y

ACTIONS: Bactericidal; inhibits DNA gyrase

DOSAGE: Adults. 200–400 mg PO bid or IV q12h. Adults & Peds. >1 y: Ophth 1–2 gtt in eye(s) q2–4h for 2 d, then qid for 5 more d. Peds. Do NOT administer systemically in children <18 y. Peds 1–12 y: Otic 5 gtt in ear(s) bid for 10 d. Adults & Peds >12 y: Otic 10 gtt in ear(s) bid for 10 d

SUPPLIED: Tabs 200, 300, 400 mg; inj 20, 40 mg/mL; ophth 0.3%

NOTES: May cause nausea and vomiting, diarrhea, insomnia, and headache; drug interactions with antacids, sucralfate, and aluminum-, calcium-, magnesium-, iron-, or zinc-containing products decrease absorption; may increase theophylline levels; dosage adjustment in renal impairment; ophth form used for ears

Olanzapine (Zyprexa)

COMMON USES: Psychotic disorders

ACTIONS: Dopamine and serotonin antagonist

DOSAGE: ↑ to max of 20 mg/d **SUPPLIED:** Tabs 5, 7.5, 10 mg

NOTES: May take many weeks to titrate to therapeutic dose; cigarette smoking will decrease levels

Olsalazine (Dipentum)

COMMON USES: Maintenance of remission of ulcerative colitis

ACTIONS: Topical antiinflammatory activity

DOSAGE: 500 mg PO bid **SUPPLIED:** Caps 250 mg

NOTES: Take with food; may cause diarrhea

Omeprazole (Prilosec)

COMMON USES: Duodenal and gastric ulcers, Zollinger-Ellison syndrome, GERD, and H. pylori

infections

ACTIONS: Proton-pump inhibitor **DOSAGE:** 20–40 mg PO qd–bid **SUPPLIED:** Caps 10, 20, 40 mg

NOTES: Combination (ie, antibiotic) therapy necessary for H. pylori infection

Ondansetron (Zofran)

COMMON USES: Prevention of nausea and vomiting associated with cancer chemotherapy and postoperative nausea and vomiting

ACTIONS: Serotonin receptor antagonist

DOSAGE: Adults & Peds. Chemotherapy: 0.15 mg/kg/dose IV prior to chemotherapy, then repeated 4 and 8 h after the first dose or 4–8 mg PO tid; administer the first dose 30 min prior to chemotherapy. Adults. Postop: 4 mg IV immediately before induction of anesthesia or postop

SUPPLIED: Tabs 4, 8 mg; inj 2 mg/mL

NOTES: May cause diarrhea and headache; administer on a schedule, NOT PRN

Oprelvekin (Neumega)

COMMON USES: Prevention of severe thrombocytopenia due to chemotherapy **ACTIONS:** Promotes proliferation and maturation of megakaryocytes

DOSAGE: Adults. 50 µg/kg/d SC for 10-21 d. Peds. 75-100 µg/kg/d SC for 10-21 d

SUPPLIED: Inj NOTES: Interleukin-11

Oral Contraceptives, Biphasic, Monophasic, Triphasic, Progestin Only (see Table 22–3, pages 623–625)

COMMON USES: Birth control and regulation of anovulatory bleeding

ACTIONS: Birth Control: Suppresses LH surge, prevents ovulation, progestins thicken cervical mucous, inhibits fallopian tubule cilia, ↓ endometrial thickness and hence ↓ chances of fertilization. Anovulatory bleeding: Cyclic hormones mimic the body's natural cycle and help regulate the endometrial lining, resulting in regular bleeding q 28 d; may also reduce uterine bleeding and dysmenorrhea

DOSAGE: 28-d cycle pills taken qd. 21-d cycle pills taken qd, no pills taken during the last 7 d of the cycle (during the menstrual period)

SUPPLIED: 28-d cycle pills (21 hormonally active pills + 7 placebo/Fe supplementation). 21-d cycle pills (21 hormonally active pills). See Table 22–3, page 000

NOTES: Taken correctly, 99.9% effective for preventing pregnancy, but do not protect against STD; encourage use of additional barrier contraceptive. Over long periods can \(\psi \) risk of ectopic pregnancy, benign breast disease, and future development of ovarian, and uterine cancer. \(Absolute contra: \) Undiagnosed abnormal vaginal bleeding, pregnancy, estrogen-dependent malignancy, hypercoagulation disorders, liver disease, and smokers >35 y. \(Relative contra: \) Migraine headaches, HTN, diabetes, sickle cell disease, and gallbladder disease. \(Rx \) for menstrual cycle control: Start with a monophasic pill. Pill must be taken for 3 mo before switching to another brand. Abnormal bleeding continues, changed to higher estrogen dose pill.

Rx for birth control: Choose pill with the most beneficial side effect profile for particular patient. Side effects numerous and due to symptoms of estrogen excess or progesterone deficiency. Because each pill's side effect profile is unique (found in package insert), Rx may be tailored to specific patient. Common side effects: Intramenstrual bleeding, oligomenorrhea, amenorrhea, increased appetite/weight gain, loss of libido, fatigue, depression, mood swings, mastalgia, headaches, melasma, increase vaginal discharge, acne/greasy skin, corneal edema, nausea

Orphenadrine (Norflex)

COMMON USES: Muscle spasms

ACTIONS: Central atropine-like effects cause indirect skeletal muscle relaxation, euphoria, and

analgesia

DOSAGE: 100 mg PO bid, 60 mg IM/IV q12h

SUPPLIED: Tabs 100 mg; SR tabs 100 mg; inj 30 mg/mL

Oseltamivir (Tamiflu)

COMMON USES: Influenza A and B
ACTIONS: Inhibition of viral neuraminidase

DOSAGE: 75 mg bid for 5 d **SUPPLIED:** Caps 75 mg

NOTES: Initiate within 48 h of symptom onset; ↓ dose in renal impairment

Oxacillin (Bactocill, Prostaphlin)

COMMON USES: Infections caused by susceptible strains of S. aureus and Streptococcus

ACTIONS: Bactericidal; inhibits cell wall synthesis

DOSAGE: *Adults.* 1–2 mg IV q4–6h. *Peds.* 150–200 mg/kg/d IV q4–6h

SUPPLIED: Inj; caps 250, 500 mg; soln 250 mg/5 mL

Oxaprozin (Daypro)

COMMON USES: Arthritis and pain

ACTIONS: NSAID; inhibits prostaglandin synthesis

DOSAGE: 600–1200 mg/d **SUPPLIED:** Caplets 600 mg

Oxazepam (Serax) [C]

COMMON USES: Anxiety, acute alcohol withdrawal, and anxiety with depressive symptoms

ACTIONS: Benzodiazepine

DOSAGE: Adults. 10-15 mg PO tid-qid; severe anxiety and alcohol withdrawal may require up to

30 mg qid. *Peds.* 1 mg/kg/d in ÷ doses **SUPPLIED:** Caps 10, 15, 30 mg; tabs 15 mg

NOTES: One of the metabolites of diazepam (Valium); avoid abrupt discontinuation

Oxcarbazepine (Trileptal)

COMMON USES: Partial seizures

ACTIONS: Produce blockage of voltage-sensitive Na channels, resulting in stabilization of hyperex-

cited neural membranes

DOSAGE: Adults. 300 mg bid, ↑ dose weekly to a usual dose of 1200–2400 mg/d. Peds. 8–10 mg/kg bid, NOT to exceed 600 mg/d; ↑ dose weekly to target maintenance dose

SUPPLIED: Tabs 150, 300, 600 mg

NOTES: May cause clinically significant hyponatremia; possible cross-sensitivity to carbamazepine

Oxiconazole (Oxistat)

COMMON USES: Tinea pedis, tinea cruris, and tinea corporis

ACTIONS: Antifungal antibiotic DOSAGE: Apply bid SUPPLIED: 1% Cream; lotion

Oxybutynin (Ditropan, Ditropan XL)

COMMON USES: Symptomatic relief of urgency, nocturia, and incontinence associated with neurogenic or reflex neurogenic bladder

ACTIONS: Direct antispasmodic effect on smooth muscle; increases bladder capacity

DOSAGE: Adults & Peds > 5 y. 5 mg PO tid–qid. Adults. ER 5 mg PO qd; ↑ to 30 mg/d PO, (5 and 10 mg/tab). Peds 1–5 y. 0.02 mg/kg/dose bid–qid (syrup 5 mg/5 mL)

SUPPLIED: Tabs 5 mg; ER tabs 5, 10, 15 mg; syrup 5 mg/5 mL

NOTES: Anticholinergic side effects

Oxycodone [Dihydrohydroxycodeinone] (OxyContin, OxyIR, Roxicodone) [C-II]

COMMON USES: Moderate to severe pain, normally used in combination with nonnarcotic analgesics

ACTIONS: Narcotic analgesic

DOSAGE: Adults. 5 mg PO q6h PRN. Peds. 6–12 y: 1.25 mg PO q6h PRN. >12 y: 2.5 mg q6h PRN **SUPPLIED:** Immediate release caps (OxyIR) 5 mg; tabs (Percolone) 5 mg tabs; CR (OxyContin) 10, 20, 40, 80 mg; liq 5 mg/5 mL; soln conc 20 mg/mL

NOTES: Usually prescribed in combination with acetaminophen or aspirin; OxyContin useful for chronic cancer pain

Oxycodone and Acetaminophen (Percocet, Tylox) [C-II]

COMMON USES: Moderate to severe pain

ACTIONS: Narcotic analgesic

DOSAGE: Adults. 1–2 tabs/caps PO q4–6h PRN. Peds. Oxycodone 0.05–0.15 mg/kg/dose q4–6h

PRN; up to 5 mg/dose

 $\textbf{SUPPLIED:} \ \ Percocet \ tabs \ 5 \ mg \ of \ oxycodone, \ 325 \ mg \ of \ acetaminophen; \ Tylox \ caps \ 5 \ mg \ of \ oxycodone, \ 500 \ mg \ of \ acetaminophen. \ Soln \ 5 \ mg \ of \ oxycodone \ and \ 325 \ mg \ of \ acetaminophen/5 \ mL$

NOTES: Acetaminophen max dose of 4 g/d

Oxycodone and Aspirin (Percodan, Percodan-Demi) [C-II]

COMMON USES: Moderate to moderately severe pain

ACTIONS: Narcotic analgesic with NSAID

DOSAGE: Adults.1-2 tabs/caps PO q4-6h PRN. Peds. 0.05-0.15 mg/kg/dose q4-6h, max 5

mg/dose (based on oxycodone)

SUPPLIED: Percodan 4.5 mg oxycodone hydrochloride 0.38 mg oxycodone terephthalate, 325 mg aspirin; Percodan-Demi 2.25 mg oxycodone hydrochloride, 0.19 mg oxycodone terephthalate, 325 mg aspirin

Oxymorphone (Numorphan) [C-II]

COMMON USES: Moderate to severe pain, sedative

ACTIONS: Narcotic analgesic

DOSAGE: 0.5 mg IM, SC, IV initially, 1-1.5 mg q4-6h PRN. PR: 5 mg q4-6h PRN

SUPPLIED: Inj 1, 1.5 mg/mL; supp 5 mg **NOTES:** Chemically related to hydromorphone

Oxytocin (Pitocin, Syntocinon)

COMMON USES: Induction of labor and control of postpartum hemorrhage; promote milk let down in lactating woman

ACTIONS: Stimulate muscular contractions of the uterus, stimulate milk flow during nursing

DOSAGE: 0.001–0.002 U/min IV inf; titrate to desired effect, to a max of 0.02 U/min. *Breast feeding:* 1 spray in both nostrils 2–3 min before feeding

SUPPLIED: Inj 10 U/mL; nasal soln 40 U/mL

NOTES: Can cause uterine rupture and fetal death; monitor vital signs closely; nasal form for breast feeding only

Paclitaxel (Taxol)

COMMON USES: Ovarian and breast cancer

ACTIONS: Mitotic spindle poison promotes microtubule assembly and stabilization against depolymerization (a taxrane)

DOSAGE: 135–250 mg/m² as a 3–24-h IV inf

SUPPLIED: Inj 6 mg/mL

NOTES: Toxicity symptoms: Hypersensitivity reactions (dyspnea, hypotension, urticaria, rash) usually within 10 min of starting infusion; minimize with corticosteroid, antihistamine (H₁ and H₂ antagonist) pretreatment. Myelosuppression, peripheral neuropathy, transient ileus, myalgia, bradycardia, hypotension, mucositis, diarrhea, nausea and vomiting, fever, rash, headache, and phlebitis. Hematologic toxicity schedule-dependent; leukopenia dose-limiting by 24-h inf; neurotoxicity dose-limiting by short (1–3-h) inf. Infuse this agent in glass or polyolefin containers using polyethylene-lined nitroglycerin tubing sets. PVC inf sets result in leaching of plasticizer

Pamidronate (Aredia)

COMMON USES: Hypercalcemia of malignancy and Paget's disease; palliation of symptomatic bone metastases

ACTIONS: Inhibition of normal and abnormal bone resorption

DOSAGE: Hypercalcemia: 60 mg IV over 4 h or 90 mg IV over 24 h. Paget's disease: 30 mg/d IV for 3 d

SUPPLIED: Powder for inj 30, 60, 90 mg

NOTES: *Toxicity symptoms:* Fever, tissue irritation at inj site, uveitis, fluid overload, HTN, abdominal pain, nausea and vomiting, constipation, UTI, bone pain, hypokalemia, hypocalcemia, hypomagnesemia, and hypophosphatemia; slow inf rate necessary

Pancreatin/Pancrelipase (Pancrease, Cotazyme, Creon, Ultrase)

COMMON USES: Exocrine pancreatic secretion deficiency (CF, chronic pancreatitis, other pancreatic insufficiency) and for steatorrhea of malabsorption syndrome

ACTIONS: Pancreatic enzyme supplementation

DOSAGE: Adults & Peds. 1–3 caps (tabs) with meals and snacks; dosage ↑ to 8 caps (tabs)

SUPPLIED: Caps, tabs

NOTES: Avoid antacids; may cause nausea, abdominal cramps, or diarrhea; do not crush or chew EC products; dosage dependent on patient's digestive requirements

Pancuronium (Pavulon)

COMMON USES: Rx of patients on mechanical ventilation

ACTIONS: Nondepolarizing neuromuscular blocker

DOSAGE: *Adults.* 2–4 mg IV q2–4h PRN. *Peds.* 0.02–0.10 mg/kg/dose q2–4h PRN

SUPPLIED: Inj 1, 2 mg/mL

NOTES: Intubate patient and keep on controlled ventilation; use an adequate amount of sedation or analgesia; adjust dose for renal or hepatic impairment

Pantoprazole (Protonix)

COMMON USES: GERD
ACTION: Proton pump inhibitor
DOSAGE: 40 mg/d PO

SUPPLIED: Tabs 40 mg

NOTES: DR tabs, therefore do NOT crush or chew tabs

Paregoric [C]

COMMON USES: Diarrhea, pain and neonatal opiate withdrawal syndrome

ACTIONS: Narcotic

DOSAGE: Adults. 5–10 mL PO qd–qid PRN. Peds. 0.25–0.5 mL/kg qd–qid. Neonatal withdrawal syndrome: 3–6 gtt PO q3–6h PRN to relieve symptoms for 3–5 d, then taper over 2–4 wk

NOTES: Contains opium; short-term use only. (See also Kaolin-Pectin.)

Paroxetine (Paxil)

COMMON USES: Depression, OCD, panic disorder, and social anxiety disorder

ACTIONS: Serotonin reuptake inhibitor **DOSAGE:** 10–60 mg PO as a single daily dose **SUPPLIED:** Tabs 10, 20, 30,40 mg; susp 10 mg/5 mL

NOTES: Should be administered in AM; may cause sexual dysfunction

Penbutolol (Levatol)

COMMON USES: HTN

ACTIONS: Competitively blocks β -adrenergic receptors, β_1 , β_2

DOSAGE: 20–40 mg/d SUPPLIED: Tabs 20 mg

Penciclovir (Denavir)

COMMON USES: Herpes simplex

ACTIONS: Competitive inhibitor of DNA polymerase

DOSAGE: Apply topically at first sign of lesions, then q2h for 4 d

SUPPLIED: Cream 1%

Penicillin G, Aqueous (Potassium or Sodium) (Pfizerpen)

COMMON USES: Most gram (+) infections (except penicillin-resistant staphylococci), including streptococci, N. meningitidis, syphilis, clostridia, and some coliforms

ACTIONS: Bactericidal; inhibits cell wall synthesis

DOSAGE: Adults. 400,000–800,000 U PO qid; IV doses vary greatly depending on indications; range from 1.2–24 million U/d in + doses q4h. Peds. Newborns <1 wk: 25,000–50,000 U/kg/dose IV q12h. Infants 1 wk < 1 mo: 25,000–50,000 U/kg/dose IV q8h. Children: 100,000–300,000 U/kg/24h IV + o4h

SUPPLIED: Powder for inj

NOTES: Beware of hypersensitivity reactions. Dosage adjustment in renal impairment

Penicillin G Benzathine (Bicillin)

COMMON USES: Useful as a single-dose treatment regimen for streptococcal pharyngitis, rheumatic fever and glomerulonephritis prophylaxis, and syphilis

ACTIONS: Bactericidal; inhibits cell wall synthesis

DOSAGE: Adults. 1.2–2.4 million U deep IM inj q 2–4 wk. Peds. 50,000 U/kg/dose to a max of 2.4 million U/dose deep IM inj q 2–4 wk

SUPPLIED: Inj 300,000, 600,000 U/mL

NOTES: Sustained action with detectable levels up to 4 wk; considered the drug of choice for treatment of noncongenital syphilis; Bicillin L-A contains the benzathine salt only; Bicillin C-R contains a combination of the benzathine and procaine (300,000 U of procaine with 300,000 U of benzathine/mL or 900,000 U of benzathine with 300,000 U of procaine/2 mL)

Penicillin G Procaine (Wycillin, others)

COMMON USES: Moderately severe infections caused by penicillin G-sensitive organisms that respond to low, persistent serum levels

ACTIONS: Bactericidal; inhibits cell wall synthesis

DOSAGE: Adults.0.6–4.8 million U/d in \div doses q12–24h. Peds. 25,000–50,000 U/kg/d IM \div qd–bid

SUPPLIED: Ini 300.000, 500.000, 600,000 U/mL

NOTES: Long-acting parenteral penicillin; blood levels up to 15 h; give probenecid at least 30 min prior to administration of penicillin to prolong action

Penicillin V (Pen-Vee K, Veetids, others)

COMMON USES: Most gram (+) infections, including streptococci, *N. meningitidis*, syphilis, clostridia, and some coliforms

ACTIONS: Bactericidal; inhibits cell wall synthesis

DOSAGE: Adults. 250–500 mg PO q6h. Peds. 25–50 mg/kg/24h PO in 4 ÷ doses

SUPPLIED: Tabs 125, 250, 500 mg; susp 125, 250 mg/5 mL

NOTES: Well-tolerated oral penicillin; 250 mg = 400,000 U of penicillin G

Pentamidine (Pentam 300, Nebupent)

COMMON USES: Rx and prevention of PCP

ACTIONS: Inhibits DNA, RNA, phospholipid, and protein synthesis

DOSAGE: Adults & Peds. 4 mg/kg/24h IV qd for 14–21 d. Adults & Peds >5 y. Prevention: 300 mg once q 4 wk, administered via Respigard II neb

SUPPLIED: Inj 300 mg/vial; aerosol 300 mg

NOTES: Monitor for severe hypotension following IV administration; associated with pancreatic islet cell necrosis leading to hypoglycemia and hyperglycemia; monitor hematology lab results for leukopenia and thrombocytopenia; IV requires dosage adjustment in renal impairment

Pentazocine (Talwin) [C-IV]

COMMON USES: Moderate to severe pain

ACTIONS: Partial narcotic agonist-antagonist

DOSAGE: *Adults.* 30 mg IM or IV; 50–100 mg PO q3–4h PRN. *Peds.* 5–8 y: 15 mg IM q4h PRN.

8-14 y: 30 mg IM q4h PRN

SUPPLIED: Tabs 50 mg (+ naloxone 0.5 mg); inj 30 mg/mL

NOTES: 30-60 mg IM equianalgesic to 10 mg of morphine IM; associated with considerable dysphoria; dosage adjustment in renal impairment

Pentobarbital (Nembutal, others) [C-II]

COMMON USES: Insomnia, convulsions, and induced coma following severe head injury

ACTIONS: Barbiturate

DOSAGE: Adults. Sedative: 20–40 mg PO or PR q6–12h. Hypnotic: 100–200 mg PO or PR hs PRN. Induced coma: Load 5–10 mg/kg IV, then maintenance 1–3 mg/kg/h IV cont inf to keep the serum level between 20 and 50 mg/mL. Peds. Hypnotic: 2–6 mg/kg/dose PO hs PRN. Induced coma: See adult dosage

SUPPLIED: Caps 50, 100 mg; elixir 18.5 mg/5 mL; supp 30, 60, 120, 200 mg; inj 50 mg/mL

NOTES: Can cause respiratory depression; may produce profound hypotension when used aggressively IV for cerebral edema; tolerance to sedative–hypnotic effect acquired within 1–2 wk; reduce dose in severe hepatic impairment

Pentosan Polysulfate Sodium (Elmiron)

COMMON USES: Relief of pain/discomfort associated with interstitial cystitis

ACTIONS: Acts as buffer on bladder wall

DOSAGE: 100 mg PO tid on empty stomach with water 1 h ac or 2 h pc **SUPPLIED:** Caps 100 mg

NOTES: Toxicity symptoms: Alopecia, diarrhea, nausea, and headaches

Pentostatin (Nipent)

COMMON USES: Hairy cell leukemia, CLL, mycosis fungoides, ALL, and adult T-cell leukemia

ACTIONS: Irreversible inhibitor of adenosine deaminase **DOSAGE:** 4–5 mg/m²/wk for 3 consecutive weeks

SUPPLIED: Inj 10 mg

NOTES: *Toxicity symptoms:* Renal dysfunction; myelosuppression (especially leukopenia), lymphocytopenia, fever, and infection possible; neurologic toxicity symptoms (lethargy and fatigue, dry skin, keratoconjunctivitis, and nausea and vomiting); dosage adjustment in renal impairment

Pentoxifylline (Trental)

COMMON USES: Symptomatic management of peripheral vascular disease **ACTIONS:** Lowers blood cell viscosity by restoring erythrocyte flexibility

DOSAGE: 400 mg PO tid pc

SUPPLIED: Tabs 400 mg

NOTES: Treat for at least 8 wk to see full effect; ↓ to bid if GI or CNS effects occur

Pergolide (Permax)

COMMON USES: Parkinson's disease

ACTIONS: Centrally active dopamine receptor agonist

DOSAGE: Initially, 0.05 mg PO tid, titrated q 2–3 d to desired effect, usual maintenance dose 2–3

mg/d in ÷ doses

SUPPLIED: Tabs 0.05, 0.25, 1.0 mg

NOTES: May cause hypotension during initiation of therapy

Perindopril Erbumine (Aceon)

COMMON USES: HTN and CHF
ACTIONS: ACE inhibitor

DOSAGE: 4-8 mg/d

SUPPLIED: Tabs 2, 4, 8 mg

NOTES: Avoid taking with food; dosage adjustment in renal impairment; contra in PRG

Permethrin (Nix, Elimite)

COMMON USES: Eradication of lice and scabies

ACTIONS: Pediculicide

DOSAGE: Adults & Peds. Saturate the hair and scalp; allow to remain in the hair for 10 min before

SUPPLIED: Topical liq 1%; cream 5%

Perphenazine (Trilafon)

COMMON USES: Psychotic disorders, intractable hiccups, and severe nausea

ACTIONS: Phenothiazine; blocks postsynaptic mesolimbic dopaminergic receptors in the brain DOSAGE: Adults. Antipsychotic: 4-16 mg PO tid; max 64 mg/d. Hiccups: 5 mg IM q6h PRN or 1 mg IV at not less than 1-2 mg/min intervals to a max of 5 mg. Peds. 1-6 y: 4-6 mg/d in ÷ doses. $6-12 \text{ y: } 6 \text{ mg/d in } \div \text{ doses.} > 12 \text{ y: } 4-16 \text{ mg } 2-4 \times /d$

SUPPLIED: Tabs 2, 4, 8, 16 mg; oral conc 16 mg/5 mL; inj 5 mg/mL

Phenazopyridine (Pyridium, others)

COMMON USES: Lower urinary tract irritation

ACTIONS: Local anesthetic on urinary tract mucosa

DOSAGE: Adults. 100-200 mg PO tid. Peds 6-12 y. 12 mg/kg/24h PO in 3 ÷ doses

SUPPLIED: Tabs 95, 100, 200 mg

NOTES: GI disturbances; causes red-orange urine color, which can stain clothing; dosage adjustment in renal impairment

Phenelzine (Nardil)

COMMON USES: Depression **ACTIONS:** MAO inhibitor

DOSAGE: Adults. 15 mg tid. Elderly: 15–60 mg/d in ÷ doses

SUPPLIED: Tabs 15 mg

NOTES: May cause postural hypotension; may take 2-4 wk to see therapeutic effect; avoid tyramine-containing foods

Phenobarbital [C-IV]

COMMON USES: Seizure disorders, insomnia, and anxiety

ACTIONS: Barbiturate

DOSAGE: Adults. Sedative-hypnotic: 30-120 mg/f PO or IM PRN. Anticonvulsant: Loading dose of 10-12 mg/kg in 3 ÷ doses, then 1-3 mg/kg/24h PO, IM, or IV. Peds. Sedative-hypnotic: 2-3 mg/kg/24h PO or IM hs PRN. Anticonvulsant: Loading dose of 15-20 mg/kg ÷ into 2 equal doses 4 h apart, then 3-5 mg/kg/24h PO ÷ in 2-3 doses

SUPPLIED: Tabs 8, 15, 16, 30, 32, 60, 65, 100 mg; elixir 15, 20 mg/5 mL; inj 30, 60, 65, 130 mg/mL NOTES: Tolerance develops to sedation; paradoxic hyperactivity seen in pediatric patients; long half-life allows single daily dosing. (See Table 22-7, pages 631-634.)

Phenylephrine (Neo-Synephrine)

COMMON USES: Vascular failure in shock, hypersensitivity, or drug-induced hypotension; nasal congestion: mydriatic

ACTIONS: α-Adrenergic agonist

DOSAGE: Adults. Mild to moderate hypotension: 2–5 mg IM or SC elevates BP for 2 h; 0.1–0.5 mg IV elevates BP for 15 min. Severe hypotension or shock: Initiate cont inf at 100-180 mg/min; after BP is stabilized, maintenance rate of 40-60 mg/min. Nasal congestion: 1-2 sprays/nostril PRN. Ophth: 1 gtt 15-30 min before examination. Peds. Hypotension: 5-20 μg/kg/dose IV q 10-15 min or 0.1–0.5 mg/kg/min IV infusion, titrated to desired effect. *Nasal congestion:* 1 spray/nostril q3–4h PRN

SUPPLIED: Inj 10 mg/mL; nasal soln 0.125, 0.16, 0.25, 0.5, 1%; ophth soln 0.12, 2.5, 10%

NOTES: Promptly restore blood volume if loss has occurred; use with extreme caution in patients with hyperthyroidism, bradycardia, partial heart block, myocardial disease, or severe arteriosclerosis; use large veins for infusion to avoid extravasation; phentolamine 10 mg in 10–15 mL of NS for local inj as antidote for extravasation; activity potentiated by oxytocin, MAO inhibitors, and tricyclic antidepressants. (See Table 20–10, page 637.)

Phenytoin (Dilantin)

COMMON USES: Seizure disorders

ACTIONS: Inhibits seizure spread in the motor cortex

DOSAGE: Adults & Peds. Load: 15–20 mg/kg IV at a max inf rate of 25 mg/min or orally in 400-mg doses at 4-h intervals. Adults. Maintenance: Initially, 200 mg PO or IV bid or 300 mg hs; then follow serum concentrations. Peds. Maintenance: 4–7 mg/kg/24h PO or IV ÷ qd-bid

SUPPLIED: Caps 30, 100 mg; chewable tabs 50 mg; oral susp 30, 125 mg/5 mL; inj 50 mg/mL

NOTES: Use caution with cardiac depressant side effects, especially with IV administration; follow levels as needed (see Table 22–7, pages 631–634); nystagmus and ataxia early signs of toxicity; gum hyperplasia occurs with long-term use; avoid use of oral susp if possible because of erratic absorption; avoid use in pregnancy

Physostigmine (Antilirium)

COMMON USES: Antidote for tricyclic antidepressant, atropine, and scopolamine overdose; glaucoma

ACTIONS: Reversible cholinesterase inhibitor

DOSAGE: Adults. 2 mg IV or IM q 20 min. Peds. 0.01–0.03 mg/kg/dose IV q 15–30 min, to total of 2 mg if necessary

SUPPLIED: Inj 1 mg/mL; ophth oint 0.25%

NOTES: Rapid IV administration associated with convulsions; cholinergic side effects; may cause asystole. (See also Chapter 21.)

Phytonadione [Vitamin K] (AquaMEPHYTON, others)

COMMON USES: Coagulation disorders caused by faulty formation of factors II, VII, IX, and X; hyperalimentation

ACTIONS: Supplementation; needed for the production of factors II, VII, IX, and X

DOSAGE: Children and Adults. Anticoagulant-induced prothrombin deficiency: 2.5–10.0 mg PO or IV slowly. Hyperalimentation: 10 mg IM or IV q wk. Infants. 0.5–1.0 mg/dose IM, SC, or PO CHENTER: The Special 2.10 mg/dos.

SUPPLIED: Tabs 5 mg; inj 2, 10 mg/mL

NOTES: With parenteral treatment, the first change in prothrombin usually seen in 12-24~h; anaphylaxis can result from IV dosage; administer IV slowly

Pindolol (Visken)

COMMON USES: HTN

ACTIONS: Competitively blocks β -adrenergic receptors, β_1 , β_2 , ISA

DOSAGE: 5-10 mg bid, to max dose of 60 mg/d

SUPPLIED: Tabs 5, 10 mg

Pioglitazone (Actos)

COMMON USES: Type 2 DM in combination with diet or other agents

ACTIONS: Increases insulin sensitivity

DOSAGE: 15-45 mg/d

SUPPLIED: Tabs 15, 30, 45 mg

NOTES: Do NOT use in hepatic impairment

Pipecuronium (Arduan)

COMMON USES: Adjunct to general anesthesia **ACTIONS:** Nondepolarizing neuromuscular blocker

DOSAGE: Adults & Peds. 0.05-0.085 mg/kg initially, followed by 0.5-2 µg/kg/min (ICU)

SUPPLIED: Inj 10 mg

NOTES: Dosage adjustment in renal failure

Piperacillin (Pipracil)

COMMON USES: Infections caused by susceptible strains of gram- bacteria (including Klebsiella, Proteus, E. coli, Enterobacter, P. aeruginosa, and Serratia) involving the skin, bone, respiratory tract, urinary tract, abdomen, and septicemia

ACTIONS: Bactericidal; inhibits cell wall synthesis

DOSAGE: Adults. 3 gm IV q4–6h. Peds. 200–300 mg/kg/d IV \div q4–6h

SUPPLIED: Ini

NOTES: Often used in combination with aminoglycosides; dosage adjustment in renal failure

Piperacillin-Tazobactam (Zosyn)

COMMON USES: Infections caused by susceptible strains of gram (-) bacteria (including Klebsiella, Proteus, E. coli, Enterobacter, P. aeruginosa, and Serratia) involving the skin, bone, respiratory tract, urinary tract, abdomen, and septicemia

ACTIONS: Bactericidal: inhibits cell wall synthesis

DOSAGE: Adults. 3.375-4.5 g IV q6h

SUPPLIED: Inj

NOTES: Often used in combination with aminoglycoside; dosage adjustment in renal failure

Pirbuterol (Maxair)

COMMON USES: Prevention and Rx of reversible bronchospasm

ACTIONS: β₂-Adrenergic agonist

DOSAGE: Adults & Peds >12 y. 2 inhal q4-6h; max 12 inhal/d

SUPPLIED: Aerosol 0.2 mg/actuation

NOTES: Mouth rinsed with water after each use

Piroxicam (Feldene)

COMMON USES: Arthritis and pain

ACTIONS: NSAID: inhibits prostaglandin synthesis

DOSAGE: 10-20 mg/d SUPPLIED: Caps 10, 20 mg

Plasma Protein Fraction (Plasmanate, others)

COMMON USES: Shock and hypotension ACTIONS: Plasma volume expansion

DOSAGE: Adults. Initially, 250-500 mL IV (NOT >10 mL/min); subsequent inf depend on clinical

response. Peds. 10-15 mL/kg/dose IV; subsequent inf depend on clinical response

SUPPLIED: Inj 5%

NOTES: Hypotension associated with rapid inf; 130–160 meq Na/L; NOT substitute for RBC

Plicamycin (Mithracin)

COMMON USES: Hypercalcemia of malignancy; disseminated embryonal cell carcinoma or germ cell tumors of the testis

ACTIONS: Antibiotic; binds to the outside of the DNA molecule, interrupting DNA-directed RNA synthesis, DNA intercalation

DOSAGE: Hypercalcemia: 25 mg/kg/d IV qod for 3–8 doses. Cancer: 25–30 mg/kg/d for 8–10 d

SUPPLIED: Inj

NOTES: *Toxicity symptoms:* Thrombocytopenia; drug-induced deficiency of clotting factors II, V, VII, and X, resulting in bleeding and bruising; dosage adjustment in renal or hepatic impairment

Pneumococcal Vaccine, Polyvalent (Pneumovax-23)

COMMON USES: Immunization against pneumococcal infections in patients predisposed to or at

high risk. (See Table 22–9, page 636.) **ACTIONS:** Active immunization

DOSAGE: Adults & Peds >2 y. 0.5 mL IM

SUPPLIED: Inj 25 mg each of polysaccharide isolates/0.5-mL dose **NOTES:** Do NOT vaccinate during immunosuppressive therapy

Pneumococcal 7-valent Conjugate Vaccine (Prevnar)

COMMON USES: Immunization against pneumococcal infections in infants and children. (See Table 22–9, page 636.)

ACTIONS: Active immunization

DOSAGE: 0.5 mL IM/dose; series consists of 3 doses; 1st dose at 2 mo of age with subsequent doses q 2 mo

SUPPLIED: Inj

Podophyllin (Podocon-25, Condylox Gel 0.5%, Condylox)

COMMON USES: Topical therapy of benign growths (genital and perianal warts [condylomata acuminata], papillomas, fibroids

ACTIONS: Direct antimitotic effect. Exact mechanism unknown

DOSAGE: Condylox gel and Condylox are applied 3 consecutive d/wk for 4 wk. Use Podocon-25 sparingly on the lesion, leave on for 1–4 h, then thoroughly wash off

SUPPLIED: Podocon-25 contains benzoin 15 mL bottles; Condylox gel 0.5% 35 g clear gel; Condylox soln 0.5% 35 g clear

NOTES: Podocon-25 applied only by the clinician; NOT to be dispensed to patient. Contra in PRG,

diabetics, bleeding lesions, immunocompromised

Polyethylene Glycol [PEG] Electrolyte Solution (GoLYTELY, CoLyte)

COMMON USES: Bowel cleansing prior to examination or surgery

ACTIONS: Osmotic cathartic

DOSAGE: Adults. Following 3-4-h fast, drink 240 mL of soln q 10 min until 4 L is consumed. Peds.

25-40 mL/kg/h for 4-10 h

SUPPLIED: Powder for reconstitution to 4 L in container

NOTES: 1st bowel movement should occur in approximately 1 h; may cause some cramping or

nausea

Polymyxin B and Hydrocortisone (Otobiotic Otic)

COMMON USES Superficial bacterial infections of external ear canal

ACTIONS: Antibiotic antiinflammatory combination

DOSAGE: 4 gtt in ear(s) tid-qid

SUPPLIED: Soln polymyxin B 10,000 U/ hydrocortisone 0.5%/ mL

NOTES: Useful in neomycin allergy

Potassium Citrate (Urocit-K)

COMMON USES: Alkalinize urine, prevention of urinary stones (uric acid, calcium stones if hypoci-

traturic)

ACTIONS: Urinary alkalinizer

DOSAGE: 10-20 mEq PO tid with meals, max 100 mEq/d **NOTES:** Tabs 540 mg = 5 mEq, 1080 mg = 10 mEq

Potassium Citrate and Citric Acid (Polycitra-K)

COMMON USES: Alkalinize urine, prevention of urinary stones (uric acid, calcium stones if hypocitraturic)

ACTIONS: Urinary alkalinizer

DOSAGE: 10–20 mEq PO tid with meals, max 100 mEq/d **NOTES:** Soln 10 mEq/5 mL; powder 30 mEq/packet

Potassium Idodide [Lugol's Solution] (SSKI, Thyro-Block)

COMMON USES: Thyroid crisis, reduction of vascularity before thyroid surgery, block thyroid uptake of radioactive isotopes of iodine, thin bronchial secretions

ACTIONS: Iodine supplement

DOSAGE: Adults & Peds. Preop thyroidectomy: 50–250 mg PO tid (2–6 gtt strong iodine soln); administer 10 d preop. Thyroid crisis: Adults & Peds >1 y. 300 mg (6 gtt SSKI q8h). Infants <1 y. ½ dose)

 $\textbf{SUPPLIED:}\ Tabs\ 130\ mg;\ soln\ SSKI\ 1\ g/mL;\ Lugol's\ soln,\ strong\ iodine\ 100\ mg/mL\ ;\ syrup\ 325\ mg/5\ mL$

Potassium Supplements (Kaon, Kaochlor, K-Lor, Slow-K, Micro-K, Klorvess, others). (See Table 22–4, page 626.)

COMMON USES: Prevention or Rx of hypokalemia (often related to diuretic use)

ACTIONS: Supplementation of potassium

DOSAGE: Adult: 20–100 mEq/d PO ÷ qd–bid; IV 10–20 mEq/h, max 40 mEq/h and 150 mEq/d (monitor frequent potassium levels when using high-dose IV infusions). *Peds.* Calculate potassium deficit; 1–3 mEq/kg/d PO ÷ qd–qid; IV max dose 0.5–1 mEq/kg/h

SUPPLIED: Oral forms (see Table 22-4, page 626); injectable forms

NOTES: Can cause GI irritation; mix powder and liquid with beverage (unsalted tomato juice, etc); use cautiously in renal insufficiency as well as with NSAIDs and ACE inhibitors. CI salt recommended in coexisting alkalosis, for coexisting acidosis use acetate, bicarbonate, citrate or gluconate salt. (See also Chapter 9.)

Pramipexole (Mirapex)

COMMON USES: Parkinson's disease

ACTION: Dopamine agonist

DOSAGE: 1.5-4.5 mg/d, beginning with 0.375 mg/d in $3 \div$ doses

SUPPLIED: Tabs 0.125, 0.25, 1, 1.5 mg

NOTES: Titrate dosage slowly

Pramoxine (Anusol Ointment, Proctofoam-NS, others)

COMMON USES: Relief of pain and itching from external and internal hemorrhoids and anorectal surgery; topical for burns and dermatosis

ACTIONS: Topical anesthetic

DOSAGE: Apply cream, oint, gel or spray, freely to anal area q3-h

SUPPLIED: [OTC] all 1%; foam (Proctofoam NS), cream, oint, lotion, gel, pads, spray

Pramoxine + Hydrocortisone (Enzone, Proctofoam-HC)

COMMON USES: Relief of pain and itching from hemorrhoids

ACTIONS: Topical anesthetic

DOSAGE: Apply freely to anal area tid-qid

SUPPLIED: Cream pramoxine hydrochloride 1% hydrocortisone acetate 0.5/1%; foam pramoxine 1% hydrocortisone 1%; lotion pramoxine 1% hydrocortisone 0.25/1/2.5%, pramoxine 2.5% and hydrocortisone 1%

Pravastatin (Pravachol)

COMMON USES: Reduction of elevated cholesterol levels

ACTIONS: HMG-CoA reductase inhibitor

DOSAGE: 10–40 mg PO hs **SUPPLIED:** Tabs 10, 20, 40 mg

NOTES: Avoid concurrent use with gemfibrozil. Follow LFT's

Prazepam (Centrax) [C]

COMMON USES: Anxiety disorders and alcohol withdrawal

ACTIONS: Benzodiazepine

DOSAGE: 5–10 mg PO tid–qid, or 20–50 mg PO as a single dose hs to minimize daytime drowsi-

ness
SUPPLIED: Discontinued

Prazosin (Minipress)

COMMON USES: HTN and CHF

ACTIONS: Peripherally acting α-adrenergic blocker

DOSAGE: Adults. 1 mg PO tid; can ↑ to max daily dose of up to 20 mg/d. Peds. 5–25 μg/kg/dose

q6h, up to $25 \mu g/kg/dose$ **SUPPLIED:** Caps 1, 2, 5 mg

NOTES: Can cause orthostatic hypotension, so the patient should take the first dose hs; tolerance develops to this effect; tachyphylaxis may result

Prednisolone

See Steroids, systemic (Table 22-5, page 627)

Prednisone

See Steroids, systemic (Table 22–5, page 627)

Probenecid (Benemid, others)

COMMON USES: Prevention of gout and hyperuricemia; prolong serum levels of penicillins or cephalosporins

ACTIONS: Renal tubular blocking agent

DOSAGE: Adults. Gout: 250 mg bid for 1 wk, then 0.5 g PO bid. Can ↑ by 500 mg/mo up to 2–3 g/d. Antibiotic effect: 1–2 g PO 30 min prior to dose of antibiotic. Peds >2 y. 25 mg/kg, then 40 mg/kg/d PO ÷ qid

SUPPLIED: Tabs 500 mg

Procainamide (Pronestyl, Procan)

Used for emergency cardiac care (see Chapter 21)

COMMON USES: Supraventricular and ventricular arrhythmias

ACTIONS: Class 1A antiarrhythmic

DOSAGE: Adults. For emergency cardiac care, see Chapter 21. Chronic dosing: 50 mg/kg/d PO in ÷ doses q4–6h. Peds. For emergency cardiac care, see Chapter 21. Maintenance: 15–50 mg/kg/24h PO ÷ q3–6h

SUPPLIED: Tabs and caps 250, 375, 500 mg; SR tabs 250, 500, 750, 1000 mg; inj 100, 500 mg/mL **NOTES:** Can cause hypotension and a lupus-like syndrome; dosage adjustment required with renal or hepatic impairment (see Table 22–7, pages 631–634. See also Table 20–10, p. 637.)

Procarbazine (Matulane)

COMMON USES: Hodgkin's disease, non-Hodgkin's lymphoma, and brain tumors

ACTIONS: Alkylating agent; inhibition of DNA and RNA synthesis

DOSAGE: 2–4 mg/kg/d × 7 d, then 4–6 mg/kg/d until response. Maintenance 1–2 mg/kg/d/ in com-

bination, $60-100 \text{ mg/m}^2/\text{d} \times 10-14 \text{ d}$

SUPPLIED: Caps 50 mg

NOTES: Toxicity symptoms: Myelosuppression, hemolytic reactions (with G6PD deficiency), nausea, vomiting, and diarrhea; disulfiram-like reaction. Cutaneous reactions. Constitutional symposium of the symposium

toms, myalgia, and arthralgia. CNS effects may be related to the high concentrations of drug reached in CSF or because of MAO inhibitor effects, Azoospermia and cessation of menses common

Prochlorperazine (Compazine)

COMMON USES: Nausea and vomiting, agitation, and psychotic disorders

ACTIONS: Phenothiazine; blocks postsynaptic mesolimbic dopaminergic receptors in the brain DOSAGE: Adults. Antiemetic: 5-10 mg PO tid-qid or 25 mg PR bid or 5-10 mg deep IM q4-6h. Antipsychotic: 10-20 mg IM acutely or 5-10 mg PO tid-qid for maintenance. Peds. 0.1-0.15

mg/kg/dose IM q4-6h or 0.4 mg/kg/24h PO ÷ tid-qid

SUPPLIED: Tabs 5, 10, 25 mg; SR caps 10, 15, 30 mg; syrup 5 mg/5 mL; supp 2.5, 5, 25 mg; inj 5

NOTES: A much larger dose may be required for antipsychotic effect; extrapyramidal side effects common; treat acute extrapyramidal reactions with diphenhydramine

Procyclidine (Kemadrin)

COMMON USES: Parkinson's syndrome **ACTIONS:** Blocking excess acetylcholine DOSAGE: 2.5 mg PO tid, up to 20 mg/d

SUPPLIED: Tabs 5 mg NOTES: Contra in glaucoma

Promethazine (Phenergan)

COMMON USES: Nausea and vomiting, motion sickness, sedation

ACTIONS: Phenothiazine; blocks postsynaptic mesolimbic dopaminergic receptors in the brain DOSAGE: Adults. 12.5-50 mg PO, PR, or IM bid-qid PRN. Peds. 0.1-0.5 mg/kg/dose PO or IM

a12-6h PRN

SUPPLIED: Tabs 12.5, 25, 50 mg; syrup 6.25 mg/5 mL, 25 mg/5 mL; supp 12.5, 25, 50 mg; inj 25, 50 mg/mL

NOTES: High incidence of drowsiness

Propafenone (Rythmol)

COMMON USES: Life-threatening ventricular arrhythmias

ACTIONS: Class IC antiarrhythmic DOSAGE: 150-300 mg PO q8h **SUPPLIED:** Tabs 150, 225, 300 mg

NOTES: May cause dizziness, unusual taste, 1st-degree heart block, and prolongation of QRS and

OT intervals

Propantheline (Pro-Banthine)

COMMON USES: Symptomatic treatment of small intestine hypermotility, spastic colon, ureteral spasm, bladder spasm, pylorospasm

ACTIONS: Antimuscarinic agent

DOSAGE: Adults. 15 mg PO ac and 30 mg PO hs. Peds. 1-3 mg/kg/24h PO ÷ tid-qid

SUPPLIED: Tabs 7.5, 15 mg

NOTES: Anticholinergic side effects, eg, dry mouth and blurred vision common

Propofol (Diprivan)

COMMON USES: Induction or maintenance of anesthesia; continuous sedation in intubated patients

ACTIONS: Sedative hypnotic; mechanism unknown

DOSAGE: Anesthesia: 2–2.5 mg/kg induction then 0.1–0.2 mg/kg/min cont inf. ICU sedation: 5–50 µg/kg/min cont inf

SUPPLIED: Inj 10 mg/mL

NOTES: 1 mL of propofol contains 0.1 g of fat; may increase serum triglycerides when administered for extended periods

Propoxyphene (Darvon) [C-IV]

Propoxyphene and Acetaminophen (Darvocet) [C-IV]

Propoxyphene and Aspirin (Darvon Compound-65, Darvon-N + Aspirin) [C-IV]

COMMON USES: Mild to moderate pain

ACTIONS: Narcotic analgesic **DOSAGE:** 1–2 PO q4h PRN

SUPPLIED: Darvon: propoxyphene HCl caps 65 mg; Darvon-N: propoxyphene napsylate 100-mg tabs; Darvocet-N: propoxyphene napsylate 50 mg/acetaminophen 325 mg; Darvocet-N 100: propoxyphene napsylate 100 mg/acetaminophen 650 mg; Darvon Compound-65: propoxyphene HCl 65-mg/aspirin 389-mg/caffeine 32-mg caps; Darvon-N with aspirin: propoxyphene napsylate 100 mg/aspirin 325 mg

NOTES: Intentional overdose can be lethal

Propranolol (Inderal)

Used for emergency cardiac care (see also Chapter 21)

COMMON USES: HTN, angina, MI

ACTIONS: Competitively blocks β -adrenergic receptors, β_1 , β_2

DOSAGE: Adults. Angina: 80–320 mg/d PO ÷ bid–qid or 80–160 mg/d SR. Arrhythmia: 10–80 mg PO tid–qid or 1 mg IV slowly, repeat q 5 min up to 5 mg. HTN: 40 mg PO bid or 60–80 mg/d SR, ↑ weekly to max 640 mg/d. Hypertrophic subaoritc stenosis: 20–40 mg PO tid–qid. MI: 180–240 mg PO ÷ tid–qid. Migraine prophylaxis: 80 mg/d ÷ qid–tid, ↑ weekly to max 160–240 mg/d + tid–qid; wean off if no response in 6 wk. Pheochromocytoma: 30–60 mg/d ÷ tid–qid. Thyrotoxicosis: 1–3 mg IV single dose; 10–40 mg PO q6h. Tremor: 40 mg PO bid, ↑ as needed to max 320 mg/d. Peds. Arrhythmia: 0.5–1.0 mg/kg/d ÷ tid–qid, ↑ as needed q3–7d to max 60 mg/d; 0.01–0.1 mg/kg IV over 10 min, max dose 1 mg. HTN: 0.5–1.0 mg/kg ÷ bid–qid, ↑ as needed q 3–7 d to 2 mg/kg/d max

SUPPLIED: Tabs 10, 20, 40, 60, 80, 90 mg; caps SR 60, 80, 120, 160 mg; oral soln 4 mg/mL, 8 mg/mL, 80 mg/mL; inj 1 mg/mL

NOTES: Dosage adjustment in renal impairment

Propylthiouracil [PTU]

COMMON USES: Hyperthyroidism

ACTIONS: Inhibits production of T_3 and T_4 and conversion of T_4 to T_3

DOSAGE: Adults. Initial: 100 mg PO q8h (may need up to 1200 mg/d for control); after the patient is euthyroid (6–8 wk), taper the dose by ½ q 4–6 wk to Maintenance: 50–150 mg/24h; can usually be discontinued in 2–3 y. **Peds.** Initial: 5–7 mg/kg/24h PO ÷ q8h. Maintenance: ½–½ of the initial dose

SUPPLIED: Tabs 50 mg

NOTES: Follow the patient clinically; monitor TFT

Protamine Sulfate

COMMON USES: Reversal of heparin effect

ACTIONS: Neutralizes heparin by forming a stable complex

DOSAGE: Adults & Peds. Based on amount of heparin reversal desired; give IV slowly; 1 mg reverses approximately 100 U of heparin given in the preceding 3–4 h, to a max dose of 50 mg

SUPPLIED: Inj 10 mg/mL

NOTES: Follow coagulation studies; may have anticoagulant effect if given without heparin

Pseudoephedrine (Sudafed, Novafed, Afrinol, others)

COMMON USES: Decongestant

ACTIONS: Stimulates α -adrenergic receptors, resulting in vasoconstriction

DOSAGE: Adults. 30–60 mg PO q6–8h; SR caps 120 mg PO q12h. Peds. 4 mg/kg/24h PO ÷ qid

SUPPLIED: Tabs 30, 60 mg; caps 60 mg; SR tabs 120, 240 mg; SR caps 120 mg; liq 7.5 mg/0.8 mL, 15, 30 mg/5 mL

NOTES: Contra in patients with poorly controlled HTN or CAD and in patients taking MAO inhibitors; ingredient in many cough and cold preparations

Psyllium (Metamucil, Serutan, Effer-Syllium)

COMMON USES: Constipation and diverticular disease of the colon

ACTIONS: Bulk laxative

DOSAGE: 1 tsp (7 g) in a glass of water qd-tid

SUPPLIED: Granules 4, 25 g/tsp; powder 3.5 g/packet

NOTES: Do NOT use if suspected bowel obstruction; one of the safest laxatives; psyllium in effervescent (Effer-Syllium) form usually contains potassium and should be used with caution in renal failure

Pyrazinamide

COMMON USES: Active TB

ACTIONS: Bacteriostatic; mechanism unknown

DOSAGE: Adults. 15–30 mg/kg/24h PO ÷ tid-qid; max 2 g/d. Peds. 15–30 mg/kg/d PO ÷ qd-bid

SUPPLIED: Tabs 500 mg

NOTES: May cause hepatotoxicity; use in combination with other antituberculosis drugs; consult MMWR for the latest recommendations on the treatment of tuberculosis; dosage regimen differs for directly observed therapy; adjust dose for renal or hepatic impairment

Pyridoxine [Vitamin B₆] (Nestrex)

COMMON USES: Rx and prevention of vitamin B6 deficiency, including drug-induced (ie INH, hydralazine)

ACTIONS: Supplementation of vitamin B₆

DOSAGE: Adults. Deficiency: 10-20 mg/d. PO Drug-induced neuritis: 100-200 mg/d; 25-100 mg/d prophylaxis. Peds. 5-25 mg/d × 3 wk

SUPPLIED: Tabs 25, 50, 100 mg; inj 100 mg/mL

Quazepam (Doral) [CIV]

COMMON USES: Insomnia ACTIONS: Benzodiazepine DOSAGE: 7.5-15 mg PO hs PRN SUPPLIED: Tabs 7.5, 15 mg

NOTES: ↓ Dose in the elderly: do NOT discontinue abruptly

Quetiapine (Seroquel)

COMMON USES: Acute exacerbations of schizophrenia ACTIONS: Serotonin and dopamine antagonism DOSAGE: 150-750; mg/d; initiate at 25-100 mg bid-tid

SUPPLIED: Tabs 25, 100, 200 mg

NOTES: ↑ Dose slowly; adjust dose for hepatic and geriatric patients

Quinapril (Accupril)

COMMON USES: HTN and heart failure

ACTIONS: ACE inhibitor

DOSAGE: 10-80 mg PO qd in a single dose **SUPPLIED:** Tabs 5, 10, 20, 40 mg NOTES: Dosage adjustment in renal impairment

Quinidine (Quinidex, Quinaglute)

ACTIONS: Class 1A antiarrhythmic

DOSAGE: Adults. PAC, PVCs: 200–300 mg PO tid–qid. Conversion of AF or flutter: Use after digitalization, 200 mg q2–3h for 8 doses; then ↑ daily dose to a max of 3–4 g or until normal rhythm.

Peds. 15-60 mg/kg/24h PO in 4-5 ÷ dose

SUPPLIED: Sulfate: Tabs 200, 300 mg; SR tabs 300 mg; Gluconate: SR tabs 324 mg; inj 80 mg/mL **NOTES:** Contra in digitalis toxicity and AV block; follow serum levels if available (see Table 22–7, pages 631–634); extreme hypotension seen with IV administration. Sulfate salt contains 83% quinidine; gluconate salt contains 62% quinidine; obsage adjustment in renal impairment

Quinupristin/Dalfopristin (Synercid)

COMMON USES: Infections caused by vancomycin-resistant *Entercoccus faecium*, and other gram+ organisms

ACTIONS: Inhibits both the early and late phase of protein synthesis at the ribosomes

DOSAGE: Adults & Peds. 7.5 mg/kg IV q8-12h

SUPPLIED: Inj 500 mg (150 mg quinupristin/350 mg dalfopristin)

NOTES: Administer through central line if possible; NOT compatible with saline or heparin, there-

fore flush IV lines with dextrose

Rabeprazole (Aciphex)

COMMON USES: Peptic ulcers, GERD, and hypersecretory conditions

ACTIONS: Proton pump inhibitor **DOSAGE:** 20 mg/d; may be ↑ to 60 mg/d

SUPPLIED: Tabs 60 mg **NOTES:** Do NOT crush tabs

Raloxifene (Evista)

COMMON USES: Prevention of osteoporosis

ACTIONS: Partial antagonist of estrogen that behaves like estrogen

DOSAGE: 60 mg/d SUPPLIED: Tabs 60 mg

Ramipril (Altace)

COMMON USES: HTN and heart failure

ACTIONS: ACE inhibitor

DOSAGE: 2.5–20 mg/d PO ÷ qd–bid **SUPPLIED:** Caps 1.25, 2.5, 5, 10 mg

NOTES: May use in combination with diuretics; may cause a nonproductive cough; dosage adjust-

ment in renal impairment

Ranitidine (Zantac)

COMMON USES: Duodenal ulcer, active benign ulcers, hypersecretory conditions, and GERD

ACTIONS: H2-receptor antagonist

DOSAGE: Adults. Ulcer: 150 mg PO bid, 300 mg PO hs, or 50 mg IV q6–8h; or 400 mg IV/d cont inf, then maintenance of 150 mg PO hs. Hypersecretion: 150 mg PO bid, up to 600 mg/d. GERD: 300 mg PO bid; maintenance 300 mg PO hs. Peds. 0.75–1.5 mg/kg/dose IV q6–8h or 1.25–2.5 mg/kg/dose PO q12

SUPPLIED: Tabs 75, 150, 300 mg; syrup 15 mg/mL; inj 25 mg/mL

NOTES: ↓ Dose with renal failure; oral and parenteral doses are different

Repaglinide (Prandin)

COMMON USES: Type 2 DM

ACTIONS: Stimulates insulin release from pancreas

DOSAGE: 0.5–4 mg ac **SUPPLIED:** Tabs 0.5, 1, 2 mg

Reteplase (Retavase)

COMMON USES: Post-AMI **ACTIONS:** Thrombolytic agent

DOSAGE: 10 U IV over 2 min, 2nd dose 30 min later of 10 U IV over 2 min

SUPPLIED: Inj 10.8 U/2 mL

Ribavirin (Virazole)

COMMON USES: RSV infection in infants and; hepatitis C, (in combination with interferon alfa-2b)

ACTIONS: Unknown

DOSAGE: RSV: 6 g in 300 mL of sterile water inhaled over 12–18 h. Hep C: 600 mg PO bid in combination with interferon alfa-2b (See Rebetron, page 000)

SUPPLIED: Powder for aerosol 6 g; caps 200 mg

NOTES: Aerosolized by a SPAG; may accumulate on soft contact lenses; monitor H/H frequently;

PRG test monthly

Rifabutin (Mycobutin)

COMMON USES: Prevention of M. avium complex infection in AIDS patients with a CD4 count

<100

ACTIONS: Inhibits DNA-dependent RNA polymerase activity

DOSAGE: 150–300 mg/d PO SUPPLIED: Caps 150 mg

NOTES: Adverse effects and drug interactions similar to rifampin

Rifampin (Rifadin)

COMMON USES: TB and Rx and prophylaxis of N. meningitidis, H. influenzae, or S. aureus carriers

ACTIONS: Inhibits DNA-dependent RNA polymerase activity

DOSAGE: Adults. N. meningitidis and H. influenzae carrier: 600 mg/d PO for 4 d. TB: 600 mg PO or IV qd or 2×/wk with combination-therapy regimen. Peds. 10–20 mg/kg/dose PO or IV qd-bid

SUPPLIED: Caps 150, 300 mg; inj 600 mg

NOTES: Multiple drug interactions; causes orange-red discoloration of bodily secretions, including tears; never used as a single agent to treat active TB

Rifapentine (Priftin)

COMMON USES: TB

ACTIONS: Inhibits DNA-dependent RNA polymerase activity

DOSAGE: Intensive phase: 600 mg PO 2×/wk for 2 mo; separate doses by 3 or more days. Continuation phase: 600 mg/wk

SUPPLIED: Tabs 150 mg

NOTES: Adverse effects and drug interactions similar to rifampin

Rimantadine (Flumadine)

COMMON USES: Prophylaxis and Rx of influenza A virus infections

ACTIONS: Antiviral agent

DOSAGE: Adults. 100 mg PO bid. Peds. 5 mg/kg/d PO, NOT to exceed 150 mg/d

SUPPLIED: Tabs 100 mg; syrup 50 mg/5 mL

NOTES: Dosage adjustment in severe renal or hepatic impairment; initiate within 48 h of symptom onset

Rimexolone (Vexol Ophthalmic)

COMMON USES: Postop inflammation and uveitis

ACTIONS: Steroid

DOSAGE: Adults & Peds > 2 y. Uveitis: 1–2 gtt/h daytime and q2h at night, taper to 1 gtt q4h; postop 1–2 gtt qid up to 2 wk

SUPPLIED: 1% susp **NOTES:** Taper dose to zero

Risedronate (Actonel)

COMMON USES: Prevention and Rx of postmenopausal osteoporosis; Paget's disease

ACTIONS: Bisphosphonate; inhibits osteoclast-mediated bone resorption

DOSAGE: 5 mg/d PO with 6-8 oz water; 30 mg/d for 2 mo for Paget's disease

SUPPLIED: Tabs 5, 30 mg

NOTES: Take 30 min before first food or drink of the day; maintain upright position for at least 30 min after administration, interaction with calcium supplements; may cause GI distress and arthralgia; NOT recommended in moderate to severe renal impairment

Risperidone (Risperdal)

COMMON USES: Psychotic disorders

ACTIONS: Benzisoxazole antipsychotic agent

DOSAGE: 1–6 mg PO bid **SUPPLIED:** Tabs 1, 2, 3, 4 mg

NOTES:
↓ Starting doses in elderly, renal or hepatic impairment; orthostatic hypotension; extrapyramidal reactions with higher doses

Ritonavir (Norvir)

COMMON USES: HIV infection when therapy is warranted

ACTIONS: Protease inhibitor; inhibits maturation of immature noninfectious virions to mature in-

fectious virus

DOSAGE: 600 mg PO bid or 400 mg PO bid in combination with Saquinavir

SUPPLIED: Caps 100 mg; soln 80 mg/mL

NOTES: Titrate dose over 1 wk to avoid GI complications; take with food; has many drug interactions; may cause perioral and peripheral paresthesias; store in refrigerator

Rivastigmine (Exelon)

COMMON USES: Mild to moderate dementia associated with Alzheimer's disease

ACTIONS: Enhances cholinergic activity

DOSAGE: 1.5 mg bid; ↑ to 6 mg bid, with dosage increases at 2-wk intervals

SUPPLIED: Caps 1.5, 3, 4.5, 6 mg; soln 2 mg/mL

NOTES: Associated with significant dose-related GI adverse effects

Rizatriptan (Maxalt)

COMMON USES: Acute migraine attacks **ACTIONS:** Serotonin 5-HT, receptor antagonist **DOSAGE:** 5–10 mg PO; may repeat once in 2 h **SUPPLIED:** Tabs 5, 10 mg; disintegrating tabs 5, 10 mg

Rofecoxib (Vioxx)

COMMON USES: Osteoarthritis, acute pain, and primary dysmenorrhea

ACTIONS: NSAID; COX-2 inhibitor

DOSAGE: 12.5-50 mg/d

SUPPLIED: Tabs 12.5, 25 mg; susp 12.5 mg/5 mL, 25 mg/5 mL

NOTES: Alert patients to be aware of GI ulceration or bleeding; use with caution in renal impair-

ment; ↓ dose in elderly

Rosiglitazone (Avandia)

COMMON USES: Type 2 DM **ACTIONS:** ↑ Insulin sensitivity **DOSAGE:** 4–8 mg/d PO or in 2 ÷ doses

SUPPLIED: Tabs 2, 4, 8 mg

NOTES: May be taken without regard to meals; do NOT use in active liver disease

Salmeterol (Serevent)

COMMON USES: Asthma and exercise-induced bronchospasm

ACTIONS: Sympathomimetic bronchodilator

DOSAGE: 2 inhal bid

SUPPLIED: Met-dose inhaler; NOT for relief of acute attacks

Saquinavir (Fortovase)

COMMON USES: HIV infection ACTIONS: HIV protease inhibitor DOSAGE: 1200 mg PO tid within 2 h pc

SUPPLIED: Caps 200 mg

Sargramostim [GM-CSF] (Leukine)

COMMON USES: Myeloid recovery following BMT or cancer chemotherapy

ACTIONS: Activates mature granulocytes and macrophages **DOSAGE:** *Adults & Peds.* 250 mg/m²/d IV for 21 d (BMT)

SUPPLIED: Inj 250, 500 mg **NOTES:** May cause bone pain

Scopolamine, Transdermal (Transderm-Scop)

COMMON USES: Prevention of nausea and vomiting associated with motion sickness

ACTIONS: Anticholinergic, antiemetic

DOSAGE: Apply 1 TD patch behind the ear q 3 d; 0.3–0.65 IM/IV/SC, repeat PRN q4–6h

SUPPLIED: Patch 1.5 mg, injectable forms

NOTES: May cause dry mouth, drowsiness, and blurred vision. Apply at least 4 h before exposure

Secobarbital (Seconal) [C-II]

COMMON USES: Insomnia

ACTIONS: Rapid-acting barbiturate

DOSAGE: Adults. 100-200 mg IM hs PRN. Peds. 3-5 mg/kg/dose IM hs PRN, up to 100 mg

SUPPLIED: Inj 50 mg/mL

NOTES: Beware of respiratory depression; tolerance acquired within 1-2 wk

Selegiline (Eldepryl)

COMMON USES: Parkinson's disease ACTIONS: Inhibits MAO activity DOSAGE: 5 mg PO bid

SUPPLIED: Tabs 5 mg

NOTES: May cause nausea and dizziness

Selenium Sulfide (Exsel Shampoo, Selsun Blue Shampoo, Selsun Shampoo)

COMMON USES: Scalp seborrheic dermatitis, itching and flaking of the scalp due to dandruff; treatment of tinea versicolor

ACTIONS: Antiseborrheic

DOSAGE: Dandruff, seborrhea: Massage 5–10 mL into wet scalp, leave on 2–3 min, rinse and repeat; use 2×/wk, then once q 1–4 wk PRN. *Tinea versicolor*: Apply qd for 7 d, 2.5% on area and lather with small amounts of water; leave on skin for 10 min, then rinse

SUPPLIED: Shampoo 1, 2.5%

Sertraline (Zoloft)

COMMON USES: Depression

ACTIONS: Inhibits neuronal uptake of serotonin

DOSAGE: 50–200 mg/d PO **SUPPLIED:** Tabs 25, 50, 100 mg

NOTES: Can activate manic/hypomanic state; has caused weight loss in clinical trials; caution in he-

patic impairment

Sibutramine (Meridia)

COMMON USES: Obesity

ACTIONS: Blocks uptake of norepinephrine, serotonin, and dopamine

DOSAGE: 10 mg/d, may ↓ to 5 mg after 4 wk

SUPPLIED: Caps 5, 10, 15 mg

NOTES: Use with low-calorie diet, monitor BP

Sildenafil (Viagra)

COMMON USES: Erectile dysfunction

ACTIONS: Smooth muscle relaxation and increased inflow of blood to the corpus cavernosum; inhibits phosphodiesterase type 5 responsible for cGMP breakdown resulting in increased cGMP activity.

DOSAGE: 25–100 mg 1 h prior to attempted sexual activity, max dosing is once daily

SUPPLIED: Tabs 25, 50, 100 mg

NOTES: Contra with nitrates of any form; adjust dose in persons >65 y, hepatic/severe renal impairment, potent CYP3A4 inhibitors (ie, protease inhibitors); may cause headache, blue haze visual disturbance, usually reversible; cardiac events in the absence of nitrate use debatable

Silver Nitrate (Dey-Drop)

COMMON USES: Prevention of ophthalmia neonatorium due to GC; removal of granulation tissue, warts and cauterization of wounds

ACTIONS: Caustic antiseptic and astringent

DOSAGE: Adults & Peds. Apply to moist surface 2-3×/wk for several weeks or until desired effect.

Peds. Newborns: Apply 2 gtt into conjunctival sac immediately after birth

SUPPLIED: Topical impregnated applicator sticks, 10% oint, 10, 25, 50% soln; ophth 1% amp

NOTES: May stain tissue black, usually resolves

Silver Sulfadiazine (Silvadene)

COMMON USES: Prevention of sepsis in 2nd- and 3rd-degree burns

ACTIONS: Bactericidal

DOSAGE: Adults & Peds. Aseptically cover the affected area with 1/6-in. coating bid

SUPPLIED: Cream 1%

NOTES: Can have systemic absorption with extensive application

Simethicone (Mylicon)

COMMON USES: Flatulence **ACTIONS:** Defoaming action

DOSAGE: *Adults & Peds.* 40–125 mg PO pc and hs PRN **SUPPLIED:** Tabs 40, 80, 125 mg; caps 125 mg; gtt 40 mg/0.6 mL

Simvastatin (Zocor)

COMMON USES: Reduction of elevated cholesterol levels

ACTIONS: HMG-CoA reductase inhibitor

DOSAGE: 5–80 mg PO hs **SUPPLIED:** Tabs 5, 10, 20, 40 mg

NOTES: Avoid concurrent use of gemfibrozil

Sirolimus [Rapamycin] (Rapamune)

COMMON USES: Prophylaxis of organ rejection ACTIONS: Inhibits T-lymphocyte activation

DOSAGE: 2 mg/d PO SUPPLIED: Soln 1 mg/mL

NOTES: Dilute in water or orange juice; do NOT drink grapefruit juice while on sirolimus; take 4 h after cyclosporin; dosage adjustment in hepatic impairment. Routine blood levels not needed except in Peds or liver failure (trough 9–17 ng/mL)

Sodium Bicarbonate

Used for emergency cardiac care (see Chapter 21)

COMMON USES: Alkalinization of urine, RTA, metabolic acidosis

DOSAGE: Adults. Emergency cardiac care: Initiate adequate ventilation, 1 mEq/kg/dose IV; can repeat 0.5 mEq/kg in 10 min once or based on acid-base status. Metabolic acidosis: 2–5 mEq/kg IV over 8 h and PRN based on acid-base status. Alkalinize urine: 4 g (48 mEq) PO, then 1–2 g q4h; adjust based on urine pH. Chronic renal failure: 1–3 mEq/kg/d. Distal RTA: 1 mEq/kg/d PO. Peds. >1 y: Emergency cardiac care: See Adult. <1 y: Emergency cardiac care: Initiate adequate ventilation, 1:1 dilution 1 mEq/mL dosed 1 mEq/kg IV; can repeat with 0.5 mEq/kg in 10 min once or based on acid-base status. Chronic renal failure: See Adult. Distal RTA: 2–3 mEq/kg/d PO. Proximal RTA: 5–10 mEq/kg/d titrate based on serum bicarbonate levels. Urine alkalinization: 84–840 mg/kg/d (1–10 mEq/kg/d) + doses; adjust based on urine pH

SUPPLIED: IV inf, powder, and tabs. 300 mg = 3.6 mEq; 325 mg = 3.8 mEq; 520 mg = 6.3 mEq; 600 mg = 7.3 mEq; 650 mg = 7.6 mEq

NOTES: 1 g neutralizes 12 mEq of acid; in infants, do NOT exceed 10 mEq/min inf

Sodium Citrate (Bicitra)

COMMON USES: Alkalinization of urine; dissolve uric acid and cysteine stones

ACTIONS: Urinary alkalinizer

DOSAGE: *Adults:* 2–6 tsp (10–30 mL) diluted in 1–3 oz water pc and hs. *Peds.* 1–3 tsp (5–15 mL)

diluted in 1-3 oz water pc and hs

SUPPLIED: 15- or 30-mL unit dose: 16 (473 mL) or 4 (118 mL) fl oz

NOTES: Do NOT give to patients on aluminum-based antacids. Contra in patients with severe renal impairment of sodium-restricted diets

Sodium Polystyrene Sulfonate (Kayexalate)

COMMON USES: Hyperkalemia

ACTIONS: Sodium and potassium ion-exchange resin

DOSAGE: Adults. 15-60 g PO or 30-60 g PR q6h based on serum K⁺. Peds. 1 g/kg/dose PO or PR

q6h based on serum K+

SUPPLIED: Powder; susp 15 g/60 mL sorbitol

NOTES: Can cause hypernatremia; given with an agent, eg, sorbitol to promote movement through the bowel

Sorbitol

COMMON USES: Constipation

ACTIONS: Laxative

DOSAGE: 30-60 mL of a 20-70% soln PRN

SUPPLIED: Lia 70%

Sotalol (Betapace)

COMMON USES: Ventricular arrhythmias **ACTIONS:** β-Adrenergic-blocking agent

DOSAGE: 80 mg PO bid; may be ↑ to 240-320 mg/d

SUPPLIED: Tabs 80, 120, 160, 240 mg **NOTES:** Adjust dosage for renal insufficiency

Spironolactone (Aldactone)

COMMON USES: Hyperaldosteronism, essential HTN, and edematous states (CHF, cirrhosis)

ACTIONS: Aldosterone antagonist; K-sparing diuretic

DOSAGE: Adults. 25-100 mg PO qid. Peds. 1-3.3 mg/kg/24h PO ÷ bid-qid. Neonates: 0.5-

1 mg/kg/dose q8h

SUPPLIED: Tabs 25, 50, 100 mg

NOTES: Can cause hyperkalemia and gynecomastia; avoid prolonged use; diuretic of choice for cirrhotic edema and ascites

Stavudine (Zerit)

COMMON USES: Advanced HIV disease

ACTIONS: Reverse-transcriptase inhibitor

DOSAGE: Adults. >60 kg: 40 mg bid. <60 kg: 30 mg bid

SUPPLIED: Caps 15, 20, 30, 40 mg; soln 1 mg/mL

NOTES: May cause peripheral neuropathy; not a cure for HIV; dosage adjustment in renal impairment

Steroids, Systemic (see also Table 22-5, page 627)

The following relates only to the commonly used systemic glucocorticoids.

COMMON USES: Endocrine disorders (adrenal insufficiency), rheumatoid disorders, collagen-vascular diseases, dermatologic diseases, allergic states, edematous states (cerebral, nephrotic syndrome), immunosuppression for transplantation, hypercalcemia, malignancies (breast, lymphomas), preoperatively (in any patient who has been on steroids in the previous year, known hypoadrenalism, preop for adrenalectomy); injection into joints/tissue

ACTIONS: Glucocorticoid

DOSAGE: Varies with use and institutional protocols. Adrenal insufficiency, acute (Addisonian crisis): Adult. Hydrocortisone: 100 mg IV q8h; then 300 mg/d ÷ q8h; convert to 50 mg PO q8h × 6 doses, taper to 30-50 mg/d ÷ bid. Peds. Hydrocortisone: 1-2 mg/kg IV; then 150-250 mg/d ÷ tid. Adrenal insufficiency, chronic (physiologic replacement): May need mineralocorticoid supplementation such as Florinef Adults. Hydrocortisone 20 mg PO qAM, 10 mg PO qPM; cortisone 0.5-0.75 mg/kg/d ÷ bid; cortisone 0.25–0.35 mg/kg/d IM; dexamethasone 0.03–0.15 mg/kg/d or 0.6–0.75 mg/m²/d in ÷ q6–12h PO, IM, IV. *Peds*. Hydrocortisone 0.5–0.75 mg/kg/d PO tid; hydrocortisone succinate 0.25-0.35 mg/kg/d IM. Asthma, acute: Peds. Prednisolone 1-2 mg/kg/d or prednisone 1-2 mg/kg/d ÷ qd-bid for up to 5 d; prednisolone 2-4 mg/kg/d IV ÷ tid. Congenital adrenal hyperplasia: **Peds.** Initially hydrocortisone 30-36 mg/m²/d PO ÷ ½ dose q AM, ½ dose q PM; mainenance: 20-25 mg/m²/d ÷ bid. Extubation/airway edema: Dexamethasone 0.5-1 mg/kg/d IM/IV ÷ q6h, start beginning 24 h prior to extubation; continue for 4 additional doses. Immunosuppressive/ antiinflammatory: Adults & Older Peds. Hydrocortisone 15-240 mg PO, IM, IV q12h; methylprednisolone: 4-48 mg/d PO, taper to lowest effective dose; methylprednisolone sodium succinate 10-80 mg/d IM. Adults. Prednisone or prednisolone 5-60 mg/d PO, ÷ qd-qid. Infants and Younger Children. 2.5-10 mg/kg/d hydrocortisone PO ÷ q6-8h; 1-5 mg/kg/d IM/IV ÷ bid. Nephrotic syndrome: Peds. Prednisolone or prednisone 2 mg/kg/d PO ÷ tid-qid until urine is protein-free for 5 d, use up to 28 d; for persistent proteinuria, 4 mg/kg/dose PO qod max 120 mg/d for an additional 28 d; maintenance: 2 mg/kg/dose god for 28 d; taper over 4-6 wk (max 80 mg/d). Septic shock: Adults. Hydrocortisone 500 mg-1 g IM/IV q2-6h. Peds. Hydrocortisone 50 mg/kg IM/IV, repeat q4-24h PRN. Status asthmaticus: Adult and Peds. Hydrocortisone 1-2 mg/kg/dose IV q6h; then by 0.5-1 mg/kg q6h. Rheumatic disease: Adults. Intraarticular: Hydrocortisone acetate 25-37.5 mg large joint; 10-25 mg small joint; methylprednisolone acetate 20-80 mg large joint, 4-10 mg small joint. Intrabursal: Hydrocortisone acetate 25-37.5 mg. Intraganglial: Hydrocortisone acetate 25-37.5 mg. Tendon sheath: Hydrocortisone acetate 5-12.5 mg. Perioperative steroid coverage: Hydrocortisone 100 mg IV night before surgery, 1 h preop, intraop, and 4, 8, and

12 h postop; pod #1 100 mg IV q6h; pod #2 100 mg IV q8h; pod #3 100 mg IV q12h; pod #4 50 mg IV q12h; pod #5 25 mg IV q12h; then resume prior oral dosing if chronic use or discontinue if only perioperative coverage required. Cerebral edema: Dexamethasone 10 mg IV; then 4 mg IV

NOTES: See Table 22-5, page 627. All can cause hyperglycemia, "steroid psychosis," adrenal suppression; never acutely stop steroids, especially if chronic treatment; taper dose. Hydrocortisone succinate administered systemically, acetate form intraarticular

Steroids, Topical

See Table 22-6 (pages 628-630)

COMMON USES: Relief of inflammatory and pruritic manifestations of corticosteroid-response dermatoses

ACTIONS: Corticosteroid, antiinflammatory

DOSAGE: Varies with indication and formulation (See Table 22–6 (pages 628–630) for frequency of application)

SUPPLIED: See Table 22-6, pages 628-630

Streptokinase (Streptase, Kabikinase)

Used for emergency cardiac care (see Chapter 21)

COMMON USES: Coronary artery thrombosis, acute massive PE, DVT, and some occluded vascular grafts

ACTIONS: Activates plasminogen to plasmin that degrades fibrin; fibrinolytic

DOSAGE: Adults. PE: Loading dose of 250,000 IU IV through a peripheral vein over 30 min, then 100,000 IU/h IV for 24-72 h. Coronary artery thrombosis: 1.5 million U IV over 60 min. DVT or arterial embolism: Load as with PE, then 100,000 IU/h for 72 h. Peds. 3500-4000 U/kg over 30 min, followed by 1000-1500 U/kg/h

SUPPLIED: Powder for inj 250,000, 600,000, 750,000, 1,500,000 IU

NOTES: If maintenance inf inadequate to maintain thrombin clotting time 2–5 × control, refer to the package insert, or the American Hospital Formulary Service for adjustments. Antibodies remain 3-6 mo following dose

Streptomycin

COMMON USES: TB or serious *Enterococcus* infections

ACTIONS: Aminoglycoside: interferes with protein synthesis

DOSAGE: 1–4 g/d IM in 1–2 ÷ doses (endocarditis); TB 15 mg/kg/d

SUPPLIED: Ini 400 mg/mL

NOTES: Increased incidence of vestibular toxicity; adjust dose in renal impairment

Streptozocin (Zanosar)

COMMON USES: Pancreatic islet cell tumors and carcinoid tumors

ACTIONS: DNA-DNA (interstrand) cross-linking; DNA, RNA, and protein synthesis inhibitor **DOSAGE:** 1–1.5 g/m² q 4 wk (single agent); 500 mg –1 g/m²/d for 5 d q 4–6 wk (combination regimens)

SUPPLIED: Inj 1 g

NOTES: Toxicity symptoms: Nausea and vomiting and duodenal ulcers; myelosuppression rare (20%) and mild; nephrotoxicity (proteinuria and azotemia often heralded by hypophosphatemia) can be dose-limiting. Hypo- or hyperglycemia may occur; phlebitis and pain at the site of inj may also occur. Use with caution; adjust dose in renal impairment

Succimer (Chemet)

COMMON USES: Lead poisoning **ACTIONS:** Heavy metal-chelating agent

DOSAGE: Adults & Peds. 8-15 kg: 100 mg PO; 16-23 kg: 200 mg PO; 24-34 kg: 300 mg PO;

SUPPLIED: Caps 100 mg

NOTES: May cause a rash; patients should drink a lot of fluids

Succinylcholine (Anectine, Quelicin, Sucostrin)

COMMON USES: Adjunct to general anesthesia to facilitate endotracheal intubation and to induce skeletal muscle relaxation during surgery or mechanically supported ventilation

ACTIONS: Depolarizing neuromuscular blocking agent

DOSAGE: Adults. 0.6 mg/kg IV over 10-30 s, followed by 0.04-0.07 mg/kg as needed to maintain muscle relaxation. Peds. 1-2 mg/kg/dose IV, followed by 0.3-0.6 mg/kg/dose at intervals of 10-20

SUPPLIED: Inj 20, 50, 100 mg/mL; powder for inj 100 mg, 500 mg, 1 g/vial

NOTES: May precipitate malignant hyperthermia; respiratory depression or prolonged apnea may occur; many drug interactions potentiating activity of succinylcholine; observe for cardiovascular effects; use only freshly prepared solutions; ↓ in severe liver disease

Sucraffate (Carafate)

COMMON USES: Duodenal and gastric ulcers

ACTIONS: Forms ulcer-adherent complex that protects against acid, pepsin, and bile acid **DOSAGE:** Adults. 1 g PO qid, 1 h prior to meals and hs. Peds. 40-80 mg/kg/d ÷ q6h

SUPPLIED: Tabs 1 g; susp 1 g/10 mL

NOTES: Continue treatment for 4–8 wk unless healing is demonstrated by x-ray or endoscopy; constipation most frequent side effect

Sufentanil (Sufenta) [C-II]

COMMON USES: Analgesic adjunct to maintain balanced general anesthesia

ACTIONS: Potent synthetic opioid

DOSAGE: Adjunctive: 1-8 μg/kg with nitrous oxide/oxygen; maintenance of 10-50 μg PRN. General anesthesia: 8-30 µg/kg with oxygen and a skeletal muscle relaxant. Maintenance: 25-50 µg PRN.

SUPPLIED: Inj 50 µg/mL

NOTES: Respiratory depressant effects persisting longer than the analgesic effects; 80 times more potent than morphine

Sulfacetamide (Bleph-10, Cetamide, Sodium Sulamyd)

COMMON USES: Conjunctival infections **ACTIONS:** Sulfonamide antibiotic

DOSAGE: 10% Oint apply qid and hs; soln for keratitis apply q2–3h depending on severity

SUPPLIED: Oint 10%; soln 10, 15, 30%

Sulfacetamide Prednisolone (Blephamide, others)

COMMON USES: Steroid-responsive inflammatory ocular conditions with infection or a risk of infection

ACTIONS: Antibiotic and antiinflammatory

DOSAGE: Adult and Peds > 2 y. Apply oint to lower conjunctival sac qd-qid; soln 1-3 gtt 2-3 h while awake

SUPPLIED: Oint: Sulfacetamide 10%/prednisolone 0.5%, sulfacetamide 10%/prednisolone 0.2%, sulfacetamide 10%/prednisolone 0.25%; susp: sulfacetamide 10%/prednisolone/0.25%, sulfacetamide 10%/prednisolone 0.5%, sulfacetamide sodium 10%/prednisolone 0.2%, sulfacetamide 10% and prednisolone 0.25%

NOTES: Ophth susp can be used as an otic agent

Sulfasalazine (Azulfidine)

COMMON USES: Ulcerative colitis ACTIONS: Sulfonamide: actions not clear **DOSAGE:** Adults. Initially, 1 g tid–qid; ↑ to a max of 8 g/d in 3–4 ÷ doses; maintenance 500 mg PO qid. Peds. Initially, 40–60 mg/kg/24h PO ÷ q4–6h; maintenance 20–30 mg/kg/24h PO ÷ q6h

SUPPLIED: Tabs 500 mg; EC tabs 500 mg; oral susp 250 mg/5 mL

NOTES: Can cause severe GI upset; discolors urine

Sulfinpyrazone (Anturane)

COMMON USES: Acute and chronic gout

ACTIONS: Inhibits renal tubular absorption of uric acid

DOSAGE: 100–200 mg PO bid for 1 wk, then ↑ as needed to maintenance of 200–400 mg bid

SUPPLIED: Tabs 100 mg; caps 200 mg

NOTES: Avoid in renal impairment; take with food or antacids, take with plenty of fluids; avoid salicylates

Sulindac (Clinoril)

COMMON USES: Arthritis and pain

ACTIONS: NSAID; inhibits prostaglandin synthesis

DOSAGE: 150–200 mg bid **SUPPLIED:** Tabs 150, 200 mg

Sumatriptan (Imitrex)

COMMON USES: Acute treatment of migraine attacks
ACTIONS: Vascular serotonin receptor agonist

DOSAGE: SC: 6 mg SC as a single dose, PRN, to a max of 12 mg/24h; Oral: 25 mg, repeat in 2 h, PRN, 100 mg/d max oral dose; max 300 mg/d. Nasal spray: 1 single spray into 1 nostril, may re-

peat in 2 h, max 40 mg/24hh

SUPPLIED: Inj 12 mg/mL; tabs 25, 50 mg; nasal spray 5, 20 mg

NOTES: May cause pain and bruising at the injection site; avoid in angina, ischemic heart disease, uncontrolled HTN, and ergot administration

Tacrine (Cognex)

COMMON USES: Mild to moderate dementia **ACTIONS:** Cholinesterase inhibitor **DOSAGE:** 10–40 mg PO qid, up to 160 mg/d

SUPPLIED: Caps 10, 20, 30, 40 mg

NOTES: May cause elevations in transaminases; monitor LFT regularly; separate doses from food

Tacrolimus [FK 506] (Prograf)

COMMON USES: Prophylaxis of organ rejection **ACTIONS:** Macrolide immunosuppressant

DOSAGE: IV: 0.05-0.1 mg/kg/d as cont inf. PO: 0.15-0.3 mg/kg/d ÷ into 2 doses

SUPPLIED: Caps 1, 5 mg; inj 5 mg/mL

NOTES: May cause neurotoxicity and nephrotoxicity; \downarrow in renal impairment; may need to \downarrow in hepatic impairment

Tamoxifen (Nolvadex)

COMMON USES: Breast cancer (postmenopausal, estrogen receptor-positive), endometrial cancer, melanoma, reduction of breast cancer in high-risk women

ACTIONS: Nonsteroidal antiestrogen; mixed agonist-antagonist effect

DOSAGE: 20–40 mg/d (typically 10 mg bid or 20 mg/d)

SUPPLIED: Tabs 10, 20 mg

NOTES: *Toxicity symptoms:* Menopausal symptoms (hot flashes, nausea, and vomiting) in premenopausal patients. Vaginal bleeding and menstrual irregularities. Skin rash, pruritus vulvae, dizziness, headache, and peripheral edema. Acute flare of bone metastasis pain and hypercalcemia.

With high doses, retinopathy. Increased risk of pregnancy in sexually active premenopausal women by inducing ovulation

Tamsulosin (Flomax)

COMMON USES: Benign prostatic hyperplasia **ACTIONS:** Antagonist of α -receptors on the prostate

DOSAGE: 0.4 mg/d

SUPPLIED: Caps 0.4 mg; do NOT crush, chew, or open caps

Tazarotene (Tazorac)

COMMON USES: Facial acne vulgaris; stable plaque psoriasis up to 20% body surface area

ACTIONS: Keratolytic

DOSAGE: Adults & Peds > 12 y. Acne: Cleanse face, dry, and apply thin film qd hs on acne lesions.

Psoriasis: Apply hs SUPPLIED: Gel 0.05, 0.1%

Telmisartan (Micardis)

COMMON USES: HTN

ACTIONS: Angiotensin II receptor antagonists

DOSAGE: 40–80 mg/d SUPPLIED: Tabs 40, 80 mg NOTES: Avoid use during PRG

Temazepam (Restoril) [C-IV]

COMMON USES: Insomnia
ACTIONS: Benzodiazepine
DOSAGE: 15–30 mg PO hs PRN
SUPPLIED: Caps 7.5, 15, 30 mg
NOTES: ↓ Dose in elderly

Tenecteplase (TNKase)

COMMON USES: Reduction of mortality associated with AMI

ACTIONS: Thrombolytic; TPA

DOSAGE: 30-50 mg; see following table

Weight (kg)	TNKase Volume (mg)	TNKase ^a (mL)
<60	30	6
≥60–<70	35	7
≥70–<80	40	8
≥80–<90	45	9
>90	50	10

SUPPLIED: Inj 50 mg, reconstituted with 10 mL sterile water

Teniposide [VM-26] (Vumon)

COMMON USES: ALL (refractory pediatric), small-cell lung cancer, Kaposi's sarcoma, non-Hodgkin's lymphoma

ACTIONS: Topoisomerase II inhibitor, interfering with strand passage and DNA ligase activities of topoisomerase II. Cell cycle-specific activity late S, early G2 phase

DOSAGE: $45-60 \text{ mg/m}^2/d \times 5 \text{ d q } 21 \text{ d}; 120-160 \text{ mg/m}^2 \text{ on d } 1, 3, \text{ and 5 q } 21 \text{ d}; 100 \text{ mg/m}^2 \text{ on}$

d 1 and 2 q 3 wk; 100 mg/m²/wk

SUPPLIED: Inj 10 mg/mL

NOTES: Toxicity symptoms: Myelosuppression (especially leukopenia and thrombocytopenia), hypotension, chemical phlebitis, skin rashes, HTN, hypersensitivity reactions (urticaria, flushing, rashes, or hypotension), and secondary leukemia. Adjust dose in significant renal impairment; consider adjustment in hepatic impairment

Terazosin (Hytrin)

COMMON USES: BPH and HTN

ACTIONS: α-1 Blocker (blood vessel and bladder neck/prostate) **DOSAGE:** Initially, 1 mg PO hs; ↑ to a max of 20 mg/d PO

SUPPLIED: Tabs 1, 2, 5, 10 mg; caps 1, 2, 5, 10 mg

NOTES: Hypotension and syncope following first dose; dizziness, weakness, nasal congestion, pe-

ripheral edema common; should be used with thiazide diuretic for HTN

Terbinafine (Lamisil)

COMMON USES: Onychomycosis, athlete's foot

ACTIONS: Inhibits squalene epoxidase resulting in fungal death

DOSAGE: Oral: 250 mg/d PO for 6-12 wk. Topical: Apply to affected area

SUPPLIED: Tabs 250 mg; cream 1%

NOTES: Full clinical effect may take months due to need for new nail growth; NO occlusive dressings; dosage adjustment in renal impairment

Terbutaline (Brethine, Bricanyl)

COMMON USES: Reversible bronchospasm (asthma, COPD); inhibition of labor

ACTIONS: Sympathomimetic

DOSAGE: Adults. Bronchodilator: 2.5-5 mg PO qid or 0.25 mg SC; may repeat in 15 min (max 0.5 mg in 4 h). Met-dose inhaler: 2 inhal q4-6h. Premature labor: Acutely 2.5-10 mg/min/IV, gradually ↑ as tolerated q 10–20 min; maintenance 2.5 – 10 mg PO q 4–6h until term; or 0.25 mg SC q 30 min. Peds. Oral: 0.05-0.15 mg/kg/dose PO tid; max 5 mg/24h

SUPPLIED: Tabs 2.5, 5 mg; inj 1 mg/mL; met-dose inhaler

NOTES: Caution with diabetes, HTN, hyperthyroidism; high doses may precipitate β-1-adrenergic effects

Terconazole (Terazol [vaginal])

COMMON USES: Vaginal fungal infections

ACTIONS: Topical antifungal

DOSAGE: 1 applicatorful or 1 supp intravaginally hs for 7 d SUPPLIED: Vaginal cream 0.4%, vaginal supp 80 mg

Tetanus Immune Globulin [TIG]

COMMON USES: Passive immunization against tetanus for any person with a suspected contaminated wound and unknown immunization status (Chapter 17)

ACTIONS: Passive immunization

DOSAGE: Adults & Peds. 250–500 U IM (higher doses if delay in initiation of therapy)

SUPPLIED: Inj 250-U vial or syringe

NOTES: May begin active immunization series at different inj site if required

Tetanus Toxoid

COMMON USES: Protection against tetanus

ACTIONS: Active immunization

DOSAGE: See Chapter 17 and Table 22–9, page 636 for tetanus prophylaxis

SUPPLIED: Inj tetanus toxoid, fluid, measured in limes flocculation (Lf) units of toxoid: 4–5 Lf units/0.5 mL; tetanus toxoid, adsorbed, 5, 10 Lf units/0.5 mL

Tetracycline (Achromycin V, Sumycin)

COMMON USES: Broad-spectrum antibiotic treatment against Staphylococcus, Streptococcus, Chlamydia, Rickettsia, and Mycoplasma

ACTIONS: Bacteriostatic; inhibits protein synthesis

DOSAGE: Adults. 250–500 mg PO bid-qid. Peds >8 y. 25–50 mg/kg/24h PO q6–12h. Do NOT use in children <8 y old

iii ciiiidieii < o y oic

SUPPLIED: Caps 100, 250, 500 mg; tabs 250, 500 mg; oral susp 250 mg/5 mL

NOTES: Can stain enamel and depress bone formation in children; caution with use in pregnancy; do NOT use in the presence of impaired renal function (see Doxycycline page 531)

Theophylline (Theolair, Theo-Dur, Somophyllin, others)

COMMON USES: Asthma, bronchospasm

ACTIONS: Relaxes smooth muscle of the bronchi and pulmonary blood vessels

DOSAGE: Adults. 900 mg PO ÷ q6h; SR products may be ÷ q8–12h × (maintenance). Peds. 16–22 mg/kg/24h PO ÷ q6h; SR products may be ÷ q8–12h × (maintenance)

SUPPLIED: Elixir 80, 150 mg/15 mL; liq 80, 160 mg/15 mL; caps 100, 200, 250 mg; tabs 100, 125, 200, 225, 250, 300 mg; SR caps 50, 75, 100, 125, 200, 250, 260, 300 mg; SR tabs 100, 200, 250, 300, 400, 450, 500 mg

NOTES: See drug levels in Table 22–7 (pages 631–634); many drug interactions; side effects include nausea, vomiting, tachycardia, and seizures

Thiamine [Vitamin B₁]

COMMON USES: Thiamine deficiency (beriberi); alcoholic neuritis; Wernicke's encephalopathy

ACTIONS: Dietary supplementation

DOSAGE: Adults. Deficiency: 100 mg/d IM for 2 wk, then 5–10 mg/d PO for 1 mo. Wernicke's encephalopathy: 100 mg IV in single dose, then 100 mg/d IM for 2 wk. **Peds.** 10–25 mg/d IM for 2 wk, then 5–10 mg/24h PO for 1 mo

SUPPLIED: Tabs 5, 10, 25, 50, 100, 500 mg; inj 100, 200 mg/mL

NOTES: IV thiamine administration associated with anaphylactic reaction; give IV slowly

Thiethylperazine (Torecan)

COMMON USES: Nausea and vomiting **ACTIONS:** Antidopaminergic antiemetic **DOSAGE:** 10 mg PO, PR, or IM qd-tid

SUPPLIED: Tabs 10 mg; supp 10 mg; inj 5 mg/mL **NOTES:** Extrapyramidal reactions may occur

6-Thioguanine [6-TG] (Tabloid)

COMMON USES: AML, ALL, CML

ACTIONS: Purine-based antimetabolite (substitutes for natural purines interfering with nucleotide

synthesis)

DOSAGE: 2-3 mg/kg/d SUPPLIED: Tabs 40 mg

NOTES: Toxicity symptoms: Myelosuppression (especially leukopenia and thrombocytopenia), nausea and vomiting, anorexia, stomatitis, and diarrhea. Hepatotoxicity rare; dosage adjustment in renal or hepatic impairment

Thioridazine (Mellaril)

COMMON USES: Psychotic disorders; short-term treatment of depression, agitation, organic brain syndrome

ACTIONS: Phenothiazine antipsychotic

DOSAGE: Adults. Initially, 50–100 mg PO tid; maintenance 200–800 mg/24h PO in 2–4 ÷ doses.

Peds > 2 y. 0.5–3 mg/kg/24h PO in 2–3 ÷ doses

 $\textbf{SUPPLIED:} \ \, \text{Tabs } 10,\,15,\,25,\,50,\,100,\,150,\,200 \; mg; \, or al \, \, conc \,\, 30,\,100 \,\, mg/mL; \, or al \, \, susp \,\, 25,\,100 \,\, mg/mL; \, or \, al \,\, susp \,\, 25,\,100 \,\, mg/mL; \, or \, al \,\, susp \,\, 25,\,100 \,\, mg/mL; \, or \, al \,\, susp \,\, 25,\,100 \,\, mg/mL; \, or \, al \,\, susp \,\, 25,\,100 \,\, mg/mL; \, or \, al \,\, susp \,\, 25,\,100 \,\, mg/mL; \, or \, al \,\, susp \,\, 25,\,100 \,\, mg/mL; \, or \, al \,\, susp \,\, 25,\,100 \,\, mg/mL; \, or \, al \,\, susp \,\, 25,\,100 \,\, mg/mL; \, or \, al \,\, susp \,\, 25,\,100 \,\, mg/mL; \, or \, al \,\, susp \,\, 25,\,100 \,\, mg/mL; \, or \, al \,\, susp \,\, 25,\,100 \,\, mg/mL; \, or \, al \,\, susp \,\, 25,\,100 \,\, mg/mL; \, or \, al \,\, susp \,\, 25,\,100 \,\, mg/mL; \, or \, al \,\, susp \,\, 25,\,100 \,\, mg/mL; \, or \, al \,\, susp \,\, 25,\,100 \,\, mg/mL; \, or \, al \,\, susp \,\, 25,\,100 \,\, mg/mL; \, or \, al \,\, susp \,\, 25,\,100 \,\, mg/mL; \, or \, al \,\, susp \,\, 25,\, 100 \,\, al \,\, susp \,\, 25,\, 100 \,\, sus$

5 mL

NOTES: Low incidence of extrapyramidal effects; may cause ventricular arrhythmias

Thiothixene (Navane)

COMMON USES: Psychotic disorders

ACTIONS: Antipsychotic

DOSAGE: Adults & Peds >12 y. Mild to moderate psychosis: 2 mg PO tid, up to 20–30 mg/d. Severe psychosis: 5 mg PO bid; ↑ to a max of 60 mg/24h PRN. IM use: 16–20 mg/24h ÷ bid–qid; max 30 mg/d. Peds <12 y. 0.25 mg/kg/24h PO + a6–12h

SUPPLIED: Caps 1, 2, 5, 10, 20 mg; oral conc 5 mg/mL; inj 2, 5 mg/mL **NOTES:** Drowsiness and extrapyramidal side effects most common

Tiagabine (Gabitril)

COMMON USES: Adjunctive therapy in treatment of partial seizures

ACTIONS: Inhibition of GABA

DOSAGE: Initial 4 mg/d, ↑ by 4 mg during 2nd wk; may keep increasing by 4–8 mg/d until clinical response achieved; max dose 56 mg/d

SUPPLIED: Tabs 4, 12, 16, 20 mg

NOTE: Use gradual withdrawal; used in combination with other anticonvulsants

Ticarcillin (Ticar)

COMMON USES: Infections caused by susceptible strains of gram (-) bacteria (including *Klebsiella, Proteus, E. coli, Enterobacter, P. aeruginosa, and Serratia*) involving the skin, bone, respiratory tract, urinary tract, abdomen, and septicemia

ACTIONS: Bacteriocidal; inhibits cell wall synthesis

DOSAGE: Adults. 3 g IV q4-6h. Peds. 200-300 mg/kg/d IV ÷ q4-6h

SUPPLIED: Inj

NOTES: Often used in combination with aminoglycoside; dosage adjustment in renal impairment

Ticarcillin/Potassium Clavulanate (Timentin)

COMMON USES: Infections caused by susceptible strains of gram (–) bacteria (including *Klebsiella, Proteus, E. coli, Enterobacter, P. aeruginosa*, and *Serratia*) involving the skin, bone, respiratory tract, urinary tract, abdomen, and septicemia

ACTIONS: Bactericidal; inhibits cell wall synthesis

DOSAGE: Adults. 3.1 g IV q4-6h. Peds. 200-300 mg/kg/d IV ÷ q4-6h

SUPPLIED: Inj

NOTES: Often used in combination with aminoglycosides; dosage adjustment in renal impairment

Ticlopidine (Ticlid)

COMMON USES: Reduces the risk of thrombotic stroke

ACTIONS: Platelet aggregation inhibitor

DOSAGE: 250 mg PO bid **SUPPLIED:** Tabs 250 mg

NOTES: Administer with food; may cause neutropenia, monitor WBC and LFTs

Timolol (Blocadren)

COMMON USES: HTN and MI

ACTIONS: Competitively blocks β -adrenergic receptors, β_1 , β_2 **DOSAGE:** *HTN:* 10–20 mg bid, up to 60 mg/d. *MI:* 10 mg bid

SUPPLIED: Tabs 5, 10, 20 mg

Timolol, Ophthalmic (Timoptic)

COMMON USES: Glaucoma ACTIONS: β-Blocker

DOSAGE: 0.25% 1 gt bid; ↓ to qd when controlled; use 0.5% if needed; 1 gt gel qd

SUPPLIED: Soln 0.25/0.5%; Timoptic XE (0.25, 0.5%) gel-forming soln

Tioconazole (Vagistat)

COMMON USES: Vaginal fungal infections

ACTIONS: Topical antifungal

DOSAGE: 1 applicatorful intravaginally hs (single dose)

SUPPLIED: Vaginal oint 6.5%

Tirofiban (Aggrastat)

COMMON USES: Acute coronary syndrome **ACTIONS:** Glycoprotein IIb/IIIa inhibitor

DOSAGE: Initial 0.4 µg/kg/min for 30 min, followed by 0.1 µg/kg/min

SUPPLIED: Inj 50 µg/mL, 250 µg/mL

NOTES: Adjust dose in renal insufficiency; use in combination with heparin

Tobramycin (Nebcin)

COMMON USES: Serious gram- infections, especially Pseudomonas

ACTIONS: Aminoglycoside; inhibits protein synthesis

DOSAGE: Adults. 1–2.5 mg/kg/dose IV q8–24h (see page 620). Peds. 2.5 mg/kg/dose IV q8h

SUPPLIED: Inj 10, 40 mg/mL

NOTES: Nephrotoxic and ototoxic; ↓ with renal insufficiency; monitor creatinine clearance and serum concentrations for dosage adjustments (see Table 22–7, pages 631–634, and page 620).

Tobramycin Ophthalmic (AK Tob, Tobrex)

COMMON USES: Ocular bacterial infections

ACTIONS: Aminoglycoside antibiotic

DOSAGE: 1–2 gtt q4h; oint bid-tid; if severe infections, use oint q3–4h, or 2 gtt q 30–60 min, then

less frequently

SUPPLIED: Oint and soln tobramycin 0.3%

Tobramycin and Dexamethasone Ophthalmic (TobraDex)

COMMON USES: Ocular bacterial infections associated with significant inflammation

ACTIONS: Antibiotic with antiinflammatory

DOSAGE: 0.3% oint apply q3–8h or soln 0.3% apply 1–2 gtt q1–4h **SUPPLIED:** Oint and soln tobramycin 0.3% and dexamethasone 0.1%

Tocainide (Tonocard)

COMMON USES: Suppression of ventricular arrhythmias, including PVCs, and ventricular tachy-

ACTIONS: Class IB antiarrhythmic

DOSAGE: 400–600 mg PO q8h, up to 2400 mg/d

SUPPLIED: Tabs 400, 600 mg

NOTES: Properties similar to those of lidocaine; ↓ dose in renal failure; CNS and GI side effects common

Tolazamide (Tolinase)

COMMON USES: Type 2 DM

ACTION: Sulfonylurea. Stimulates the release of insulin from the pancreas; increases insulin sensitivity at peripheral sites; reduces glucose output from the liver

DOSAGE: 100-500 mg/d

SUPPLIED: Tabs 100, 250, 500 mg

Tolazoline (Priscoline)

COMMON USES: Persistent pulmonary vasoconstriction and HTN of the newborn, peripheral vasospastic disorders

ACTIONS: Competitively blocks α-adrenergic receptors

DOSAGE: Adults. 10-50 mg IM/IV/SC qid

Neonates. 1–2 mg/kg IV over 10–15 min, followed by 1–2 mg/kg/h

SUPPLIED: Inj 25 mg/mL

Tolbutamide (Orinase)

COMMON USES: Type 2 DM

ACTION: Sulfonylurea. Stimulates the release of insulin from the pancreas; increases insulin sensi-

tivity at peripheral sites; reduces glucose output from the liver

DOSAGE: 500–1000 mg bid **SUPPLIED:** Tabs 500 mg

NOTES: May require dosage adjustment in hepatic impairment

Tolmetin (Tolectin)

COMMON USES: Arthritis and pain

ACTIONS: NSAID; inhibits prostaglandin synthesis **DOSAGE:** 200–600 mg tid, to a max of 2000 mg/d **SUPPLIED:** Tabs 200, 600 mg; caps 400 mg

Tolnaftate [OTC] (Tinactin)

COMMON USES: Tinea pedis, tinea cruris, tinea corporis, tinea manus, tinea versicolor

ACTIONS: Topical antifungal

DOSAGE: Apply to area bid for 2–4 wk

SUPPLIED: OTC 1% liq; gel; powder; cream; soln

Tolterodine (Detrol, Detrol LA)

COMMON USES: Management of overactive bladder (frequency, urgency, urge incontinence)

ACTIONS: Anticholinergic

DOSAGE: Detrol 1–2 mg PO bid; Detrol LA 2–4 mg/d **SUPPLIED:** Detrol tabs 1, 2 mg; Detrol LA tabs 2, 4 mg

NOTES: Do not administer to patients with urinary retention, gastric retention, or uncontrolled nar-

row-angle glaucoma; dry mouth common side effect

Topiramate (Topamax)

COMMON USES: Partial onset seizures

ACTIONS: Anticonvulsant

DOSAGE: Total dose 400 mg/d. See product information for 8-wk titration schedule

SUPPLIED: Tabs 25, 100, 200 mg; caps sprinkles 15, 25, 50 mg

NOTES: May precipitate kidney stones; dosage adjustment in renal impairment

Topotecan (Hycamtin)

COMMON USES: Ovarian cancer (cisplatin-refractory), small-cell lung cancer, and non-Hodgkin's lymphoma

ACTIONS: Topoisomerase I inhibitor; interferes with DNA synthesis

DOSAGE: 1.5 mg/m²/d as an 1-h IV inf for 5 consecutive days, repeated q 3 wk

SUPPLIED: Vials containing 4 mg of lyophilized drug reconstituted in sterile water and diluted in

NS or 5% dextrose

NOTES: *Toxicity symptoms:* Myelosuppression, nausea and vomiting, diarrhea, drug fever, and skin rash. ↓ Dose for renal dysfunction

Torsemide (Demadex)

COMMON USES: Edema, HTN, CHF, and hepatic cirrhosis

ACTIONS: Loop diuretic; inhibits reabsorption of sodium and chloride in the ascending loop of

Henle and distal tubule

DOSAGE: 5-20 mg/d PO or IV

SUPPLIED: Tabs 5, 10, 20, 100 mg; inj 10 mg/mL

Tramadol (Ultram)

COMMON USES: Moderate to severe pain **ACTIONS:** Centrally acting analgesic

DOSAGE: 50-100 mg PO q4-6h PRN, not to exceed 400 mg/d

SUPPLIED: Tabs 50 mg

NOTES: Lowers seizure threshold, tolerance or dependence may develop

Trandolapril (Mavik)

COMMON USES: HTN, CHF, LVD, post-AMI

ACTIONS: ACE inhibitor

DOSAGE: HTN: 2-4 mg/d. CHF/LVD: 4 mg/d

SUPPLIED: Tabs 1, 2, 4 mg NOTES: Dosage adjustment in renal or hepatic impairment

Trazodone (Desyrel)

COMMON USES: Depression

ACTIONS: Antidepressant; inhibits reuptake of serotonin and norepinephrine **DOSAGE:** Adults & Adolescents. 50–150 mg PO ad-aid; max 600 mg/d

SUPPLIED: Tabs 50, 100, 150, 300 mg

NOTES: May take 1-2 wk for symptomatic improvement; anticholinergic side effects

Tretinoin, Systemic [Tretinoic Acid] (Vesanoid)

COMMON USES: APL induction therapy

ACTIONS: Differentiating agent; all trans retinoic acid

DOSAGE: 45 mg/m²/d in ÷ doses for approximately 40 d

SUPPLIED: Caps 10 mg

NOTES: Toxicity symptoms: Cutaneous (dryness, chafing), neurologic (headache), hypertriglyceridemia, and treatment-related leukocytosis reported in APL, as well as "retinoic acid syndrome"

Tretinoin, Topical [Retinoic Acid] (Retin-A, Avita)

COMMON USES: Acne vulgaris, sun-damaged skin, some skin cancers

ACTIONS: Exfoliant retinoic acid derivative

DOSAGE: Adults & Peds> 12. Apply qd hs; if irritation develops, ↓ frequency

SUPPLIED: Cream 0.025, 0.05, 0.1%; gel 0.01, 0.025, 0.1%; liq 0.05%

NOTES: Avoid sunlight

Triamcinolone and Nystatin (Mycolog-II)

COMMON USES: Cutaneous candidiasis **ACTIONS:** Antifungal and antiinflammatory DOSAGE: Apply lightly to area bid; max 25 d **SUPPLIED:** Cream and oint 15, 30, 60, 120 mg

NOTES: Contra in varicella

Triamterene (Dyrenium)

COMMON USES: Edema associated with CHF, cirrhosis

ACTIONS: Potassium-sparing diuretic

DOSAGE: Adults. 100-300 mg/24h PO ÷ qd-bid. Peds. 2-4 mg/kg/d in 1-2 ÷ doses

SUPPLIED: Caps 50, 100 mg

NOTES: Can cause hyperkalemia, blood dyscrasias, liver damage, and other reactions; dosage adjustment in renal or hepatic impairment

Triazolam (Halcion) [C-IV]

COMMON USES: Short-term management of insomnia

ACTIONS: Benzodiazepine

DOSAGE: 0.125–0.25 mg/d PO hs PRN **SUPPLIED:** Tabs 0.125, 0.25 mg

NOTES: Additive CNS depression with alcohol and other CNS depressants; ↓ dose; avoid in cirrhosis

1110313

Triethanolamine (Cerumenex)

COMMON USES: Cerumen removal ACTIONS: Ceruminolytic agent

DOSAGE: Fill the ear canal and insert the cotton plug; irrigate with water after 15 min; repeat as

needed

SUPPLIED: Soln 6, 12 mL

Triethylene-Triphosphoramide [Thiotepa, TESPA, TSPA] (Thioplex)

COMMON USES: Hodgkin's and non-Hodgkin's lymphomas; leukemia; breast, ovarian, and bladder cancers (IV and intravesical therapy), preparative regimens for allogeneic and autologous BMT in high doses

ACTIONS: Polyfunctional alkylating agent

DOSAGE: 0.5 mg/kg q 1--4 wk, $6 \text{ mg/m}^2 \text{ IM or IV} \times 4 \text{ d q } 2\text{--}4 \text{ wk}$, $15\text{--}35 \text{ mg/m}^2 \text{ by cont IV}$ inf over 48 h; 60 mg instilled into the bladder and retained 2 h q 1--4 wk; $900\text{--}125 \text{ mg/m}^2 \text{ in ABMT regimens}$ (the highest dose that can be administered without ABMT is 180 mg/m^2); $1\text{--}10 \text{ mg/m}^2$ (typically 15 mg) IT once or twice a week; 0.8 mg/kg in 1--2 L of soln may be instilled intraperitoneally **SUPPLIED:** Inj 15 mg

NOTES: Toxicity symptoms: Myelosuppression, nausea, vomiting, dizziness, headache, allergy, and paresthesias

Trifluoperazine (Stelazine)

COMMON USES: Psychotic disorders

ACTIONS: Phenothiazine; blocks postsynaptic mesolimbic dopaminergic receptors in the brain **DOSAGE:** *Adults.* 2–10 mg PO bid. *Peds 6–12 y.* 1 mg PO qd–bid initially, then gradually ↑ up to

15 mg/d

SUPPLIED: Tabs 1, 2, 5, 10 mg; oral conc 10 mg/mL; inj 2 mg/mL

NOTES: ↓ Dose in elderly and debilitated patients; oral conc must be diluted to 60 mL or more prior to administration; requires several weeks for onset of effects

Trifluridine (Viroptic)

COMMON USES: Herpes simplex keratitis and conjunctivitis

ACTIONS: Antiviral

DOSAGE: 1 gt q2h (max 9 gtt/d); \downarrow to 1 gt q4h after healing begins; treat up to 14 d

SUPPLIED: 1% soln

Trihexyphenidyl (Artane)

COMMON USES: Parkinson's disease
ACTIONS: Blocks excess acetylcholine at cerebral synapses

DOSAGE: 2-5 mg PO qd-qid

SUPPLIED: Tabs 2, 5 mg; SR caps 5 mg; elixir 2 mg/5 mL

NOTES: Contra in narrow-angle glaucoma

Trimethobenzamide (Tigan)

COMMON USES: Nausea and vomiting

ACTIONS: Inhibits medullary chemoreceptor trigger zone

DOSAGE: Adults. 250 mg PO or 200 mg PR or IM tid-qid PRN. Peds. 20 mg/kg/24h PO or 15

mg/kg/24h PR or IM in 3–4 ÷ doses (NOT recommended for infants) **SUPPLIED:** Caps 100, 250 mg; supp 100, 200 mg; inj 100 mg/mL

NOTES: In the presence of viral infections, may mask emesis or mimic CNS effects of Reye's syn-

drome; may cause parkinsonian-like syndrome

Trimethoprim (Trimpex, Proloprim)

 $\textbf{COMMON USES:} \ \ UTI \ due \ to \ susceptible \ gram+ \ and \ gram- \ organisms; often \ used \ for \ suppression \ of$

UTI

ACTIONS: Inhibits dihydrofolate reductase

DOSAGE: Adults. 100 mg/d PO bid or 200 mg/d PO. Peds. 4 mg/kg/d in 2 ÷ doses

SUPPLIED: Tabs 100, 200 mg; oral soln 50 mg/5 mL

NOTES: ↓ Dose in renal failure

Trimethoprim-Sulfamethoxazole [Co-trimoxazole] (Bactrim, Septra)

COMMON USES: UTI, otitis media, sinusitis, bronchitis, and Shigella, P. carinii, and Nocardia in-

fections

ACTIONS: Dual effect of SMX-inhibiting synthesis of dihydrofolic acid and TMP-inhibiting dihydrofolate reductase to impair protein synthesis

DOSAGE: Adults. 1 DS tab PO bid or 5–20 mg/kg/24h (based on TMP component) IV in 3–4 ÷ doses. *P. carinii*: 15–20 mg/kg/d IV or PO (TMP component) in 4 ÷ doses. *Nocardia*: 10–15 mg/kg/d IV or PO (TMP component) in 4 ÷ doses. *Peds*. 8–10 mg/kg/24h (TMP) PO ÷ into 2 doses or 3–4 doses IV: do NOT use in newborns

SUPPLIED: Regular tabs 80 mg of TMP and 400 mg of SMX; DS tabs 160 mg of TMP and 800 mg of SMX; oral susp 40 mg of TMP and 200 mg of SMX/ 5 mL; inj 80 mg of TMP and 400 mg of SMX/5 mL

NOTES: Synergistic combination; reduce dosage in renal failure; maintain adequate hydration

Trimetrexate (Neutrexin)

COMMON USES: Moderate to severe PCP **ACTIONS:** Inhibits dihydrofolate reductase **DOSAGE:** 45 mg/m² IV q24h for 21 d

SUPPLIED: Inj

NOTES: Administer with leucovorin 20 mg/m² IV q6h for 24 d; use cytotoxic precautions; infuse over 60 min; ↓ in hepatic impairment

Trimipramine (Surmontil)

COMMON USES: Depression

ACTIONS: Tricyclic antidepressant; increases synaptic concentration of serotonin and/or norepi-

nephrine in CNS

DOSAGE: 50–300 mg/d PO hs **SUPPLIED:** Caps 25, 50, 100 mg

Urokinase (Abbokinase)

COMMON USES: PE, DVT, restore patency to IV catheters

ACTIONS: Converts plasminogen to plasmin that causes clot lysis

DOSAGE: Adults & Peds. Systemic effect: 4400 IU/kg IV over 10 min, followed by 4400–6000 IU/kg/h for 12 h. Restore catheter patency: Inject 5000 IU into catheter and gently aspirate

SUPPLIED: Powder for inj 5000 IU/mL, 250,000 IU vial

NOTES: Do NOT use systemically within 10 d of surgery, delivery, or organ biopsy

Valacyclovir (Valtrex)

common uses: Herpes zoster; genital herpes

ACTIONS: Prodrug of acyclovir, inhibits viral DNA replication

DOSAGE: 1 g PO tid; genital herpes treatment 500 mg bid × 7 d, prophylaxis 500–1000 mg/d

SUPPLIED: Caplets 500 mg

NOTES: Dosage adjustment in renal impairment

Valproic Acid and Divalproex (Depakene, Depakote)

COMMON USES: Rx epilepsy, mania; prophylaxis of migraines **ACTIONS:** Anticonvulsant; increases the availability of GABA

DOSAGE: Adults & Peds. Seizures: 30-60 mg/kg/24h PO + tid (after initiation of 10-15 mg/dh/24h). Mania: 750 mg in 3 + doses, ↑ to a max of 60 mg/kg/d. Migraines: 250 mg bid, ↑ to 1000 mg/d

SUPPLIED: Valproic acid: caps 250 mg; syrup 250 mg/5 mL. Divalproex: EC tabs 125, 250, 500; caps 125 mg

caps 125 mg

NOTES: Monitor LFT and follow serum levels (see Table 22–7, pages 631–634); concurrent use of phenobarbital and phenytoin may alter serum levels of these agents; \downarrow dose in hepatic impairment

Valrubicin (Valstar)

COMMON USES: Intravesical treatment of BCG-refractory CIS when immediate cystectomy would be associated with unacceptable morbidity or mortality

ACTIONS: Semisynthetic doxorubicin analogue; cytotoxic **DOSAGE:** 800 mg intravesically weekly for 6 wk

SUPPLIED: Liq 200 mg/5 mL

NOTES: Dilute 800 mg in approximately 75 mL NS; minimal systemic absorption with intact bladder. Do NOT use within 1–2 wk of biopsy as systemic absorption can cause myelosuppression; can cause local bladder symptoms; contra with bladder capacity of < 75 mL or active UTI

Valsartan (Diovan)

COMMON USES: HTN

ACTIONS: Angiotensin II receptor antagonist

DOSAGE: 80 –160 mg/d **SUPPLIED:** Caps 80, 160 mg

NOTES: Use with caution with K-sparing diuretics or K supplements

Vancomycin (Vancocin, Vancoled)

COMMON USES: Serious MRSA infections and in enterococcal endocarditis in combination with aminoglycosides in penicillin-allergic patients; oral treatment of *C. difficile* pseudomembranous colitis

ACTIONS: Inhibits cell wall synthesis

DOSAGE: Adults. 1 g IV q12h; for colitis 125-500 mg PO q6h. Peds (NOT neonates). 40 mg/

kg/24h IV in ÷ doses q6-12h

SUPPLIED: Caps 125, 250 mg; powder for oral soln; powder for inj 500 mg, 1000 mg, 10 g/vial **NOTES!** Ototoxic and nephrotoxic; NOT absorbed orally, provides local effect in gut only; IV dose must be given slowly over 1 h to prevent "red-man syndrome"; adjust dose in renal failure (for drug levels, see Table 22–7, pages 631–634)

Varicella Virus Vaccine (Varivax)

COMMON USES: Prevention of varicella (chicken pox) infection

ACTIONS: Active immunization

DOSAGE: Adults & Peds. 0.5 mL SC, repeated in 4-8 wk

SUPPLIED: Powder for inj

NOTES: Live virus; do NOT administer to immunocompromised

Vasopressin [Antidiuretic Hormone (ADH)] (Pitressin)

COMMON USES: Diabetes insipidus; relief of gaseous GI tract distention; severe GI bleeding

ACTIONS: Posterior pituitary hormone, potent GI vasoconstrictor

DOSAGE: Adults & Peds. Diabetes insipidus: 2.5–10 U SC or IM tid–qid or 1.5–5.0 U IM q 1–3 d

of the tannate. GI hemorrhage: 0.2-0.4 U/min

SUPPLIED: Inj 20 U/mL

NOTES: Use with caution with any vascular disease

Vecuronium (Norcuron)

COMMON USES: Skeletal muscle relaxation during surgery or mechanical ventilation

ACTIONS: Nondepolarizing neuromuscular blocker

DOSAGE: Adults & Peds. 0.08-0.1 mg/kg IV bolus; maintenance of 0.010-0.015 mg/kg after

25-40 min followed with additional doses q 12-15 min

SUPPLIED: Powder for inj 10 mg

NOTES: Drug interactions leading to an increased effect of vecuronium include aminoglycosides, tetracycline, and succinylcholine; fewer cardiac effects than with pancuronium

Venlafaxine (Effexor)

COMMON USES: Depression

ACTIONS: Potentiation of neurotransmitter activity in the CNS

DOSAGE: 75-375 mg/d ÷ into 2-3 equal doses

SUPPLIED: Tabs 25, 37.5, 50, 75, 100 mg; ER caps 37.5, 75, 150 mg

NOTES: Dosage adjustment in renal or hepatic impairment

Verapamil (Calan, Isoptin)

Used for emergency cardiac care (see Chapter 21)

COMMON USES: Angina, essential HTN, and arrhythmias

ACTIONS: Ca channel-blocker

DOSAGE: Adults. Arrhythmias: See Chapter 21. Angina: 80–120 mg PO tid, up to 480 mg/24h. HTN: 80–180 mg PO tid or SR tabs 120–240 mg PO qd to 240 mg bid. Peds. <1 y: 0.1–0.2 mg/kg IV over 2 min (may repeat in 30 min). *I–16* y: 0.1–0.3 mg/kg IV over 2 min (may repeat in 30 min); do NOT exceed 5 mg. Oral: *I–5* y: 4–8 mg/kg/d in 3 ÷ doses. >5 y: 80 mg q6–8h

SUPPLIED: Tabs 40, 80, 120 mg; SR tabs 120, 180, 240 mg; SR caps 120, 180, 240, 360 mg; inj 5 mg/2 mL

NOTES: Use caution with elderly patients; ↓ dose in renal or hepatic failure; constipation common

Vinblastine (Velban, Velbe)

COMMON USES: Hodgkin's and non-Hodgkin's lymphomas, mycosis fungoides, testicular cancer, choriocarcinoma, breast cancer, histiocytosis X, non-small-cell lung cancer, AIDS-related Kaposi's sarcoma, renal cell carcinoma

ACTIONS: Inhibits microtubule assembly through binding to tubulin

DOSAGE: 0.1–0.5 mg/kg/wk (4–20 mg/m²)

SUPPLIED: Inj 1 mg/mL

NOTES: *Toxicity symptoms:* Myelosuppression (especially leukopenia), nausea and vomiting (rare), constipation, neurotoxicity (similar to that listed for vincristine but less frequent), alopecia, rash; myalgia and tumor pain common; dosage adjustment in hepatic impairment

Vincristine (Oncovin, Vincasar PFS)

COMMON USES: ALL, breast carcinoma, sarcoma (including Ewing's and rhabdomyosarcoma), Wilms' tumor, Hodgkin's and non-Hodgkin's lymphomas, neuroblastoma, small-cell lung cancer, multiple myeloma

ACTIONS: Promotes disassembly of mitotic spindle, causing metaphase arrest

DOSAGE: 0.4–1.4 mg/m² (single doses do NOT usually exceed 2 mg)

SUPPLIED: Inj 1 mg/mL

NOTES: Toxicity symptoms: Neurotoxicity commonly dose-limiting, jaw pain (trigeminal neuralgia), fever, fatigue and anorexia, constipation and paralytic ileus, bladder atony, no significant myelosuppression observed with standard doses. Soft tissue necrosis possible with extravasation; dosage adjustment in hepatic impairment

Vinorelbine (Navelbine)

COMMON USES: Non-small-cell lung cancer (single agent or with cisplatin), breast cancer

ACTIONS: Inhibits polymerization of microtubules, impairing mitotic spindle formation, semisynthetic vinca alkaloid

DOSAGE: 30 mg/m²/wk SUPPLIED: Inj 10 mg

NOTES: Toxicity symptoms: Myelosuppression (especially leukopenia), mild GI effects and infrequent neurotoxicity (6–29%), constipation and paresthesias (rare). Tissue damage can result from extravasation. Dosage adjustment in hepatic impairment

Vitamin B₁

See Thiamine (page 609)

Vitamin B₆

See Pyridoxine (page 596)

Vitamin B₁₂

See Cyanocobalamin (page 521)

Vitamin K

See Phytonadione (page 589)

Warfarin (Coumadin)

COMMON USES: Prophylaxis and Rx of PE and DVT, AF with embolization, other postoperative indications

ACTIONS: Inhibits vitamin K-dependent production of clotting factors in the order VII-IX-X-II

DOSAGE: See Table 22–10 (page 637) for anticoagulation guidelines. *Adults*. Individualize dose to keep INR 2.0–3.0 for most indications, for mechanical heart valves desired INR is 2.5–3.5. ACCP guidelines recommend initiation with 5 mg, unless rapid attainment of therapeutic INR is necessary (use 7.5–10 mg) if patient elderly or has other bleeding risk factors (↓). others recommend 10–15 mg PO, IM, or IV qd for 1–3 d; then maintenance, 2–10 mg/d PO, IV, or IM; follow daily INR during initial phase to guide dosage. *Peds.* 0.05–0.34 mg/kg/24h PO, IM, or IV. Follow PT/INR closely to adiust dosage

SUPPLIED: Tabs 1, 2, 2.5, 3, 4, 5, 6, 7.5, 10 mg; inj

NOTES: INR now the preferred test rather than PT; Check INR periodically on maintenance dose; beware of bleeding caused by over anticoagulation (PT >3 × control or INR >5.0–6.0); to rapidly correct over coumadinization, use vitamin K or FFP or both; highly teratogenic; do NOT use in pregnancy. Caution patient on taking Coumadin with other medications, especially aspirin. Common warfarin interactions: Potentiates acetaminophen, alcohol (with liver disease), amiodarone, cimetidine, ciprofloxacin, co-trimoxazole, erythromycin, fluconazole, flu vaccine, isoniazid, itra-conazole, metronidazole, ometprazole, phenytoin, propranolol, quinidine, tetracycline. Inhibits barbiturates, carbamazepine, chlordiazepoxide, cholestyramine, dicloxacillin, nafcillin, rifampin, sucralfate, high vitamin K foods

Witch Hazel (Tucks Pads, others)

COMMON USES: After bowel movement cleansing to decrease local irritation or relieve hemorrhoids; after anorectal surgery and episiotomy

DOSAGE: Apply PRN

SUPPLIED: Presoaked pads, liq

Zafirlukast (Accolate)

common uses: Prophylaxis and chronic Rx of asthma

ACTIONS: Selective and competitive inhibitor of leukotriene D4 and E4

DOSAGE: 20 mg bid **SUPPLIED:** Tabs 20 mg

NOTES: NOT for acute exacerbations of asthma, contra in nursing women; associated with hepatic dysfunction, which has been reversible on discontinuation

Zalcitabine [DdC] (Hivid)

COMMON USES: HIV patients intolerant of zidovudine and didanosine

ACTIONS: Antiretroviral agent **DOSAGE:** 0.75 mg PO tid **SUPPLIED:** Tabs 0.375, 0.75 mg

NOTES: May be used in combination with zidovudine; may cause peripheral neuropathy; dosage

adjustment in renal impairment

Zaleplon (Sonata)

COMMON USES: Insomnia

ACTION: A nonbenzodiazepine sedative hypnotic, a pyrazolopyrimidine

DOSAGE: 5–20 mg hs PRN **SUPPLIED:** Caps 5, 10 mg

Zanamivir (Relenza)

COMMON USES: Influenza

ACTIONS: Inhibits viral neuraminidase **DOSAGE:** 2 inhal (10 mg) bid for 5 d **SUPPLIED:** Powder for inhal 5 mg

NOTES: Uses a Diskhaler for administration; initiate within 48 h of symptom onset; do NOT use in

pulmonary disease

Zidovudine (Retrovir)

COMMON USES: HIV infections **ACTIONS:** Inhibits reverse transcriptase

DOSAGE: Adults. 200 mg PO tid or 300 mg PO bid or 1–2 mg/kg/dose IV q4h. Pregnancy: 100 mg PO 5×/d until the start of labor, then during labor 2 mg/kg over 1 h followed by 1 mg/kg/h until

clamping of the umbilical cord. *Peds.* 160 mg/m²/dose q8h

SUPPLIED: Caps 100 mg; tabs 300 mg; syrup 50 mg/5 mL; inj 10 mg/mL

NOTES: Not a cure for HIV infections; hematologic toxicity; dosage adjustment in renal impair-

Zidovudine and Lamivudine (Combivir)

COMMON USES: HIV infections

ACTIONS: Combination inhibitors of reverse transcriptase

DOSAGE: Adults & Peds 12 v. 1 tab bid

SUPPLIED: Caps zidovudine 300 mg/lamivudine 150 mg

NOTES: An alternative to \downarrow number of caps for combination therapy with the two agents

Zileuton (Zyflo)

common uses: Prophylaxis and chronic treatment of asthma

ACTIONS: Inhibitor of 5-lipoxygenase

DOSAGE: 600 mg qid **SUPPLIED:** Tabs 600 mg

NOTES: MUST take on a regular basis; does NOT treat acute exacerbation; hepatotoxic/do NOT

use in hepatic impairment

Zolmitriptan (Zomig)

COMMON USES: Acute treatment of migraine

Action: Selective agonist of serotonin to cause vasoconstriction **DOSAGE:** Initial 2.5 mg, may repeat after 2 h to a max of 10 mg in 24 h **NOTES:** Use with caution in hepatic impairment; do NOT use in PRG

Zolpidem (Ambien) [C-IV]

COMMON USES: Short-term treatment of insomnia

ACTIONS: Hypnotic agent **DOSAGE:** 5–10 mg PO hs PRN **SUPPLIED:** Tabs 5, 10 mg

Zonisamide (Zonegran)

COMMON USES: Partial seizures
ACTIONS: Anticonvulsant

DOSAGE: Initial 100 mg/d; may be ↑ to 400 mg/d

SUPPLIED: Caps 100 mg

NOTES: Contra in persons with hypersensitivity to sulfonamides

Aminoglycoside Dosing

Table 22–7 (pages 631–634) gives information on the trough and peak levels of the aminoglycosides gentamicin, tobramycin, and amikacin. Peak levels should be drawn 30 min after the dose is completely infused; trough levels should be drawn 30 min prior to the dose. As a general rule, draw the peak and trough around the fourth maintenance dose. Therapy can be initiated with the recommended guidelines that follow.

Procedure (Adult)

- Calculate estimated CrCl based on SCr, age, and weight (in kg), or a formal CrCl can also be ordered, if time permits.
- 2. Select loading dose:

Gentamicin: 1.5–2.0 mg/kg Tobramycin: 1.5–2.0 mg/kg Amikacin: 5.0–7.5 mg/kg

3. By using Table 22–8 (page 635), select maintenance dose (as a percentage of the chosen loading dose) most appropriate for the renal function of patient based on the CrCl and dosing interval. Shaded areas are suggested percentages and intervals for any given CrCl. This is only an empiric dose to begin therapy. Monitor serum levels routinely for optimal therapy. Use Table 22–7 (pages 631–634) for the drug levels to follow for each drug.

IMMUNIZATION SCHEDULE (SEE TABLE 22-9, PAGE 636)

Perform active immunization of normal infants and children based on Table 22–9 (page 636). In addition, perform TB tine test at 15–19 mo and again at the entry to school (4–6 y). Hep B = hepatitis B vaccine; DtaP = diphtheria and tetanus toxoids and acellular pertussis vaccine. Td = Tetanus toxoid. Hib = *Haemophilus* influenza type b vaccine. IPV = all-inactivated polio virus vaccine. MMR = measles-mumps-rubella vaccine. Var = varicella. Hep A = hepatitis A vaccine. For additional details refer to *MMWR* Vol 50, No 01; Jan 12, 2001.

TABLE 22-1
Quick Guide to Dosing of Acetaminophen Based on the Tylenol Product Line

	Suspension* Drops and Original Drops 80 mg/0.8 ml Dropperful	Chewable* Tablets 80 mg tabs	Suspension* Liquid and Original Elixir 160 mg/5 ml	Junior* Strength 160 mg Caplets/ Chewables	Regular [†] Strength 325 mg Caplets/ Tablets	Extra Strength [†] 500 mg Caplets/ Gelcaps
Q-3 mo/6-11 lb/2.5-5.4 kg 4-11 mo/12-17 lb/5.5-7.9 kg 12-23 mo/18-23 lb/8.0-10.9 kg 2-3 y/24-35 lb/11.09-15.9 kg 4-5 y/36-47 lb/16.0-21.9 kg 6-8 y/48-59 lb/22.0-26.9 kg 9-10 y/60-71 lb/27.0-31.9 kg 11 y/72-95 lb/32.0-43.9 kg Adults & children 12 y and over/96 lb and over/44.0 kg and over	½ dppr [‡] (0.4 mL) 1 dppr [‡] (0.8 mL) 1½ dppr [‡] (1.2 mL) 2 dppr [‡] (1.6 mL)	2 tab 3 tab 4 tab 5 tab 6 tab	½ tsp ¾ tsp 1 tsp 1½ tsp 2 tsp 2½ tsp 4 tsp	2 cap/tab 2½ cap/tab 3 cap/tab 4 cap/tab	1 or 2 caps/tabs	2 caps/gel

^{*}Doses should be administered 4 or 5 times daily or as directed by your doctor. Do not exceed 5 doses in 24 h.

[‡]Dropperful.

[†]No more than 8 dosage units in any 24-h períod. Not to be takén for pain for more than 10 days or for fever for more than 3 days unless directed by a physician.

TABLE 22–2 Comparison of Insulins

Type of Insulin	Onset (h)	Peak (h)	Duration (h)
Ultra Rapid			
Humalog (Lispro) NovoLog (Insulin	Immediate	0.5–1.5	3–5
aspart) Rapid	Immediate	0.5–1.5	3–5
Regular lletin II	0.25-0.5	2.0-4.0	5–7
Humulin R	0.5	2.5-4.0	6–8
Novolin R	0.5	2.0-5.0	5–8
Velosulin Intermediate	0.5	2.0–5.0	6–8
NPH lletin II	1.0-2.0	6–12	18-24
Lente lletin II	1.0-2.0	6–12	18–24
Humulin N	1.0-2.0	6–12	14-24
Novulin L	2.5-5.0	<i>7</i> –15	18-24
Novulin 70/30 Prolonged	0.5	7–12	24
Ultralente	4.0-6.0	14-24	28-36
Humulin U Lantus (insulin	4.0–6.0	8–20	24–28
glargine) Combination Insulins Humalog Mix (lispro protamine/	4.0–6.0	No peak	24
lispro)	0.25–0.5	1–4	24

TABLE 22-3 Some Oral Contraceptives

Drug (Manufacturer)	Estrogen (µg)*	Progestin (mg) [†]
MONOPHASICS		
Alesse 21, 28 (Wyeth-Ayerst)	Ethinyl estradiol (20)	Desogestrel (0.15)
Brevicon 21, 28 (Watson) [‡]	Ethinyl estradiol (35)	Norethindrone (0.5)
Demulen 1/35 21 (Searle) [‡]	Ethinyl estradiol (35)	Ethynodiol diacetate (1)
Demulen 1/50 21 (Searle) [‡]	Ethinyl estradiol (50)	Ethynodiol diacetate
Desogen (Organon)	Ethinyl estradiol (30)	Desogestrel (0.15)
Genora 1/50 28 (Physicians total care)	Mestranol (50)	Norethindrone (1)
Genora 1/35 21, 28 (Physicians total care)	Ethinyl estradiol (35)	Norethindrone (1)
Levlen 21, 28 (Berlex)	Ethinyl estradiol (30)	Levonorgestrel (0.15)
Levlite 21, 28 (Berlex)	Ethinyl estradiol (20)	Levonorgestrel (0.1)
Levora 21, 28 (Watson)	Ethinyl estradiol (30)	Levonorgestrel (0.15)
Loestrin 1.5/30 21, 28 (Parke-Davis)	Ethinyl estradiol (30)	Norethindrone acetate (1.5)
Loestrin 1/20 21, 28 (Parke-Davis)	Ethinyl estradiol (20)	Norethindrone acetate (1)
Lo/Ovral (Wyeth-Ayerst) [‡]	Ethinyl estradiol (30)	Norgestrel (0.3)
Low-Ogestrel (Watson)	Ethinyl estradiol (30)	Norgestrel (0.3)
Modicon 28 (Ortho-McNeil)	Ethinyl estradiol (35)	Norethindrone (0.5)
Necon 1/50 21, 28 (Watson)	Mestranol (50)	Norethindrone (1)
Necon 0.5/35E 21, 28 (Watson)	Ethinyl estradiol (35)	Norethindrone (0.5)
Necon 1/35 21, 28 (Watson)	Ethinyl estradiol (35)	Norethindrone (1)
Nelova 0.5/35E 21 (Warner-Chilcott) [‡]	Ethinyl estradiol (35)	Norethindrone (0.5)
Nelova 1/35 21 (Warner-Chilcott)	Ethinyl estradiol (35)	Norethindrone (1)
Nelova 1/50 21 (Warner-Chilcott)‡	Mestranol (50)	Norethindrone (1)
Nordette-21 (Wyeth-Ayerst) [‡]	Ethinyl estradiol (30)	Levonorgestrel (0.15)
Norinyl 1/35 21, 28 (Watson)	Ethinyl estradiol (35)	Norethindrone (1)
Norinyl 1/50 21, 28 (Watson)	Mestranol (50)	Norethindrone (1)

TABLE 22-3 (Continued)

Drug	Estrogen (µg)*	Progestin (mg) [†]
Ogestrel-28 (Watson)	Ethinyl estradiol (50)	Norgestrel (0.5)
Ortho-Cept 21 (Ortho-McNeil)‡	Ethinyl estradiol (30)	Desogestrel (0.15)
Ortho-Cyclen 21 (Ortho-McNeil)‡	Ethinyl estradiol (35)	Norgestimate (0.25)
Ortho-Novum 1/35 21 (Ortho-McNeil)‡	Ethinyl estradiol (35)	Norethindrone (1)
Ortho-Novum 1/50 21 (Ortho-McNeil)‡	Mestranol (50)	Norethindrone (1)
Ovcon 35 21, 28 (Warner Chilcott)	Ethinyl estradiol (35)	Norethindrone (0.4)
Ovcon 50 21, 28 (Warner Chilcott)	Ethinyl estradiol (50)	Norethindrone (1)
Ovral (Wyeth-Ayerst) [‡]	Ethinyl estradiol (50)	Norgestrel (0.5)
Zovia 1/50E 21, 28 (Watson)	Ethinyl estradiol (50)	Ethynodiol diacetate (1)
Zovia 1/35E 21, 28 (Watson)	Ethinyl estradiol (35)	Ethynodiol diacetate (1)
BIPHASICS		
Jenest-28 (Organon)	Ethinyl estradiol (35)	Norethindrone (0.5, 1)
Necon 10/11 21, 28 (Watson)	Ethinyl estradiol (35)	Norethindrone (0.5, 1)
Nelova 10/11 21 (Warner-Chilcott)	Ethinyl estradiol (35)	Norethindrone (0.5, 1)
Ortho-Novum 10/11 21 (Ortho-McNeil)‡	Ethinyl estradiol (35, 35)	Norethindrone (0.5, 1.0)
TRIPHASICS [§]		
Estrostep 28 (Parke-Davis)	Ethinyl estradiol (20, 30, 35)	Norethindrone acetate (1)
Mircette 28 (Organoon)	Ethinyl estradiol (20, 0, 10)	Desogestrel (0.15)
Ortho Tri-Cyclen (Ortho-McNeil)‡	Ethinyl estradiol (35, 35, 35)	Norgestimate (0.18, 0.215, 0.25)

TABLE 22-3 (Continued)

Drug	Estrogen (µg)*	Progestin (mg) [†]
Ortho-Novum 7/7/7 21 (Ortho-McNeil) [‡] Tri-Levlen 21, 28 (Berlex) Tri-Norinyl 21, 28 (Watson) Triphasil–21 (Wyeth-Ayerst) [‡] Trivora-28 (Watson)	Ethinyl estradiol (35, 35, 35) Ethinyl estradiol (30, 40, 30) Ethinyl estradiol (35, 35, 35) Ethinyl estradiol (30, 40, 30) Ethinyl estradiol (30, 40, 30)	Norethindrone (0.5, 0.75, 1.0) Levonorgestrel (0.05, 0.075, 0.125) Norethindrone (0.5, 1.0, 0.5) Levonorgestrel (0.05, 0.075, 0.125) Levonorgestrel (0.05, 0.075, 0.125)
PROGESTIN ONLY		
Micronor (Ortho-McNeil) Nor-QD (Watson) Ovrette (Wyeth-Ayerst)	None None None	Norethindrone (0.35) Norethindrone (0.35) Norgestrel (0.075)

^{*}Ethinyl estradiol and mestranol are not equivalent milligram for milligram; the results of some studies indicate that 35 µg of ethinyl estradiol is equivalent to 50 mg of mestranol.

[†]Different progestins are not equivalent milligram for milligram.

†Also available in a 28-day regimen at slightly different cost.

§Estrogen/progesterone dose varies based on the time of the cycle (ie, days 1–7, 8–14, 15–21).

TABLE 22-4
Some Common Oral Potassium Supplements (see page 592)

Brand Name	Salt	Form	meq potassium/ Dosing Unit
Glu-K	Gluconate	Tablet	2 meq/tablet
Kaochlor 10%	KCl	Liquid	20 meq/15 mL
Kaochlor S-F 10% (sugar-free)	KCl	Liquid	20 meq/15 mL
Kaochlor Eff	Bicarbonate/KCl/ citrate	Effervescent tablet	20 meg/tablet
Kaon elixir	Gluconate	Liquid	20 meg/mL
Kaon	Gluconate	Tablets	5 meg/tablet
Kaon-Cl	KCl	Tablet, SR	6.67 meq/tablet
Kaon-Cl 20%	KCl	Liquid	40 meq/15 mL
KayCiel	KCl	Liquid	20 meq/15 mL
K-Lor	KCl	Powder	15 or 20 meq/packet
Klorvess	Bicarbonate/KCl	Liquid	20 meq/15 mL
Klotrix	KCl	Tablet, SR	10 meq/tablet
K-Lyte	Bicarbonate/	Effervescent	
	citrate	tablet	25 meq/tablet
K-Tab	KCl	Tablet, SR	10 meq/tablet
Micro-K	KCl	Capsules, SR	8 meq/capsule
Slow-K	KCl	Tablet, SR	8 meq/tablet
Tri-K	Acetate/bicar- bonate and citrate	Liquid	45 meq/15 mL
Twin-K	Citrate/gluconate	Liquid	20 meq/5 mL

TABLE 22–5 Comparison of Systemic Steroids (see page 603)

Drug	Relative Equivalent Dose (mg)	Mineralocorticoid Activity	Duration (h)	Route
Betamethasone	0.75	0	36–72	PO, IM
Cortisone (Cortone)	25.00	2	8–12	PO, IM
Dexamethasone (Decadron)	0.75	0	36–72	PO, IV
Hydrocortisone (Solu-Cortef, Hydrocortone)	20.00	2	8–12	PO, IM, IV
Methylprednisolon acetate (Depo-Medrol)	e 4.00	0	36–72	PO, IM, IV
Methylprednisolon succinate (Solu-Medrol)	e 4.00			PO, IM, IV
Prednisone (Deltasone)	5.00	1	12–36	PO
Prednisolone (Delta-Cortef)	5.00	1	12–36	PO, IM, IV

TABLE 22-6
Topical Steroid Preparations (See page 604 for additional information)

Agent	Common Trade Names	Potency	Apply
Aclometasone dipropionate	Aclovate, cream, oint 0.05%	Low	bid/tid
Amcinonide	Cyclocort, cream, lotion, oint 0.1%	High	bid/tid
Betamethasone	•	· ·	
Betamethasone valerate	Valisone cream, lotion 0.01%	Low	qd/bid
Betamethasone valerate	Valisone cream, 0.01, 0.1%, oint, lotion 0.1%	Intermediate	qd/bid
Betamethasone dipropi- onate	Diprosone cream (0.05%) Diprosone aerosol (0.1%)	High	qd/bid
Betamethasone dipropi- onate, augmented	Diprolene oint, gel 0.05%	Ultra high	qd/bid
Clobetasol propionate	Temovate cream, gel, oint, scalp, soln 0.05%	Ultra high	bid (2 wk max)
Clocortolone pivalate	Cloderm cream 0.1%	Intermediate	gd-gid
Desonide .	DesOwen, cream, oint, lotion 0.05%	Low	bid-gid
Desoximetasone			
Desoximetasone 0.05%	Topicort LP cream, gel 0.05%	Intermediate	
Desoximetasone 0.25%	Topicort cream, oint	High	
Dexamethasone base	Aeroseb-Dex aerosol 0.01% Decadron cream 0.1%	Low	bid–qid
Diflorasone diacetate Fluocinolone	Psorcon cream, oint 0.05%	Ultrahigh	bid/qid
Fluocinolone acetonide 0.01%	Synalar cream, soln 0.01%	Low	bid/tid

TABLE 22-6 (Continued)

Agent	Common Trade Names	Potency	Apply
Fluocinolone acetonide 0.025%	Synalar oint, cream 0.025%	Intermediate	bid/tid
Fluocinolone acetonide 0.2%	Synalar-HP cream 0.2%	High	bid/tid
Fluocinonide 0.05%	Lidex, anhydrous cream, gel, soln 0.05%	High	bid/tid oint
	Lidex-E aqueous cream 0.05%		
Flurandrenolide	Cordran cream, oint 0.025% cream, lotion, oint 0.05% tape, 4 µg/cm²	Intermediate Intermediate Intermediate	bid/tid bid/tid qd
Fluticasone propionate	Activate cream 0.05%, oint 0.005%	Intermediate	bid
Halobetasol .	Cutivate cream, oint 0.05%	Very High	bid
Halcinonide	Halog cream 0.025%, emollient base 0.1% cream, oint, solution 0.1%	High	qd/tid
Hydrocortisone	, , , , , , , , , , , , , , , , , , , ,		
Hydrocortisone	Cortisone, Caldecort, Hycort, Hytone, etc. aerosol 1%, cream: 0.5, 1,2.5%, gel 0.5% oint 0.5, 1, 2.5%, lotion 0.5, 1, 2.5% paste 0.5% soln 1%	Low	tid/qid
Hydrocortisone acetate	Corticaine cream, oint 0.5, 1%	Low	tid/qid
Hydrocortisone butyrate	Locoid oint, soln 0.1%	Intermediate	bid/tid
Hydrocortisone valerate	Westcort cream, oint 0.2% oint, lotion 0.025%	Intermediate	bid/tid

TABLE 22-6 (Continued)

Agent	Common Trade Names	Potency	Apply	
Mometasone furoate	Elocon 0.1% cream, oint, lotion	Intermediate	qd	
Prednicarbate	Dermatop 0.1% cream	Intermediate	bid	
Triamcinolone	·			
Triamcinolone acetonide 0.025%	Aristocort, Kenalog cream,	Low	tid/qid	
Triamcinolone acetonide 0.1%	Aristocort, Kenalog cream, oint, lotion 0.1% Aerosol 0.2 mg/2-sec spray	Intermediate	tid/qid	
Triamcinolone acetonide 0.5%	Aristocort, Kenalog cream, oint 0.5%	High	tid/qid	

TABLE 22-7 Common Drug Levels

Drug	When to Sample	Therapeutic Levels	Usual Half-life	Potentially Toxic Levels
ANTIBIOTICS				
Gentamicin	Peak: 30 min after 30-min infusion (peak level not necessary if extended interval dosing: 6 mg/kg/dose) Trough: <0.5 h before next dose	Peak: 5–8 μg/mL Trough <2 mg/mL <1.0 μg/mL for ext- tended intervals (6 mg/kg/dose) Peak levels not needed with extended-interval dosing	2 h	Peak: >12 μg/mL
Tobramycin	Same as above	Same as above	Same as above	
Amikacin	Same as above	Peak: 20-30 µg/mL	2 h	Peak: >35 µg/mL
Vancomycin	Peak: 1 h after 1 h-infusion Trough: <0.5 h before next dose	Peak: 30–40 µg/mL	6–8 h	Peak: >50 μg/mL Trough: >15 μg/mL
ANTICONVULSAN	NTS			
Carbamazepine	Trough: just before next oral dose	8-12 µg/mL (monotherapy) 4-8 µg/mL (polytherapy)	15–20 h	Trough: >12 μg/mL
Ethosuximide Phenobarbital Phenytoin	Trough: just before next oral dose Trough: just before next dose Use free phenytoin to monitor Trough: just before next dose	40-100 μg/mL 15-40 μg/mL 5-12 μg/mL	30–60 h 40–120 h Concentration- dependent	Trough: >100 μg/mL Trough: >40 μg/mL >2 μg/mL

TABLE 22-7 (Continued)

Drug	When to Sample	Therapeutic Levels	Usual Half-life	Potentially Toxic Levels
Primidone	Trough just before next dose (note-primidone is metabolized to phenobarb. Order levels separately)	5–12 µg/mL	10–12 h	>12 µg/mL
Valproic acid	Trough: just before next dose	50-100 μg/mL	5–20 h	>100 µg/mL
BRONCHODILATO	RS			
Caffeine	Trough: just before next dose	Adults 5–15 µg/mL Neonate 6–11 mg/mL	Adults 3–4 h Neonates 30– 140 h	20 μg/mL
Theophylline (IV)	IV: 12–24 h after infusion started	5–15 μg/mL	Nonsmoking adult-8 h Children and	>20 µg/mL
. , . ,			smoking adults -4 h	
Theophylline (PO)	Peak levels: not recommended Trough level: just before next dose	5–15 µg/mL	-4 N	
CARDIOVASCULAR	RAGENTS			
Amiodarone	Trough: just before next dose	1-2.5 μg/mL	30–100 days	>2.5 µg/mL

TABLE 22-7 (Continued)

Drug	When to Sample	Therapeutic Levels	Usual Half-life	Potentially Toxic Levels
Digoxin	Trough: just before next dose (levels drawn earlier than 6 h after a dose will be artificially elevated)	0.8–2.0 ng/mL	36 h	>2 ng/mL
Disopyramide	Trough: just before next dose	2-5 μg/mL	4–10 h	>5 µg/mL
Flecainide	Trough: just before next dose	0.2-1.0 μg/mL	11–14 h	>1.0 µg/mL
Lidocaine	Steady-state levels are usually achieved after 6–12 h	1.2–5.0 μg/mL	1.5 h	>6 µg/mL
Procainamide	Trough: just before next oral dose	4-10 µg/mL	Procaine: 3-5 h	>10 µg/mL
		NAPA + Procain: 5-30 µg/mL	NAPA: 6–10 h	>30 µg/mL (NAPA + Procain)
Quinidine	Trough: just before next oral dose	2-5 μg/mL	6 h	0.5 μg/mL
OTHER AGENTS				
Amitriptyline plus nortriptyline	Trough: just before next dose	120-250 ng/mL		
Nortriptyline	Trough: just before next dose	50-140 ng/mL		
Lithium	Trough: just before next dose	0.5-1.5 meq/mL	18–20 h	>1.5 meq/mL
lmipramine plus desipramine	Trough: just before next dose	150-300 ng/mL		·
Desipramine	Trough: just before next dose	50-300 ng/mL		
Methotrexate	By protocol	<0.5 µmol/L after 48 h		

TABLE 22-7 (Continued)

Drug	When to Sample	Therapeutic Levels	Usual Half-life	Potentially Toxic Levels
Cyclosporine	Trough: just before next dose	Highly variable Renal: 150–300 ng/mL (RIA)	Highly variable	
	- 1 - 1 6	Hepatic: 150– 300 ng/mL		
Doxepin	Trough: just before next dose	100-300 ng/mL		
Trazodone	Trough: just before next dose	900-2100 ng/mL		

^{*}Results of therapeutic drug monitoring must be interpreted in light of the complete clinical situation. For information on dosing or interpretation of drug levels contact the pharmacist or an order for a pharmacokinetic consult may be written in the patient's chart. Based on data from Pharmacy and Therapeutics Committee Formulary, 41st edition, Thomas Jefferson University Hospital, Philadelphia, PA.

TABLE 22–8
Percentage of Loading Dose Required for Dosage Interval
Chosen for Aminoglycosides (see page 620 for dosing
information)

CrCl	Dosing Interval		
(mL/min)	8 h	12 h	24 h
90	90	_	_
90	88	_	_
70	84	_	_
60	79	91	_
50	74	87	_
40	66	80	_
30	57	72	92
25	51	66	88
20	45	54	83
15	37	50	75
10	29	40	64
7	24	33	55
5	20	28	48
2	14	20	35
0	9	13	25

Source: Based on data from Hull JH, Sarubbi FA: Gentamicin serum concentrations: Pharmacokinetic predictions. Ann Intern Med 1976;85:183–189. Shaded boxes indicate suggested dosage intervals. Abbreviation: CrCl = creatinine clearance.

TABLE 22–9
Recommended Childhood Immunization Schedule (United States, January–December 2001)

						A	GE					
VACCINE	Birth	1 mo	2 mo	4 mo	6 mo	12 mo	15 mo	18 mo	24 mo	4-6 y	11–12 y	14–18 y
Hepatitis B† (Hep B)		Нер В #1										
		He	p B #2			Hep	ь В #3				(Hep B)	
Diphtheria and tetanus toxoids (Td) and pertussis§ (DTaP)			DTaP	DTaP	DTaP			DTaP		DTaP	Td	
Haemophilus influenzae type b¶ (Hib)			Hib	Hib	Hib	Hi	b					
Inactivated polio** (IPV)			IPV	IPV		IP'	V			IPV		
Pneumococcal ^{††} conjugate (PCV)			PCV	PCV	PCV	PC	CV					
Measles-mumps- rubella ^{§§} (MMR)						٨	AMR			MMR	MMR	
Varicella¶¶ (Var)							Var				Var	
Hepatitis A*** (Hep A)									Н	ep A in s	selected ar	eas

kange of recommended ages for vaccination.

Vaccines to be given if previously recommended doses were missed or were given earlier than the recommended minimum age.

Recommended in selected states and/or regions.

See text for abbreviations.

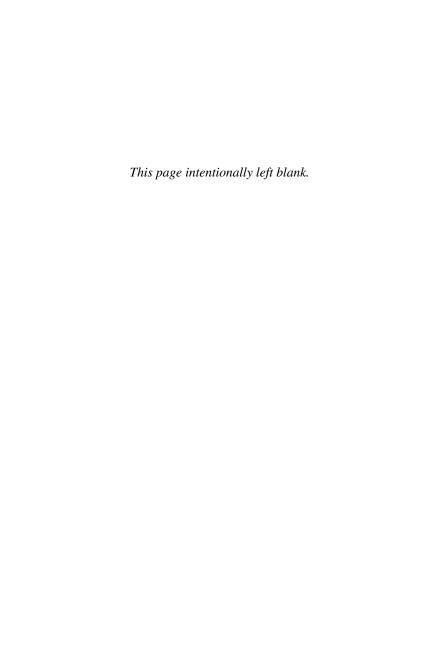
TABLE 22–10
Oral Anticoagulant Standards of Practice (see Warfarin, page 618)

Thromboembolic Disorder	INR	Duration
Deep Venous Thrombosis		
Prophylaxis (high-risk surgery)	2–3	<3 mo or until ambulatory
Treatment: single episode	2–3	3-6 mo
Recurrent systemic embolism	2–3	Indefinite
Prevention of Systemic Embolism		
Atrial fibrillation (AF)	2–3	Indefinite
AF: cardioversion	2–3	3 wk prior;
7 W. Ca. a.c., 0.0.0	- 0	4 wk post sinus rhythm
Valvular heart disease	2–3	Indefinite
Cardiomyopathy	2–3	Indefinite
, , ,		
Acute Myocardial Infarction	2–3	<3 mo
Prevention of systemic embolization Prevention of recurrence	2-3 2.5-3.5	<s mo<br="">Indefinite</s>
Prevention of recurrence	2.5–3.5	indefinite
Prosthetic Valves		
Tissue heart valves	2–3	3 mo
Bileaflet mechanical valve in aortic position	2–3	Indefinite
Other mechanical prosthetic valves ^a	2.5-3.5	Indefinite

Source: Based on data published in Chest 1998;114 Supplement 439S-769S.

Abbreviation: INR: international normalized ratio.

[°]May add aspirin 81 mg to warfarin in patients with ball-cage valves or with additional risk factors.



APPENDIX

Apgar Scores
Body Surface Area
Adult
Children
Body Weights, Desirable
Cancer Screening
Recommendations
Epidemiology Basics

Glasgow Coma Scale

APGAR SCORES

Apgar scores (Table A-1) are a numerical expression of a newborn infant's physical condition. Usually determined 1 min after birth and again at 5 min, the score is the sum of points gained on assessment of color, heart rate, reflex irritability, muscle tone, and respirations.

BODY SURFACE AREA

Adult

Figure A-1 is a nomogram for determining the body surface area of an adult.

Children

Figure A-2 is a nomogram for determining the body surface area of children.

BODY WEIGHTS, DESIRABLE

Table A-2 gives desirable body weights for men and women.

CANCER SCREENING RECOMMENDATIONS

Table A-3 lists the recommendations from the American Cancer Society for cancer screening programs in average risk, asymptomatic people. These are the recommendations of the ACS and may not be supported by other organizations.

EPIDEMIOLOGY BASICS

Prevalence = \frac{Number of persons who have a disease at one point in time}{Number of persons at risk at that point}

(continued on page 645)

TABLE A-1 Apgar Scores

	Score					
Sign	0	1	2			
Appearance (color)	Blue or pale	Pink body with blue extremities	Completely pink			
Pulse (heart rate)	Absent	Slow (<100/min)	>100/min			
Grimace (reflex irritability	No response	Grimace	Cough or sneeze			
Activity (muscle tone)	Limp	Some flexion	Active movement			
Respirations	Absent	Slow, irregular	Good, crying			

TABLE A-2
Desirable Weights (in lb) for Men and Women*

		Age
Height	19–34	35 Years and Older
5′0″	97–128	108–138
5'1"	101-132	111–143
5'2"	104–13 <i>7</i>	115–148
5'3"	107-141	119–152
5'4"	111–146	122–1 <i>57</i>
5'5"	114–150	126–162
5'6"	118–156	130–16 <i>7</i>
5'7"	121-160	134–172
5'8"	125-164	138–1 <i>7</i> 8
5'9"	129-169	142-183
5'10"	132-174	146-188
5'11"	136–179	151–194
6′0″	140-184	155–199
6′1″	144-189	159-205
6'2"	148-195	164-210

^{*}Weights are based on weighing in without shoes or clothes.

Source: United States Department of Agriculture and United States Department of Health and Human Resources, 1990.

Appendix 641

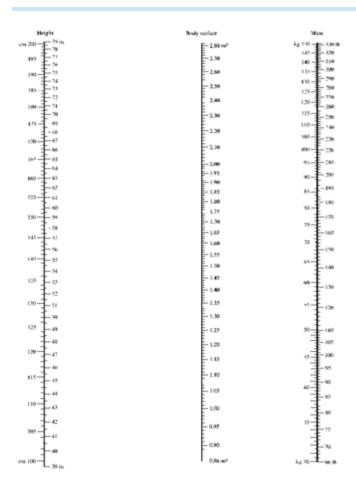


FIGURE A-1 Body surface area: Adult. Use a straight edge to connect the height and mass. The point of intersection on the body surface line gives the body surface area (in m²). (Reprinted, with permission, from: Lentner C [ed]: *Geigy Scientific Tables*, 8th ed. Ciba-Geigy, San Francisco CA, 1981, Vol. 1, p. 226.)

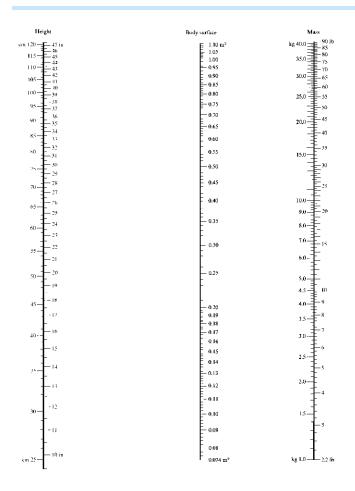


FIGURE A-2 Body surface area: Child. Use a straight edge to connect the height and mass. The point of intersection on the body surface line gives the body surface area (in m²). (Reprinted, with permission, from: Lentner C [ed]: *Geigy Scientific Tables*, 8th ed. Ciba-Geigy, San Francisco CA, 1981, Vol. 1, p. 227.)

TABLE A-3
Recommendations for Cancer Screening for Average Risk, Asymptomatic People

Cancer Site	Population	Test or Procedure	Frequency
Breast	Women, age 20+	Breast self-examination Clinical breast examination	Monthly, starting at age 20 Every 3 years, ages 20–39 Annual, starting at age 40*
Colorectal	Men & women, age 50+	Mammography Fecal occult blood test & flexible sigmoidoscopy [†]	Annual, starting at age 40 Annual fecal occult blood test and flexible sigmoid- oscopy at age 50; thereafter, fecal occult blood test every year and flexible sigmoidoscopy every 5 years
		-or- Double contrast barium enema [†]	Double contrast barium enema at age 50; thereafter, every 5–10 y
		-or- Colonoscopy [†]	Colonoscopy every 10 y starting at age 50
Prostate	Men, age 50+	Digital rectal examination & prostate specific antigen test	Annual digital rectal examination and prostate-specific antigen test should be offered to men starting at ago 50‡
Cervix	Women, age 18+	Pap test and pelvic examination	All women who are, or have been, sexually active, or have reached age 18 should have an annual Pap test and pelvic examination. After a woman has had 3 or more consecutive satisfactory normal annual examinations, the Pap test may be performed less frequently at the discretion of the physician.

TABLE A-3 (Continued)

Cancer- Men & women Examinations every 3 y from ages 20–39 y and annually after age 40. The cancer-
related age 20+ related check-up should include examination for cancers of the thyroid, testicles, ovaries, lymph nodes, oral cavity, and skin, as well as health counseling about tobe sun exposure, diet and nutrition, risk factors, sexual practices, and environmental an occupational exposures.

Appendix 645

(continued from page 639)

Incidence =
$$\frac{\text{Number of new cases of a disease over a period of time}}{\text{Number of persons at risk during that period}}$$

Sensitivity = Proportion of subjects with the disease who have a positive test = $(a/a + c)$

Specificity = Proportion of subjects without the disease who have a negative test = (d/b + d)

Predictive value = Positive: likelihood of a positive test indicates disease = (a/a + b)= Negative: likelihood of a negative test indicates lack of disease = (d/c + d)

		+ (Present)	ease — (Absent)
	(+)	a	b
Test	(-)	С	d

GLASCOW COMA SCALE

The Glasgow Coma Scale (*EMV* Scale) gives a fairly reliable, objective way to monitor changes in levels of consciousness. It is based on *Eye* opening, *Motor* responses, and *Verbal* responses. A person's EMV score is based on the total of the three responses. The score ranges from 3 (lowest) to 15 (highest) (Table A–4).

TABLE A-4
Glasgow Coma Scale

Parameter	Response		Score
Eyes	Open: Spontaneo	usly	4
		To verbal command	3 2
		To pain	2
		No response	1
Best motor response	To verbal command	Obeys	6
'	To painful stimulus	Localized pain	5
	'	Flexion-withdrawal	4
		Decorticate (flex)	3
		Decerebrate (extend)	2
		No response	1
Best verbal response		Oriented, converses	5
'		Disoriented, converses	4
		Inappropriate responses	3
		Incomprehensible sound	
		No response	1

MEASUREMENTS

Equivalents (Approximate)

Length

1 centimeter (cm) = 0.4 in. 1 meter (m) = 39.4 in.

Household

1 teaspoon (tsp) = 5 mL 1 tablespoon (tbsp) = 15 mL 1 ounce (oz) = 30 mL 8 ounces (oz) = 1 cup = 240 mL 1 quart (qt) = 946 mL

Apothecary

1 grain (gr) = 60 mg 30 gram (g) = 1 oz 1 g = 15 gr

SI PREFIXES AND SYMBOLS

Factor	Prefix	Symbol
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10^{1}	deka	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f

PERFORMANCE STATUS SCALES

Table A-5 lists the most common performance scales used clinically.

RADIATION TERMINOLOGY

Measure	Old Term	SI Unit
Activity	curie	becquerel (Bq)
Absorbed dose	rad	gray (Gy)

TEMPERATURE CONVERSION

Table A-6 gives information for converting temperature from the Fahrenheit (F) scale to the centigrade, or Celsius (C), scale and vice versa.

(continued on page 649)

TABLE A-5
Performance Status Scales

Karnofsky		ECOG		AJCC	
% Normal Status	Activity Level	Grade	Activity Level	Grade	Activity
100	Normal; no complaints; no evidence of disease;	0	Normal activity	НО	Normal activity
90	Able to carry on normal activity; minor sign or symptoms of disease				
80	Normal activity with effort; some signs or symptoms	1	Symptoms but ambulatory	H1	Symptomatic and ambulatory; cares for self
70	Cares for self; unable to carry on normal activity or progressing rapidly to active work				30.1
60	Requires occasional assistance but able to care for self	2	In bed 50% of time	H2	Ambulatory 50% of time occasionally needs assistance
50	Requires considerable assistance and frequent medical care				
	% Normal Status 100 90 80 70	% Normal Status Level 100 Normal; no complaints; no evidence of disease; 90 Able to carry on normal activity; minor sign or symptoms of disease 80 Normal activity with effort; some signs or symptoms of disease 70 Cares for self; unable to carry on normal activity or progressing rapidly to active work 60 Requires occasional assistance but able to care for self 50 Requires considerable assistance and frequent	% Normal Status Level Grade 100 Normal; no complaints; 0 no evidence of disease; 90 Able to carry on normal activity; minor sign or symptoms of disease 80 Normal activity with effort; some signs or symptoms of disease 70 Cares for self; unable to carry on normal activity or progressing rapidly to active work 60 Requires occasional assistance but able to care for self 50 Requires considerable assistance and frequent	% Normal Status Level Grade Activity Level Grade Level 100 Normal; no complaints; 0 Normal activity no evidence of disease; 90 Able to carry on normal activity; minor sign or symptoms of disease 80 Normal activity with effort; 1 Symptoms but some signs or symptoms of disease 70 Cares for self; unable to carry on normal activity or progressing rapidly to active work 60 Requires occasional assistance but able to care for self 50 Requires considerable assistance and frequent	% Normal Status Activity Level Grade Activity Level Grade 100 Normal; no complaints; no evidence of disease; no evidence of disease; Able to carry on normal activity; minor sign or symptoms of disease 0 Normal activity with effort; some signs or symptoms of disease 1 Symptoms but ambulatory H1 80 Normal activity with effort; some signs or symptoms of disease 1 Symptoms but ambulatory H1 70 Cares for self; unable to carry on normal activity or progressing rapidly to active work 0 Requires occasional assistance but able to care for self 2 In bed 50% of time H2 of time 50 Requires considerable assistance and frequent assistance and frequent 1 1 1 1 1

TABLE A-5 (Continued)

	Karnofsky		E	ECOG		AJCC
Functional Status	% Normal Status	Activity Level	Grade	Activity Level	Grade	Activity
Unable to care for self; requires equivalent of needed institutional	40	Disabled; requires special care and assistance	3	In bed 50% of time	НЗ	Ambulatory 50% of time; nursing care
or hospital care; may be progressing rapidly	30	Severely disabled; hospital- ization indicated through death not imminent				
	20	Very sick; hospitalization necessary	4	100% bedridde	en H4	Bedridden; may need hospitalization
	10	Moribund; fatal processes				
	0	Dead				

Abbreviations: ECOG = Eastern Cooperative Oncology Group; AJCC = American Joint Committee on Cancer.

Source: Reprinted, with permission, from Practical Oncology. Cameron R (ed). Appleton & Lange, Stamford, CT, 1993.

Appendix 649

TABLE A-6
Temperature Conversion Table

17.7 15.0 15.5 16.1 16.6 17.0 17.2	0 35.0 35.5 36.0 36.5 37.0 37.5 38.0	32.0 95.0 95.9 96.8 97.7 98.6 99.5
35.5 36.1 36.6 37.0 37.2	35.5 36.0 36.5 37.0 37.5	95.9 96.8 97.7 98.6 99.5
86.1 86.6 87.0 87.2	36.0 36.5 37.0 37.5	96.8 97.7 98.6 99.5
36.6 37.0 37.2	36.5 37.0 37.5	97.7 98.6 99.5
37.0 37.2	37.0 37.5	98.6 99.5
37.2	37.5	99.5
·· ·-		
R7 7	20 0	
	36.0	100.4
88.3	38.5	101.3
88.8	39.0	102.2
39.4	39.5	103.1
10.0	40.0	104.0
10.5	40.5	104.9
11.1	41.0	105.8
5/9	F = (C × 9/	5) + 32
degrees Eghrenheit: C = degr	rees Celsius	
	88.8 89.4 40.0 40.5 41.1	38.8 39.0 39.4 39.5 40.0 40.0 40.5 41.0

TNM AND OTHER SYSTEMS OF CLASSIFICATION FOR COMMON TUMORS

TNM stands for "tumor, nodes, metastasis" and is a universally accepted classification system for malignancy staging. The UICC (Union Internationale Contre le Cancer) and the AJCC (American Joint Committee on Cancer) have adopted this system and have published this system in TNM Classification of Malignant Tumours, 5th ed John Wiley & Sons, New York, 1997. The following is a highly selected listing of commonly encounters solid tumors (breast, bladder, cervix, colon and rectum, kidney, lung, melanoma, ovary, stomach, thyroid, uterus, and prostate) as well as the classification for lymphomas. Where appropriate, other common staging systems are noted (ie, Duke's classification of colon cancer)

TNM CLASSIFICATION

Breast

Primary Tumor (T)

TX Primary tumor cannot be assessed

T0 No evidence of primary tumor

Tis Carcinoma in situ: Intraductal carcinoma, lobular carcinoma in situ, or Paget's disease of the nipple with no tumor. *Note:* Paget disease associated with a tumor is classified according to the size of the tumor.

T1 Tumor 2 cm or less in greatest dimension

T1mic Microinvasion 0.1 cm or less in greatest dimension

T1a More than 0.1 cm but not more than 0.5 cm in greatest dimension

T1b More than 0.5 cm but not more than 1 cm in greatest dimension

T1c More than 1 cm but not more than 2 cm in greatest dimension

- Tumor more than 2 cm but not more than 5 cm in greatest dimension
- Tamor more than 5 cm in greatest dimension
- T4 Tumor of any size with direct extension to chest wall or skin
 - T4a Extension to chest wall
 - T4b Edema (including peau d'orange) or ulceration of the skin of breast or satellite skin nodules confined to same breast
 - T4c Both T4a and T4b
 - T4d Inflammatory carcinoma

Lymph Node (N)

- NX Regional lymph nodes cannot be assessed
- No No regional lymph node metastasis
- N1 Metastasis to movable ipsilateral axillary lymph nodes(s)
- N2 Metastasis to ipsilateral axillary lymph node(s) fixed to one another or to other structures
- N3 Metastasis to ipsilateral internal mammary lymph node(s)

Distant Metastasis (M)

- MX Presence of distant metastasis cannot be assessed
- M0 No distant metastasis
- M1 Distant metastasis (includes metastasis to ipsilateral supraclavicular lymph nodes)

Pathologic Classification (pTNM)

Primary Tumor (pT)

The pT categories correspond to the T categories.

Regional Lymph Nodes (pN)

pNX Regional lymph nodes cannot be assessed

pN0 No regional lymph node metastasis

pN1 Metastasis to movable ipsilateral axillary lymph node(s)

pN1a Only micrometastasis (none larger than 0.2 cm)pN1b Metastasis to lymph nodes, any larger than 0.2 cm

pN1bi Metastasis in 1–3 lymph nodes, any more than 0.2 cm and all less

than 2 cm in greatest dimension

pN1bii Metastasis to 4 or more lymph nodes, any more than 0.2 cm and

all less than 2 cm in greatest dimension

pN1biii Extension of tumor beyond the capsule of a lymph node metasta-

sis less than 2 cm in greatest dimension

pN1biv Metastasis to a lymph node 2 cm or more in greatest dimension

pN2 Metastasis to ipsilateral axillary nodes that are fixed

pN3 Metastasis to ipsilateral internal mammary lymph nodes(s)

Pathologic Classification

The pM category corresponds to the M category above.

Bladder

Primary Tumor (T)

- TX Primary tumor cannot be assessed
- T0 No evidence of primary tumor
 - Tis Carcinoma in situ: "flat tumor"

Appendix 651

- Ta Noninvasive papillary carcinoma
- T1 Tumor invades subepithelial connective tissue
- T2 Tumor invades muscle
 - T2a Tumor invades superficial muscle (inner half)
 - T2b Tumor invades deep muscle (outer half)
- T3 Tumor invades perivesical tissue
 - T3a Microscopically
 - T3b Macroscopically (extravesical mass)
- T4 Tumor invades any of the following: prostate, uterus, vagina, pelvic wall, abdominal wall
 - T4a Tumor invades prostate or uterus or vagina
 - T4b Tumor invades pelvic wall or abdominal wall

Lymph Node (N)

- NX Regional lymph nodes cannot be assessed
- No No regional lymph node metastasis
- N1 Metastasis in a single lymph node, 2 cm or less in greatest dimension
- N2 Metastasis in a single lymph node, more than 2 cm but not more than 5 cm in greatest dimension, or multiple lymph nodes, none more than 5 cm in greatest dimension
- N3 Metastasis in a lymph node more than 5 cm in greatest dimension

Distant Metastasis (M)

- MX Presence of distant metastasis cannot be assessed
- M0 No distant metastasis
- M1 Distant metastasis

Pathologic Classification (pTNM)

The pT, pN, and pM categories correspond to the T, N, and M categories.

Cervix

Primary Tumor (T)

- TX Primary tumor cannot be assessed
- T0 No evidence of primary tumor
- Tis Carcinoma in situ
- T1 Cervical carcinoma confined to uterus
 - T1a Preclinical invasive carcinoma diagnosed by microscopy only
 - $\textbf{T1ai} \ \ \text{Stromal invasion no greater than 3.0 mm in depth and 7.0 mm or less in horizontal spread}$
 - T1aii Stromal invasion more than 3.0 mm and not more than 5.0 mm with a horizontal spread 7.0 mm or less
 - T1b Clinically visible lesion confined to the cervix or microscopic lesion greater than T1a2
 - T1bi Clinically visible lesion 4 cm or less in greatest dimension
 - T1bii Clinically visible lesion more than 4 cm in greatest dimension
- T2 Cervical carcinoma invades beyond uterus but not to pelvic wall or to the lower third of vagina
 - T2a Tumor without parametrial invasion
 - T2b Tumor with parametrial invasion
- T3 Cervical carcinoma extends to pelvic wall and/or involves lower third of vagina and/or causes hydronephrosis or nonfunctioning kidney
 - T3a Tumor involves lower third of the vagina, no extension to pelvic wall

- T3b Tumor extends to pelvic wall and/or causes hydronephrosis or nonfunctioning kidney
- **T4** Tumor invades mucosa of bladder or rectum and/or extends beyond the true pelvis *Note:* The presence of bullous edema is not sufficient to classify a tumor as T4.

Lymph Node (N)

- NX Regional lymph nodes cannot be assessed
- No regional lymph node metastasis
- N1 Regional lymph node metastasis

Distant Metastasis (M)

- MX Presence of distant metastasis cannot be assessed
- M0 No distant metastasis
- M1 Distant metastasis

Pathologic Classification (pTNM)

The pT, pN and pM categories correspond to the T, N, and M categories.

Colon and Rectum

Primary Tumor (T)

- TX Primary tumor cannot be assessed
- T0 No evidence of primary tumor
- Tis Carcinoma in situ: intraepithelial or invasion of lamina propria*
- T1 Tumor invades submucosa
- T2 Tumor invades muscularis propria
- T3 Tumor invades through muscularis propria into subserosa, or into nonperitonealized pericolic or perirectal tissues
- Tumor perforates visceral peritoneum or directly invades other organs or structures

Lymph Node (N)

- NX Regional lymph nodes cannot be assessed
- No regional lymph node metastasis
- N1 Metastasis in 1–3 pericolic or perirectal lymph nodes
- N2 Metastasis in 4 or more pericolic or perirectal lymph nodes

Distant Metastasis (M)

- MX Presence of distant metastasis cannot be assessed
- M0 No distant metastasis
- M1 Distant metastasis

Pathologic Classification (pTNM)

The pT, pN and pM categories correspond to the T, N, and M categories.

DUKES' CLASSIFICATION (ASTER-COLLER MODIFICATION) OF COLON CANCER

STAGE A: Into muscularis propria, nodes negative
STAGE B1: Extends through entire wall, nodes negative
STAGE B2: Extends into muscularis propria, nodes positive
STAGE C1: Extends through entire wall, 1–3 nodes positive

^{*}Tis includes cancer cells confined within the glandular basement membrane (intraepithelial) or lamina propria (intramucosal) with no extension through muscularis mucosa into submucosa.

Appendix 653

STAGE C2: ≥ 4 nodes positive STAGE D: Metastatic disease

Kidney

Primary Tumor (T)

- TX Primary tumor cannot be assessed
- T0 No evidence of primary tumor
- T1 Tumor 7 cm or less in greatest dimension limited to the kidney
- T2 Tumor more than 7 cm in greatest dimension limited to the kidney
- T3 Tumor extends into major veins or invades adrenal gland or perinephric tissues but not beyond Gerota's fascia
 - T3a Tumor invades adrenal gland or perinephric tissues but not beyond Gerota's fascia
 - T3b Tumor grossly extends into renal vein(s) or vena cava below diaphragm
 - T3c Tumor grossly extends into vena cava above diaphragm
- T4 Tumor invades beyond Gerota's fascia

Lymph Node (N)

- NX Regional lymph nodes cannot be assessed
- No regional lymph node metastasis
- N1 Metastasis in a single regional lymph node
- N2 Metastasis in more than one regional lymph node

Distant Metastasis (M)

- MX Presence of distant metastasis cannot be assessed
- M0 No distant metastasis
- M1 Distant metastasis

Pathologic Classification (pTNM)

The pT, pN and pM categories correspond to the T, N, and M categories.

Lung

Primary Tumor (T)

- TX Primary tumor cannot be assessed, or tumor proven by presence of malignant cells in sputum or bronchial washings but not visualized by imaging or bronchoscopy
- T0 No evidence of primary tumor
- Tis Carcinoma in situ
- T1 Tumor 3 cm or less in greatest dimension, surrounded by lung or visceral pleura, without bronchoscopic evidence of invasion more proximal than the lobar bronchus
- T2 Tumor with *any* of the following features of size or extent: More than 3 cm in greatest dimension; involves main bronchus, 2 cm or more distal to the carina; invades the visceral pleura; associated with atelectasis or obstructive pneumonitis that extends to the hilar region but does not involve the entire lung
- T3 Tumor of any size that directly invades any of the following: chest wall (including superior sulcus tumors), diaphragm, mediastinal pleura, parietal pericardium; or tumor in the main bronchus less than 2 cm distal to the carina but without involvement of the carina; or associated atelectasis or obstructive pneumonitis of the entire lung
- T4 Tumor of any size that invades any of the following: mediastinum, heart, great vessels, trachea, esophagus, vertebral body, carina; or tumor with a malignant pleural effusion

Lymph Node (N)

- NX Regional lymph nodes cannot be assessed
- No regional lymph node metastasis
- N1 Metastasis in ipsilateral peribronchial and/or ipsilateral hilar lymph nodes, including direct extension
- N2 Metastasis in ipsilateral mediastinal and/or subcarinal lymph node(s)
- N3 Metastasis in contralateral mediastinal, contralateral hilar, ipsilateral or contralateral scalene, or supraclavicular lymph node(s)

Distant Metastasis (M)

- MX Presence of distant metastasis cannot be assessed
- M0 No distant metastasis
- M1 Distant metastasis

OTL OF

Pathologic Classification (pTNM)

The pT, pN and pM categories correspond to the T, N, and M categories.

ANN ARBOR STAGING CLASSIFICATION

DEELMELON

Lymphoma (Hodgkin's Disease and Non-Hodgkin's Lymphoma)

STAGE	DEFINITION
I	Limited to one area
II	Involvement of two or more areas on the same side of the diaphragm
III	Involvement of two or more areas on both sides of the diaphragm
	III ₁ Upper abdomen, spleen, splenic and hilar nodes
	III ₂ Lower abdominal nodes
IV	Extra lymph node involvement

Melanoma of the Skin (Excluding Eyelid)

Primary Tumor (pT)

- pTX Primary tumor cannot be assessed
- pT0 No evidence of tumor
- pTis Melanoma in situ (atypical melanotic hyperplasia, severe melanotic dysplasia), not an invasive lesion (Clark's level I)
- **pT1** Tumor 0.75 mm or less in thickness and invades the papillary dermis (Clark's level II)
- pT2 Tumor more than 0.75 mm but not more than 1.5 mm in thickness and/or invades to papillary-reticular dermal interface (Clark's level III)
- pT3 Tumor more than 1.5 mm but not more than 4 mm in thickness and/or invades the reticular dermis (Clark's level IV)
 - pT3a Tumor more than 1.5 mm but not more than 3 mm in thickness
 - **pT3b** Tumor more than 3 mm but not more than 4 mm in thickness
- **pT4** Tumor more than 4 mm in thickness and/or invades the subcutaneous tissue (Clark's level V) and/or satellite(s) within 2 cm of the primary tumor
 - **pT4a** Tumor more than 4 mm in thickness and/or invades the subcutaneous tissue **pT4b** Satellite(s) with 2 cm of primary tumor

Lymph Node (N)

- NX Regional lymph nodes cannot be assessed
- No No regional lymph node metastasis

Appendix 655

N1 Metastasis 3 cm or less in greatest dimension in any regional lymph node(s)

N2 Metastasis more than 3 cm in greatest dimension in any regional lymph node(s)

N2a Metastasis more than 3 cm in greatest dimension in any regional lymph node(s) and/or in-transit metastasis

N2b In-transit metastasis

N2c Both (N2a and N2b)

Distant Metastasis (M)

MX Presence of distant metastasis cannot be assessed

M0 No distant metastasis

M1 Distant metastasis

M1a Metastasis in skin or subcutaneous tissue or lymph node(s) beyond the regional lymph nodes

M1b Visceral metastasis

Ovary

Primary Tumor (T)

TNM	FIGO*	DEFINITION
TX		Primary tumor cannot be assessed
T0	I	No evidence of primary tumor
T1		Tumor limited to ovaries
T1a	Ia	Tumor limited to one ovary; capsule intact, no tumor on ovarian surface
T1b	Ib	Tumor limited to both ovaries; capsules intact, no tumor on ovarian surface
T1c	Ic	Tumor limited to one or both ovaries with any of the following: capsule ruptured, tumor on ovarian surface, malignant cells in as- cites, or peritoneal washings
T2	II	Tumor involves one or both ovaries with pelvic extension
T2a	IIa	Extension or implants on uterus or tubes
T2b	IIb	Extension to other pelvic tissues
T2c	IIc	Pelvic extension (2a or 2b) with malignant cells in ascites or peritoneal washing
T3	III	Tumor involves one or both ovaries with microscopically con-
		firmed and/or N1 peritoneal metastasis outside the pelvis or regional lymph node metastasis
T3a	IIIa	Microscopic peritoneal metastasis beyond pelvis
T3b	$IIIb^{\dagger}$	Macroscopic peritoneal metastasis beyond pelvis 2 cm or less in greatest dimension
T3c	IIIc	Peritoneal metastasis beyond pelvis more than 2 cm in greatest and/or N1 dimension or regional lymph node metastasis

Lymph Node (N)

NX Regional lymph nodes cannot be assessed

No regional lymph node metastasis

N1 Regional lymph node metastasis

^{*}FIGO = Fédération Internationale de Gynécologie et d'Obstétrique.

[†]Liver capsule metastasis is T3/stage III, liver parenchymal metastasis M1/stage IV. Pleural effusion must have positive cytology for M1/stage IV.

Distant Metastasis (M)

TNM	FIGO	DEFINITION
MX		Presence of distant metastasis cannot be assessed
M0		No distant metastasis
M1	IV	Distant metastasis (excludes peritoneal metastasis)

Stomach

Primary Tumor (T)

- TX Primary tumor cannot be assessed
- T0 No evidence of primary tumor
- Tis Carcinoma in situ: Intraepithelial tumor without invasion of lamina propria
- T1 Tumor invades lamina propria or submucosa
- T2 Tumor invades muscularis propria or subserosa
- T3 Tumor penetrates serosa (visceral peritoneum) without invasion of adjacent structures
- T4 Tumor invades adjacent structures

Lymph Node (N)

- NX Regional lymph node(s) cannot be assessed
- No regional lymph node metastasis
- N1 Metastasis in 1–6 regional lymph node(s)
- N2 Metastasis in 7–15 regional lymph nodes(s)
- N3 Metastasis in more than 15 regional lymph nodes(s)

Distant Metastasis (M)

- MX Presence of distant metastasis cannot be assessed
- M0 No distant metastasis
- M1 Distant metastasis

Pathologic Classification (pTNM)

The pT, pN and pM categories correspond to the T, N, and M categories.

Thyroid Gland

Primary Tumor (T)

All categories may be subdivided: (a) solitary; (b) multifocal-measure the largest for classification

- TX Primary tumor cannot be assessed
- T0 No evidence of primary tumor
- T1 Tumor 1 cm or less in greatest dimension limited to the thyroid
- T2 Tumor more than 1 cm but not more than 4 cm in greatest dimension limited to the thyroid
- T3 Tumor more than 4 cm in greatest dimension limited to the thyroid
- T4 Tumor of any size extending beyond the thyroid capsule

Lymph Node (N)

Regional nodes are the cervical and upper mediastinal lymph nodes

- NX Regional lymph nodes cannot be assessed
- No No regional lymph node metastasis
- N1 Regional lymph node metastasis
 - N1a Metastasis in ipsilateral cervical lymph nodes
 - N1b Metastasis in bilateral, midline, or contralateral cervical or mediastinal lymph nodes

Distant Metastasis (M)

MX Presence of distant metastasis cannot be assessed

M0 No distant metastasis M1 Distant metastasis

Pathologic Classification (pTNM)

The pT, pN, and pM categories correspond to the T, N, and M categories.

Uterus

Primary Tumor (T)

TNM	FIGO	DEFINITION
TX		Primary tumor cannot be assessed
T0		No evidence of primary tumor
Tis	0	Carcinoma in situ
T1	I	Tumor confined to corpus
T1a	Ia	Tumor limited to endometrium
T1b	Ib	Tumor invades up to less than one half of myometrium
T1c	Ic	Tumor invades up to more than one half of myometrium
T2	II	Tumor invades cervix but does not extend beyond uterus
T2a	Пa	Endocervical glandular involvement only
T2b	IIb	Cervical stomal invasion
T3	Ш	Local and/or regional spread as specified in T3a, b, N1, and FIGO
		IIIA, B, C.
T3a	Шa	Tumor involves serosa and/or adnexa (direct extension or metasta-
		sis) and/or cancer cells in ascites or peritoneal washings
T3b	IIIb	Vaginal involvement (direct extension or metastasis)
N1	IIIc	Metastasis to pelvic and/or paraaortic lymph nodes
T4*	IVa	Tumor invades bladder mucosa and/or bowel mucosa

Lymph Node (N)

NX Regional lymph nodes cannot be assessed
 N0 No regional lymph node metastasis
 N1 Regional lymph node metastasis

Distant Metastasis (M)

TNM	FIGO [†]	DEFINITION
MX		Presence of distant metastasis cannot be assessed
M0		No distant metastasis
M1	Ivb	Distant metastasis (excluding metastasis to vagina, pelvic serosa,
		or adnexa, including metastasis to intraabdominal lymph nodes
		other than paraaortic and/or inguinal nodes)

Pathologic Classification (pTNM)

The pT, pN, and pM categories correspond to the T, N, and M categories.

Prostate

T0 No evidence of primary tumor

T1 Nonpalpable disease (old stage "A")

T1a Three or fewer microscopic foci of carcinoma
 T1b More than 3 microscopic foci of carcinoma
 T1c No palpable tumor, diagnosed by elevated PSA

^{*}The presence of bullous edema is not sufficient evidence to classify a tumor T4.

[†]FIGO = Fédération Internationale de Gynécologie et d'Obstétrique

- T2 Tumor presents clinically or grossly, limited to the gland (old stage "B")
 - T2a Tumor involves one lobe
 - T2b Tumor involves both lobes
- T3 Tumor extends through the prostatic capsule (old stage "C")
 - T3a Extracapsular extension (unilateral or bilateral)
 - T3b Tumor invades seminal vesical(s)
- T4 Tumor is fixed or invades adjacent structures other than seminal vesicles: bladder neck, external sphincter, rectum, levator muscles, and/or pelvic wall.

Regional Lymph Nodes (N)

- NX Regional lymph nodes cannot be assessed
- N0 No regional lymph node metastasis
- N1 Regional lymph node metastasis

Distant Metastasis (M)

- MX Distant metastasis cannot be assessed
- M0 No distant metastasis
- M1 Distant metastasis
 - M1a Nonregional lymph node(s)
 - M1b Bone(s)
 - M1c Other site(s)

Pathologic Classification (pTNM)

The pT, pN and pM categories correspond to the T, N, and M categories. However, there is no pT1 category because there is insufficient tissue to assess the highest pT category.

WEIGHT CONVERSION

Table A-7 gives information for converting weight in pounds (lb) to weight in kilograms (kg) and vice versa.

TABLE A-7
Weight Conversion Table

lb	kg	kg	lb	
1	0.5	1	2.2	
2	0.9	2	4.4	
4	1.8	3	6.6	
6 8	2.7	4	8.8	
8	3.6	5	11.0	
10	4.5	6	13.2	
20	9.1	8	17.6	
30	13.6	10	22.0	
40	18.2	20	44.0	
50	22.7	30	66.0	
60	27.3	40	88.0	
70	31.8	50	110.0	
80	36.4	60	132.0	
90	40.9	70	154.0	
100	45.4	80	1 <i>7</i> 6.0	
150	68.2	90	198.0	
200	90.8	100	220.9	
kg = lb ×	0.454	lb = kg ×	2.2	

INDEX

Note: Page numbers followed by f indicate figures; those followed by t indicate tables.

```
and dosage of, 488
Abbokinase (urokinase), indications,
       actions, and dosage of, 615
Abciximab (ReoPro)
  for emergency cardiac care, 464
  indications, actions, and dosage of, 488
Abdominal computed tomography, 330
Abdominal distention, differential
       diagnosis of, 42
Abdominal magnetic resonance imaging,
Abdominal pain, differential diagnosis of,
Abdominal paracentesis, 296-297, 298f
Abdominal ultrasound, 329
Abdominal x-rays, 326
Abelcet (amphotericin B lipid complex),
       indications, actions, and dosage of,
       497
Abscesses, dental, 470
Absorbable sutures, 345, 346t
Acalculous cholecystitis, 434
Acanthocytes, 104
Acarbose (Precose), indications, actions,
       and dosage of, 488
Accelerations, in fetal heart rate, 276
Accolate (zafirlukast), indications, actions,
       and dosage of, 619
Accupril (quinapril), indications, actions,
       and dosage of, 596
Accutane (isotretinoin), indications,
       actions, and dosage of, 555-556
Acebutolol (Sectral), indications, actions,
```

and dosage of, 488

Abacavir (Ziagen), indications, actions,

```
Acetaminophen (Datril; Tylenol)
  antidote for, 471
  indications, actions, and dosage of, 488,
  route, effects, and dosage for, 321t
Acetaminophen + butalbital +/- caffeine
       (Fioricet; Medigesic; Phrenilin
       Forte; Repan; Sedapap-10 Two-
       dyne; Triapin Axocet), indications,
       actions, and dosage of, 489
Acetaminophen + codeine (Tylenol No. 1,
       No. 2, No. 4), indications, actions,
       and dosage of, 489
Acetazolamide (Diamox)
  for hyperphosphatemia, 192
  indications, actions, and dosage of, 489
Acetic acid + aluminum acetate (Otic
       Domeboro), indications, actions,
       and dosage of, 489
Acetoacetate, laboratory diagnosis and, 55
Acetone, laboratory diagnosis and, 55
Acetylcysteine (Mucomyst; Mucosil), 364
  indications, actions, and dosage of,
    489-490
N-Acetylcysteine, for acetaminophen
       poisoning, 471
Achromycin V (tetracycline)
  indications, actions, and dosage of,
     153t 609
  interaction with enteral nutrition, 223
Acid-base disorders, 163-175
  blood gas interpretation and, 163,
     165-166
  definition of, 163, 164t, 165f
```

Aceon (perindopril erbumine), indications, actions, and dosage of, 587–588

Activated clotting time (ACT), 105 Activated partial thromboplastin time

laboratory diagnosis and, 55

actions, and dosage of, 531

Adriamycin (doxorubicin), indications,

Acid-base disorders (continued)

hypoxia, 171f, 171-172

Superchar)

indications, actions, and dosage of, 514

clinical use of, 472

metabolic acidosis, 164t, 166–167	(aPTT), 107
metabolic alkalosis, 164t, 167, 169	Actonel (risedronate), indications, actions,
mixed, 163	and dosage of, 599
respiratory acidosis, 164t, 169-170	Actos (pioglitazone), indications, actions,
respiratory alkalosis, 164t, 170-171	and dosage of, 589
sample problems involving, 172-175	Actretin (Soriatane), indications, actions,
simple, 163	and dosage of, 488
Acid-fast stain, 121	Acular (ketorolac, ophthalmic),
Acidosis	indications, actions, and dosage of,
metabolic, 164t, 166–167	557
respiratory, 164 <i>t</i> , 169–170	Acupuncture, for pain management, 323
Acid phosphatase, laboratory diagnosis	Acute abdominal series, 326
and, 55	Acute coronary syndromes algorithm,
Acinetobacter, Gram stain characteristics	459f
of, 125t, 126t	Acute intravascular hemolysis, 202
Aciphex (rabeprazole), indications,	Acute lung injury, transfusions and, 202,
actions, and dosage of, 597	203
Aclovate (aclometasone dipropionate),	Acute renal failure, 432–433
potency and application of, 628t	diet for, $207t$
Acne, organisms responsible and empiric	Acute specimens (titers), 132
therapy for, 141t	Acute tubular necrosis, 432
Acne rosacea, organisms responsible and	Acyclovir (Zovirax), indications, actions,
empiric therapy for, 141t	and dosage of, 147t, 148t, 149t,
Acquired immunodeficiency syndrome.	490
See Human immunodeficiency	Adalat (nifedipine), indications, actions,
virus (HIV) infection; Human	and dosage of, 578
immunodeficiency virus (HIV)	Adalat CC (nifedipine), indications,
testing	actions, and dosage of, 578
ACTH stimulation test, 55–56	Adapin (doxepin)
Actidose (activated charcoal)	half-life and therapeutic and toxic levels
clinical use of, 472	of, 634 <i>t</i>
indications, actions, and dosage of, 514	indications, actions, and dosage of, 530
Actimmune (interferon gamma-1B),	Adenosine (Adenocard)
indications, actions, and dosage of,	for emergency cardiac care, 461
554	indications, actions, and dosage
Actinomyces, Gram stain characteristics	of, 490
of, 125 <i>t</i>	Adrenalin. See Epinephrine (Adrenalin;
Actiq (fentanyl, transmucosal system),	Sus-Phrine)
indications, actions, and dosage of,	Adrenal masses, differential diagnosis of,
538	42
Activase (alteplase, recombinant)	Adrenal scans, 333
for emergency cardiac care, 466	α ₁ -Adrenergic blockers, 479
indications, actions, and dosage of,	Adrenergic nervous system, 395, 397,
492–493	397t, 398t
Activated charcoal (Actidose; Liqui-Char;	Adrenocorticotropic hormone (ACTH),

- Adrucil (fluorouracil), indications, actions, and dosage of, 540
- Adult respiratory distress syndrome (ARDS), 429–431
- Advanced cardiac life support (ACLS), 449–468
 - algorithms for, 450f-460f
 - drugs used in, 449, 461–467 electrical defibrillation and cardioversion for, 467–468
 - transcutaneous pacing for, 468
- Advil (Ibuprofen)
 - indications, actions, and dosage of, 551 route, effects, and dosage for, 321t
- Aerobid (flunisolide), indications, actions, and dosage of, 540
- Aeromonas hydrophilia, Gram stain characteristics of, 126t
- Aeroseb-Dex (dexamethasone base), potency and application of, 628*t*
- Aerosol therapy, 363
- topical medications for, 364
- AFB smear, 121
- Afrinol (pseudoephedrine), indications, actions, and dosage of, 595–596
- Afterload, 395
 - measurement of, 410
- Agenerase (amprenavir), indications, actions, and dosage of, 150t, 498
- Aggrastat (tirofiban)
 - for emergency cardiac care, 464 indications, actions, and dosage of, 611
- AIDS. See Human immunodeficiency virus (HIV) infection; Human immunodeficiency virus (HIV) testing
- Air-contrast BE, 328
- AK-Beat (levobunolol), indications, actions, and dosage of, 560
- AK-DEX Ophthalmic (dexamethasone, ophthalmic), indications, actions, and dosage of, 524
- Akne-Mycin Topical (erythromycin, topical), indications, actions, and dosage of, 534
- AK-NEO-DEX Ophthalmic (neomycin + dexamethasone), indications, actions, and dosage of, 576
- AK Poly Bac Ophthalmic (bacitracin + polymyxin B, ophthalmic),

- indications, actions, and dosage of, 502
- AK Spore HC Ophthalmic (bacitracin, neomycin, polymyxin B, + hydrocortisone, ophthalmic), indications, actions, and dosage of, 502
- AK Spore Ophthalmic (bacitracin, neomycin, + polymyxin B, ophthalmic), indications, actions, and dosage of, 502
- AK Tob (tobramycin, ophthalmic), indications, actions, and dosage of, 611
- AK-Tracin Ophthalmic (bacitracin, ophthalmic), indications, actions, and dosage of, 502
- Alanine aminotransferase (ALT; SGPT), laboratory diagnosis and, 57
- Albalon-A Opthalmic (naphazoline + antazoline), indications, actions, and dosage of, 575
- Albendazole, indications for, 153t, 154t
- Albumin, blood levels of, laboratory diagnosis and, 56
- Albumin (Albuminar; Albutein; Buminate), indications, actions, and dosage of, 200t, 490
- Albumin/globulin ratio (A/G ratio), laboratory diagnosis and, 56
- Albuterol (Proventil; Ventolin), 364 for anaphylaxis, 469 indications, actions, and dosage of, 490 nebulized, for asthmatic attacks, 469
- Albuterol + ipratropium (Combivent), indications, actions, and dosage of, 490
- Aldactazide (hydrochlorothiazide + spironolactone), indications, actions, and dosage of, 549
- Aldactone (spironolactone), indications, actions, and dosage of, 603
- Aldara (imiquimod), indications, actions, and dosage of, 148t, 552
- Aldesleukin [IL-2] (Proleukin), indications, actions, and dosage of, 491
- Aldomet (methyldopa), indications, actions, and dosage of, 569
- Aldosterone, laboratory diagnosis and, 56

Alendronate (Fosamax), indications, actions, and dosage of, 491 Alesse 21, 28, 623t Aleve (naproxen), indications, actions, and dosage of, 575575 Alfentanil (Alfenta), indications, actions, and dosage of, 491 Alginic acid + aluminum hydroxide and magnesium trisilicate (Gaviscon), indications, actions, and dosage of, Alimentum, 224t Alkaline phosphatase, laboratory diagnosis and, 56-57 Alkalinization, for poisoning, 472 Alkalosis metabolic, 164t, 167, 169 respiratory, 164t, 170-171 Alka-Mints (calcium carbonate) for hypocalcemia, 190 indications, actions, and dosage Alkeran (melphalan), indications, actions, and dosage of, 566 Alkylating agents, 478 Allegra (fexofenadine), indications, actions, and dosage of, 538-539 Allergic reactions to latex, 344 medications for, 476 to transfusions, 202, 203 Allopurinol (Aloprim; Lopurin; Zyloprim), indications, actions, and dosage of, 491 Alomide Ophthalmic (lodoxamide), indications, actions, and dosage of, 562 Alopecia, differential diagnosis of, 42 Aloprim (allopurinol), indications, actions, and dosage of, 491 Alosetran (Iotronex), indications, actions, and dosage of, 491 Alpha-fetoprotein (AFP), laboratory diagnosis and, 57 Alphagan (brimonidine), indications, actions, and dosage of, 506 Alpha-1 receptors, 397 Alprazolam (Xanax), indications, actions,

and dosage of, 492

Alprostadil [prostaglandin E_1] (Prostin VR), indications, actions, and dosage of, 492

Alprostadil, intracavernosal (Caverject; Edex), indications, actions, and dosage of, 492

Alprostadil, urethral suppository (Muse), indications, actions, and dosage of, 492

Altace (ramipril)

for emergency cardiac care, 461 indications, actions, and dosage of, 597

Alteplase, recombinant [TPA] (Activase) for emergency cardiac care, 466 indications, actions, and dosage of, 492–493

AlternaGel (aluminum hydroxide) for hyperphosphatemia, 192 indications, actions, and dosage of, 493

Altretamine (Hexalen), indications, actions, and dosage of, 493

Alum (ammonium aluminum sulfate), indications, actions, and dosage of, 496

Aluminum carbonate (Basaljel) for hyperphosphatemia, 192 indications, actions, and dosage of, 493

Aluminum hydroxide (ALternaGel; Amphojel)

for hyperphosphatemia, 192 indications, actions, and dosage of, 493 Aluminum hydroxide + magnesium

carbonate (Gaviscon), indications, actions, and dosage of, 493

Aluminum hydroxide + magnesium hydroxide (Maalox), indications, actions, and dosage of, 493–494

Aluminum hydroxide + magnesium trisilicate (Gaviscon; Gaviscon-2), indications, actions, and dosage of, 493

Alupent (metaproterenol), 364 indications, actions, and dosage of, 567 Amantadine (Symmetrel), indications,

actions, and dosage of, 148t, 494 Amaryl (glimepiride), indications, actions, and dosage of, 545

Ambien (zolpidem), indications, actions, and dosage of, 620

- Ambisome (amphotericin B liposomal), indications, actions, and dosage of, 497
- Amcil (ampicillin)

indications, actions, and dosage of, 497

for subacute bacterial endocarditis prophylaxis, 158t, 159t

Amcinonide (Cyclocort), potency and application of, 628t

Amebiasis, drugs for treating, 153t

Amenorrhea, differential diagnosis of, 42 Amerge (naratriptan), indications, actions,

and dosage of, 575–576 Amicar (aminocaproic acid), indications,

actions, and dosage of, 494–495 Amifostine (Ethyol), indications, actions, and dosage of, 494

Amikacin (Amikin)

half-life and therapeutic and toxic levels of, 631t

indications, actions, and dosage of, 494

Amiloride (Midamor), indications, actions, and dosage of, 494

Amino acid solutions, for total parenteral nutrition, 229–230, 230*t*

Aminocaproic acid (Amicar), indications, actions, and dosage of, 494–495

Amino-Cerv pH 5.5 Cream, indications, actions, and dosage of, 495

Aminoglutethimide (Cytadren), indications, actions, and dosage of, 495

Aminoglycosides, 476

dosing procedure for, 620 levels of, 620, 631*t*

loading dose required for chosen dosing intervals for, 635*t*

Aminophylline, indications, actions, and dosage of, 495

Amiodarone (Cordarone; Pacerone) for emergency cardiac care, 461 half-life and therapeutic and toxic levels of, 632t

indications, actions, and dosage of, 495 Amitriptyline (Elavil)

indications, actions, and dosage of, 495 route, effects, and dosage for, 322t

- Amitriptyline + nortriptyline, half-life and therapeutic and toxic levels of, 633t
- Amlodipine (Norvasc), indications, actions, and dosage of, 496
- Ammonia, laboratory diagnosis and, 57

Ammonium aluminum sulfate (Alum), indications, actions, and dosage of, 496

Ammonium lactate [lactic acid + ammonium hydroxide], indications, actions, and dosage of, 558

Amniotic fluid fern test, 242-243

Amoxapine (Asendin), indications, actions, and dosage of, 496

Amoxicillin (Amoxil; Polymox) indications, actions, and dosage of, 496

for subacute bacterial endocarditis prophylaxis, 158t, 159t

Amoxicillin + clavulanic acid (Augmentin), indications, actions, and dosage of, 496

Amphojel (aluminum hydroxide) for hyperphosphatemia, 192 indications, actions, and dosage of, 493

Amphotec (amphotericin B cholesteryl), indications, actions, and dosage of,

Amphotericin B (Fungizone), indications, actions, and dosage of, 151t, 496–497

Amphotericin B cholesteryl (Amphotec), indications, actions, and dosage of, 497

Amphotericin B lipid complex (Abelcet), indications, actions, and dosage of, 497

Amphotericin B liposomal (Ambisome), indications, actions, and dosage of, 497

Ampicillin (Amcil; Omnipen) indications, actions, and dosage of, 497 for subacute bacterial endocarditis prophylaxis, 158t, 159t

Ampicillin-sulbactam (Unasyn), indications, actions, and dosage of, 497

Ammunovin (Aconomoso) indications	indications actions and decree of 400
Amprenavir (Agenerase), indications, actions, and dosage of, 150 <i>t</i> , 498	indications, actions, and dosage of, 498 Ankle, arthrocentesis of, 249, 250 <i>f</i>
Amrinone (Inocor)	Ankle-Arm Index (AAI), 266
for emergency cardiac care, 461	Ankle-brachial (A/B) index, 266
indications, actions, and dosage of, 498	Ann Arbor staging classification, 654
infusion guidelines for, 439 <i>t</i>	Anogenital warts, drugs of choice for
Amylase, laboratory diagnosis and, 57	treating, 148 <i>t</i>
Amyl nitrate, for cyanide poisoning, 471	Anorexia, differential diagnosis of, 42
Analgesics	Anoscopy, 300
for migraine headaches, 486	Ansaid (flurbiprofen), indications, actions,
narcotic, 486	and dosage of, 541
nonnarcotic, 486	Antacids, 483
nonopioid, 320, 321t	Anthralin (Anthraderm), indications,
nonsteroidal anti-inflammatory agents,	actions, and dosage of, 498
486	Antianxiety agents, 480
opioid, 320, 321 <i>t</i> –322 <i>t</i>	Antiarrhythmic agents, 479
Anaphylaxis, 468–469	Antibiotics, 476–477
transfusions and, 203	antineoplastic, 478
Anaprox (naproxen), indications, actions,	•
and dosage of, 575	half-life and therapeutic and toxic levels of, 631 <i>t</i>
Anaspaz (hyoscyamine), indications,	ophthalmic, 483
actions, and dosage of, 551	Anticholinergic crisis, 469–470
Anastrozole (Arimidex), indications,	Anticholinesterases, antidote for, 471
actions, and dosage of, 498	Anticoagulants, 484
Anatomic hand scrubs, 341	standards of practice for, 637 <i>t</i>
Ancef (cefazolin)	Anticonvulsants, 480
indications, actions, and dosage of, 511	half-life and therapeutic and toxic levels
for subacute bacterial endocarditis	of, $631t$ – $632t$
prophylaxis, 158t	for pain management, 320
Ancylostoma duodenale infections, drugs	Antidepressants, 480
for treating, 153 <i>t</i>	cyclic, antidote for, 471
Anectine (succinylcholine), indications,	for pain management, 320
actions, and dosage of, 605	Antidiabetic agents, 482
Anemia, chronic, red blood cell	Antidiarrheal agents, 482
transfusions for, 196	Antidiarrical agents, 463 Antidiuretic hormone [vasopressin]
	(Pitressin)
Anergy screen (battery), 304 Anestacon Topical. <i>See</i> Lidocaine	
(Anestacon Topical; Xylocaine)	indications, actions, and dosage of, 617
Anesthetics	infusion guidelines for, 443 <i>t</i>
	Antidotes, 471, 476
local, 320, 348, 349t, 486 systemic, 320	Antiemetic agents, 483
=	Antifungals, 477
Angiography, 327–328	
Angiotensin-converting enzyme (ACE) inhibitors, 479	Antiglobulin test direct, 105
· · · · · · · · · · · · · · · · · · ·	indirect, 105, 107
for emergency cardiac care, 449	
Angiotensin II receptor antagonists, 479	Antigout agents, 485 Antihemophilic factor [AHF; factor VIII]
Anion gap, 166	
Anion gap acidosis, 166	(Monoclate)
Anistreplase (Eminase)	indications, actions, and dosage of, 498
for emergency cardiac care, 467	for transfusion, 199t

Antihemophilic factor, cryoprecipitated, 198 <i>t</i>	Apresoline (hydralazine), indications, actions, and dosage of, 549
Antihistamines, 476	Aprotinin (Trasylol), indications, actions,
Antilirium (physostigmine)	and dosage of, 499
for anticholinergic crisis, 470	AquaMEPHYTON (phytonadione)
antidote for, 471	indications, actions, and dosage of, 589
indications, actions, and dosage of, 589	in total parenteral nutrition, 231
Antimetabolites, 478	Ara-C [cytarabine] (Cytosar-U),
Antimicrobial agents, 476–478. See also	indications, actions, and dosage of
Antibiotics	522
Antimycobacterials, 477	Aramine (metaraminol), indications,
Antineoplastic agents, 478–479	actions, and dosage of, 567
Antinuclear antibody (ANA; FANA),	Arava (leflunomide), indications, actions,
laboratory diagnosis and, 58	and dosage of, 559
Antiparkinson agents, 480	Ardeparin (Normiflo), indications,
Antiplatelet agents, 484	actions, and dosage of, 499
Antipsychotics, 481	Arduan (pipecuronium), indications,
Antiretrovirals, 477	actions, and dosage of, 590
Antistreptolysin O/antistreptococcal O	Aredia (pamidronate)
(ASO) titer, laboratory diagnosis	for hypercalcemia, 189
and, 57	indications, actions, and dosage of,
Antithrombic agents, 484	584–585
Antithrombin-III (AT-III), 105	Argyll-Robertson pupil, 21
Antithymocyte globulin [ATG] (Atgam),	Arimidex (anastrozole), indications,
indications, actions, and dosage of,	actions, and dosage of, 498
499	Aristocort (triamcinolone acetonide),
Antithyroid agents, 482	potency and application of, 630t
Antitussives, 487	Artane (trihexyphenidyl), indications,
Antiulcer agents, 483	actions, and dosage of, 614
Antivert (meclizine), indications, actions,	Arterial line placement, 243–245, 244 <i>f</i>
and dosage of, 564	Arterial oxygen content (Ca_{O2}), derivation
Antivirals, 477–478	and normal values for, $437t$
Anturane (sulfinpyrazone), indications,	Arterial oxygen saturation (S_{AO_2}), for
actions, and dosage of, 606	cardiac output determination, 413
Anuria, differential diagnosis of, 43,	Arterial puncture, 245–246
49–50	Arteriovenous oxygen (A- V_{02}) difference
Anusol Ointment (pramoxine),	for cardiac output determination,
indications, actions, and dosage of,	410–412, 411 <i>t</i>
592	derivation and normal values for,
Anzemet (dolasetron), indications,	437t
actions, and dosage of, 529–530	Arthritis
Aortic insufficiency (AI), 16t	differential diagnosis of, 43
Aortic stenosis (AS), 16t	septic, organisms responsible and
AP films of chest, 325	empiric therapy for, 134 <i>t</i>
Apgar scores, 639, 640t	synovial fluid interpretation and, 250
Apheresis, 194	Arthrocentesis, 246–250
Apley's test, 21	contraindications to, 246
Apothecary measurement units, 646	indications for, 246
Apraclonidine (Iodipine), indications,	materials for, 247
actions, and dosage of, 499	procedures for, 247–250, 248 <i>f</i> –250 <i>f</i>

Arthrocentesis (continued) synovial fluid interpretation and, 249-250, 251t Artificial tears (Tears Naturale), indications, actions, and dosage of, Asacol (mesalamine), indications, actions, and dosage of, 566 Ascariasis, drugs for treating, 153t Ascites, differential diagnosis of, 43 Ascitic fluid, diagnosis of, 297, 299t Ascorbic acid, in total parenteral nutrition, Asendin (amoxapine), indications, actions, and dosage of, 496 Aseptic meningitis, cerebrospinal fluid in, 287tL-Asparaginase (Elspar), indications, actions, and dosage of, 499 Aspartate aminotransferase (AST; SGOT), laboratory diagnosis and, 58 Aspergillosis, systemic drugs for treating, Aspiration, with enteral nutrition, 223 Aspirin (sodium salicylate) for emergency cardiac care, 461 indications, actions, and dosage of, 499-500 route, effects, and dosage for, 321t Aspirin + butalbital, caffeine and codeine (Fiorinal + Codeine), indications, actions, and dosage of, 500 Aspirin + butalbital compound (Fiorinal; Lanorinal), indications, actions, and dosage of, 500 Aspirin + codeine (Empirin No. 2, No. 3, No. 4), indications, actions, and dosage of, 500 Assist controlled ventilation, 424, 425f Asthmatic attacks, 469 Asystole algorithm, 454f Atacand (candesartan), indications, actions, and dosage of, 509 Atarax (hydroxyzine), indications, actions, and dosage of, 551 Atenolol (Tenormin) for emergency cardiac care, 462 indications, actions, and dosage

of, 500

Atenolol + chlorthalidone (Tenoretic), indications, actions, and dosage of, Atgam (antithymocyte globulin), indications, actions, and dosage of, Ativan (lorazepam) indications, actions, and dosage of, 563 for seizures, 472 Atorvastatin (Lipitor), indications, actions, and dosage of, 500 Atovaquone (Mepron), indications, actions, and dosage of, 500-501 Atracurium (Tracrium), indications, actions, and dosage of, 501 Atrial arrhythmias, on electrocardiograms, 372-374, 373f-375f Atrial fibrillation (AF), 373–374, 375f anticoagulant standard of practice for, 637tAtrial flutter, 374, 375f Atrial hypertrophy, electrocardiogram and, 380 Atrial septal defect (ASD), 17t Atrioventricular junctional or nodal rhythm, 374-375, 376f Atrophy, of skin, 20 Atropine, 364 for anticholinesterase poisoning, 471 indications, actions, and dosage of, 501 Atropine sulfate, for emergency cardiac care, 461 Attending physicians, 2 Attending rounds, 3 Auer rods, 104 Aufalglan (benzocaine + antipyrine), indications, actions, and dosage of, 504 Augmentin (amoxicillin + clavulanic acid), indications, actions, and

dosage of, 496

Autoantibody test, 105, 107

Autoantibodies, laboratory diagnosis and,

actions, and dosage of, 599-600

Autologous blood donation, 193-194

Avandia (rosiglitazone), indications,

and dosage of, 555

Avapro (irbesartan), indications, actions,

Austin Flint murmur, 21

Avelox (moxifloxacin), indications, actions, and dosage of, 574

Aventyl (nortriptyline)

half-life and therapeutic and toxic levels of, 633*t*

indications, actions, and dosage of, 580 Avita (tretinoin, topical), indications, actions, and dosage of, 613

Avlosulfon (dapsone), indications, actions, and dosage of, 523

Avulsed teeth, 470

Axid (nizatidine), indications, actions, and dosage of, 579

Axis deviation, o electrocardiograms, 369–370, 370*f*

Azactam (aztreonam), indications, actions, and dosage of, 501

Azathioprine (Imuran), indications, actions, and dosage of, 501

Azithromycin (Zithromax)

indications, actions, and dosage of, 501 for subacute bacterial endocarditis prophylaxis, 158*t*

Azopt (brinzolamide), indications, actions, and dosage of, 506

Azotemia, progressive, 432-433

Aztreonam (Azactam), indications, actions, and dosage of, 501

Azulfidine (sulfasalazine), indications, actions, and dosage of, 605–606

R

Babesia microti infections, characteristics and treatment of, 156t–157t

Babesiosis, characteristics and treatment of, 156*t*–157*t*

Babinski's sign, 24

Baby bilirubin, laboratory diagnosis and, 59

Baciguent (bacitracin, topical), indications, actions, and dosage of, 502

Bacilli anthracis, Gram stain characteristics of, 125t

Bacillus, Gram stain characteristics of, 123f

Bacillus Calmette-Guérin [BCG], indications, actions, and dosage of, 503 Bacillus fragilis, Gram stain characteristics of, 126t

Bacitracin

neomycin, polymyxin B, + hydrocortisone, ophthalmic (AK Spore HC Ophthalmic; Cortisporin Ophthalmic), indications, actions, and dosage of, 502

neomycin, polymyxin B, + hydrocortisone, topical (Cortisporin), indications, actions, and dosage of, 502

neomycin, polymyxin B, + lidocaine, topical (Clomycin), indications, actions, and dosage of, 502

neomycin, + polymyxin B, ophthalmic (AK Spore Ophthalmic; Neosporin Ophthalmic), indications, actions, and dosage of, 502

neomycin, + polymyxin B, topical (Neosporin ointment), indications, actions, and dosage of, 502

Bacitracin, ophthalmic (AK-Tracin Ophthalmic), indications, actions, and dosage of, 502

Bacitracin + polymyxin B, ophthalmic (AK Poly Bac Ophthalmic; Polysporin Ophthalmic), indications, actions, and dosage of, 502

Bacitracin + polymyxin B, topical (Polysporin), indications, actions, and dosage of, 502

Bacitracin, topical (Baciguent), indications, actions, and dosage of, 502

Back pain, differential diagnosis of, 43 Baclofen (Lioresal), indications, actions, and dosage of, 502

Bacterial endocarditis

organisms responsible and empiric therapy for, 136*t*–137*t*

subacute, prophylaxis, 155, 158*t*–159*t* Bacterial infections. *See also specific*

infections
cerebrospinal fluid in, 287t
transfusion-associated risk of
transmission, 204

Bactocill (oxacillin), indications, actions, and dosage of, 582–583

Bactrim (trimethoprim-sulfamethoxazole), for anaphylaxis, 469 indications, actions, and dosage of, indications, actions, and dosage of, 528 153t, 615 Benazepril (Lotensin), indications, actions, and dosage of, 503 Bactroban (mupirocin), indications, actions, and dosage of, 574 Benemid (probenecid), indications, Bainbridge's reflex, 24 actions, and dosage of, 593 Baker tubes, 273 Benign prostatic hyperplasia, medications Balloon port, of Swan-Ganz catheter, 399 for, 487 Band cells, 100 Bentyl (dicyclomine), indications, actions, Barium enema (BE), 328 and dosage of, 526 Barium swallow, 328 Benylin DM (dextromethorphan), Basal energy expenditure (BEE), 209 indications, actions, and dosage of, Basaljel (aluminum carbonate) 525 for hyperphosphatemia, 192 Benzamycin (erythromycin + benzoyl indications, actions, and dosage of, 493 peroxide), indications, actions, and Base excess/deficit, laboratory diagnosis dosage of, 534 and, 59 Benznidazole, indications for, 154t Basiliximab (Simulect), indications, Benzocaine + antipyrine (Aufalglan), actions, and dosage of, 502 indications, actions, and dosage of, 504 Basophil(s), laboratory diagnosis and, 101 Basophilia, 100, 104 Benzonatate (Cogentin), indications, Basophilic stippling, 104 actions, and dosage of, 504 Battle's sign, 24 Bepridil (Vascar), indications, actions, and dosage of, 504 Baycol (cerivastatin), indications, actions, and dosage of, 514 Beractant (Survanta), indications, actions, BCG [bacillus Calmette-Guérin] (BCG; and dosage of, 504 Thera Cys; TICE), indica-Bergman's triad, 24 tions, actions, and dosage Beta blockers, 479-480 of. 503 antidote for, 471 BCNU (carmustine), indications, actions, for emergency cardiac care, 461-462 and dosage of, 510 Betadine hand scrub, 340-341 Beat-to-beat variability, 276 Betagan (levobunolol), indications, Beau's lines, 24 actions, and dosage of, 560 Betamethasone, dose, activity, duration, Becaplermin (Regranex Gel), indications, and route for, 627t actions, and dosage of, 503 Beck's triad, 24 Betamethasone dipropionate (Diprosone), Beclomethasone (Beconase: Vancenase potency and application of, 628t Nasal Inhaler), indications, Betamethasone valerate (Valisone), actions, and dosage of, 503 potency and application of, 628t Bedside procedures, 239-314. See also Betapace (sotalol), indications, actions, specific procedures and dosage of, 602 basic equipment for, 240, 240t, 241f, Beta-1 receptors, 397 242f Beta-2 receptors, 397 notes for, 35 Betaseron (interferon β-1B), indications, Bedside rounds, 4 actions, and dosage of, 554 Belladonna + opium suppositories (B & O Betaxolol (Kerlone), indications, actions, Supprettes), indications, actions, and dosage of, 504 and dosage of, 503 Betaxolol, ophthalmic (Betoptic), Bell's palsy, 24 indications, actions, and dosage of, Benadryl (diphenhydramine) 504

Bethanechol (Duvoid; Urecholine), indications for, 306 indications, actions, and dosage of, materials for, 307, 307f procedure for, 307-308 504-505 Blastomycosis, systemic drugs for Betoptic (betaxolol, ophthalmic), indications, actions, and dosage of, treating, 151t Bleeding scans, 333 Biaxin (clarithromycin) Bleeding time, 105 indications, actions, and dosage of, 517 Bleomycin sulfate (Blenoxane), for subacute bacterial endocarditis indications, actions, and dosage of, prophylaxis, 158t 505-506 Bicalutamide (Casodex), indications, Bleph-10 (sulfacetamide), indications, actions, and dosage of, 505 actions, and dosage of, 605 Bicarbonate. See also Potassium Blephamide (sulfacetamide + bicarbonate; Sodium bicarbonate prednisolone), indications, actions, laboratory diagnosis and, 59, 61-62 and dosage of, 605 Bicillin (penicillin G benzathine), Blocadren (timolol), indications, actions, indications, actions, and dosage of, and dosage of, 610 586 Blood, in urine, 111 Bicitra (sodium citrate), indications, Blood alcohol, laboratory diagnosis and, actions, and dosage of, 602 BiCNU (carmustine), indications, actions, Blood and body fluid precautions, 155 and dosage of, 510 Blood collection, 95 BIDA-scans, 334 heelstick for, 274, 275f Bigeminy, 375, 377f venipuncture for, 309-314 Bile loss, IV fluid replacement with, 179 Blood component therapy, 193-204 Bilirubin apheresis for, 194 neonatal, laboratory diagnosis and, 59 autologous blood donation for, 193-194 blood banking procedures, 193 in urine, 111 Biopsy, of skin, 302 blood groups and, 194, 196t Biotin, in total parenteral nutrition, 231t donor-restricted blood products for, 194 Biot's breathing, 24 emergency transfusions, 194 Bisacodyl (Dulcolax), indications, actions, infectious disease risk associated with. 203-204 and dosage of, 505 Bisferious pulse, 24 irradiated blood components for, 194 Bismuth subsalicylate (Pepto-Bismol), preoperative blood set up for, 194, 195t indications, actions, and dosage of, procedure for, 201-202 products for, 196, 197t-200t, 201 505 routine blood donation for, 193 Bisoprolol (Zebeta), indications, actions, and dosage of, 505 transfusion reactions and, 202-203 Bite wound (human and animal) Blood cultures, 129-130 infections, organisms responsible Blood gases, 161-163 and empiric therapy for, 142t capillary, 161 Bitolterol (Tornalate), indications, actions, determination of, 162-163 and dosage of, 505 interpretation of, 163, 165-166 Bitot's spots, 24 normal values for, 161, 162t Bladder aspiration, suprapubic, venous, 161 percutaneous, 309, 310f Blood groups, 194, 196t Bladder cancer, staging of, 650-651 Blood loss Bladder catheterization, 306-308 acute, red blood cell transfusions for, contraindications to, 306 196

Bretylium

Blood loss (continued)

allowable, red blood cell transfusions	indications, actions, and dosage
for, 196	of, 506
Blood pressure guidelines, 14, 20t	infusion guidelines for, 439t
Blood pressure measurement, of	Brevibloc (esmolol)
orthostatic pressure, 286-289	for emergency cardiac care, 462
Blood smears, 95–97, 96f, 97t	indications, actions, and dosage
Blood urea nitrogen (BUN), laboratory	of, 534
diagnosis and, 59	infusion guidelines for, 440t
Blood volume, total, 177	Brevicon 21, 28, 623t
Blumberg's sign, 24	Bricanyl (terbutaline), indications, actions,
Blumer's shelf, 24	and dosage of, 608
Body fluids. See also Fluids and	Brimonidine (Alphagan), indications,
electrolytes; specific fluids and	actions, and dosage of, 506
electrolytes	Brinzolamide (Azopt), indications,
composition and daily production of,	actions, and dosage of, 506
181 <i>t</i>	Broad casts, in urine sediment, 114
total body water, 177	Bromocriptine (Parlodel), indications,
Body surface area	actions, and dosage of, 506
of adults, 639, 641 <i>f</i>	Bronchiolitis, drug of choice for treating,
of children, 639, 642f	148 <i>t</i>
Body weight, desirable, 639, 640t	Bronchitis, organisms responsible and
Bone infections, organisms responsible	empiric therapy for, 134t
and empiric therapy for, $134t$	Bronchodilators, 487
Bone marrow aspiration/biopsy, 250,	half-life and therapeutic and toxic levels
252–253	of, 632 <i>t</i>
Bone scans, 333	Bronchopulmonary hygiene, 362–364
Bone turnover, high, hypercalcemia with,	Brontex (guaifenesin + codeine),
188	indications, actions, and dosage of,
Bordetella pertussis, Gram stain	546
characteristics of, 124 <i>f</i> , 126 <i>t</i>	Brucella, Gram stain characteristics of,
Borrelia burgdorferi infections,	124 <i>f</i> , 126 <i>t</i>
characteristics and treatment of,	Brudzinski's sign, 24
156 <i>t</i> –157 <i>t</i>	Brugia malayi infections, drugs for
B & O Supprettes (belladonna + opium	treating, 153t
suppositories), indications, actions,	Buclizine (Bucladin-s Softabs),
and dosage of, 503	indications, actions, and dosage of,
Bouchard's nodes, 24	506
Bradycardia, 276, 371	Budesonide (Pulmicort; Rhinocort),
algorithm for, 455f	indications, actions, and dosage of,
Brain scans, 333	506
Branhamella catarrhalis, Gram stain	Bullae, 20
characteristics of, 125 <i>t</i>	Bumetanide (Bumex), indications, actions,
Branham's sign, 24	and dosage of, 506–507
Breast cancer	Buminate (albumin), indications, actions,
screening recommendations for, 643 <i>t</i>	and dosage of, 200t, 490
staging of, 649–650	BUN/creatinine ratio (BUN/CR),
Breast lumps, differential diagnosis of, 43	laboratory diagnosis and, 59–60
Brethine (terbutaline), indications, actions,	Bundle branch block (BBB), 379, 380f,
and dosage of, 608	381 <i>f</i>

381*f*

Bupivacaine (Marcaine; Sensoricaine) indications, actions, and dosage of, 507	Calcium acetate (Calphron; Phos-Ex; PhosLo), indications, actions, and
for suturing, 349t	dosage of, 508
Buprenorphine (Buprenex), indications,	Calcium alginate swab, 129
actions, and dosage of, 507	Calcium carbonate (Alka-Mints; Tums)
Bupropion (Wellbutrin; Zyban),	for hypocalcemia, 190
indications, actions, and dosage of,	indications, actions, and dosage of, 508
507	Calcium-channel blockers, 479
Burn wounds	antidote for, 471
infections of, organisms responsible and	Calcium chloride
empiric therapy for, 141 <i>t</i> –142 <i>t</i>	for calcium-channel blocker poisoning,
IV fluid replacement with, 179	471
Burr cells, 104	for emergency cardiac care, 462
Burrows, 20	for hyperkalemia, 187
Buspirone (Buspar), indications, actions,	for hypocalcemia, 190
and dosage of, 507	indications, actions, and dosage of,
Busulfan (Myleran), indications, actions,	508-509
and dosage of, 507	Calcium citrate, for hypocalcemia, 190
Butorphanol (Stadol), indications, actions,	Calcium glubionate (Neo-calglucon)
and dosage of, 507	for hypocalcemia, 190
Butterfly needles, 280	indications, actions, and dosage of, 508
	Calcium gluceptate, indications, actions,
	and dosage of, 508-509
C	Calcium gluconate
C. diphtheriae, throat culture for, 131	for emergency cardiac care, 462
CA 15-3, laboratory diagnosis and, 60	for hypermagnesemia, 190
CA 19-9, laboratory diagnosis and, 60	for hypocalcemia, 190
CA-125, laboratory diagnosis and, 60	indications, actions, and dosage of,
Caffeine, half-life and therapeutic and	508-509
toxic levels of, 632t	Calcium lactate, for hypocalcemia, 190
Calan (verapamil)	Calcium salts (chloride, gluconate,
for emergency cardiac care, 467	gluceptate), indications, actions,
indications, actions, and dosage	and dosage of, 508-509
of, 617	CaldeCort (hydrocortisone)
Calcipotriene (Davonex), indications,	indications, actions, and dosage
actions, and dosage of, 507-508	of, 550
Calcitonin, blood levels of, laboratory	potency and application of, 629t
diagnosis and, 61	Calfactant (Infasurf), indications, actions,
Calcitonin (Cibocalcin; Miacalcin)	and dosage of, 509
for hypercalcemia, 189	Calgiswab, 129
indications, actions, and dosage	Caloric requirements
of, 508	calculation of, 209, 213
Calcitriol (Rocaltrol), indications, actions,	in stressed patients, calculation
and dosage of, 508	of, 228
Calcium	Calphron (calcium acetate), indications,
elemental, for hypocalcemia, 190	actions, and dosage of, 508
excess of. See Hypercalcemia	Camptosar (irinotecan), indications,
requirement for, 178	actions, and dosage of, 555
serum, laboratory diagnosis and, 61	Cancer
urine, 116	hypercalcemia with, 188

Cancer (<i>continued</i>) screening recommendations for, 639,	algorithms for, 450 <i>f</i> –460 <i>f</i> drugs used in, 449, 461–467
643 <i>t</i> –644 <i>t</i>	electrical defibrillation and
Cancer-related check-ups, 644t	cardioversion for, 467-468
Candesartan (Atacand), indications,	Cardiac contractility, 395
actions, and dosage of, 509	measurement of, 410
Candidiasis	Cardiac failure, renal failure, 235
cystitis due to, systemic drugs for	Cardiac hypertrophy, on
treating, 151t	electrocardiograms, 380-383,
oral, systemic drugs for treating, 151t	381 <i>f</i> –383 <i>f</i>
vaginal. See Vaginal candidiasis	Cardiac index (CI), 395
Cantor tubes, 272	derivation and normal values for, 437t
Capillary fingersticks/heelsticks, 95	Cardiac output (CO), 395
Capoten (captopril)	adrenergic nervous system and, 395,
for emergency cardiac care, 449	397, 397t, 398t
indications, actions, and dosage of, 509	derivation and normal values for, 437t
Capsaicin (Capsin; Zostrix), indications,	determinants of, 395, 396f
actions, and dosage of, 509	determinations of, 410-413
Captopril (Capoten)	Cardiac pacing, 468
for emergency cardiac care, 449	Cardiac scans, 333–334
indications, actions, and dosage of, 509	Cardiogenic shock, 414, 431
Captopril test, 61	Cardiomyopathy, anticoagulant standard
Caraway tubes, 274	of practice for, 637t
Carbamazepine (Tegretol)	Cardiopulmonary resuscitation (CPR),
half-life and therapeutic and toxic levels	445–449
of, 631 <i>t</i>	adult, 445–447, 448
indications, actions, and dosage of, 509	child, 447, 448
route, effects, and dosage for, 322t	foreign body obstructed airway
Carbidopa + levodopa (Sinemet),	sequence for, 448
indications, actions, and dosage of,	infant, 447, 448
509–510	neonatal, 447–448
Carbocaine (mepivacaine), for suturing,	one-rescuer, 445–446
349t	primary survey for, 447
Carbohydrate controlled diet, 207 <i>t</i>	recovery position for, 449
Carbon dioxide, laboratory diagnosis and,	secondary survey for, 447
61–62	two-rescuer, 446–447
Carbon monoxide	Cardiovascular agents, 479–480
antidote for, 471	half-life and therapeutic and toxic levels
laboratory diagnosis and, 62	of, $632t$ – $633t$
Carboplatin (Paraplatin), indications,	Cardiovascular evaluation, 391–395
actions, and dosage of, 510	blood pressure in, 392–393
Carboxyhemoglobin, laboratory diagnosis	heart murmurs in, 393–395
and, 62	inspection in, 391–392
Carcinoembryonic antigen (CEA),	mean arterial blood pressure in, 393,
laboratory diagnosis and, 62	394 <i>f</i>
	v
Cardene (nicardipine) indications, actions, and dosage of, 578	pulse pressure in, 393 Cardioversion, 468
infusion guidelines for, 441 <i>t</i> –442 <i>t</i>	DC-synchronized, 374
Cardiac angiography, 328	Cardizem (diltiazem)
Cardiac care, emergency, 449–468	for emergency cardiac care, 462

- indications, actions, and dosage of, 528 infusion guidelines for, 439*t*
- Cardura (doxazosin), indications, actions, and dosage of, 530 Carisoprodol (Soma), indications, actions,
- and dosage of, 510 Carmustine (BCNU; BiCNU), indications,
- Carmustine (BCNU; BiCNU), indications actions, and dosage of, 510
- Carteolol (Cartrol; Occupress Ophthalmic), indications, actions, and dosage of, 510
- Carvedilol (Coreg), indications, actions, and dosage of, 510
- Casodex (bicalutamide), indications, actions, and dosage of, 505
- Casts, in urine sediment, 114
- Cataflam (diclofenac)
 - indications, actions, and dosage of, 526 route, effects, and dosage for, 321t
- Catapres (clonidine, oral), indications, actions, and dosage of, 518
- Catapres TS (clonidine, transdermal), indications, actions, and dosage of, 518
- Catecholamines
 - fractional serum, laboratory diagnosis and 62
- fractionated, in urine, 117
- Cathartics, 483
- Catheter(s). See also Bladder catheterization; Central venous catheterization; Peripherally inserted central catheter (PICC)
 - lines; Pulmonary artery catheters French units for, 240, 241f vascular, sepsis of, 435
- Catheterization. See Peripherally inserted central catheter (PICC) lines
- Caverject (alprostadil, intracavernosal), indications, actions, and dosage of,
- Cavitary lesions, of lungs, 338
- CCNU (lomustine), indications, actions, and dosage of, 562
- Ceclor (cefaclor), indications, actions, and dosage of, 510–511
- Cedax (ceftibutin), indications, actions, and dosage of, 513
- CeeNu (lomustine), indications, actions, and dosage of, 562

- Cefaclor (Ceclor), indications, actions, and dosage of, 510–511
- Cefadroxil (Duricef; Ultracef) indications, actions, and dosage of, 511 for subacute bacterial endocarditis prophylaxis, 158t
- Cefadyl (cephapirin), indications, actions, and dosage of, 514
- Cefazolin (Ancef; Kefzol) indications, actions, and dosage
 - for subacute bacterial endocarditis prophylaxis, 158t
- Cefdinir (Omnicef), indications, actions, and dosage of, 511
- Cefepime (Maxipime), indications, actions, and dosage of, 511
- Cefixime (Suprax), indications, actions, and dosage of, 511
- Cefizox (ceftizoxime), indications, actions, and dosage of, 513
- Cefmetazole (Zefazone), indications, actions, and dosage of, 511
- Cefobid (cefoperazone), indications, actions, and dosage of, 512
- Cefonicid (Monocid), indications, actions, and dosage of, 511–512
- Cefoperazone (Cefobid), indications, actions, and dosage of, 512
- Cefotan (cefotetan), indications, actions, and dosage of, 512
- Cefotaxime (Claforan), indications, actions, and dosage of, 512
- Cefotetan (Cefotan), indications, actions, and dosage of, 512
- Cefoxitin (Mefoxin), indications, actions, and dosage of, 512
- Cefpodoxime (Vantin), indications, actions, and dosage of, 512
- Cefprozil (Cefzil), indications, actions, and dosage of, 512
- Ceftazidime (Ceptaz; Fortaz; Tazicef; Tazidime), indications, actions, and dosage of, 513
- Ceftibutin (Cedax), indications, actions, and dosage of, 513
- Ceftin (cefuroxime), indications, actions, and dosage of, 513
- Ceftizoxime (Cefizox), indications, actions, and dosage of, 513

Ceftriaxone (Rocephin), indications, Cephulac (lactulose), indications, actions, actions, and dosage of, 513 and dosage of, 558 Cefuroxime (Ceftin; Zinacef), indications, Ceptaz (ceftazidime), indications, actions, actions, and dosage of, 513 and dosage of, 513 Cefzil (cefprozil), indications, actions, and Cerebellum, herniation of, with lumbar dosage of, 512 puncture, 286 Cerebral angiography, 328 Celecoxib (Celebrex) indications, actions, and dosage of, 513 Cerebral perfusion pressure (CPP), derivation and normal values for. route, effects, and dosage for, 321t Celexa (citalopram), indications, actions, and dosage of, 517 Cerebrospinal fluid (CSF), differential Cellcept (mycophenolate mofetil), diagnosis of, 287t-288t indications, actions, and dosage of, Cerebryx (fosphenytoin) indications, actions, and dosage of, 543 Cellulitis, organisms responsible and for seizures, 473t empiric therapy for, 142t Cerivastatin (Baycol), indications, actions, Celsius/Fahrenheit conversion, 646, 649t and dosage of, 514 Cenestin (estrogens, conjugated-Cerubidine (daunorubicin), indications, synthetic), indications, actions, and actions, and dosage of, 523 dosage of, 535-536 Cerumenex (triethanolamine), indications, Centrally acting antihypertensive agents, actions, and dosage of, 614 Cervical cancer Central nervous system agents, 480-481 screening recommendations for, 643t Central venous catheterization, 253-260 staging of, 651-652 catheter removal and, 260 Cervical infections, tests for, 291 complications of, 257-258, 260 Cervicitis, organisms responsible and contraindications to, 254 empiric therapy for, 135t femoral vein approach for, 259-260 Cetamide (sulfacetamide), indications, historical background of, 254 actions, and dosage of, 605 indications for, 253 Cetirizine (Zyrtec), indications, actions, left internal jugular vein approach for, and dosage of, 514 258-259, 259f Chadwick's sing, 24 materials for, 254 Chagas' disease, drugs for treating, 154t right internal jugular vein approach for, Chancroid, organism responsible and 256-258, 257f empiric therapy for, 135t Chandelier sign, 24, 290 subclavian approach for, 254-256 Central venous pressure (CVP), 397-399, Charcot's triad, 24 398t Chartwork, 33-40 Check-out rounds, 3-4 derivation and normal values for, 437t Centrax (prazepam), indications, actions, Chemet (succimer), indications, actions, and dosage of, 593 and dosage of, 604-605 Cephalexin (Keflex; Keftab) Chemically defined formulas, for enteral indications, actions, and dosage of, 513 nutrition, 217 for subacute bacterial endocarditis Chest computed tomography, 331 prophylaxis, 158t Chest electrodes, 267, 267f Cephalosporins, 476 Chest magnetic resonance imaging, 332 Cephapirin (Cefadyl), indications, actions, Chest pain, differential diagnosis of, 43 and dosage of, 514 Chest physiotherapy, 363

Chest tube placement, 260-263

complications of, 263

Cephradine (Velosef), indications, actions,

and dosage of, 514

Cholangiography, T-tube, 329

Cholecalciferol [vitamin D₃],

Cholangitis, organisms responsible and

empiric therapy for, 137t

historical background of, 261

procedure for, 261-263, 262f

Chlorzoxazone (Paraflex: Parafon Forte

dosage of, 515-516

DSC), indications, actions, and

indications for, 260-261

materials for, 261

Chest x-rays, 325 indications, actions, and dosage reading, 335, 336f, 337f, 338 Chevne-Stokes respirations, 24 Cholecystitis Children. See also Infant formulas and acalculous, 434 organisms responsible and empiric body surface area of, 639, 642f therapy for, 137t"rule of sixes" nomogram for Cholestasis, total parenteral nutrition for, calculating fluids in, 179, 181t 237 Chills, differential diagnosis of, 43 Cholesterol, laboratory diagnosis and, Chlamydia cultures, 291 62-63, 63t, 80f Chlamydial infections, organism Cholesterol restricted diet, 208t responsible and empiric therapy Cholestyramine (Questran), indications, for, 135t actions, and dosage of, 516 Chloral hydrate (Noctec), indications, Chromic catgut sutures, 346t actions, and dosage of, 514 Chromium, in total parenteral nutrition, Chlorambucil (Leukeran), indications, 231, 232t actions, and dosage of, 514 Chronulac (lactulose), indications, actions, Chlordiazepoxide (Librium), indications, and dosage of, 558 actions, and dosage of, 515 Chvostek's sign, 24 Chlorhexidine 6-min hand scrub, 341 Chylothorax, 50 Chloride Cibocalcin (calcitonin) requirement for, 178 for hypercalcemia, 189 serum, laboratory diagnosis and, 62 indications, actions, and dosage spot urine study for, 114 of, 508 Chloride-insensitive (resistant) metabolic Ciclopirox (Loprox), indications, actions, alkalosis, 169 and dosage of, 516 Chloride-sensitive (responsive) metabolic Cidofovir (Vistide), indications, actions, alkalosis, 167, 169 and dosage of, 146t, 516 Chloroquine phosphate, indications for, 153t Ciloxan (ciprofloxacin, ophthalmic), Chlorothiazide (Diuril), indications, indications, actions, and dosage of, actions, and dosage of, 515 517 Chlorpheniramine (Chlor-Trimeton), Cimetidine (Tagamet), indications, indications, actions, and dosage of, actions, and dosage of, 516 515 Ciprofloxacin (Cipro), indications, Chlorpromazine (Thorazine), indications, actions, and dosage of, 516 actions, and dosage of, 515 Ciprofloxacin, ophthalmic (Ciloxan), Chlorpropamide (Diabinese), indications, indications, actions, and dosage of, actions, and dosage of, 515 517 Chlorthalidone (Hygroton), indications, Ciprofloxacin, otic (Cipro HC Otic), actions, and dosage of, 515 indications, actions, and dosage of, Chlor-Trimeton (chlorpheniramine), 517 indications, actions, and dosage of, Cipro HC Otic (ciprofloxacin, otic), indications, actions, and dosage of,

517

Cisplatin (Platinol AQ), indications,

actions, and dosage of, 517

- 13-cis retinoic acid [isotretinoin]
 (Accutane), indications, actions,
 and dosage of, 555-556
- Citalopram (Celexa), indications, actions, and dosage of, 517
- Citrobacter, Gram stain characteristics of, 124f
- Cladribine (Leustatin), indications, actions, and dosage of, 517
- Claforan (cefotaxime), indications, actions, and dosage of, 512
- Clarithromycin (Biaxin)
 - indications, actions, and dosage of, 517
 - for subacute bacterial endocarditis prophylaxis, 158t
- Claritin (loratadine), indications, actions, and dosage of, 563
- Clean catch urine specimens, urine, 308–309
- Clear liquid diet, 206t-207t
- Clemastine fumarate (Tavist), indications, actions, and dosage of, 518
- Clindamycin (Cleocin; Cleocin-T)
 - indications, actions, and dosage of, 153t, 518
 - for subacute bacterial endocarditis prophylaxis, 158t
- Clinoril (ulindac), indications, actions, and dosage of, 606
- Clobetasol propionate (Temovate), potency and application of, 628t
- Clocortolone pivalate (Cloderm), potency and application of, 628t
- Clofazimine (Lamprene), indications, actions, and dosage of, 518
- Clomycin (bacitracin, neomycin, polymyxin B, + lidocaine, topical), indications, actions, and dosage of, 502
- Clonazepam (Klonopin), indications, actions, and dosage of, 518
- Clonidine, oral (Catapres), indications, actions, and dosage of, 518
- Clonidine, transdermal (Catapres TS), indications, actions, and dosage of, 518
- Clopidogrel (Plavix), indications, actions, and dosage of, 519

- Clopra (metoclopramide), indications, actions, and dosage of, 569
- Clorazepate (Tranxene), indications, actions, and dosage of, 519
- Clostridium, Gram stain characteristics of, 123f, 126t
- Clostridium difficile assay, 63, 131
- Clotrimazole (Lotrimin; Mycelex), indications, actions, and dosage of, 519
- Clotrimazole + betamethasone (Lotrisone), indications, actions, and dosage of, 519
- Cloxacillin (Cloxapen; Tegopen), indications, actions, and dosage of, 519
- Clozapine (Clozaril), indications, actions, and dosage of, 519
- Clubbing, differential diagnosis of, 43
- Coagulation cascade, 106f
- Cocaine, indications, actions, and dosage of, 519–520
- Coccidioidomycosis, systemic drugs for treating, 151*t*
- Codeine
 - indications, actions, and dosage of, 520
 - 520 route, effects, and dosage for, 321*t*
- Cogentin (benzonatate), indications, actions, and dosage of, 504
- Cognex (tacrine), indications, actions, and dosage of, 606
- Coin lesions, of lungs, 338
- Colace (docusate sodium), indications, actions, and dosage of, 529
- Colchicine, indications, actions, and dosage of, 520
- Cold agglutinins, laboratory diagnosis and, 63–64
- Colesevelam (Welchol), indications, actions, and dosage of, 520
- Colestid (colestipol), indications, actions, and dosage of, 520
- Colfosceril palmitate (Exosurf Neonatal), indications, actions, and dosage of, 520
- Colitis, cytomegalovirus, drugs of choice for treating, 146*t*
- Colloids, composition of, 178 Color, of urine, 110

Coombs' test

Colorectal cancer

screening recommendations for, 643t	direct, 105
staging of, 652	indirect, 105, 107
CoLyte (polyethylene glycol [PEG]- electrolyte solution), indications,	Copper, in total parenteral nutrition, 231, 232 <i>t</i>
actions, and dosage of, 590-591	Cordarone (amiodarone)
Coma, 470	for emergency cardiac care, 461
differential diagnosis of, 44	half-life and therapeutic and toxic levels
Combivent (albuterol + ipratropium),	of, 632 <i>t</i>
indications, actions, and dosage of,	indications, actions, and dosage of, 495
490	Cordran (flurandrenolide), potency and
Combivir (zidovudine + lamivudine),	application of, 629t
indications, actions, and dosage of,	Coreg (carvedilol), indications, actions,
619	and dosage of, 510
Compazine (prochlorperazine), indica-	Corgard (nadolol), indications, actions,
tions, actions, and dosage of, 594	and dosage of, 574
Complement, laboratory diagnosis and, 64	Corlopam (fenoldopam), indications,
Complete blood cell count (CBC)	actions, and dosage of, 537
left shift in, 100	Corrected reticulocyte count, 100–101
normal values for, 97, 98t–99t	Corrigan's pulse, 24
normal variations in, 97	Corticaine (hydrocortisone acetate)
Computed tomography (CT), 330–331	indications, actions, and dosage
Comtan (entacapone), indications, actions,	of, 603
and dosage of, 532	potency and application of, 629t
Comvax (haemophilus B conjugate	Corticosteroids. See also specific
vaccine), indications, actions, and	corticosteroids
dosage of, 547	for hypercalcemia, 189
Condylox (podophyllin), indications,	for pain management, 320
actions, and dosage of, 148t,	in urine, 118
590–591	Cortisol
Condylox Gel 0.5% (podophyllin),	free, in urine, 117
indications, actions, and dosage of,	serum, laboratory diagnosis and, 64
148 <i>t</i> , 590–591	Cortisone (Cortone)
Conjunctivitis, organism responsible and	dose, activity, duration, and route for,
empiric therapy for, 135 <i>t</i>	627 <i>t</i>
Consent, informed, 240	indications, actions, and dosage
Constipation	of, 603
differential diagnosis of, 44	Cortisporin (bacitracin, neomycin,
with enteral nutrition, 223	polymyxin B, + hydrocortisone,
Contact isolation, 155	topical), indications, actions, and
Contaminants, in urine sediment, 112	dosage of, 502
Continuous positive airway pressure	Cortisporin Ophthalmic (bacitracin,
(CPAP), 426	neomycin, polymyxin B, +
Contrast media, 327	hydrocortisone, ophthalmic),
reactions to, 327	indications, actions, and dosage of,
Controlled substances, 475-476	502
Controlled ventilation, 424, 425 <i>f</i>	Cortisporin Ophthalmic and Otic
Conus medullaris trauma, with lumbar	(neomycin, polymyxin, +
puncture, 286	hydrocortisone), indications,
Convalescent specimens (titers), 132	actions, and dosage of, 577

Cortisporin-TC Otic Drops (neomycin, serum, laboratory diagnosis and, 65 colistin, + hydrocortisone), Creatinine clearance, 115-116 indications, actions, and dosage of, determination of, 116 576 Creatinine phosphokinase (CPK) isoenzymes of, laboratory diagnosis Cortisporin-TC Otic Suspension (neomycin, colistin, and, 65 hydrocortisone, + thonzonium), laboratory diagnosis and, 65 indications, actions, and dosage of, Creeping eruption, drugs for treating, 576 Cortizone (hydrocortisone) Creon (pancreatin + pancrelipase), indications, actions, and dosage of, 550 indications, actions, and dosage of, 585 potency and application of, 629t Cortone (cortisone) Cricothyrotomy, 263-264 dose, activity, duration, and route for, Critical care. See Intensive care unit (ICU) 62.7t Critical closing volume (CCV), 416f, 417 indications, actions, and dosage of, 603 Critical illness, hypocalcemia and, 189 Cortrosyn stimulation test, 55-56 Crixivan (indinavir), indications, actions, Corvert (ibutilide) and dosage of, 150t, 553 for emergency cardiac care, 464 Cromolyn sodium (Intal; Nasalcrom; indications, actions, and dosage of, 551 Opticrom), indications, actions, and dosage of, 520-521 Corynebacterium, Gram stain characteristics of, 123f, 126t Cross-table lateral abdominal x-rays, 326 Cosmegen (dactinomycin), indications, Crotamiton, indications for, 154t actions, and dosage of, 523 Croup, 131 Cosopt (dorzolamide + timolol), Crusts, 20 indications, actions, and dosage of, Cryocrit, laboratory diagnosis and, 65 530 Cryoglobulins, laboratory diagnosis and, Cotazyme (pancreatin + pancrelipase), indications, actions, and dosage of, Cryoprecipitated antihemophilic factor, Co-trimoxazole [trimethoprim-Cryptococcosis, systemic drugs for sulfamethoxazole] (Bactrim; treating, 151t Septra), indications, actions, and Cryptosporidiosis, drugs for treating, 153t dosage of, 153t, 615 Crystal(s), in urine sediment, 112 Coudé catheter, 307, 307f Crystalline amino acid solutions, for total Cough, differential diagnosis of, 44 parenteral nutrition, 229-230, Coumadin (warfarin) 230tindications, actions, and dosage Crystalloids, composition of, 180t of, 618 Crystal violet, 122 interaction with enteral nutrition, 223 C-spine x-rays, 326 Counterimmunoelectrophoresis (CEP; Culdocentesis, 264-265 CIEP), laboratory diagnosis and, Cullen's sign, 24 Curling's ulcers, 433 64 - 65Cozaar (losartan), indications, actions, and Cushing's triad, 24 dosage of, 563 Cushing's ulcers, 433 C-peptide, insulin, laboratory diagnosis Cutaneous larva migrans, drugs for and, 60 treating, 153t C-reactive protein (C-RP), laboratory Cutivate (fluticasone propionate), potency diagnosis and, 60 and application of, 629t

Cyanide, antidote for, 471

Creatinine, 115

Cyanocobalamin [vitamin B₁₂] CytoGam (cytomegalovirus immune blood level of, laboratory diagnosis and, globulin), indications, actions, and dosage of, 522 Cytology, of ascitic or pleural fluid, 299t indications, actions, and dosage of, 521 Cytomegalovirus (CMV) in total parenteral nutrition, 231t antibodies to, laboratory diagnosis and, Cyanosis, differential diagnosis of, 44 66 Cyclic antidepressants, antidote cultures for, 132 for, 471 drugs of choice for treating infections Cyclobenzaprine (Flexeril), indications, by, 146t actions, and dosage of, 521 transfusion-associated risk of Cyclocort (amcinonide), potency and transmission, 204 application of, 628t Cytomegalovirus immune globulin [CMV-Cyclogyl (cyclopentolate), indications, IVIG] (CytoGam), indications, actions, and dosage of, 521 actions, and dosage of, 522 Cyclopentolate (Cyclogyl), indications, Cytomel (liothyronine), indications, actions, and dosage of, 521 actions, and dosage of, 562 Cyclophosphamide (Cytoxan; Neosar), Cytosar-U (cytarabine), indications, indications, actions, and dosage of, actions, and dosage of, 522 Cytotec (misoprostol), indications, 521 Cyclospora infection, drugs for treating, actions, and dosage of, 572 Cytovene (ganciclovir), indications, Cyclosporine (Neoral; Sandimmune) actions, and dosage of, 146t, half-life and therapeutic and toxic levels 543-544 Cytoxan (cyclophosphamide), indications, indications, actions, and dosage of, actions, and dosage of, 521 521-522 Cycrin (medroxyprogesterone), indications, actions, and dosage of, Dacarbazine (DTIC), indications, actions, Cyproheptadine (Periactin), indications, and dosage of, 522 actions, and dosage of, 522 Dacliximab (Zenapax), indications, Cysteine, in urine, 117 actions, and dosage of, 522 Cysticercosis, drugs for treating, 154t Dactinomycin (Cosmegen), indications, Cysticercus cellulosae infections, drugs actions, and dosage of, 523 for treating, 154t Dalgan (dezocine), indications, actions, Cystitis, organisms responsible and and dosage of, 525 empiric therapy for, 143t Dalmane (flurazepam), indications, Cystography, 328 actions, and dosage of, 541 Cystospaz (hyoscyamine), indications, Dalteparin (Fragmin), indications, actions, actions, and dosage of, 551 and dosage of, 523 Cytadren (aminoglutethimide), Dantrolene (Dantrium), indications, indications, actions, and dosage of, actions, and dosage of, 523 Dapsone (Avlosulfon), indications, Cytarabine [Ara-C] (Cytosar-U), actions, and dosage of, 523 indications, actions, and dosage of, Darier's sign, 24 Darkfield examination, 122 Cytarabine liposome (DepoCyt), Darvocet (propoxyphene + indications, actions, and dosage of, acetaminophen), indications,

actions, and dosage of, 595

522

Darvon (propoxyphene), indications, Dehydroepiandrosterone sulfate actions, and dosage of, 595 (DHEAS), laboratory diagnosis Darvon Compound-65 (propoxyphene + aspirin), indications, actions, and Delavirdine (Rescriptor), indications, dosage of, indications, actions, and actions, and dosage of, 523-524 dosage of, 595 Delayed hypersensitivity skin testing, 303 Darvon-N + Aspirin (propoxyphene + Delirium, differential diagnosis of, 44 aspirin), indications, actions, and Delivery notes, 37 dosage of, indications, actions, and Del-Mycin Topical (erythromycin, dosage of, 595 topical), indications, actions, and Daunomycin (daunorubicin), indications, dosage of, 534 actions, and dosage of, 523 Delta-Cortef (prednisolone) Daunorubicin (Cerubidine; Daunomycin), dose, activity, duration, and route for, indications, actions, and dosage of, 523 indications, actions, and dosage of, 603 Deltasone (prednisone) Davonex (calcipotriene), indications, actions, and dosage of, dose, activity, duration, and route for, 507-508 627t Daypro (oxaprozin), indications, actions, for hypercalcemia, 189 and dosage of, 583 indications, actions, and dosage of, 603 Daytril (acetaminophen) Demadex (torsemide), indications, antidote for, 471 actions, and dosage of, 613 indications, actions, and dosage of, 488, Demeclocycline (Declomycin), indications, actions, and dosage of, route, effects, and dosage for, 321t DDAVP (desmopressin), indications, Dementia, differential diagnosis of, actions, and dosage of, 524 44-45 Decadron (dexamethasone base), potency Demerol (meperidine) and application of, 628t indications, actions, and dosage Decadron (dexamethasone) dose, activity, duration, and route for, route, effects, and dosage for, 321t Demser (metyrosine), indications, actions, indications, actions, and dosage of, 603, and dosage of, 570 Demulen 1/35 21, 623t 604 Demulen 1/50 21, 623t route, effects, and dosage for, 322t Decelerations, in fetal heart rate, 276 de Musset's sign, 26 Declomycin (demeclocycline), Denavir (penciclovir), indications, actions, indications, actions, and dosage of, and dosage of, 147t, 585 524 Dennis tubes, 273 Decongestants, 487 Dental emergencies, 470 Decubitus abdominal x-rays, 326 Dental examination, 14, 17, 19f Decubitus ulcers, organisms responsible Depakene (valproic acid) and empiric therapy for, 142t half-life and therapeutic and toxic levels Deep somatic pain, 315 of, 632t Deep venous thrombosis (DVT) indications, actions, and dosage of, 616 anticoagulant standard of practice for, Depakote (divalproex), indications, actions, and dosage of, 616 prevention of, 435 DepoCyt (cytarabine liposome), Dehydroepiandrosterone (DHEA), indications, actions, and dosage of, laboratory diagnosis and, 66 522

Depo-Medrol (methylprednisolone acetate)	Ophthalmic), indications, actions,
dose, activity, duration, and route for,	and dosage of, 524
627 <i>t</i>	Dexamethasone suppression test, 66
indications, actions, and dosage of, 603	Dexferrum (iron dextran), indications,
Depo Provera (medroxyprogesterone),	actions, and dosage of, 555
indications, actions, and dosage of,	Dexpanthenol (Ilopan; Ilopan-choline
564	Oral)
Dermalon (nylon) sutures, 346t	indications, actions, and dosage of, 525
Dermatologic agents, 481	in total parenteral nutrition, 231t
Dermatologic descriptions, 20–21	Dexrazoxane (Zinecard), indications,
Dermatome, 22f–23f	actions, and dosage of, 525
Dermatop (prednicarbate), potency and	Dextran 40 (Rheomacrodex), indications,
application of, 630t	actions, and dosage of, 525
Desipramine (Norpramin)	Dextromethorphan (Benylin DM;
half-life and therapeutic and toxic levels	Mediquell; Pediacare 1),
of, 633 <i>t</i>	indications, actions, and dosage of,
indications, actions, and dosage of, 524	525
Desmopressin (DDAVP; Stimate),	Dey-Drop (silver nitrate), indications,
indications, actions, and dosage of, 524	actions, and dosage of, 601 Dezocine (Dalgan), indications, actions,
Desogen (Organon), 623t	and dosage of, 525
Desonide (DesOwen), potency and	Diabeta (glyburide), indications, actions,
application of, 628t	and dosage of, 545
Desoximetasone (Topicort), potency and	Diabetes
application of, 628t	insulins for. See Insulins
Desyrel (trazodone)	total parenteral nutrition formulation
half-life and therapeutic and toxic levels	for, 235
of, 634t	Diabinese (chlorpropamide), indications,
indications, actions, and dosage of, 613	actions, and dosage of, 515
Detrol LA (tolterodine), indications,	Diagnostic peritoneal lavage (DPL),
actions, and dosage of, 612	295
DEXA, 326	Dialose (docusate potassium), indications,
Dexacort Phosphate Turbinaire	actions, and dosage of, 529
(dexamethasone, nasal),	Diamox (acetazolamide)
indications, actions, and dosage of,	for hyperphosphatemia, 192
524	indications, actions, and dosage of, 489
Dexamethasone (Decadron)	Diaphragm, on chest x-rays, 335, 337f
dose, activity, duration, and route for,	Diarrhea
627 <i>t</i>	differential diagnosis of, 45
indications, actions, and dosage of, 603,	with enteral nutrition, 218, 223
604	IV fluid replacement with, 179
route, effects, and dosage for, 322t	Diastolic heart murmurs, 394–395
Dexamethasone base (Aeroseb-Dex;	Diastolic hypertension, 392
Decadron), potency and	Diazepam (Valium)
application of, 628t	indications, actions, and dosage of,
Dexamethasone, nasal (Dexacort	525–526
Phosphate Turbinaire), indications,	for seizures, 472, 473 <i>t</i>
actions, and dosage of, 524	Diazoxide (Hyperstat; Proglycem),
Dexamethasone, ophthalmic (AK-DEX Ophthalmic; Decadron	indications, actions, and dosage of, 526
Ophthalline, Decadion	320

Dibucaine (Nupercainal), indications,

(Oxycontin; OxyIR; Roxicodone),

indications, actions, and dosage of,

583

Dilacor (diltiazem)

actions, and dosage of, 526 for emergency cardiac care, 462 Diclofenac (Cataflam; Voltaren) indications, actions, and dosage of, 528 indications, actions, and dosage of, 526 infusion guidelines for, 439t route, effects, and dosage for, 321t Dilantin (phenytoin) Dicloxacillin (Dycill; Dynapen), half-life and therapeutic and toxic levels indications, actions, and dosage of, of, 631t-632t 526 indications, actions, and dosage of, 589 Dicyclomine (Bentyl), indications, interaction with enteral nutrition, 223 actions, and dosage of, 526 Dilaudid (hydromorphone), indications, Didanosine [DDI] (Videx), indications, actions, and dosage of, 550 actions, and dosage of, 526-527 Diltiazem (Cardizem; Dilacor; Tiazac) for emergency cardiac care, 462 Didronel (etidronate disodium), indications, actions, and dosage of, 528 indications, actions, and dosage of, 536 infusion guidelines for, 439t Dimenhydrinate (Dramamine), Diet(s), hospital, 205, 206t–208t Dietary supplements, 481 indications, actions, and dosage of, Diethylcarbamazine, indications for, 153t Diethylenetriamine pentaacetic acid Dimercaptosuccinic acid (technetium-99m (technetium-99m DTPA), 334 DMSA), 334 Differential diagnosis, 41-52 Dimethyl sulfoxide [DMSO] (Rimso 50), Differential WBC, 96-97, 97t indications, actions, and dosage of, Diflorasone diacetate (Psorcon), potency 528 and application of, 628t Diovan (valsartan), indications, actions, Diflucan (fluconazole), indications, and dosage of, 616 actions, and dosage of, 151t, Dipentum (olsalazine), indications, 539-540 actions, and dosage of, 580-581 Diflunisal (Dolobid), indications, actions, Diphenhydramine (Benadryl) and dosage of, 527 for anaphylaxis, 469 Digibind (digoxin immune Fab) indications, actions, and dosage for emergency cardiac care, 462 of, 528 indications, actions, and dosage of, 471, Diphenoxylate + atropine (Lomotil), 527 indications, actions, and dosage of, Digitalis 528 electrocardiogram and, 386 Diphyllobothrium latum infections, drugs toxicity of, 386 for treating, 154t Digoxin (Lanoxicaps; Lanoxin) Dipivefrin (Propine), indications, actions, antidote for, 471 and dosage of, 528 for emergency cardiac care, 462 Diplopia, differential diagnosis of, 45 half-life and therapeutic and toxic levels Diprivan (propofol), indications, actions, and dosage of, 594 Diprosone (betamethasone dipropionate), indications, actions, and dosage of, 527 Digoxin immune Fab (Digibind) potency and application of, 628t for emergency cardiac care, 462 Dipylidium canium infections, drugs for indications, actions, and dosage of, 471, treating, 154t Dirithromycin (Dynabac), indications, 527 Dihydrohydroxycodeinone [oxycodone] actions, and dosage of, 529

Discharge precautions, 156

Discharge summaries/notes, 34-35

Disopyramide (Napamide; Norpace)

Dopamine (Dopastat; Intropin) for emergency cardiac care, 462

indications, actions, and dosage of,

half-life and therapeutic and toxic levels

indications, actions, and dosage

of, 633t

of, 529	398t, 530
Disseminated intravascular coagulation	infusion guidelines for, 440t
(DIC), 434–435	Doppler echocardiography, 330
Distal port, of Swan-Ganz catheter, 400	Doppler pressures, 265–266
Ditropan (oxybutynin), indications,	Doral (quazepam), indications, actions,
actions, and dosage of, 583	and dosage of, 596
Ditropan XL (oxybutynin), indications,	Dornase alfa (Pulmozyme), indications,
actions, and dosage of, 583	actions, and dosage of, 530
Diuretics, 479–480	Dorzolamide (Trusopt), indications,
Diuril (chlorothiazide), indications,	actions, and dosage of, 530
actions, and dosage of, 515	Dorzolamide + timolol (Cosopt),
Divalproex (Depakote), indications,	indications, actions, and dosage of,
actions, and dosage of, 616	530
Diverticulitis, organisms responsible and	Doss (docusate sodium), indications,
empiric therapy for, 135t	actions, and dosage of, 529
Dizziness, differential diagnosis of, 45	Doxazosin (Cardura), indications, actions,
DNA probes, 132	and dosage of, 530
Dobbhoff tubes, 273	Doxepin (Adapin; Sinequan)
Dobutamine (Dobutrex)	half-life and therapeutic and toxic levels
for emergency cardiac care, 462	of, 634t
indications, actions, and dosage of,	indications, actions, and dosage
398t, 529	of, 530
infusion guidelines for, 439t–440t	Doxepin, topical (Zonalon), indications,
Docetaxel (Taxotere), indications, actions,	actions, and dosage of, 531
and dosage of, 529	Doxorubicin (Adriamycin; Rubex),
Docusate calcium (Surfak), indications,	indications, actions, and dosage of,
actions, and dosage of, 529	531
Docusate potassium (Dialose), indications,	Doxycycline (Vibramycin), indications,
actions, and dosage of, 529	actions, and dosage of, $153t$,
Docusate sodium (Colace; Doss),	531
indications, actions, and dosage of, 529	Dramamine (dimenhydrinate), indications, actions, and dosage of, 528
Döhle's inclusion bodies, 104	Draping patients, for surgery, 343
Dolasetron (Anzemet), indications,	Drawer sign, 24
actions, and dosage of, 529-530	Dronabinol (Marinol), indications,
Doll's eyes, 24	actions, and dosage of, 531
Dolobid (diflunisal), indications, actions,	Droperidol (Inapsine), indications,
and dosage of, 527	actions, and dosage of, 531
Dolophine (methadone)	Droxia (hydroxyurea), indications,
indications, actions, and dosage of,	actions, and dosage of, 551
567–568	Drug interactions, with enteral nutrition,
route, effects, and dosage for, 321t	223
Donnatal (hyoscyamine, atropine,	DSA, 327
scopolamine, + phenobarbital),	DTIC (dacarbazine), indications, actions,
indications, actions, and dosage of,	and dosage of, 522
551	Dukes' classification, of colon cancer,
Donor-directed blood products, 194	652

Dulcolax (bisacodyl), indications, actions, Econazole (Spectazole), indications, and dosage of, 505 actions, and dosage of, 531-532 Duodenal ulcers, organism responsible Edecrin (ethacrynic acid), indications, and empiric therapy for, 144t actions, and dosage of, 536 Duo-Tube, 273 Edema, differential diagnosis of, 46 Edex (alprostadil, intracavernosal), Dupuvtren's contracture, 25 Duragesic (fentanyl, transdermal), indications, actions, and dosage of, indications, actions, and dosage of, 538 Edrophonium (Tensilon), indications, Duramorph (morphine) actions, and dosage of, 532 for emergency cardiac care, 465 Education, assertiveness in obtaining, 3 indications, actions, and dosage of, 573 Efavirenz (Sustiva), indications, actions, route, effects, and dosage for, 321t and dosage of, 532 Duricef (cefadroxil) Effer-Syllium (psyllium), indications, indications, actions, and dosage of, 511 actions, and dosage of, 596 for subacute bacterial endocarditis Effexor (venlafaxine), indications, actions, prophylaxis, 158t and dosage of, 617 Duroziez's sign, 25 Efudex (fluorouracil, topical), indications, Duvoid (bethanechol), indications, actions, and dosage of, 541 Ehrlichiosis, characteristics and treatment actions, and dosage of, 504-505 of, 156t-157t Dyazide (hydrochlorothiazide + triamterene), indications, actions, Elavil (amitriptyline) and dosage of, 549 indications, actions, and dosage Dycill (dicloxacillin), indications, actions, of, 495 and dosage of, 526 route, effects, and dosage for, 322t Dynabac (dirithromycin), indications, Eldepryl (selegiline), indications, actions, actions, and dosage of, 529 and dosage of, 600 Dynacire (isradipine), indications, actions, Electrical alternans, 25 and dosage of, 555-556 Electrical defibrillation, 467-468 Dynamic compliance, 417-418 Electrical stimulation, for pain Dynapen (dicloxacillin), indications, management, 323 actions, and dosage of, 526 Electrocardiograms (ECGs), 266–268, Dyrenium (triamterene), indications, 367-388, 368f, 369f actions, and dosage of, 613-614 atrial arrhythmias on, 372-374, Dysmorphic red cells, 114-115 373f-375f Dysphagia, differential diagnosis of, 45 axis deviation in, 369-370, 370f Dyspnea, differential diagnosis of, 45 in cardiac hypertrophy, 380-383, Dysuria, differential diagnosis of, 46 381f-383f drug effects on, 386 electrolyte effects on, 385-386, 386f E heart blocks on, 377–379, 379f–381f Ear(s), medications for, 482 heart rate and, 371, 371f Earache, differential diagnosis of, 46 hypothermia, 387f, 388 Ecchymoses, 20 in hypothermia, 387f, 388 Echinococcus granulosus infections, drugs indications for, 266 leads for, 368 for treating, 154t materials for, 266 Echocardiography, 330 in myocardial infarction, 383f-385f, Echothiophate iodine (Phospholine Ophthalmic), indications, actions, 383-384, 385t and dosage of, 532 nodal rhythm on, 374-375, 376f

normal ECG complex and, 368f,	Empirin No. 2, No. 3, No. 4 (aspirin +
368–369	codeine), indications, actions, and
paper for, 368	dosage of, 500
in pericarditis, 387, 387f	Empyema, 50
procedure for, 266–268, 267f	organisms responsible and empiric
sinus rhythms on, 371–372, 372f–373f	therapy for, 136t
standardization for, 367, 368f	E-mycin (erythromycin), indications,
ventricular arrhythmias on, 375-377,	actions, and dosage of, 533-534
376f–378f	Enalapril (Vasotec)
in Wolff-Parkinson-White syndrome,	for emergency cardiac care, 449
388, 388f	indications, actions, and dosage of, 532
Electrolytes. See also Fluids and	Enalaprilat IV, for emergency cardiac care,
electrolytes; specific electrolytes	449
electrocardiograms and, 385–386, 386f	Encephalitis, herpes simplex virus, drugs
spot urine study for, 114	of choice for treating, 147 <i>t</i>
Electromyography, for pain evaluation,	Endobronchial endoscopic collection, 130
319	Endocarditis, bacterial
Elemental formulas, for enteral nutrition,	organisms responsible and empiric
217	therapy for, 136 <i>t</i> –137 <i>t</i>
Elimite (permethrin), indications, actions,	subacute, prophylaxis of, 155, 158 <i>t</i> –159 <i>t</i>
and dosage of, 153t, 154t, 588	
Elmiron (pentosan polysulfate sodium),	Endocrine system, medications for, 482
indications, actions, and dosage of,	Endotracheal intubation, 268–270
587	contraindications to, 268
Elocon (mometasone furoate), potency	indications for, 268
and application of, 630t	materials for, 268, 269 <i>t</i>
Elspar (L-asparaginase), indications,	technique for, 268–270, 270 <i>f</i>
actions, and dosage of, 499	Endovaginal ultrasound, 329
Embolism, prevention of, anticoagulant	Enfamil 20, 224 <i>t</i>
standard of practice for, 637t	Enfamil 24, 224 <i>t</i>
Emcyt (estramustine phosphate),	Enfamil Premature 20, 225t
indications, actions, and dosage of,	Enfamil Special Care 24, 225t
535	Engerix-B (hepatitis B vaccine),
Emergency cardiac care (ECC),	indications, actions, and dosage of,
449–468	548
algorithms for, 450f–460f	Enoxaparin (Lovenox), indications,
drugs used in, 449, 461–467	actions, and dosage of, 532
electrical defibrillation and	Entacapone (Comtan), indications,
cardioversion for, 467–468	actions, and dosage of, 532
Emergency transfusions, 194	Entamoeba histolytica infections, drugs
Emesis, IV fluid replacement for, 179	for treating, 153t
Emgel Topical (erythromycin, topical),	Enteral nutrition, 213, 214t, 214-223
indications, actions, and dosage of,	complications of, 218, 223
534	initiating tube feedings for, 217-218,
Eminase (anistreplase)	218t-222t
for emergency cardiac care, 467	postoperative, 223
indications, actions, and dosage of, 498	products for, 214, 215t–216t, 217
EMLA (lidocaine + prilocaine),	Enteric precautions, 155
indications, actions, and dosage of,	Enterobacter, Gram stain characteristics
561	of. 124f

ERCP (endoscopic retrograde

infusion guidelines for, 440t

Enterobius vermicularis infections, drugs

actions, and dosage of, 566

for treating, 153t cholangiopancreatography), 328 Enteroclysis, 328 Erectile dysfunction, differential diagnosis Enterococcus, Gram stain characteristics of. 48 of, 123f, 125t Ergamisol (levamisole), indications, Entriflex tubes, 273 actions, and dosage of, 560 Entuss-D (hydrocodone + Erosions, cutaneous, 20 pseudoephedrine), indications, Erysipelas, organism responsible and actions, and dosage of, 550 empiric therapy for, 142t Enzone (pramoxine + hydrocortisone), Erythrocin (erythromycin), indications, indications, actions, and dosage of, actions, and dosage of, 533-534 Erythrocytapheresis, 194 592 Enzymes, 484 Erythrocytes. See Red blood cell(s) Eosinophils, laboratory diagnosis and, 101 (RBCs) Ephedrine, indications, actions, and Erythrocyte sedimentation rate (ESR), 108 dosage of, 532-533 Erythromycin (E-mycin; Erythrocin; Epidemiology, 639, 645 Ilosone), indications, actions, and Epiglottitis, 131 dosage of, 533-534 organisms responsible and empiric Erythromycin + benzoyl peroxide therapy for, 137t(Benzamycin), indications, actions, Epinephrine, racemic, 364 and dosage of, 534 Epinephrine (Adrenalin; Sus-Phrine) Erythromycin, ophthalmic (Ilotycin actions of, 398t Ophthalmic), indications, actions, for anaphylaxis, 468, 469 and dosage of, 534 for asthmatic attacks, 469 Erythromycin + sulfisoxazole (Eryzole; for emergency cardiac care, 462 Pediazole), indications, actions, indications, actions, and dosage and dosage of, 534 of, 533 Erythromycin, topical (Akne-Mycin infusion guidelines for, 440t Topical; Del-Mycin Topical; for suturing, 348, 349t Emgel Topical; Staticin Topical), Epistaxis, differential diagnosis of, 46 indications, actions, and dosage of, Epithelial casts, in urine sediment, 114 Epithelial cells, in urine sediment, 112 Erythropoietin [epoetin alfa] (Epogen; Epivir (lamivudine), indications, actions, Procrit), indications, actions, and and dosage of, 146t, 558 dosage of, 533 Epivir-HBV (lamivudine), indications, Erythropoietin (EPO), laboratory actions, and dosage of, 146t, 558 diagnosis and, 66-67 Epoetin alfa [erythropoietin] (Epogen; Eryzole (erythromycin + sulfisoxazole), Procrit), indications, actions, and indications, actions, and dosage of, 534 dosage of, 533 Epoprostenol (Flolan), indications, Escherichia coli, Gram stain characteristics of, 124f, 126t actions, and dosage of, 533 Eprosartan (Teveten), indications, actions, Esidrix (hydrochlorothiazide), indications, and dosage of, 533 actions, and dosage of, 549 Epstein-Barr virus (EBV), 146t Eskalith (lithium carbonate), indications, Eptifibatide (Integrilin) actions, and dosage of, 562 for emergency cardiac care, 464 Esmolol (Brevibloc) indications, actions, and dosage of, 533 for emergency cardiac care, 462 Equanil (meprobamate), indications, indications, actions, and dosage of, 534

Esophageal procedures, subacute bacterial endocarditis prophylaxis for, 158*t*

Esophagitis, cytomegalovirus, drugs of choice for treating, 146*t*

Esophagography, 328

Estazolam (Prosom), indications, actions, and dosage of, 534

Estinyl (ethinyl estradiol), indications, actions, and dosage of, 536

Estrace (estradiol), indications, actions, and dosage of, 535

Estracyte (estramustine phosphate), indications, actions, and dosage of, 535

Estraderm (estradiol, transdermal), indications, actions, and dosage of, 535

Estradiol (Estrace), indications, actions, and dosage of, 535

Estradiol, serum, laboratory diagnosis and, 67

Estradiol, transdermal (Estraderm), indications, actions, and dosage of, 535

Estramustine phosphate (Emcyt; Estracyte), indications, actions, and dosage of, 535

Estratab (estrogens, esterified), indications, actions, and dosage of, 535

Estratest (estrogens, esterified + methyltestosterone), indications, actions, and dosage of, 535

Estrogen(s), conjugated (Premarin), indications, actions, and dosage of, 535

Estrogen(s), conjugated + methylprogesterone (Premarin + Methylprogesterone), indications, actions, and dosage of, 535–536

Estrogen(s), conjugated +
methyltestosterone (Premarin +
Methyltestosterone), indications,
actions, and dosage of, 536

Estrogen(s), conjugated-synthetic (Cenestin), indications, actions, and dosage of, 535–536

Estrogen(s), esterified (Estratab; Menest), indications, actions, and dosage of, 535 Estrogen(s), esterified + methyltestosterone (Estratest), indications, actions, and dosage of, 535

Estrogen receptors, laboratory diagnosis and, 67

Estrogen supplementation, 485 Estrostep 28, 624*t*

Ethacrynic acid (Edecrin), indications, actions, and dosage of, 536

Ethambutol (Myambutol), indications, actions, and dosage of, 536

Ethanol

blood levels of, laboratory diagnosis and, 67

for methanol poisoning, 471

Ethibond (polyester) sutures, 347t

Ethilon (nylon) sutures, 346t

Ethinyl estradiol (Estinyl; Feminone), indications, actions, and dosage of, 536

Ethmozine (moricizine), indications, actions, and dosage of, 573

Ethosuximide (Zarontin)

half-life and therapeutic and toxic levels of, 631t

indications, actions, and dosage of, 536

Ethyol (amifostine), indications, actions, and dosage of, 494

Etidronate disodium (Didronel), indications, actions, and dosage of, 536

Etodolac (Lodine), indications, actions, and dosage of, 536–537

Etoposide [VP-16] (Vepesid), indications, actions, and dosage of, 537

Eubacterium, Gram stain characteristics of, 126t

Eulexin (flutamide), indications, actions, and dosage of, 541–542

Eumorphic blood cells, 114

Euvolemic hypernatremia, 184–185

Evening rounds, 3-4

Evista (raloxifene), indications, actions, and dosage of, 597

Ewald tubes, 273

Ewart's sign, 25

Excoriations, 21t

Femara (letrozole), indications, actions, Exosurf Neonatal (colfosceril palmitate), indications, actions, and dosage of, and dosage of, 559 Feminone (ethinyl estradiol), indications, Expiratory chest x-rays, 325 actions, and dosage of, 536 Expiratory reserve volume (ERV), 416 Femoral vein, venipuncture using, 313 Exsel Shampoo (selenium sulfide), Fenofibrate (Tricor), indications, actions, and dosage of, 537 indications, actions, and dosage of, 600 Fenoldopam (Corlopam), indications, Extremity perfusion, 392 actions, and dosage of, 537 Extrinsic factor, laboratory diagnosis and, Fenoprofen (Nalfon), indications, actions, and dosage of, 537-538 Extubation, from mechanical ventilation, Fentanyl (Sublimaze) 428-429 indications, actions, and dosage of, 538 route, effects, and dosage for, 321t ExU (excretory urography), 328 Exudative ascites, 297 Fentanyl Oralet (fentanyl, transmucosal Eyes, medications for, 482-483 system), indications, actions, and dosage of, 538 Fentanyl, transdermal (Duragesic), indications, actions, and dosage of, Factor VII, for transfusion, 199t Factor VIII [antihemophilic factor] Fentanyl, transmucosal system (Actiq; (Monoclate) Fentanyl Oralet), indications, actions, and dosage of, 538 indications, actions, and dosage of, 498 Fergon (ferrous gluconate), indications, for transfusion, 199t Factor IX concentrate, 200t actions, and dosage of, 538 Fahrenheit/celsius conversion, 646, 649t Ferric gluconate complex (Ferrlecit), Failure to thrive, differential diagnosis of, indications, actions, and dosage of, Ferritin, laboratory diagnosis and, 68 Famciclovir (Famvir), indications, actions, and dosage of, 147t, 148t, 537 Ferrlecit (ferric gluconate complex), Family history, 10 indications, actions, and dosage of, Famotidine (Pepcid), indications, actions, and dosage of, 537 Ferrous gluconate (Fergon), indications, Famvir (famciclovir), indications, actions, actions, and dosage of, 538 Ferrous sulfate, indications, actions, and and dosage of, 147t, 148t, 537 dosage of, 538 Fast catgut sutures, 346t Fat, fecal, laboratory diagnosis and, 67 Fetal heart rate, internal fetal scalp Fat restricted diet, 208t monitoring of, 275-276 Fatty casts, in urine sediment, 114 Fetal scalp monitoring, internal, 275-276 Febrile reactions, to transfusions, Fever nonhemolytic, 202 differential diagnosis of, 46 Fecal fat, laboratory diagnosis and, 67 of unknown origin, differential diagnosis of, 46 Fecal leukocytes, 128 Fever work-up, 270-272 Feeding tubes, 273 Feldene (piroxicam) Fexofenadine (Allegra), indications, indications, actions, and dosage of, 590 actions, and dosage of, 538-539 Fibrin D-Dimers, 107 route, effects, and dosage for, 321t Fellows, 2 Fibrin degradation products (FDPs), 107 Felodipine (Plendil), indications, actions, Fibrinogen, 107 Fibrin split products (FSPs), 107 and dosage of, 537

FIGO classification, 655, 657 Filariasis, drugs for treating, 153*t* Filgrastim [G-CSF] (Neupogen), indications, actions, and dosage of, 539 Finasteride (Propecia: Proscar)

Finasteride (Propecia; Proscar), indications, actions, and dosage of, 539

Fioricet (acetaminophen + butalbital +/caffeine), indications, actions, and dosage of, 489

Fiorinal (aspirin + butalbital compound), indications, actions, and dosage of, 500

Fiorinal + Codeine (aspirin + butalbital, caffeine and codeine), indications, actions, and dosage of, 500

First-degree heart block, 377, 379f

Fissures, cutaneous, 21t

Fistulography, 328

Flagyl (metronidazole), indications, actions, and dosage of, 153t, 154t, 570

Flamp (fludarabine phosphate), indications, actions, and dosage of, 540

Flat and upright abdominal x-rays, 326 Flat plates, 326

Flatulence, differential diagnosis of, 47 Flavoxate (Urispas), indications, actions, and dosage of, 539

Flecainide (Tambocor)

half-life and therapeutic and toxic levels of, 633t

indications, actions, and dosage of, 539

Fleet's Phospho-soda (sodium phosphate), for hypophosphatemia, 192

Flexeril (cyclobenzaprine), indications, actions, and dosage of, 521

Flexible sigmoidoscopy, 300

Flolan (epoprostenol), indications, actions, and dosage of, 533

Flomax (tamsulosin), indications, actions, and dosage of, 607

Flonase (fluticasone, nasal), indications, actions, and dosage of, 542

Florinef (fludrocortisone acetate), indications, actions, and dosage of, 540 Flovent (fluticasone, oral), indications, actions, and dosage of, 542

Flovent Rotadisk (fluticasone, oral), indications, actions, and dosage of, 542

Floxin (ofloxacin), indications, actions, and dosage of, 580–581

Floxuridine (FUDR), indications, actions, and dosage of, 539

Fluconazole (Diflucan), indications, actions, and dosage of, 151*t*, 539–540

5-Flucytosine, indications for, 151t
Fludarabine phosphate (Flamp; Fludara), indications, actions, and dosage of, 540

Fludrocortisone, for renal tubular acidosis, 168t

Fludrocortisone acetate (Florinef), indications, actions, and dosage of, 540

Fluids and electrolytes, 177–192. See also Intravenous (IV) fluids

baseline fluid requirement and, 178 electrolyte abnormality diagnosis and treatment, 184–192

electrolyte requirements and, 178 fluid compartments and, 177 glucose requirements and, 178 IV rate determination for, 183–184 maintenance fluids, 179, 181*t* ordering IV fluids, 179–183 parenteral fluid composition and,

178–179 red blood cell mass and, 177 specific replacement fluids, 179, 182*f*–183*f*, 183

total blood volume and, 177 total body water, 177

water balance and, 177–178

Flumadine (rimantadine), indications, actions, and dosage of, 148t, 598–599

Flumazenil (Romazicon)

for benzodiazepine poisoning, 471 for emergency cardiac care, 462 indications, actions, and dosage of, 540

Flunisolide (Aerobid; Nasolide), indications, actions, and dosage of, 540

Fluocinolone acetonide (Synalar; Synalar-HP), potency and application of, 628t, 629t

Fluocinonide (Lidex; Lidex-E), potency and application of, 629*t*

Fluogen (influenza vaccine), indications, actions, and dosage of, 553

Fluorescent treponemal antibody absorbed (FTS-ABS), laboratory diagnosis and, 68

Fluoroquinolones, 477

Fluorouracil [5-FU] (Adrucil), indications, actions, and dosage of, 540

Fluorouracil, topical [5-FU] (Efudex), indications, actions, and dosage of, 541

Fluoxetine (Prozac; Sarafem), indications, actions, and dosage of, 541

Fluoxymesterone (Halotestin), indications, actions, and dosage of, 541

Fluphenazine (Permitil; Prolixin), indications, actions, and dosage of, 541

Flurandrenolide (Cordran), potency and application of, 629t

Flurazepam (Dalmane), indications, actions, and dosage of, 541

Flurbiprofen (Ansaid), indications, actions, and dosage of, 541

Flushield (influenza vaccine), indications, actions, and dosage of, 553

Flutamide (Eulexin), indications, actions, and dosage of, 541–542

Fluticasone, nasal (Flonase), indications, actions, and dosage of, 542

Fluticasone, oral (Flovent; Flovent Rotadisk), indications, actions, and dosage of, 542

Fluticasone propionate (Cutivate), potency and application of, 629*t* Fluvastatin (Lescol), indications, actions,

and dosage of, 542 Fluvirin (influenza vaccine), indications,

actions, and dosage of, 553

Fluvoxamine (Luvox), indications, actions, and dosage of, 542

Fluzone (influenza vaccine), indications, actions, and dosage of, 553

Folex (methotrexate)

half-life and therapeutic and toxic levels of, 633*t*

indications, actions, and dosage of, 568 Foley catheter, 307, 307f

Folic acid

blood levels of, laboratory diagnosis and, 68

indications, actions, and dosage of, 542 in total parenteral nutrition, 231*t*

Follicle-stimulating hormone (FSH), laboratory diagnosis and, 68

Fomivirsen (Vitravene), indications and dosage for, 146*t*

Fong lesion/syndome, 25

Food fibers, in ascitic fluid, 299t

Forced expired volume in 1 second (FEV/d1/D), 360, 361t

Forced vital capacity (FVC), 360, 361*t* Fortaz (ceftazidime), indications, actions, and dosage of, 513

Fortovase (saquinavir), indications, actions, and dosage of, 150t, 600

Fosamax (alendronate), indications, actions, and dosage of, 491

Foscarnet (Foscavir)

indications, actions, and dosage of, 542 indications and dosage for, 146t, 147t, 149t

Fosfomycin (Monurol), indications, actions, and dosage of, 542–543

Fosinopril (Monopril), indications, actions, and dosage of, 543

Fosphenytoin (Cerebryx)

indications, actions, and dosage of, 543 for seizures, 473*t*

Fourth heart sound (S_4) , 17t

Fragmin (dalteparin), indications, actions, and dosage of, 523

Frank's sign, 25

French units, 240, 241*f*

Frequency, urinary, differential diagnosis of, 47

Fresh frozen plasma (FFP), 198t-199t

FUDR (floxuridine), indications, actions, and dosage of, 539

Full liquid diet, 206t

Functional residual capacity (FRC), 360, 361*t*, 416, 416*f*, 417*f*

indications, actions, and dosage of, 544

for subacute bacterial endocarditis

actions, and dosage of, 544

prophylaxis, 159t

Fungal infections, systemic drugs for

Fungal serologies, laboratory diagnosis

treating, 151t-152t

of, 631t

and, 68 Garamycin (gentamicin, ophthalmic), Fungizone (amphotericin B), indications, indications, actions, and dosage of, actions, and dosage of, 151t, 496-497 Garamycin (gentamicin, topical), Furadantin Macrobid (nitrofurantoin), indications, actions, and dosage of, 545 indications, actions, and dosage of, 579 Gastric cancer, staging of, 656 Furosemide (Lasix) Gastric loss, IV fluid replacement with, 179 for emergency cardiac care, 462-463 indications, actions, and dosage of, 543 Gastric ulcers, organism responsible and for renal tubular acidosis, 168t empiric therapy for, 144t Fusobacterium Gram stain characteristics Gastrin, serum, laboratory diagnosis and, of. 126t Gastroenteritis, organisms responsible and empiric therapy for, 137t - 138tGastrografin enema, 328 Gabapentin (Neurontin), indications, Gastrointestinal agents, 483-484 actions, and dosage of, 543 Gastrointestinal intubation, 272-274 Gabitril (tiagabine), indications, actions, complications of, 274 and dosage of, 610 indications for, 272 Galactorrhea, differential diagnosis of, 47 materials for, 272 Gallium nitrate (Ganite) procedure for, 273-274 for hypercalcemia, 189 tubes for, 272-273 indications, actions, and dosage of, 543 Gastrointestinal procedures, subacute Gallium scans, 334 bacterial endocarditis prophylaxis Gallops, 394 for, 158t, 159t Gamimmune N (immune globulin, Gatifloxacin (Tequin), indications, intravenous), indications, actions, actions, and dosage of, 544 and dosage of, 552 Gaviscon (alginic acid + aluminum Gamma globulin, indications and dosage hydroxide and magnesium for, 146t trisilicate), indications, actions, Gamma-glutamyl transpeptidase, serum and dosage of, 491 (SGGT), laboratory diagnosis and, Gaviscon (aluminum hydroxide + 69 magnesium carbonate), Gammar IV (immune globulin, indications, actions, and dosage of, intravenous), indications, actions, 493 and dosage of, 552 Gaviscon (aluminum hydroxide + Ganciclovir (Cytovene; Vitrasert), magnesium trisilicate), indications, indications, actions, and dosage of, actions, and dosage of, 493 146t 543-544 Gaviscon-2 (aluminum hydroxide + Ganite (gallium nitrate) magnesium trisilicate), indications, for hypercalcemia, 189 actions, and dosage of, 493 indications, actions, and dosage of, 543 GC culture, 291 Garamycin (gentamicin) Gemzar (gemcitabine), indications, half-life and therapeutic and toxic levels

Glucagon

Genital herpes, drugs of choice for

Gloving, for operating room, 342-343

treating, 147t for beta blocker poisoning, 471 Genital warts, drugs of choice for treating, for emergency cardiac care, 464 148t indications, actions, and dosage of, 545 Genitourinary agents, 487 Glucophage (metformin), indications, Genitourinary procedures, subacute actions, and dosage of, 567 bacterial endocarditis prophylaxis Glucose laboratory diagnosis and, 69 for, 159t Genoptic (gentamicin, ophthalmic), in pleural fluid, 299t indications, actions, and dosage of, requirement for, 178 in urine, 111 Genora 1/35 21, 28, 623t Glucose tolerance test (GTT), 69-70 Genora 1/50 28, 623t oral, 69-70 Gentacidin (gentamicin, ophthalmic), Glucotrol (glipizide), indications, actions, indications, actions, and dosage of, and dosage of, 545 544 Glu-K (potassium gluconate), form and Gentak (gentamicin, ophthalmic), dosage of, 626t indications, actions, and dosage of, Glyburide (Diabeta; Micronase), 544 indications, actions, and dosage of, 545 Gentamicin (Garamycin) half-life and therapeutic and toxic levels Glycerin suppositories, indications, actions, and dosage of, 545-546 indications, actions, and dosage Glycohemoglobin (GHB), laboratory of, 544 diagnosis and, 70 for subacute bacterial endocarditis Glycoprotein IIb/IIIa inhibitors, for prophylaxis, 159t emergency cardiac care, 464 Gentamicin, ophthalmic (Garamycin; Glyset (miglitol), indications, actions, and Genoptic; Gentacidin; Gentak), dosage of, 571 indications, actions, and dosage of, G-Myticin (gentamicin, topical), indications, actions, and dosage of, Gentamicin + prednisolone, ophthalmic 545 (Pred-G Ophthalmic), indications, GoLYTELY (polyethylene glycol [PEG]actions, and dosage of, 545 electrolyte solution), indications, Gentamicin, topical (Garamycin; actions, and dosage of, 590-591 G-Myticin), indications, actions, Gonadorelin (Lutrepulse), indications, and dosage of, 545 actions, and dosage of, 546 Geriatrics, total parenteral nutrition Gonococcal antigen assay, 129 formulation for, 235 Gonorrhea Giardiasis, drugs for treating, 153t cultures and smear for, 129 Gibbus, 25 organism responsible and empiric Giemsa stain, 122 therapy for, 138tGlasgow Coma Scale (EMV Scale), 645, Gonozyme, 129 645tGoserelin (Zoladex), indications, actions, Glaucoma agents, 482-483 and dosage of, 546 Glimepiride (Amaryl), indications, Gowning, for operating room, 342-343 actions, and dosage of, 545 Gram stain, 122, 291 Glipizide (Glucotrol), indications, actions, of common pathogens, 122, 123f-124f, and dosage of, 545 125t - 127tGlitter cells, in urine sediment, 114 Granisetron (Kytril), indications, actions,

and dosage of, 546

Granulocytes, for transfusion, 197t	Haldol (haloperidol)
Granuloma inguinale, organism	indications, actions, and dosage of, 547
responsible and empiric therapy	route, effects, and dosage for, 322t
for, 138 <i>t</i>	Halobetasol (Ultravate), potency and
Granulomatous infection, cerebrospinal	application of, 629t
fluid in, 287t	Halog (halcinonide), potency and
Gregg's triad, 25	application of, 629t
Grey Turner's sign, 25	Haloperidol (Haldol)
Grocco's sign, 25	indications, actions, and dosage of, 547
Guaifenesin (Robitussin), indications,	route, effects, and dosage for, 322t
actions, and dosage of, 546	Haloprogin (Halotex), indications, actions
Guaifenesin + codeine (Brontex;	and dosage of, 547
Robitussin A-C), indications,	Halotestin (fluoxymesterone), indications
actions, and dosage of, 546	actions, and dosage of, 541
Guaifenesin + dextromethorphan,	Halotex (haloprogin), indications, actions
indications, actions, and dosage of,	and dosage of, 547
546	Hampton's hump, 436
Guanabenz (Wytensin), indications,	Hand scrub, surgical, 340–341
actions, and dosage of,	Haptoglobin, laboratory diagnosis and, 70
546–547	Harris-Benedict BEE, 209
Guanadrel (Hylorel), indications, actions,	Havrix (hepatitis A vaccine), indications,
and dosage of, 547	actions, and dosage of, 548
Guanethidine (Ismelin), indications,	H-BIG (hepatitis B immune globulin),
actions, and dosage of, 547	indications, actions, and dosage of
Guanfacine (Tenex), indications, actions,	548
and dosage of, 547	HDL-C (high-density lipoprotein
Guillain-Barré syndrome, cerebrospinal	cholesterol), laboratory diagnosis
fluid in, 287t	and, 63
Gynecologic agents, 485–486	Headache
Gynecomastia, differential diagnosis of,	differential diagnosis of, 47
47	spinal, 286
	Head computed tomography, 330
	Head magnetic resonance imaging, 332–333
H	Healing, of wounds, 345
Habitrol (nicotine, transdermal),	Health, personal, 2–3
indications, actions, and dosage of,	Heart, on chest x-rays, 335, 336f, 337f
578	Heart blocks, on electrocardiograms,
Haemophilus B conjugate vaccine	377–379, 379 <i>f</i> –381 <i>f</i>
(Comvax; Prohibit), indications,	Heartburn, differential diagnosis of, 47
actions, and dosage of, 547	Heart murmurs, 16 <i>t</i> –17 <i>t</i> , 18 <i>f</i> , 393–395
Haemophilus ducreyi, Gram stain	Heart rate
characteristics of, 126t	on electrocardiograms, 371, 371f
Haemophilus influenza, Gram stain	measurement of, 408
characteristics of, 124f, 126t	Heart sounds, extra, 16t–17t
Hairworm infection, drugs for treating,	Heberden's nodes, 25
154 <i>t</i>	Heelstick, 274, 275f
Halcinonide (Halog), potency and	Hegar's sign, 25
application of, 629t	Helical computed tomography, 331
Halcion (triazolam), indications, actions,	Helicobacter pylori antibody titers,
and dosage of 614	laboratory diagnosis and, 70

Hellenhorst's plaque, 25 drugs of choice for treating, 148t, 149t Helmet cells, 104 Hetastarch (Hespan), indications, actions, and dosage of, 548 Hematemesis, differential diagnosis of, 47 Hematochezia, differential diagnosis of, Hexalen (altretamine), indications, actions, and dosage of, 493 Hematocrit, 97, 101 Hibiclens 6-min hand scrub, 341 Hematologic agents, 484 Hiccups, differential diagnosis of, 48 Hematuria, differential diagnosis of, 48 HIDA-scans, 334 Hemoccult test, 89, 300 High-density formulas, for enteral Hemodialysis, diet for, 207 nutrition, 217 Hemopoietic stimulants, 484 High-density lipoprotein cholesterol Hemoptysis, differential diagnosis of, 48 (HDL), laboratory diagnosis and, Hemorrhage, synovial fluid interpretation and, 250, 251t Higher osmolality infant formulas, 224t Henderson equation, 162 High-frequency ventilation, 424, 426 Hill's sign, 25 Henderson-Hasselbalch equation, 162 Heparin Hilum, on chest x-rays, 335 indications, actions, and dosage of, 548 131 Hippuran, 334 low molecular weight, for emergency Hiprex (methenamine), indications, cardiac care, 464 actions, and dosage of, 568 for pulmonary embolism, 436 Hirsutism, differential diagnosis unfractionated, for emergency cardiac of, 48 care, 464 Histoplasmosis, systemic drugs for Hepatitis treating, 151t History, 9-11 drugs of choice for treating, 146t–147t transfusion-associated risk of psychiatric, 13-14 transmission, 203 written, 5, 28-32 Hepatitis A vaccine (Havrix; Vaqta), Histussin D (hydrocodone + indications, actions, and dosage of, pseudoephedrine), indications, actions, and dosage of, 550 Hepatitis B immune globulin (H-BIG; Hivid (zalcitabine), indications, actions, Hyperhep), indications, actions, and dosage of, 619 and dosage of, 548 Hoffmann's sign/reflex, 25 Hepatitis B vaccine (Engerix-B; Holoxan (ifosfamide), indications, actions, Recombivax-HB), indications, and dosage of, 552 actions, and dosage of, 548 Homans' sign, 25 Hepatitis testing, 70, 71t-72t, 73f, 74 Homocysteine, serum, laboratory for hepatitis A, 72t, 73f, 74 diagnosis and, 75 for hepatitis B, 72t, 73f, 74 Hookworm infections, drugs for treating, for hepatitis C, 72t, 74 Hepatobiliary scans, 334 Hormones, 482. See also specific Hepatomegaly, differential diagnosis of, hormones antineoplastic, 478 Herpes cultures, 291 gynecologic agents, 485 Herpes simplex virus (HSV) Horner's syndrome, 25 cultures for, 132 Hospital diets, 205, 206t-208t drugs of choice for treating infections Hounsfield units, 330 by, 147t House diet, 206t Herpes zoster. See also Varicella zoster Household measurement units, 646 virus (VZV) Howell-Jolly bodies, 104

- Humalog (lispro), onset, peak, and duration of effect of, 622t
- Humalog Mix (lispro protamine/lispro), onset, peak, and duration of effect of, 622t
- Human chorionic gonadotropin (hCG), serum, laboratory diagnosis and, 75
- Human granulocytic ehrlichiosis, characteristics and treatment of, 156t–157t
- Human immunodeficiency virus (HIV) infection
 - drugs of choice for treating, 150*t* transfusion-associated risk of transmission, 203–204
- Human immunodeficiency virus (HIV)
 - testing, 75–77, 76f HIV antibody and, 75
 - HIV antibody by ELISA determination and, 76
 - HIV antibody ELISA and, 75-76
 - HIV antigen and, 77
 - HIV core antigen and, 83
 - HIV DNA PCR and, 77
 - HIV RNA PCR and, 77
 - HIV viral load and, 77 HIV Western blot and, 76
- Human leukocyte antigens (HLA), laboratory diagnosis and, 74–75
- Human milk, 224t
- Human papillomavirus (HPV), drugs of choice for treating infections by, 148t
- Human T-cell leukemia virus type 1 (HTLV-1), transfusion-associated risk of transmission, 204
- Humidity therapy, 362, 363t
- Humulin N, onset, peak, and duration of effect of, 622t
- Humulin U, onset, peak, and duration of effect of, 622t
- Hyaline casts, in urine sediment, 114

 Hycamtin (topotecan) indications
- Hycamtin (topotecan), indications, actions, and dosage of, 612
- Hycodan (hydrocodone + homatropine), indications, actions, and dosage of, 550
- Hycomine (hydrocodone, chlorpheniramine, phenylephrine,

- acetaminophen, + caffeine), indications, actions, and dosage of, 550
- Hycort (hydrocortisone) indications, actions, and dosage of, 550
- potency and application of, 629t Hycotuss Expectorant (hydrocodone + guaifenesin), indications, actions,
- and dosage of, 550
 Hydralazine (Apresoline), indications,
- actions, and dosage of, 549 Hydrea (hydroxyurea), indications,
- actions, and dosage of, 551
- Hydrochlorothiazide (Esidrix;
 - Hydrodiuril), indications, actions, and dosage of, 549
- Hydrochlorothiazide + amiloride (Moduretic), indications, actions, and dosage of, 549
- Hydrochlorothiazide + spironolactone (Aldactazide), indications, actions, and dosage of, 549
- Hydrochlorothiazide + triamterene (Dyazide; Maxzide), indications, actions, and dosage of, 549
- Hydrocodone + acetaminophen (Lorcet; Vicodin), indications, actions, and dosage of, 549
- Hydrocodone + aspirin (Lortab ASA), indications, actions, and dosage of, 549
- Hydrocodone, chlorpheniramine, phenylephrine, acetaminophen, + caffeine (Hycomine), indications, actions, and dosage of, 550
- Hydrocodone + guaifenesin (Hycotuss Expectorant), indications, actions, and dosage of, 550
- Hydrocodone + homatropine (Hycodan), indications, actions, and dosage of, 550
- Hydrocodone + ibuprofen (Vicoprofen), indications, actions, and dosage of, 550
- Hydrocodone + pseudoephedrine (Entuss-D; Histussin D), indications, actions, and dosage of, 550

Hydrocortisone (CaldeCort; Cortizone; Hyoscyamine, atropine, scopolamine, + Hycort; Hytone) phenobarbital (Donnatal), indications, actions, and dosage of, 550 indications, actions, and dosage of, potency and application of, 629t 551 Hydrocortisone (Hydrocortone; Solu-Hyperalimentation. See Total parenteral nutrition (TPN) Cortef) dose, activity, duration, and route for, Hypercalcemia, 188-189 electrocardiogram and, 386 for hypercalcemia, 189 Hypercalcemia agents, 482 indications, actions, and dosage of, Hyperchloremic acidosis, 166, 168t 603-604 Hyperhep (hepatitis B immune globulin), Hydrocortisone acetate (Corticaine) indications, actions, and dosage of, indications, actions, and dosage of, 603 548 Hyperkalemia, 186-187 potency and application of, 629t Hydrocortisone butyrate (Locoid), potency electrocardiogram and, 385, 386f and application of, 629t total parenteral nutrition for, 237 Hydrocortisone sodium, for asthmatic Hypermagnesemia, 190 attacks, 469 total parenteral nutrition for, 237 Hydrocortisone succinate, indications, Hypernatremia, 184–185 actions, and dosage of, 603 Hyperosmolar nonketotic coma, total Hydrocortisone valerate (Westcort), parenteral nutrition for, 236 potency and application of, 629t Hyperparathyroidism, hypercalcemia Hydrocortone (hydrocortisone) with, 188 dose, activity, duration, and route for, 627t Hyperphosphatemia, 191-192 for hypercalcemia, 189 Hypersegmentation, of white blood cells, indications, actions, and dosage of, 104 603-604 Hyperstat (diazoxide), indications, Hydrodiuril (hydrochlorothiazide), actions, and dosage of, 526 indications, actions, and dosage of, Hypertension, 392-393 algorithm for, 460f Hypertensive crisis, 470 Hydromorphone (Dilaudid), indications, actions, and dosage of, 550 Hypertonic hyponatremia, 185 Hydrothorax, 50 Hypertrophy, on electrocardiogram, 367 5-Hydroxyindoleacetic acid (5-HIAA), in Hyperventilation syndrome, 171 urine, 117 Hypervolemic hypernatremia, 184, 185 Hypervolemic hyponatremia, 186 Hydroxyurea (Droxia; Hydrea), indications, actions, and dosage of, Hypocalcemia, electrocardiogram and, 551 386 Hydroxyzine (Atarax; Vistaril), Hypoglycemia, 471 Hypokalemia, 187-188 indications, actions, and dosage of, electrocardiogram and, 385, 386f Hygroton (chlorthalidone), indications, Hypomagnesemia, 190-191 actions, and dosage of, 515 Hyponatremia, 185-186 Hylorel (guanadrel), indications, actions, total parenteral nutrition for, 237 and dosage of, 547 Hypophosphatemia, 192 Hymenolepis nana infections, drugs for total parenteral nutrition for, 236 treating, 154t Hypotonic hyponatremia, 185 Hyoscyamine (Anaspaz; Cystospaz; Hypovolemic hypernatremia, 184 Levsin), indications, actions, and Hypovolemic hyponatremia, 186

dosage of, 551

Hypovolemic shock, 414, 431, 472

Hypoxia, 171f, 171–172	Imipramine (Tofranil), indications,
differential diagnosis of, 171-172	actions, and dosage of, 552
Hysterosalpingography (HSG), 328	Imipramine + desipramine, half-life and
Hytone (hydrocortisone)	therapeutic and toxic levels of,
indications, actions, and dosage of, 550	633 <i>t</i>
potency and application of, 629t	Imiquimod (Aldara), indications, actions,
Hytrin (terazosin), indications, actions,	and dosage of, 148t, 552
and dosage of, 608	Imitrex (sumatriptan), indications, actions,
	and dosage of, 606
	Immune globulin, intravenous (Gammar
I	IV; Gamimmune N;
Ibuprofen (Advil; Motrin; Rufen)	Sandoglobulin), indications,
indications, actions, and dosage of, 551	actions, and dosage of, 552
route, effects, and dosage for, 321t	Immune serum globulin, 200t
Ibutilide (Corvert)	Immune system agents, 484-485
for emergency cardiac care, 464	Immunization schedule, 620, 636t
indications, actions, and dosage of, 551	Immunoglobulins, quantitative, laboratory
Idarubicin (Idamycin), indications,	diagnosis and, 77
actions, and dosage of, 551	Immunomodulators, 484
Ifex (ifosfamide), indications, actions, and	Immunosuppressive agents, 485
dosage of, 552	Imodium (loperamide), indications,
I ¹²⁵ fibrinogen scanning, 334	actions, and dosage of, 562-563
Ifosfamide (Holoxan; Ifex), indications,	Impetigo, organisms responsible and
actions, and dosage of, 552	empiric therapy for, 142t
Iliopsoas test, 26	Impotence, differential diagnosis of, 48
Ilopan (dexpanthenol)	Imuran (azathioprine), indications,
indications, actions, and dosage of, 525	actions, and dosage of, 501
in total parenteral nutrition, 231t	Inapsine (droperidol), indications, actions,
Ilopan-choline Oral (dexpanthenol)	and dosage of, 531
indications, actions, and dosage of, 525	Incentive spirometry, 363-364
in total parenteral nutrition, 231t	Incidence, definition of, 645
Ilosone (erythromycin), indications,	Indapamide (Lozol), indications, actions,
actions, and dosage of, 533-534	and dosage of, 552
Ilotycin Ophthalmic (erythromycin,	Inderal (propranolol)
ophthalmic), indications, actions,	for emergency cardiac care, 462
and dosage of, 534	indications, actions, and dosage of, 595
Imaging studies, 325–338	India ink preparation, 127
computed tomography, 330-331	Indinavir (Crixivan), indications, actions,
contrast x-ray studies, 326-329	and dosage of, 150t, 553
magnetic resonance, 331-333	Indium-111 octreotide scans, 334
noncontrast x-ray studies, 325-326	Indomethacin (Indocin)
nuclear scans, 333-335	indications, actions, and dosage
preparation for, 325	of, 553
reading x-rays, 335, 336f, 337f, 338	route, effects, and dosage for, 321t
ultrasound, 329-330	Infant formulas and feeding, 223-226,
Imdur (isosorbide mononitrate),	224t-225t, 225-226
indications, actions, and dosage of,	formulas for, 224t–225t
555–556	initiating, criteria for, 225
Imipenem-cilastin (Primaxin), indications,	oral rehydration solutions for, 226
actions, and dosage of, 552	for premature infants, 225t, 225-226

Infasurf (calfactant), indications, actions,	Inhalers, 365
and dosage of, 509	Injection techniques, 276–277
Infections. See also specific infections	Innervation, cutaneous, 22f-23f
bacterial, 204, 287t	Inocor (amrinone)
of bone, organisms responsible and	for emergency cardiac care, 461
empiric therapy for, 134t	indications, actions, and dosage of, 498
cervical, tests for, 291	infusion guidelines for, 439 <i>t</i>
common, differential diagnosis and	Inotropic agents, 480
empiric therapy, 133, 134 <i>t</i> –154 <i>t</i> , 156 <i>t</i>	Inspiratory capacity (IC), 416
fungal, systemic drugs for treating,	Inspiratory reserve volume (IRV), 416
151 <i>t</i> –152 <i>t</i>	Instrument tie, 357f
granulomatous, cerebrospinal fluid in,	Insufflation, for sigmoidoscopy, 301
287 <i>t</i>	Insulins
of joints, organisms responsible and	comparison of, 622t
empiric therapy for, 134t	indications, actions, and dosage of, 553
of skin, organisms responsible and	in total parenteral nutrition, 232, 232t
empiric therapy for, 141t-142t	Intal (cromolyn sodium), indications,
of soft tissue, organisms responsible	actions, and dosage of, 520-521
and empiric therapy for, 141t–142t	Integrilin (eptifibatide)
total parenteral nutrition for, 236	for emergency cardiac care, 464
transfusion-associated risk of, 202–204	indications, actions, and dosage of, 533
urinary tract, organisms responsible and	Intensive care unit (ICU)
empiric therapy for, 143 <i>t</i> –144 <i>t</i>	drug infusions used in, 439t–443t
vaginal, 144 <i>t</i> –145 <i>t</i> , 291	equations used in, 437t–438t
viral, 146t–149t, 287t. See also specific	progress notes for, 389–391
infections	Interferon alfa-2a (Roferon-A),
Infectious mononucleosis, 146t	indications and dosage for, 146t,
Infed (iron dextran), indications, actions,	554
and dosage of, 555	Interferon alfa-2b (Intron A), indications
Infergen (interferon alfacon-1),	and dosage for, 146t, 148t, 554
Infergen (interferon alfacon-1), indications, actions, and dosage of,	and dosage for, 146t, 148t, 554 Interferon alfa-2B + ribavirin combination
Infergen (interferon alfacon-1), indications, actions, and dosage of, 147t, 554	and dosage for, 146t, 148t, 554 Interferon alfa-2B + ribavirin combination (Robetron), indications, actions,
Infergen (interferon alfacon-1), indications, actions, and dosage of, 147t, 554 Infiltrates, in lungs, 338	and dosage for, 146t, 148t, 554 Interferon alfa-2B + ribavirin combination (Robetron), indications, actions, and dosage of, 554
Infergen (interferon alfacon-1), indications, actions, and dosage of, 147t, 554 Infiltrates, in lungs, 338 Inflammatory arthritis, synovial fluid	and dosage for, 146t, 148t, 554 Interferon alfa-2B + ribavirin combination (Robetron), indications, actions, and dosage of, 554 Interferon alfacon-1 (Infergen),
Infergen (interferon alfacon-1), indications, actions, and dosage of, 147t, 554 Infiltrates, in lungs, 338 Inflammatory arthritis, synovial fluid interpretation and, 250, 251t	and dosage for, 146t, 148t, 554 Interferon alfa-2B + ribavirin combination (Robetron), indications, actions, and dosage of, 554 Interferon alfacon-1 (Infergen), indications, actions, and dosage of,
Infergen (interferon alfacon-1), indications, actions, and dosage of, 147t, 554 Infiltrates, in lungs, 338 Inflammatory arthritis, synovial fluid interpretation and, 250, 251t Inflammatory bowel disease (IBD), total	and dosage for, 146t, 148t, 554 Interferon alfa-2B + ribavirin combination (Robetron), indications, actions, and dosage of, 554 Interferon alfacon-1 (Infergen), indications, actions, and dosage of, 147t, 554
Infergen (interferon alfacon-1), indications, actions, and dosage of, 147t, 554 Infiltrates, in lungs, 338 Inflammatory arthritis, synovial fluid interpretation and, 250, 251t Inflammatory bowel disease (IBD), total parenteral nutrition formulation	and dosage for, 146t, 148t, 554 Interferon alfa-2B + ribavirin combination (Robetron), indications, actions, and dosage of, 554 Interferon alfacon-1 (Infergen), indications, actions, and dosage of, 147t, 554 Interferon β-1B (Betaseron), indications,
Infergen (interferon alfacon-1), indications, actions, and dosage of, 147t, 554 Infiltrates, in lungs, 338 Inflammatory arthritis, synovial fluid interpretation and, 250, 251t Inflammatory bowel disease (IBD), total parenteral nutrition formulation for, 235	and dosage for, 146t, 148t, 554 Interferon alfa-2B + ribavirin combination (Robetron), indications, actions, and dosage of, 554 Interferon alfacon-1 (Infergen), indications, actions, and dosage of, 147t, 554 Interferon 6-1B (Betaseron), indications, actions, and dosage of, 554
Infergen (interferon alfacon-1), indications, actions, and dosage of, 147t, 554 Infiltrates, in lungs, 338 Inflammatory arthritis, synovial fluid interpretation and, 250, 251t Inflammatory bowel disease (IBD), total parenteral nutrition formulation for, 235 Infliximab (Remicade), indications,	and dosage for, 146t, 148t, 554 Interferon alfa-2B + ribavirin combination (Robetron), indications, actions, and dosage of, 554 Interferon alfacon-1 (Infergen), indications, actions, and dosage of, 147t, 554 Interferon 6-1B (Betaseron), indications, actions, and dosage of, 554 Interferon gamma-1B (Actimmune),
Infergen (interferon alfacon-1), indications, actions, and dosage of, 147t, 554 Infiltrates, in lungs, 338 Inflammatory arthritis, synovial fluid interpretation and, 250, 251t Inflammatory bowel disease (IBD), total parenteral nutrition formulation for, 235 Infliximab (Remicade), indications, actions, and dosage of, 553	and dosage for, 146t, 148t, 554 Interferon alfa-2B + ribavirin combination (Robetron), indications, actions, and dosage of, 554 Interferon alfacon-1 (Infergen), indications, actions, and dosage of, 147t, 554 Interferon 8-1B (Betaseron), indications, actions, and dosage of, 554 Interferon gamma-1B (Actimmune), indications, actions, and dosage of,
Infergen (interferon alfacon-1), indications, actions, and dosage of, 147t, 554 Infiltrates, in lungs, 338 Inflammatory arthritis, synovial fluid interpretation and, 250, 251t Inflammatory bowel disease (IBD), total parenteral nutrition formulation for, 235 Infliximab (Remicade), indications, actions, and dosage of, 553 Influenza A virus, drugs of choice for	and dosage for, 146t, 148t, 554 Interferon alfa-2B + ribavirin combination (Robetron), indications, actions, and dosage of, 554 Interferon alfacon-1 (Infergen), indications, actions, and dosage of, 147t, 554 Interferon 8-1B (Betaseron), indications, actions, and dosage of, 554 Interferon gamma-1B (Actimmune), indications, actions, and dosage of, 554
Infergen (interferon alfacon-1), indications, actions, and dosage of, 147t, 554 Infiltrates, in lungs, 338 Inflammatory arthritis, synovial fluid interpretation and, 250, 251t Inflammatory bowel disease (IBD), total parenteral nutrition formulation for, 235 Infliximab (Remicade), indications, actions, and dosage of, 553 Influenza A virus, drugs of choice for treating infections by, 147t–148t	and dosage for, 146t, 148t, 554 Interferon alfa-2B + ribavirin combination (Robetron), indications, actions, and dosage of, 554 Interferon alfacon-1 (Infergen), indications, actions, and dosage of, 147t, 554 Interferon 8-1B (Betaseron), indications, actions, and dosage of, 554 Interferon gamma-1B (Actimmune), indications, actions, and dosage of, 554 Intern(s), 1
Infergen (interferon alfacon-1), indications, actions, and dosage of, 147t, 554 Infiltrates, in lungs, 338 Inflammatory arthritis, synovial fluid interpretation and, 250, 251t Inflammatory bowel disease (IBD), total parenteral nutrition formulation for, 235 Infliximab (Remicade), indications, actions, and dosage of, 553 Influenza A virus, drugs of choice for treating infections by, 147t–148t Influenza B virus, drugs of choice for	and dosage for, 146t, 148t, 554 Interferon alfa-2B + ribavirin combination (Robetron), indications, actions, and dosage of, 554 Interferon alfacon-1 (Infergen), indications, actions, and dosage of, 147t, 554 Interferon B-1B (Betaseron), indications, actions, and dosage of, 554 Interferon gamma-1B (Actimmune), indications, actions, and dosage of, 554 Intern(s), 1 Internal fetal scalp monitoring, 275–276
Infergen (interferon alfacon-1), indications, actions, and dosage of, 147t, 554 Infiltrates, in lungs, 338 Inflammatory arthritis, synovial fluid interpretation and, 250, 251t Inflammatory bowel disease (IBD), total parenteral nutrition formulation for, 235 Infliximab (Remicade), indications, actions, and dosage of, 553 Influenza A virus, drugs of choice for treating infections by, 147t–148t Influenza B virus, drugs of choice for treating infections by, 147t	and dosage for, 146t, 148t, 554 Interferon alfa-2B + ribavirin combination (Robetron), indications, actions, and dosage of, 554 Interferon alfacon-1 (Infergen), indications, actions, and dosage of, 147t, 554 Interferon B-1B (Betaseron), indications, actions, and dosage of, 554 Interferon gamma-1B (Actimmune), indications, actions, and dosage of, 554 Intern(s), 1 Internal fetal scalp monitoring, 275–276 Intestinal decompression tubes, 272
Infergen (interferon alfacon-1), indications, actions, and dosage of, 147t, 554 Infiltrates, in lungs, 338 Inflammatory arthritis, synovial fluid interpretation and, 250, 251t Inflammatory bowel disease (IBD), total parenteral nutrition formulation for, 235 Infliximab (Remicade), indications, actions, and dosage of, 553 Influenza A virus, drugs of choice for treating infections by, 147t–148t Influenza B virus, drugs of choice for treating infections by, 147t Influenza vaccine (Fluogen; Flushield;	and dosage for, 146t, 148t, 554 Interferon alfa-2B + ribavirin combination (Robetron), indications, actions, and dosage of, 554 Interferon alfacon-1 (Infergen), indications, actions, and dosage of, 147t, 554 Interferon B-1B (Betaseron), indications, actions, and dosage of, 554 Interferon gamma-1B (Actimmune), indications, actions, and dosage of, 554 Intern(s), 1 Internal fetal scalp monitoring, 275–276 Intestinal decompression tubes, 272 Intracranial pressure (ICP), derivation and
Infergen (interferon alfacon-1), indications, actions, and dosage of, 147t, 554 Infiltrates, in lungs, 338 Inflammatory arthritis, synovial fluid interpretation and, 250, 251t Inflammatory bowel disease (IBD), total parenteral nutrition formulation for, 235 Infliximab (Remicade), indications, actions, and dosage of, 553 Influenza A virus, drugs of choice for treating infections by, 147t–148t Influenza B virus, drugs of choice for treating infections by, 147t Influenza vaccine (Fluogen; Flushield; Fluvirin; Fluzone), indications,	and dosage for, 146t, 148t, 554 Interferon alfa-2B + ribavirin combination (Robetron), indications, actions, and dosage of, 554 Interferon alfacon-1 (Infergen), indications, actions, and dosage of, 147t, 554 Interferon B-1B (Betaseron), indications, actions, and dosage of, 554 Interferon gamma-1B (Actimmune), indications, actions, and dosage of, 554 Intern(s), 1 Internal fetal scalp monitoring, 275–276 Intestinal decompression tubes, 272 Intracranial pressure (ICP), derivation and normal values for, 438t
Infergen (interferon alfacon-1), indications, actions, and dosage of, 147t, 554 Infiltrates, in lungs, 338 Inflammatory arthritis, synovial fluid interpretation and, 250, 251t Inflammatory bowel disease (IBD), total parenteral nutrition formulation for, 235 Infliximab (Remicade), indications, actions, and dosage of, 553 Influenza A virus, drugs of choice for treating infections by, 147t–148t Influenza B virus, drugs of choice for treating infections by, 147t Influenza vaccine (Fluogen; Flushield; Fluvirin; Fluzone), indications, actions, and dosage of, 553	and dosage for, 146t, 148t, 554 Interferon alfa-2B + ribavirin combination (Robetron), indications, actions, and dosage of, 554 Interferon alfacon-1 (Infergen), indications, actions, and dosage of, 147t, 554 Interferon B-1B (Betaseron), indications, actions, and dosage of, 554 Interferon gamma-1B (Actimmune), indications, actions, and dosage of, 554 Intern(s), 1 Internal fetal scalp monitoring, 275–276 Intestinal decompression tubes, 272 Intracranial pressure (ICP), derivation and normal values for, 438t Intradermal injections, 276, 277
Infergen (interferon alfacon-1), indications, actions, and dosage of, 147t, 554 Infiltrates, in lungs, 338 Inflammatory arthritis, synovial fluid interpretation and, 250, 251t Inflammatory bowel disease (IBD), total parenteral nutrition formulation for, 235 Infliximab (Remicade), indications, actions, and dosage of, 553 Influenza A virus, drugs of choice for treating infections by, 147t–148t Influenza B virus, drugs of choice for treating infections by, 147t Influenza vaccine (Fluogen; Flushield; Fluvirin; Fluzone), indications,	and dosage for, 146t, 148t, 554 Interferon alfa-2B + ribavirin combination (Robetron), indications, actions, and dosage of, 554 Interferon alfacon-1 (Infergen), indications, actions, and dosage of, 147t, 554 Interferon B-1B (Betaseron), indications, actions, and dosage of, 554 Interferon gamma-1B (Actimmune), indications, actions, and dosage of, 554 Intern(s), 1 Internal fetal scalp monitoring, 275–276 Intestinal decompression tubes, 272 Intracranial pressure (ICP), derivation and normal values for, 438t

Intravenous (IV) fluids, 179-183	Isoniazid (INH), indications, actions, and
maintenance fluids, 179, 181t	dosage of, 555-556
specific replacement fluids, 179,	Isoosmolar infant formulas, 224t, 225t
182 <i>f</i> –183 <i>f</i> , 183	Isoproterenol (Isuprel; Medihaler-Iso)
Intravenous (IV) infusions, rate	for emergency cardiac care, 464
determination for, 183-184	indications, actions, and dosage of,
Intravenous pyelography (IVP), 328	398t, 555–556
Intravenous techniques, 278–280, 279f–281f	infusion guidelines for, 441t
Intraventricular septum rupture, 394	Isoptin (verapamil)
Intron A (interferon alfa-2b), indications	for emergency cardiac care, 467
and dosage for, 146t, 148t, 554	indications, actions, and dosage of, 617
Intropin (dopamine)	Isosorbide dinitrate (Isordil; Sorbitrate),
for emergency cardiac care, 462	indications, actions, and dosage of,
indications, actions, and dosage of,	555–556
398t, 530	Isosorbide mononitrate (Imdur; Ismo),
infusion guidelines for, 440 <i>t</i>	indications, actions, and dosage of,
Iodine-125 fibrinogen scanning, 334	555–556
Iodipine (apraclonidine), indications,	Isosporiasis infections, drugs for treating,
actions, and dosage of, 499	153 <i>t</i>
Iodoquinol, indications for, 153t	Isotonic hyponatremia, 185
Ionic contrast media, 327	Isotretinoin [13-cis retinoic acid]
Iotronex (alosetran), indications, actions,	(Accutane), indications, actions,
and dosage of, 491	and dosage of, 555–556
Ipecac syrup, indications, actions, and	Isovolemic hypernatremia, 184–185
dosage of, 554–555	Isovolemic hyponatremia, 186
Ipratropium bromide (Atrovent), 364	Isradipine (Dynacirc), indications, actions,
for asthmatic attacks, 469	and dosage of, 555–556
indications, actions, and dosage of, 555	Isuprel (isoproterenol)
Irbesartan (Avapro), indications, actions,	for emergency cardiac care, 464
and dosage of, 555	indications, actions, and dosage of,
Irinotecan (Camptosar), indications,	398t, 555–556
actions, and dosage of, 555	infusion guidelines for, 441 <i>t</i>
Iron	Itraconazole (Sporanox), indications, actions,
laboratory diagnosis and, 77	and dosage of, 151 <i>t</i> , 556–557
in total parenteral nutrition, 231	Ivermectin, indications for, 153 <i>t</i> , 154 <i>t</i>
Iron-binding capacity, total (TIBC),	,,,,,,
laboratory diagnosis and, 78	
Iron dextran (Dexferrum; Infed),	J
indications, actions, and dosage of,	Janeway's lesion, 25
555	Jaundice, differential diagnosis of, 49
Irradiation blood components, 194	Jenest-28, 624 <i>t</i>
Ismelin (guanethidine), indications,	Joffroy's reflex, 25
actions, and dosage of, 547	Joint infections, organisms responsible
Ismo (isosorbide mononitrate),	and empiric therapy for, $134t$
indications, actions, and dosage of,	Jugular venous distention, 391–392
555–556	
Isoetharine, indications, actions, and	K
dosage of, 555	Kabikinase (streptokinase)
Isolation protocols, 155–156	for emergency cardiac care, 466
Isomil 224t	indications actions and design of 604

Kaochlor (potassium supplements)	Keratoconjunctivitis, herpes simplex virus,
form and dosage of, 626t	drugs of choice for treating, 147 <i>t</i>
indications, actions, and dosage of, 592	Kerley's B lines, 338
Kaochlor 10% (potassium chloride)	Kerlone (betaxolol), indications, actions,
form and dosage of, 626t	and dosage of, 504
indications, actions, and dosage of, 592	Kernig's sign, 25
Kaochlor Eff (potassium chloride,	Ketoconazole (Nizoral), indications,
potassium citrate, and	actions, and dosage of, 557
bicarbonate), form and dosage of,	17-Ketogenic steroids (17-KGS), in urine,
626 <i>t</i>	118
Kaochlor S-F 10% (potassium chloride)	Ketone(s), in urine, 111
form and dosage of, 626t	Ketone bodies, laboratory diagnosis and,
indications, actions, and dosage of, 592	55
Kaolin-pectin (Kaodene; Kao-spen;	Ketoprofen (Orudis; Oruvail), indications,
Kapectolin), indications, actions,	actions, and dosage of, 557
and dosage of, 557	Ketorolac (Toradol), indications, actions,
Kaon (potassium gluconate)	and dosage of, 557
form and dosage of, 626t	Ketorolac, ophthalmic (Acular),
indications, actions, and dosage of, 592	indications, actions, and dosage of,
Kaon-Cl (potassium chloride)	557
form and dosage of, 626t	17-Ketosteroids (17-KS), total, in urine,
indications, actions, and dosage of, 592	118
Kaon-Cl 20% (potassium chloride)	Kidney cancer, staging of, 652-653
form and dosage of, 626t	Kilogram/pound conversion, 658, 658t
indications, actions, and dosage of, 592	Kinase, laboratory diagnosis and, 65
Kaon elixir (potassium gluconate), form	Kinyoun stain, 121
and dosage of, 626t	Klebsiella, Gram stain characteristics of,
Kao-spen (kaolin-pectin), indications,	124 <i>f</i> , 126 <i>t</i>
actions, and dosage of, 557	Klonopin (clonazepam), indications,
Kapectolin (kaolin-pectin), indications,	actions, and dosage of, 518
actions, and dosage of, 557	K-Lor (potassium chloride)
Kayexalate (sodium polystyrene	form and dosage of, 626t
sulfonate)	indications, actions, and dosage of, 592
for hyperkalemia, 187	Klorvess (potassium chloride)
indications, actions, and dosage of, 602	form and dosage of, 626t
Kayser-Fleischer rings, 25	indications, actions, and dosage of, 592
Kefzol (cefazolin)	Klotrix (potassium chloride)
indications, actions, and dosage	form and dosage of, 626t
of, 511	indications, actions, and dosage of, 592
for subacute bacterial endocarditis	Knee, arthrocentesis of, 248, 248f
prophylaxis, 158t	KOH preparation, 127
Kehr's sign, 25	Koplik's spots, 25
Keloids, 21t	Korotkoff's sounds, 25
Kemadrin (procyclidine), indications,	K-Phos (potassium phosphate), for
actions, and dosage of, 594	hypophosphatemia, 192
Kenalog (triamcinolone acetonide),	K-Tab (potassium chloride)
potency and application of, 630t	form and dosage of, 626t
Keogh tubes, 273	indications, actions, and dosage of, 592
Keppra (levetiractam), indications,	KUB x-rays, 326
actions, and dosage of, 560	Kussmaul's respirations, 25

Kussmaul's sign, 25	Lamivudine (Epivir; Epivir-HBV),
Kwell (lindane), indications, actions, and	indications, actions, and dosage of,
dosage of, 561	146 <i>t</i> , 558
Kyphosis, 26	Lamotrigine (Lamictal), indications,
Kytril (granisetron), indications, actions,	actions, and dosage of, 558
and dosage of, 546	Lamprene (clofazimine), indications,
	actions, and dosage of, 518
	Lanorinal (aspirin + butalbital compound),
L	indications, actions, and dosage of,
Labetalol (Normodyne; Trandate)	500
for emergency cardiac care, 462	Lanoxicaps (digoxin)
for hypertensive crisis, 470	antidote for, 471
indications, actions, and dosage of, 557	for emergency cardiac care, 462
infusion guidelines for, 441t	half-life and therapeutic and toxic levels
Laboratory diagnosis	of, 633 <i>t</i>
chemistry, immunology, and serology	indications, actions, and dosage of, 527
in, 53–93	Lanoxin (digoxin)
hematology and, 95-108	antidote for, 471
urine studies for, 109–119	for emergency cardiac care, 462
Laboratory studies. See also specific	half-life and therapeutic and toxic levels
studies	of, 633 <i>t</i>
before initiating total parenteral	indications, actions, and dosage of, 527
nutrition, 233	Lansoprazole (Prevacid), indications,
for monitoring total parenteral nutrition,	actions, and dosage of, 558
234	Lantus (insulin glorgine), onset, peak, and
shorthand for values and, 40f	duration of effect of, 622t
Lactate dehydrogenase (LD; LDH)	Large cells, 97, 100
isozymes of, laboratory diagnosis and,	Larva migrans
78	cutaneous, drugs for treating, 153t
laboratory diagnosis and, 78	visceral, drugs for treating, 154t
Lactic acid, laboratory diagnosis and, 78	Laryngoscopes, 269, 270f
Lactic acid + ammonium hydroxide	Lasegue's sign, 26
[ammonium lactate], indications,	Lasix (furosemide)
actions, and dosage of, 558	for emergency cardiac care, 462-463
Lactinex Granules (lactobacillus),	indications, actions, and dosage of, 543
indications, actions, and dosage of,	for renal tubular acidosis, 168t
558	Latanoprost (Xalatan), indications,
Lactobacillus, Gram stain characteristics	actions, and dosage of, 558
of, 126 <i>t</i>	Late decelerations, in fetal heart rate,
Lactobacillus (Lactinex Granules),	276
indications, actions, and dosage of,	Lateral chest films, reading, 337f, 338
558	Lateral decubitus chest x-rays, 325
Lactose-free diet, 208t	Latex allergy, 344
Lactulose (Cephulac; Chronulac),	Laxatives, 483
indications, actions, and dosage of,	LCTATE, laboratory diagnosis and, 78
558	Lead, blood, laboratory diagnosis and, 79
Lamictal (lamotrigine), indications,	Leads, for electrocardiography, 368
actions, and dosage of, 558	Lee-White clotting time, 107
Lamisil (terbinafine), indications, actions,	Leflunomide (Arava), indications, actions,
and dosage of, 608	and dosage of, 559

Levetiractam (Keppra), indications,

Left atrial enlargement (LAE),

Levelen 21, 28, 623*t* Levelite 21, 28, 623*t*

electrocardiogram and, 380, 382f actions, and dosage of, 560 Left bundle branch block (LBBB), 379, Levine's sign, 26 381f Levin tubes, 272 Left shift, 100 Levobunolol (A-K Beta; Betagan), Left ventricular end-diastolic pressure indications, actions, and dosage of, (LVEDP), 407-408 560 Left ventricular hypertrophy (LVH), Levocabastine (Livostin), indications, electrocardiogram and, 382-383, actions, and dosage of, 560 Levo-Dromoran (levorphanol), Legionella antibody, laboratory diagnosis indications, actions, and dosage of, and, 79 560 Legionella pneumophila, Gram stain Levofloxacin (Levaquin), indications, characteristics of, 126t actions, and dosage of, 560 Lente Iletin II, onset, peak, and duration Levonorgestrel implant (Norplant), of effect of, 622t indications, actions, and dosage of, Leonard tubes, 273 Lepirudin (Refludan), indications, actions, Levophed (norepinephrine) and dosage of, 559 actions of, 398t Leptocytes, 104 for emergency cardiac care, 466 indications, actions, and dosage Lescol (fluvastatin), indications, actions, and dosage of, 542 of, 580 Letrozole (Femara), indications, actions, infusion guidelines for, 442t and dosage of, 559 Levora 21, 28, 623t Leucovorin (Wellcovorin), indications, Levorphanol (Levo-Dromoran), actions, and dosage of, 559 indications, actions, and dosage of, Leukapheresis, 194 Leukeran (chlorambucil), indications, Levothyroxine (Synthroid), indications, actions, and dosage of, 514 actions, and dosage of, 560-561 Leukine (sargramostim), indications, Levsin (hyoscyamine), indications, actions, and dosage of, 600 actions, and dosage of, 551 Leukocyte alkaline phosphatase (LAP) Lhermitte's sign, 26 score/stain, laboratory diagnosis Librium (chlordiazepoxide), indications, and, 78 actions, and dosage of, 515 Leukocyte esterase, in urine, 112 Lice, drugs for treating, 153t Leukocyte-poor (reduced) red cells, 197t Lichenification, 21t Leuprolide (Lupron), indications, actions, Lidex (fluocinonide), potency and and dosage of, 559 application of, 629t Leustatin (cladribine), indications, actions, Lidex-E (fluocinonide), potency and and dosage of, 517 application of, 629t Levalbuterol (Xopenex), indications, Lidocaine (Anestacon Topical; Xylocaine) actions, and dosage of, 559 for emergency cardiac care, 465 Levamisole (Ergamisol), indications, half-life and therapeutic and toxic levels actions, and dosage of, 560 of, 633t Levaquin (levofloxacin), indications, indications, actions, and dosage actions, and dosage of, 560 of, 561 Levatol (penbutolol), indications, actions, infusion guidelines for, 441t for premature ventricular contractions, and dosage of, 585

for suturing, 348, 349t

Local anesthetics

systemic, 320

for suturing, 348, 349t

Lidocaine + prilocaine (EMLA),

561

Limb electrodes, 267

indications, actions, and dosage of,

Locoid (hydrocortisone butyrate), potency Lindane (Kwell), indications, actions, and and application of, 629t dosage of, 561 Lodine (etodolac), indications, actions, Line sepsis, 435 and dosage of, 536-537 Linezolid (Xyvox), indications, actions, Lodoxamide (Alomide Ophthalmic), and dosage of, 561 indications, actions, and dosage of, Linolenic acid, 233 Linton tubes, 273 Löffler methylene blue stain, 128 Lioresal (baclofen), indications, actions, Lomefloxacin (Maxaquin), indications, and dosage of, 502 actions, and dosage of, 562 Liothyronine (Cytomel), indications, Lomotil (diphenoxylate + atropine), actions, and dosage of, 562 indications, actions, and dosage of, Lipase, laboratory diagnosis and, 79 528 Lipid emulsions, 232-233 Lomustine (CCNU; CeeNu), indications, Lipid-lowering agents, 480 actions, and dosage of, 562 Lipid profile, laboratory diagnosis and, 79, Loniten (minoxidil), indications, actions, 80f, 81t and dosage of, 572 Lipitor (atorvastatin), indications, actions, Lo/Ovral, 623t and dosage of, 500 Loperamide (Imodium), indications, Lipoprotein profile/analysis, laboratory actions, and dosage of, 562-563 diagnosis and, 79, 80f, 81t Lopid (gemfibrozil), indications, actions, Liqui-Char (activated charcoal) and dosage of, 544 clinical use of, 472 Lopressor (metoprolol) indications, actions, and dosage of, 514 for emergency cardiac care, 462 Liquid diets, 206t–207t indications, actions, and dosage Lisinopril (Prinivil; Zestril) of. 569 for emergency cardiac care, 461 Loprox (ciclopirox), indications, actions, indications, actions, and dosage of, 562 and dosage of, 516 List, definition of, 26 Lopurin (allopurinol), indications, actions, Listeria, Gram stain characteristics of, and dosage of, 491 Loracarbef (Lorabid), indications, actions, 123f and dosage of, 563 Listeria monocytogenes, Gram stain characteristics of, 126t Loratadine (Claritin), indications, actions, Lithium, half-life and therapeutic and and dosage of, 563 toxic levels of, 633t Lorazepam (Ativan) Lithium carbonate (Eskalith), indications, indications, actions, and dosage of, 563 actions, and dosage of, 562 for seizures, 472 Liver disease Lorcet (hydrocodone + acetaminophen), diet for, 208t indications, actions, and dosage of, 549 total parenteral nutrition formulation Lordosis, 26 Liver function tests, elevated, total Lordotic chest x-rays, 325 parenteral nutrition for, 237 Lortab ASA (hydrocodone + aspirin), Liver-spleen scans, 334 indications, actions, and dosage of, Livostin (levocabastine), indications, 549 actions, and dosage of, 560 Losartan (Cozaar), indications, actions, Loa loa, drugs for treating, 153t and dosage of, 563

Lotensin (benazepril), indications, actions, and dosage of, 503	Luvox (fluvoxamine), indications, actions, and dosage of, 542
Lotrimin (clotrimazole), indications,	Lyme disease
actions, and dosage of, 519	characteristics and treatment of,
Lotrisone (clotrimazole + betamethasone),	156 <i>t</i> –157 <i>t</i>
indications, actions, and dosage of,	serology in, laboratory diagnosis and,
519	82
Louvel's sign, 26	Lyme disease vaccine (Lymerix),
Lovastatin (Mevacor), indications, actions,	indications, actions, and dosage of,
and dosage of, 563	563–564
Lovenox (enoxaparin), indications,	Lymphadenopathy, differential diagnosis
actions, and dosage of, 532	of, 49
Low-fiber diet, 207t	Lymphangiography, 328
Low lactose diet, 208t	Lymphocytes
Low-Ogestrel, 623t	atypical, laboratory diagnosis and, 102
Low osmolality infant formulas, 224t	laboratory diagnosis and, 101–102
Lowsium (magaldrate), indications,	subsets of, laboratory diagnosis and,
actions, and dosage of, 564	103–104
Low-sodium diet, 208t	Lymphogranuloma venereum, organism
Lozol (indapamide), indications, actions,	responsible and empiric therapy
and dosage of, 552	for, 135 <i>t</i>
L-PAM (melphalan), indications, actions,	Lymphoma, staging of, 654
and dosage of, 566	Lysodren (mitotane), indications, actions,
Ludiomil (maprotiline), indications,	and dosage of, 572
actions, and dosage of, 564	
Lumbar cistern, 282	
Lumbar puncture, 280, 282–286	M
Lumbar puncture, 280, 282–286 complications of, 286	M Maalox (aluminum hydroxide +
complications of, 286	Maalox (aluminum hydroxide +
complications of, 286 contraindications to, 282	Maalox (aluminum hydroxide + magnesium hydroxide),
complications of, 286 contraindications to, 282 historical background of, 282–283, 283f	Maalox (aluminum hydroxide + magnesium hydroxide), indications, actions, and dosage of,
complications of, 286 contraindications to, 282 historical background of, 282–283, 283f indications for, 280	Maalox (aluminum hydroxide + magnesium hydroxide), indications, actions, and dosage of, 493–494 McBurney's point/sign, 26 McGill Pain Questionnaire (MPQ), 319
complications of, 286 contraindications to, 282 historical background of, 282–283, 283f indications for, 280 materials for, 282	Maalox (aluminum hydroxide + magnesium hydroxide), indications, actions, and dosage of, 493–494 McBurney's point/sign, 26
complications of, 286 contraindications to, 282 historical background of, 282–283, 283f indications for, 280 materials for, 282 technique for, 284, 285f, 286, 287t–288t Lumens, of Swan-Ganz catheters,	Maalox (aluminum hydroxide + magnesium hydroxide), indications, actions, and dosage of, 493–494 McBurney's point/sign, 26 McGill Pain Questionnaire (MPQ), 319 McMurray's test, 26 Macrodantin (nitrofurantoin), indications,
complications of, 286 contraindications to, 282 historical background of, 282–283, 283f indications for, 280 materials for, 282 technique for, 284, 285f, 286, 287t–288t	Maalox (aluminum hydroxide + magnesium hydroxide), indications, actions, and dosage of, 493–494 McBurney's point/sign, 26 McGill Pain Questionnaire (MPQ), 319 McMurray's test, 26
complications of, 286 contraindications to, 282 historical background of, 282–283, 283f indications for, 280 materials for, 282 technique for, 284, 285f, 286, 287t–288t Lumens, of Swan-Ganz catheters, 399–400 Lung(s), on chest x-rays, 335, 336f, 337f,	Maalox (aluminum hydroxide + magnesium hydroxide), indications, actions, and dosage of, 493–494 McBurney's point/sign, 26 McGill Pain Questionnaire (MPQ), 319 McMurray's test, 26 Macrodantin (nitrofurantoin), indications, actions, and dosage of, 579 Macrolides, 477
complications of, 286 contraindications to, 282 historical background of, 282–283, 283f indications for, 280 materials for, 282 technique for, 284, 285f, 286, 287t–288t Lumens, of Swan-Ganz catheters, 399–400 Lung(s), on chest x-rays, 335, 336f, 337f, 338	Maalox (aluminum hydroxide + magnesium hydroxide), indications, actions, and dosage of, 493–494 McBurney's point/sign, 26 McGill Pain Questionnaire (MPQ), 319 McMurray's test, 26 Macrodantin (nitrofurantoin), indications, actions, and dosage of, 579
complications of, 286 contraindications to, 282 historical background of, 282–283, 283f indications for, 280 materials for, 282 technique for, 284, 285f, 286, 287t–288t Lumens, of Swan-Ganz catheters, 399–400 Lung(s), on chest x-rays, 335, 336f, 337f, 338 Lung cancer, staging of, 653–654	Maalox (aluminum hydroxide + magnesium hydroxide), indications, actions, and dosage of, 493–494 McBurney's point/sign, 26 McGill Pain Questionnaire (MPQ), 319 McMurray's test, 26 Macrodantin (nitrofurantoin), indications, actions, and dosage of, 579 Macrolides, 477 Macules, 21t MAG3 (technetium-99m
complications of, 286 contraindications to, 282 historical background of, 282–283, 283f indications for, 280 materials for, 282 technique for, 284, 285f, 286, 287t–288t Lumens, of Swan-Ganz catheters, 399–400 Lung(s), on chest x-rays, 335, 336f, 337f, 338 Lung cancer, staging of, 653–654 Lung capacity, 416, 416f, 417f	Maalox (aluminum hydroxide + magnesium hydroxide), indications, actions, and dosage of, 493–494 McBurney's point/sign, 26 McGill Pain Questionnaire (MPQ), 319 McMurray's test, 26 Macrodantin (nitrofurantoin), indications, actions, and dosage of, 579 Macrolides, 477 Macules, 21t MAG3 (technetium-99m mercaptoacetylthiglycine), 334
complications of, 286 contraindications to, 282 historical background of, 282–283, 283f indications for, 280 materials for, 280 technique for, 284, 285f, 286, 287t–288t Lumens, of Swan-Ganz catheters, 399–400 Lung(s), on chest x-rays, 335, 336f, 337f, 338 Lung cancer, staging of, 653–654 Lung capacity, 416, 416f, 417f Lung compliance, 417–418, 418f	Maalox (aluminum hydroxide + magnesium hydroxide), indications, actions, and dosage of, 493–494 McBurney's point/sign, 26 McGill Pain Questionnaire (MPQ), 319 McMurray's test, 26 Macrodantin (nitrofurantoin), indications, actions, and dosage of, 579 Macrolides, 477 Macules, 21t MAG3 (technetium-99m mercaptoacetylthiglycine), 334 Magaldrate (Lowsium; Riopan),
complications of, 286 contraindications to, 282 historical background of, 282–283, 283f indications for, 280 materials for, 280 technique for, 284, 285f, 286, 287t–288t Lumens, of Swan-Ganz catheters, 399–400 Lung(s), on chest x-rays, 335, 336f, 337f, 338 Lung cancer, staging of, 653–654 Lung capacity, 416, 416f, 417f Lung compliance, 417–418, 418f Lung scans, 334	Maalox (aluminum hydroxide + magnesium hydroxide), indications, actions, and dosage of, 493–494 McBurney's point/sign, 26 McGill Pain Questionnaire (MPQ), 319 McMurray's test, 26 Macrodantin (nitrofurantoin), indications, actions, and dosage of, 579 Macrolides, 477 Macules, 21t MAG3 (technetium-99m mercaptoacetylthiglycine), 334 Magaldrate (Lowsium; Riopan), indications, actions, and dosage of,
complications of, 286 contraindications to, 282 historical background of, 282–283, 283f indications for, 280 materials for, 282 technique for, 284, 285f, 286, 287t–288t Lumens, of Swan-Ganz catheters, 399–400 Lung(s), on chest x-rays, 335, 336f, 337f, 338 Lung cancer, staging of, 653–654 Lung capacity, 416, 416f, 417f Lung compliance, 417–418, 418f Lung scans, 334 Lupron (leuprolide), indications, actions,	Maalox (aluminum hydroxide + magnesium hydroxide), indications, actions, and dosage of, 493–494 McBurney's point/sign, 26 McGill Pain Questionnaire (MPQ), 319 McMurray's test, 26 Macrodantin (nitrofurantoin), indications, actions, and dosage of, 579 Macrolides, 477 Macules, 21t MAG3 (technetium-99m mercaptoacetylthiglycine), 334 Magaldrate (Lowsium; Riopan), indications, actions, and dosage of, 564
complications of, 286 contraindications to, 282 historical background of, 282–283, 283f indications for, 280 materials for, 282 technique for, 284, 285f, 286, 287t–288t Lumens, of Swan-Ganz catheters, 399–400 Lung(s), on chest x-rays, 335, 336f, 337f, 338 Lung cancer, staging of, 653–654 Lung capacity, 416, 416f, 417f Lung compliance, 417–418, 418f Lung scans, 334 Lupron (leuprolide), indications, actions, and dosage of, 559	Maalox (aluminum hydroxide + magnesium hydroxide), indications, actions, and dosage of, 493–494 McBurney's point/sign, 26 McGill Pain Questionnaire (MPQ), 319 McMurray's test, 26 Macrodantin (nitrofurantoin), indications, actions, and dosage of, 579 Macrolides, 477 Macules, 21t MAG3 (technetium-99m mercaptoacetylthiglycine), 334 Magaldrate (Lowsium; Riopan), indications, actions, and dosage of, 564 Magnesium
complications of, 286 contraindications to, 282 historical background of, 282–283, 283f indications for, 280 materials for, 282 technique for, 284, 285f, 286, 287t–288t Lumens, of Swan-Ganz catheters, 399–400 Lung(s), on chest x-rays, 335, 336f, 337f, 338 Lung cancer, staging of, 653–654 Lung capacity, 416, 416f, 417f Lung compliance, 417–418, 418f Lung scans, 334 Lupron (leuprolide), indications, actions, and dosage of, 559 Lupus erythematosus (LE) preparation,	Maalox (aluminum hydroxide + magnesium hydroxide), indications, actions, and dosage of, 493–494 McBurney's point/sign, 26 McGill Pain Questionnaire (MPQ), 319 McMurray's test, 26 Macrodantin (nitrofurantoin), indications, actions, and dosage of, 579 Macrolides, 477 Macules, 21t MAG3 (technetium-99m mercaptoacetylthiglycine), 334 Magaldrate (Lowsium; Riopan), indications, actions, and dosage of, 564 Magnesium deficiency of, 190–191
complications of, 286 contraindications to, 282 historical background of, 282–283, 283f indications for, 280 materials for, 282 technique for, 284, 285f, 286, 287t–288t Lumens, of Swan-Ganz catheters, 399–400 Lung(s), on chest x-rays, 335, 336f, 337f, 338 Lung cancer, staging of, 653–654 Lung capacity, 416, 416f, 417f Lung compliance, 417–418, 418f Lung scans, 334 Lupron (leuprolide), indications, actions, and dosage of, 559 Lupus erythematosus (LE) preparation, laboratory diagnosis and, 78	Maalox (aluminum hydroxide + magnesium hydroxide), indications, actions, and dosage of, 493–494 McBurney's point/sign, 26 McGill Pain Questionnaire (MPQ), 319 McMurray's test, 26 Macrodantin (nitrofurantoin), indications, actions, and dosage of, 579 Macrolides, 477 Macules, 21t MAG3 (technetium-99m mercaptoacetylthiglycine), 334 Magaldrate (Lowsium; Riopan), indications, actions, and dosage of, 564 Magnesium deficiency of, 190–191 excess of, 190, 237
complications of, 286 contraindications to, 282 historical background of, 282–283, 283f indications for, 280 materials for, 282 technique for, 284, 285f, 286, 287t–288t Lumens, of Swan-Ganz catheters, 399–400 Lung(s), on chest x-rays, 335, 336f, 337f, 338 Lung cancer, staging of, 653–654 Lung capacity, 416, 416f, 417f Lung compliance, 417–418, 418f Lung scans, 334 Lupron (leuprolide), indications, actions, and dosage of, 559 Lupus erythematosus (LE) preparation,	Maalox (aluminum hydroxide + magnesium hydroxide), indications, actions, and dosage of, 493–494 McBurney's point/sign, 26 McGill Pain Questionnaire (MPQ), 319 McMurray's test, 26 Macrodantin (nitrofurantoin), indications, actions, and dosage of, 579 Macrolides, 477 Macules, 21t MAG3 (technetium-99m mercaptoacetylthiglycine), 334 Magaldrate (Lowsium; Riopan), indications, actions, and dosage of, 564 Magnesium deficiency of, 190–191

total parenteral nutrition for excess of,

237

Lutrepulse (gonadorelin), indications,

actions, and dosage of, 546

Magnesium citrate, indications, actions,	Matulane (procarbazine), indications,
and dosage of, 564	actions, and dosage of, 593-594
Magnesium hydroxide (Milk of	Mavik (trandolapril), indications, actions,
Magnesia), indications, actions,	and dosage of, 613
and dosage of, 564	Maxair (pirbuterol), indications, actions,
Magnesium oxide (Mag-Ox 400)	and dosage of, 590
for hypomagnesemia, 191 indications, actions, and dosage of, 564	Maxalt (rizatriptan), indications, actions, and dosage of, 599
Magnesium sulfate	Maxaquin (lomefloxacin), indications,
for emergency cardiac care, 465	actions, and dosage of, 562
for hypomagnesemia, 191	Maxipime (cefepime), indications,
indications, actions, and dosage of, 564	actions, and dosage of, 511
Magnetic resonance imaging (MRI),	Maxitrol (neomycin, polymyxin B, +
331–333	dexamethasone), indications,
reading, 331–332	actions, and dosage of, 577
uses of, 332–333	Maxon (polyglyconate) sutures, 346t
Magnetic resonance spectroscopy (MRS),	Maxzide (hydrochlorothiazide +
332–333	triamterene), indications, actions,
Mag-Ox 400 (magnesium oxide)	and dosage of, 549
for hypomagnesemia, 191	Mean arterial blood pressure (MAP), 393
indications, actions, and dosage of, 564	394f
Malaria	derivation and normal values for, 437t
drugs for treating, 153t	Mean cellular (corpuscular) hemoglobin
prevention of, 153t	(MCH), laboratory diagnosis and,
Malathion, indications for, 153t	102
Malignancies	Mean cell (corpuscular) volume (MCV),
classification systems for, 646, 649–658	laboratory diagnosis and, 102
hypercalcemia with, 188	Mean pulmonary arterial pressure
Malnutrition, identification of, 209,	(MPAP), derivation and normal
210 <i>t</i> –212 <i>t</i>	values for, 437t
Mammography, 326	Measles virus, drug of choice for treating
Manganese, in total parenteral nutrition,	infections by, 148t
231, 232 <i>t</i>	Measurement units, 645-646
Mannitol	Mebendazole, indications for, 153t
for emergency cardiac care, 465	Mechanical soft diet, 206t
indications, actions, and dosage	Mechanical ventilation, 423-429
of, 564	extubation and, 428-429
Mantoux test, 303-304	indications for, 423, 424t
Maprotiline (Ludiomil), indications,	orders for, 426
actions, and dosage of, 564	ventilator classes for, 423-424
Marcaine (bupivacaine)	ventilator modes for, 424, 425f, 426
indications, actions, and dosage of, 507	ventilator setting changes for, 426-427
for suturing, 349t	weaning from, 427-429, 428t
Marcus-Gunn pupils, 26	Mechlorethamine (Mustargen),
Marinol (dronabinol), indications, actions,	indications, actions, and dosage of
and dosage of, 531	564
Mastitis, organism responsible and	Meclizine (Antivert), indications, actions,
empiric therapy for, 134t	and dosage of, 564
Mastoiditis, organisms responsible and	Mediastinal computed tomography, 331
empiric therapy for, $135t$	Mediastinum, on chest x-rays, 335

Meridia (sibutramine), indications,

Medical history, 9-10

Medigesic (acetaminophen + butalbital +/actions, and dosage of, 601 caffeine), indications, actions, and Meropenem (Merrem), indications, dosage of, 489 actions, and dosage of, 566 Medihaler-Iso (isoproterenol) Mesalamine (Asacol; Pentasa; Rowasa), for emergency cardiac care, 464 indications, actions, and dosage of, indications, actions, and dosage of, 398t, 555-556 Mesna (Mesnex), indications, actions, and infusion guidelines for, 441t dosage of, 567 Mediquell (dextromethorphan), Mesoridazine (Serentil), indications, indications, actions, and dosage of, actions, and dosage of, 567 525 Metabolic acidosis, 164t, 166-167 Medroxyprogesterone (Cycrin; Depo differential diagnosis of, 17B, 167f, Provera; Provera), indications, actions, and dosage of, 564 treatment of, 167 Medulla, herniation of, with lumbar Metabolic alkalosis, 164t, 167, 169 puncture, 286 differential diagnosis of, 167, 169, 169f Mefaxin (cefoxitin), indications, actions, total parenteral nutrition for, 237 and dosage of, 512 treatment of, 169 Mefloquine, indications for, 153t Metamucil (psyllium), indications, actions, and dosage of, 596 Megestrol acetate (Megace), indications, actions, and dosage of, 564 Metanephrines, in urine, 117 Melanoma, staging of, 654-655 Metaproterenol (Alupent; Metaprel), 364 Melena, differential diagnosis of, 47 indications, actions, and dosage of, 567 Mellaril (thioridazine), indications, Metaraminol (Aramine), indications, actions, and dosage of, 609-610 actions, and dosage of, 567 Meloxicam (Mobic), indications, actions, Metastron, 334 and dosage of, 564 Metaxalone (Skelaxin), indications, Melphalan (Alkeran; L-PAM), indications, actions, and dosage of, 567 actions, and dosage of, 566 Metered-dose inhalers, 365 Menest (estrogens, esterified), indications, Metformin (Glucophage), indications, actions, and dosage of, 535 actions, and dosage of, 567 Methadone (Dolophine) Meningitis aseptic, cerebrospinal fluid in, 287t indications, actions, and dosage of, organisms responsible and empiric 567-568 therapy for, 138t-139t route, effects, and dosage for, 321t Meperidine (Demerol) Methanol, antidote for, 471 indications, actions, and dosage Methenamine (Hiprex; Urex), indications, of, 566 actions, and dosage of, 568 route, effects, and dosage for, 321t Methergine (methylergonovine), Mepivacaine (Carbocaine), for suturing, indications, actions, and dosage of, 349t569 Meprobamate (Equanil; Miltown), Methimazole (Tapazole), indications, actions, and dosage of, 568 indications, actions, and dosage of, Methocarbamol (Robaxin), indications, Mepron (atovaquone), indications, actions, actions, and dosage of, 568 and dosage of, 500-501 Methotrexate (Folex; Rheumatrex) Mercaptopurine [6-MP] (Purinethol), half-life and therapeutic and toxic levels indications, actions, and dosage of, 566 indications, actions, and dosage of, 568

Methoxamine (Vasoxyl), indications,	Micardis (telmisartan), indications,
actions, and dosage of, 568-569	actions, and dosage of, 607
Methyldopa (Aldomet), indications,	Miconazole (Monistat), indications,
actions, and dosage of, 569	actions, and dosage of, 571
Methylergonovine (Methergine),	Microalbumin, spot urine study for, 115
indications, actions, and dosage of,	Microbiology, 121-159
569	blood cultures, 129-130
Methylprednisolone	differential diagnosis of common
for anaphylaxis, 469	infections and empiric therapy, 133,
for asthmatic attacks, 469	134 <i>t</i> –154 <i>t</i> , 156 <i>t</i>
indications, actions, and dosage of, 603	gonorrhea cultures and smear, 129
Methylprednisolone acetate (Depo-	isolation protocols, 155–156
Medrol)	molecular, 132
dose, activity, duration, and route for,	nasopharyngeal cultures, 129
627t	SBE prophylaxis, 155, 158 <i>t</i> –159 <i>t</i>
indications, actions, and dosage of, 603	Scotch tape test, 132
Methylprednisolone sodium succinate	sputum culture, 130
(Solu-Medrol)	staining techniques for, 121–128
dose, activity, duration, and route for,	stool cultures, 130–131
627t	susceptibility testing, 133
indications, actions, and dosage of, 603	throat cultures, 131
Metoclopramide (Clopra; Octamide;	urine cultures, 131–132
Reglan), indications, actions, and	viral cultures and serology, 132
dosage of, 569	β ₂ -Microglobulin
Metolazone (Diulo; Zaroxolyn), indications, actions, and dosage of,	laboratory diagnosis and, 82 spot urine study for, 114
569	
Metopirone (metyrapone), indications,	Microhemagglutination, <i>Treponema</i> pallidum (MHA-TP), laboratory
actions, and dosage of, 570	diagnosis and, 82
Metoprolol (Lopressor; Toprol XL)	Micro-K (potassium chloride)
for emergency cardiac care, 462	form and dosage of, 626t
indications, actions, and dosage	indications, actions, and dosage of, 592
of, 569	Micronase (glyburide), indications,
Metronidazole (Flagyl; Metrogel),	actions, and dosage of, 545
indications, actions, and dosage of,	Micronor, 625t
153 <i>t</i> , 154 <i>t</i> , 570	Midamor (amiloride), indications, actions,
Metyrapone (Metopirone), indications,	and dosage of, 494
actions, and dosage of, 570	Midazolam (Versed)
Metyrosine (Demser), indications, actions,	indications, actions, and dosage of, 571
and dosage of, 570	for seizures, 472
Mevacor (lovastatin), indications, actions,	Middle cells, 97, 100
and dosage of, 563	Mifepristone [RU 486] (Mifeprex),
Mexiletine (Mexitil), indications, actions,	indications, actions, and dosage of,
and dosage of, 570	571
Mezlocillin (Mezlin), indications, actions,	Miglitol (Glyset), indications, actions, and
and dosage of, 570	dosage of, 571
Miacalcin (calcitonin)	Migraine headache agents, 486
for hypercalcemia, 189	Milk of Magnesia (magnesium
indications, actions, and dosage of, 508	hydroxide), indications, actions,
MIBG, 333	and dosage of, 564

Miller-Abbott tubes, 272 Mobitz type II heart block, 378 Milrinone (Primacor), indications, actions, Möbius' sign, 26 and dosage of, 571 Modicon 28, 623t Miltown (meprobamate), indications, Moduretic (hydrochlorothiazide + actions, and dosage of, 566 amiloride), indications, actions, Mineral oil, indications, actions, and and dosage of, 549 Moexipril (Univasc), indications, actions, dosage of, 571 Mini mental status examination, 13-14, and dosage of, 573 15t Molecular microbiology, 132 Molindone (Moban), indications, actions, Minimum bactericidal concentration (MBC), 133 and dosage of, 573 Minimum inhibitory concentration (MIC), Mometasone furoate (Elocon), potency and application of, 630t Minipress (prazosin), indications, actions, Monistat (miconazole), indications, and dosage of, 593 actions, and dosage of, 571 Minnesota tubes, 273 Monocid (cefonicid), indications, actions, Minoxidil (Loniten; Rogaine), indications, and dosage of, 511-512 actions, and dosage of, 572 Monoclate (antihemophilic factor) Mirapex (pramipexole), indications, indications, actions, and dosage of, 498 actions, and dosage of, 592 for transfusion, 199t Mircette 28, 624t Monocryl (poliglecaprone) sutures, 346t Mirtazapine (Remeron), indications, Monocytes, laboratory diagnosis and, actions, and dosage of, 572 102 - 103Misoprostol (Cytotec), indications, Monopril (fosinopril), indications, actions, actions, and dosage of, 572 and dosage of, 543 Mithracin (plicamycin) Monospot, laboratory diagnosis and, 83 for hypercalcemia, 189 Montelukast (Singulair), indications, indications, actions, and dosage of, actions, and dosage of, 573 590-591 Monurol (fosfomycin), indications, Mitomycin C (Mutamycin), indications, actions, and dosage of, 542-543 actions, and dosage of, 572 Moraxella catarrhalis, Gram stain Mitotane (Lysodren), indications, actions, characteristics of, 125t and dosage of, 572 Morganella morganii, Gram stain Mitotic inhibitors, 478 characteristics of, 126t Mitoxantrone (Novantrone), indications, Moricizine (Ethmozine), indications, actions, and dosage of, 572-573 actions, and dosage of, 573 Mitral insufficiency (MI), 16t Morning rounds, 3 Mitral stenosis (MS), 16t Moro's reflex, 26 Mivacurium (Mivacron), indications, Morphine (Duramorph; MS Contin; actions, and dosage of, 573 Roxanol) Mixed acid-base disorders, 163 for emergency cardiac care, 465 Mixed venous oxygen content (C_{VO2}), indications, actions, and dosage of, 573 derivation and normal values for, route, effects, and dosage for, 321t 437tMotrin (Ibuprofen) M-mode echocardiography, 330 indications, actions, and dosage of, 551 Moban (molindone), indications, actions, route, effects, and dosage for, 321t and dosage of, 573 Moxifloxacin (Avelox), indications, actions, and dosage of, 574 Mobic (meloxicam), indications, actions, and dosage of, 564 MS Contin (morphine)

for emergency cardiac care, 465

Mobitz type I heart block, 377-378, 379f

Mycostatin (nystatin), indications, actions,

indications, actions, and dosage

and dosage of, 580 of, 573 Myelography, 329 route, effects, and dosage for, 321t Mucomyst (acetylcysteine), 364 Myleran (busulfan), indications, actions, indications, actions, and dosage of, and dosage of, 507 489-490 Mylicon (simethicone), indications, Mucormycosis, systemic drug for treating, actions, and dosage of, 601 Myocardial infarction (MI) Mucosil (acetylcysteine), 364 anticoagulant standard of practice for, indications, actions, and dosage of, on electrocardiograms, 367, 383f-385f, Mucus, in urine sediment, 114 383-384, 385t MUGA scans, 333-334 Myocardial ischemia Multifocal atrial tachycardia (MAT), 373, on electrocardiogram, 367 374f electrocardiogram and, 383f-385f, 384 Multiple sclerosis, cerebrospinal fluid in, Myoglobin laboratory diagnosis and, 83 288tMupirocin (Bactroban), indications, spot urine study for, 115 actions, and dosage of, 574 Muromonab-CD3 (Orthoclone OKT3), indications, actions, and dosage of, Murphy's sign, 26 Nabumetone (Relafen), indications, Muscle relaxants, 485 actions, and dosage of, 574 Musculoskeletal agents, 485 Nadolol (Corgard), indications, actions, Musculoskeletal magnetic resonance and dosage of, 574 imaging, 333 Nafcillin (Nallpen), indications, actions, Muse (alprostadil, urethral suppository), and dosage of, 574 indications, actions, and dosage of, Naftifine (Naftin), indications, actions, 492 and dosage of, 574 Musset's sign, 26 Nalbuphine (Nubain) Mustargen (mechlorethamine), indications, actions, and dosage of, 575 indications, actions, and dosage of, route, effects, and dosage for, 322t 564 Nalfon (fenoprofen), indications, actions, Mutamycin (mitomycin C), indications, and dosage of, 537-538 actions, and dosage of, 572 Nalidixic acid (Neggram), indications, Myambutol (ethambutol), indications, actions, and dosage of, 575 actions, and dosage of, 536 Nallpen (nafcillin), indications, actions, Mycelex (clotrimazole), indications, and dosage of, 574 actions, and dosage of, 519 Naloxone (Narcan) Mycobacterium, Gram stain for emergency cardiac care, 465 characteristics of, 126t indications, actions, and dosage Mycobutin (rifabutin), indications, of, 575 actions, and dosage of, 598 for opiate overdose, 471 Mycolog-II (triamcinolone + nystatin), Naltrexone (Revia), indications, actions, indications, actions, and dosage of, and dosage of, 575 613 Napamide (disopyramide) Mycophenolate mofetil (Cellcept), half-life and therapeutic and toxic levels indications, actions, and dosage of, 574 indications, actions, and dosage of, 529

Nebupent (pentamidine), indications,

Naphazoline + antazoline (Albalon-A

Ophthalmic), indications, actions, actions, and dosage of, 153t, 585 and dosage of, 575 Necator americanus infections, drugs for Naphazoline + pheniramine acetate treating, 153t (Naphcon A), indications, actions, Neck computed tomography, 331 and dosage of, 575 Necon 1/35 21, 28, 623t Naphcon A (naphazoline + pheniramine Necon 1/50 21, 28, 623t acetate), indications, actions, and Necon 10/11 21, 28, 624t dosage of, 575 Necon 0.5/35E 21, 28, 623t Naprosyn (naproxen), indications, actions, Nedocromil (Tilade), indications, actions, and dosage of, 575 and dosage of, 576 Naproxen (Aleve; Anaprox; Naprosyn), Needle(s) indications, actions, and dosage of, French units for, 240, 241f for suturing, 345 Naratriptan (Amerge), indications, actions, Needle cricothyrotomy, 263-264 and dosage of, 575-576 Nefazodone (Serzone), indications, Narcan (naloxone) actions, and dosage of, 576 for emergency cardiac care, 465 Negative nitrogen balance, 229 indications, actions, and dosage of, 575 Neggram (nalidixic acid), indications, for opiate overdose, 471 actions, and dosage of, 575 Narcotics, 486 Neisseria gonorrhoeae analgesics, 320, 321t-322t Gram stain characteristics of, 124f, 125t overdose of, 471 throat culture for, 131 Nardil (phenelzine), indications, actions, Neisseria meningitides, Gram stain and dosage of, 588 characteristics of, 124f, 125t Narrow complex SVT algorithm, 457f Nelfinavir (Viracept), indications, actions, Nasalcrom (cromolyn sodium), and dosage of, 150t, 576 indications, actions, and dosage of, Nelova 1/35 21, 623t 520-521 Nelova 1/50 21, 623t Nasogastric intubation Nelova 10/11 21, 624t Nelova 0.5/35E 21, 623t IV fluid replacement with, 179 procedure for, 273-274 Nembutal (pentobarbital), indications, tubes for, 272 actions, and dosage of, 587 Nasolide (flunisolide), indications, Neo-calglucon (calcium glubionate) actions, and dosage of, 540 for hypocalcemia, 190 Nasopharyngeal cultures, 129 indications, actions, and dosage of, 508 Nausea, differential diagnosis of, 49 Neodecadron Ophthalmic (neomycin + Navane (thiothixene), indications, actions, dexamethasone), indications, and dosage of, 610 actions, and dosage of, 576 Navelbine (vinorelbine), indications, Neomycin, colistin, hydrocortisone, + actions, and dosage of, 618 thonzonium (Cortisporin-TC Otic NAVEL mnemonic, 313 Suspension), indications, actions, and dosage of, 576 for arterial puncture, 246 Nebcin (tobramycin) Neomycin, colistin, + hydrocortisone half-life and therapeutic and toxic levels (Cortisporin-TC Otic Drops), indications, actions, and dosage of, indications, actions, and dosage of, 611 Nebulizer therapy, 363 Neomycin + dexamethasone (AK-NEOtopical medications for, 364 DEX Ophthalmic; Neodecadron

Ophthalmic), indications, actions, and dosage of, 576

Neomycin + polymyxin B (Neosporin in Cream), indications, actions, and dosage of, 576

Neomycin, polymyxin B, + Nerv dexamethasone (Maxitrol), indications, actions, and dosage of, 577

Nerv

Neomycin, polymyxin bladder irrigant, indications, actions, and dosage of, 577

Neomycin, polymyxin, + hydrocortisone (Cortisporin Ophthalmic and Otic), indications, actions, and dosage of, 577

Neomycin, polymyxin-B, + prednisolone (Poly-Pred Ophthalmic), indications, actions, and dosage of, 577

Neomycin sulfate, indications, actions, and dosage of, 577

Neonatal ophthalmia, organism responsible and empiric therapy for, 135t

Neoplasms. See also Malignancies adrenal, differential diagnosis of, 42 cerebrospinal fluid in, 288t classification systems for, 646, 649–658 cutaneous, 21t

Neoral (cyclosporine)

half-life and therapeutic and toxic levels of, 634t

indications, actions, and dosage of, 521–522

Neosar (cyclophosphamide), indications, actions, and dosage of, 521

Neosporin Cream (neomycin + polymyxin B), indications, actions, and dosage of, 576

Neosporin ointment (bacitracin, neomycin, + polymyxin B, topical), indications, actions, and dosage of, 502

Neosporin Ophthalmic (bacitracin, neomycin, + polymyxin B, ophthalmic), indications, actions, and dosage of, 502

Neo-Synephrine (phenylephrine)

indications, actions, and dosage of, 398t, 588–589 infusion guidelines for, 443t Nephrostography, percutaneous, 329 Nephrotomography, 328 Nerve blocks, 320

Nerve conduction testing, for pain evaluation, 319

Nerve root trauma, with lumbar puncture, 286

Neumega (oprelvekin), indications, actions, and dosage of, 582

Neupogen (filgrastim), indications, actions, and dosage of, 539

Neural blockade, for pain management, 319

Neurogenic shock, 414, 431

Neuroleptics, for pain management, 320 Neurologic examination, 12

Neurolysis, 320

Neuromuscular blockers, 485

Neurontin (gabapentin), indications, actions, and dosage of, 543

Neutra-Phos (sodium-potassium phosphate)

for hypercalcemia, 189

for hypophosphatemia, 192

Neutrexin (trimetrexate), indications, actions, and dosage of, 615

Neutrophils. See Polymorphonuclear neutrophils (PMNs)

Nevirapine (Viramune), indications, actions, and dosage of, 577

Niacin (Nicolar)

indications, actions, and dosage of, 577 in total parenteral nutrition, 231*t*

Nicardipine (Cardene)

indications, actions, and dosage of, 578 infusion guidelines for, 441*t*–442*t*

Nicoderm (nicotine, transdermal), indications, actions, and dosage of, 578

Nicolar (niacin)

indications, actions, and dosage of, 577 in total parenteral nutrition, 231t

Nicorette (nicotine gum), indications, actions, and dosage of, 578

Nicorette D5 (nicotine gum), indications, actions, and dosage of, 578

Nicotine, transdermal (Habitrol;	Nitrogen balance, 229
Nicoderm; Nicotrol; Prostep),	Nitrogen mustards, 478
indications, actions, and dosage of,	Nitroglycerin (Nitro-Bid IV; Nitro-Bid
578	Ointment; Nitrodisc; Nitrolingual;
Nicotine gum (Nicorette; Nicorette D5),	Transderm-Nitro)
indications, actions, and dosage of,	for emergency cardiac care, 465
578	indications, actions, and dosage of, 579
Nicotine nasal spray (Nicotrol NS),	Nitroglycerin (Tridil), infusion guidelines
indications, actions, and dosage of,	for, 442 <i>t</i>
578	Nitrolingual (nitroglycerin)
Nicotrol (nicotine, transdermal),	for emergency cardiac care, 465
indications, actions, and dosage of,	indications, actions, and dosage of, 579
578	Nitroprusside (Nipride; Nitropress)
Nicotrol NS (nicotine nasal spray),	for emergency cardiac care, 465-466
indications, actions, and dosage of,	for hypertensive crisis, 470
578	indications, actions, and dosage of, 579
Nifedipine (Adalat; Adalat CC; Procardia;	infusion guidelines for, 442t
Procardia XL), indications,	Nitrosoureas, 478
actions, and dosage of, 578	Nix (permethrin), indications, actions, and
Night of surgery notes, 36-37	dosage of, 153t, 154t, 588
Nilandron (nilutamide), indications,	Nizatidine (Axid), indications, actions,
actions, and dosage of, 578	and dosage of, 579
Nilstat (nystatin), indications, actions, and	Nizoral (ketoconazole), indications,
dosage of, 580	actions, and dosage of, 557
Nilutamide (Nilandron), indications,	Nocardia, Gram stain characteristics of,
actions, and dosage of, 578	126t
Nimodipine (Nimotop), indications,	Nocardiosis, organism responsible and
actions, and dosage of, 578–579	empiric therapy for, 139t
Nipent (pentostatin), indications, actions,	Noctec (chloral hydrate), indications,
and dosage of, 587	actions, and dosage of, 514
Nipride (nitroprusside)	Nodal rhythm, on electrocardiograms,
for emergency cardiac care, 465–466	374–375, 376 <i>f</i>
for hypertensive crisis, 470	Nodules, cutaneous, 21t
indications, actions, and dosage of, 579	Nolvadex (tamoxifen), indications,
infusion guidelines for, 442t	actions, and dosage of, 606-607
Nisoldipine (Sular), indications, actions,	Nonanion gap acidosis, 166, 168t
and dosage of, 579	Nonhemolytic febrile reactions, 202, 203
Nitrite, in urine, 111	Noninflammatory arthritis, synovial fluid
Nitro-Bid IV (nitroglycerin)	interpretation and, 250, 251t
for emergency cardiac care, 465	Nonionic contrast media, 327
indications, actions, and dosage of, 579	Nonsteroidal anti-inflammatory agents,
Nitro-Bid Ointment (nitroglycerin)	486
for emergency cardiac care, 465	Norcuron (vecuronium), indications,
indications, actions, and dosage of, 579	actions, and dosage of, 617
Nitrodisc (nitroglycerin)	Nordette-21, 623 <i>t</i>
for emergency cardiac care, 465	Norepinephrine (Levophed)
indications, actions, and dosage of, 579	actions of, 398t
Nitrofurantoin (Furadantin Macrobid;	for emergency cardiac care, 466
Macrodantin), indications, actions,	indications, actions, and dosage of, 580
and dosage of, 579	infusion guidelines for, 442t

Norflex (orphenadrine), indications,	NPH Iletin II, onset, peak, and duration of
actions, and dosage of, 582	effect of, 622t
Norfloxacin (Noroxin), indications,	Nubain (nalbuphine)
actions, and dosage of, 580	indications, actions, and dosage of, 575
Norgestrel (Ovrette), 625t	route, effects, and dosage for, 322t
indications, actions, and dosage of, 580	Nuclear scans, 333-335
Norinyl 1/35 21, 28, 623t	Nucleated RBCs, 104
Norinyl 1/50 21, 28, 623t	5'-Nucleotidase, laboratory diagnosis and,
Normal compensatory response, 163	83
Normiflo (ardeparin), indications, actions,	Numorphan (oxymorphone), indications,
and dosage of, 499	actions, and dosage of, 584
Normodyne (labetalol)	Nupercainal (dibucaine), indications,
for emergency cardiac care, 462	actions, and dosage of, 526
for hypertensive crisis, 470	Nurolong (nylon) sutures, 347t
indications, actions, and dosage of, 557	Nursoy, 224t
infusion guidelines for, 441t	Nutramigen, 224t
Noroxin (norfloxacin), indications,	Nutrition, 205–226. See also Nutritional
actions, and dosage of, 580	support; Total parenteral nutrition
Norpace (disopyramide)	(TPN)
half-life and therapeutic and toxic levels	assessment of, 205, 209, 210t–212t
of, 633 <i>t</i>	for critically ill patents, 434
indications, actions, and dosage of, 529	hospital diets and, 205, 206t–208t
Norplant (levonorgestrel implant),	requirements for, 209, 213
indications, actions, and dosage of,	Nutritional support
560	enteral, 213, 214t, 214-223
Norpramin (desipramine)	parenteral, 213-214
half-life and therapeutic and toxic levels	Nylon (Dermalon; Ethilon) sutures, 346t
of, 633 <i>t</i>	Nylon (Nurolon) sutures, 347t
indications, actions, and dosage of, 524	Nystagmus, differential diagnosis of, 49
Nor-QD, 625t	Nystatin (Mycostatin; Nilstat), indications,
Nortriptyline (Aventyl; Pamelor)	actions, and dosage of, 580
half-life and therapeutic and toxic levels	
of, 633 <i>t</i>	
indications, actions, and dosage	0
of, 580	Obesity, medication for, 482
Norvasc (amlodipine), indications,	Obstetric agents, 485–486
actions, and dosage of, 496	Obstruction series, 326
Norvir (ritonavir), indications, actions,	Obturator sign, 26
and dosage of, 150t, 599	Occupress Ophthalmic (carteolol),
Novafed (pseudoephedrine), indications,	indications, actions, and dosage of,
actions, and dosage of, 595-596	510
Novantrone (mitoxantrone), indications,	Octamide (metoclopramide), indications,
actions, and dosage of, 572-573	actions, and dosage of, 569
Novocain (procaine), for suturing, 349t	OctreoScans, 334
NovoLog (insulin aspart), onset, peak, and	Octreotide (Sandostatin), indications,
duration of effect of, 622t	actions, and dosage of, 580-581
Novulin 70/30, onset, peak, and duration	Ocuflox Ophthalmic (ofloxacin),
of effect of, 622t	indications, actions, and dosage of,
Novulin L, onset, peak, and duration of	580–581
effect of, 622t	Off-service notes, 35

Ofloxacin (Floxin; Ocuflox Ophthalmic),	indications, actions, and dosage of, 582
indications, actions, and dosage of,	Oral herpes, drugs of choice for treating,
580-581	147 <i>t</i>
Olanzapine (Zyprexa), indications,	Oral procedures, subacute bacterial
actions, and dosage of, 580-581	endocarditis prophylaxis for, 158t
Oligoclonal banding, CSF, laboratory	Oral supplements, 217
diagnosis and, 83	Orders, 6
Oliguria, 432–433	writing, 33–34
differential diagnosis of, 49–50	Organon (desogen), 623t
Olsalazine (Dipentum), indications,	Organophosphates, antidote for, 471
actions, and dosage of, 580–581	Orgestrel-28, 624t
Omeprazole (Prilosec), indications,	Orinase (tolbutamide), indications,
actions, and dosage of, 580–581	actions, and dosage of, 612
Omnicef (cefdinir), indications, actions,	Orphenadrine (Norflex), indications,
and dosage of, 511	actions, and dosage of, 582
Omnipen (ampicillin)	Ortho-Cept 21, 624 <i>t</i>
indications, actions, and dosage	Orthoclone OKT3 (muromonab-CD3),
of, 497	
	indications, actions, and dosage of,
for subacute bacterial endocarditis	574
prophylaxis, 158t, 159t	Ortho-Cyclen 21, 624 <i>t</i>
Oncovin (vincristine), indications, actions,	Ortho-Novum 1/35 21, 624t
and dosage of, 617–618	Ortho-Novum 1/50 21, 624 <i>t</i>
Ondansetron (Zofran), indications,	Ortho-Novum 7/7/7 21, 625 <i>t</i>
actions, and dosage of, 580-581	Ortho-Novum 10/11 21, 624t
On-service notes, 35	Orthostatic blood pressure measurement,
Operating room, 339–344	286–289
draping patients for, 343	Ortho Tri-Cyclen, 624t
entering, 339–340	Ortolani's test/sign, 26
gowning and gloving for, 342-343	Orudis (ketoprofen), indications, actions,
hand scrub for, 340-341	and dosage of, 557
patient preparation for, 341-342	Oruvail (ketoprofen), indications, actions,
position in, 343–344	and dosage of, 557
sterile technique for, 339	Oseltamivir (Tamiflu), indications,
universal precautions in, 344	actions, and dosage of, 147t, 582
Operative notes, 36	Osler's nodes, 26
Ophthalmia, neonatal, organism	Osmolality
responsible and empiric therapy	serum, laboratory diagnosis and, 83
for, 135 <i>t</i>	spot urine study for, 115
Ophthalmic agents, 482-483	Osteomyelitis, organisms responsible and
Opioids, 486	empiric therapy for, 134t
analgesics, 320, 321 <i>t</i> –322 <i>t</i>	Osteoporosis, medications for, 482
overdose of, 471	Otic agents, 482
Oprelvekin (Neumega), indications,	Otic Domeboro (acetic acid + aluminum
actions, and dosage of, 582	acetate), indications, actions, and
Opticrom (cromolyn sodium), indications,	dosage of, 489
actions, and dosage of, 520–521	Otitis externa, organisms responsible and
Oral cholecystography (OCG), 329	empiric therapy for, 135 <i>t</i> –136 <i>t</i>
Oral contraceptives, 485	Otitis media, organisms responsible and
composition of, 623 <i>t</i> –625 <i>t</i>	empiric therapy for, 136 <i>t</i>
composition of, ozor ozor	Simplife dierupy 101, 1301

Oxymorphone (Numorphan), indications,

Otobiotic Otic (polymyxin B +

hydrocortisone), indications,	actions, and dosage of, 584
actions, and dosage of, 590-591	Oxytocin (Pitocin; Syntocinon),
Outpatient prescriptions, writing, 37–39, 38f	indications, actions, and dosage of,
Ova, stool for, 131	584
Ovarian cancer, staging of, 655	
Ovral, 624 <i>t</i>	
Ovrette (norgestrel), 625t	P
indications, actions, and dosage of, 580	Pacerone (amiodarone)
Oxacillin (Bactocill; Prostaphlin),	for emergency cardiac care, 461
indications, actions, and dosage of,	half-life and therapeutic and toxic levels
582–583	of, 632 <i>t</i>
Oxaprozin (Daypro), indications, actions,	indications, actions, and dosage of, 495
and dosage of, 583	Pacing, transcutaneous, 468
Oxazepam (Serax), indications, actions,	Pacing Swans, 401
and dosage of, 583	Pacis (BCG [bacillus Calmette-Guérin]),
Oxcarbazepine (Trileptal), indications,	indications, actions, and dosage of,
actions, and dosage of, 583	503
Oxiconazole (Oxistat), indications,	Packed red cells (PRBCs), 197t
actions, and dosage of, 583	Paclitaxel (Taxol), indications, actions,
Oximetric PA catheters, 401	and dosage of, 584
Oxistat (oxiconazole), indications, actions,	Pain
and dosage of, 583	acute, 315–316
Oxybutynin (Ditropan; Ditropan XL),	chronic, 316
indications, actions, and dosage of,	differential diagnosis of, 42
583	Pain management, 315–323. See also
Oxycodone [dihydrohydroxycodeinone]	Analgesics
(Oxycontin; OxyIR; Roxicodone),	adverse physiologic effects of pain and,
indications, actions, and dosage of,	316, 317 <i>t</i> –318 <i>t</i>
583	classification of pain and, 315–316
Oxycodone + acetaminophen (Percocet;	evaluation for, 317
Tylox), indications, actions, and	nonpharmacologic, 320, 323
dosage of, 583–584	pain measurement and, 316, 319
Oxycodone + aspirin (Percodan;	patient controlled analgesia for, 323
Percodan-Demi), indications,	pharmacologic, 319–320, 321 <i>t</i> –322 <i>t</i>
actions, and dosage of, 584	terminology for, 315
Oxycontin (oxycodone), indications,	Pamelor (nortriptyline)
actions, and dosage of, 583	half-life and therapeutic and toxic levels
Oxygen, for carbon monoxide poisoning,	of, 633t
471	indications, actions, and dosage of, 580
Oxygenation, 418–423, 420 <i>f</i> –422 <i>f</i>	Pamidronate (Aredia)
Oxygen carrying capacity, derivation and	for hypercalcemia, 189
normal values for, 437t	indications, actions, and dosage of,
Oxygen consumption, derivation and	584–585
normal values for, 438t	Panacryl sutures, 346t
Oxygen delivery, 419	Pancoast's syndrome, 26
Oxygen supplements, 362t	Pancrease (pancreatin + pancrelipase),
OxyIR (oxycodone), indications, actions,	indications, actions, and dosage of,
and dosage of, 583	585
400480 01, 000	233

Parlodel (bromocriptine), indications,

Pancreatic disease, total parenteral

nutrition formulation for, 235	actions, and dosage of, 506
Pancreatic loss, IV fluid replacement with,	Paromomycin, indications for, 153t
179	Paromycin, indications for, 153t
Pancreatin + pancrelipase (Cotazyme;	Paroxetine (Paxil), indications, actions,
Creon; Pancrease; Ultrase),	and dosage of, 585
indications, actions, and dosage of, 585	Paroxysmal atrial tachycardia (PAT), 372–373, 374 <i>f</i>
Pancuronium (Pavulon), indications,	Partial thromboplastin time (PTT), 107
actions, and dosage of, 585	Pasteurella, Gram stain characteristics of,
P-24 antigen, laboratory diagnosis and,	124 <i>f</i>
77, 83	Pastia's lines, 26
Pantoprazole (Protonix), indications,	Patches, cutaneous, 21t
actions, and dosage of, 585	Patient controlled analgesia (PCA), 323
Papanicolaou smear, 290-291	Patient preparation, for surgery, 341-342
Paper, for electrocardiography, 368	Pavulon (pancuronium), indications,
Papillary muscle rupture, 393–394	actions, and dosage of, 585
Papules, 21t	Paxil (paroxetine), indications, actions,
Paracentesis, peritoneal (abdominal),	and dosage of, 585
296–297, 298 <i>f</i>	Pediacare 1 (dextromethorphan),
Paracoccidioidomycosis, systemic drug	indications, actions, and dosage of,
for treating, $152t$	525
Paradoxical pulse, 393, 394f	Pediazole (erythromycin + sulfisoxazole),
Paraflex (hlorzoxazone), indications,	indications, actions, and dosage of,
actions, and dosage of, 515-516	534
Parafon Forte DSC (hlorzoxazone),	Pediculus capitis, drugs for treating,
indications, actions, and dosage of,	153 <i>t</i>
515–516	Pediculus humanus infections, drugs for
Paraldehyde, for seizures, 473 <i>t</i>	treating, 153t
Paranasal sinus radiographs, 326	PEG tubes, 214
Paraplatin (carboplatin), indications,	Pelvic drug therapy, 330
actions, and dosage of, 510	Pelvic examination, 289–291
Parasites	indications for, 289
drugs for treating infections by, 153t–154t	materials for, 289 procedures for, 289–291
stool for, 131	Pelvic inflammatory disease (PID),
transfusion-associated risk of	organisms responsible and empiric
transmission, 204	therapy for, 139 <i>t</i>
in urine sediment, 112	Pelvic magnetic resonance imaging, 333
Parathyroid hormone (PTH)	Pelvic ultrasound, 330
deficiency of, hypocalcemia and, 189	Penbutolol (Levatol), indications, actions,
hypocalcemia and, 189	and dosage of, 585
laboratory diagnosis and, 84	Penciclovir (Denavir), indications, actions,
Paregoric, indications, actions, and dosage	and dosage of, 147t, 585
of, 585	Penicillin(s), 477
Parenteral fluids, composition of,	for dental abscesses, 470
178–179	Penicillin G, aqueous (potassium or
Parenteral nutrition, 213-214, 434. See	sodium) (Pentids; Pfizerpen),
also Total parenteral nutrition	indications, actions, and dosage of,
(TPN)	586

- Penicillin G benzathine (Bicillin), indications, actions, and dosage of, 586
- Penicillin G procaine (Wycillin), indications, actions, and dosage of, 585
- Penicillin V (Pen-Vee K; Veetids), indications, actions, and dosage of, 585
- Pentam 300 (pentamidine), indications, actions, and dosage of, 153*t*, 585
- Pentamidine (Nebupent; Pentam 300), indications, actions, and dosage of, 153t, 585
- Pentasa (mesalamine), indications, actions, and dosage of, 566
- Pentazocine (Talwin), indications, actions, and dosage of, 586–587
- Pentids [penicillin G, aqueous (potassium or sodium)], indications, actions, and dosage of, 586
- Pentobarbital (Nembutal), indications, actions, and dosage of, 587
- Pentosan polysulfate sodium (Elmiron), indications, actions, and dosage of, 587
- Pentostatin (Nipent), indications, actions, and dosage of, 587
- Pentoxifylline (Trental), indications, actions, and dosage of, 587
- Pen-Vee K (penicillin V), indications, actions, and dosage of, 585
- Pepcid (famotidine), indications, actions, and dosage of, 537
- Peptic ulcer disease, organism responsible and empiric therapy for, 144*t*
- Pepto-Bismol (bismuth subsalicylate), indications, actions, and dosage of, 505
- Peptostreptococcus, Gram stain characteristics of, 125t
- Percocet (oxycodone + acetaminophen), indications, actions, and dosage of, 583–584
- Percodan (oxycodone + aspirin), indications, actions, and dosage of, 584
- Percodan-Demi (oxycodone + aspirin), indications, actions, and dosage of, 584

- Percutaneous nephrostography, 329 Percutaneous suprapubic bladder aspiration, 309
- Percutaneous transhepatic cholangiography (PTHC), 329 Performance status scales, 646,
- 647*t*–648*t*
- Pergolide (Permax), indications, actions, and dosage of, 587
- Periactin (cyproheptadine), indications, actions, and dosage of, 522
- Pericardial friction rub, 394-395
- Pericardiocentesis, 291–292, 293*f* Pericarditis, on electrocardiograms, 387, 387*f*
- Perindopril erbumine (Aceon), indications, actions, and dosage of, 587–588
- Peripherally inserted central catheter (PICC) lines, 292–295
 - complications of, 295
 - contraindications to, 293
 - historical background of, 294
 - indications for, 292
 - materials for, 293
 - procedure for, 294 removal of, 294–295
- Peritoneal dialysis, diet for, 208*t*
- Peritoneal lavage, 295–296, 296t
- Peritoneal paracentesis, 296-297,
 - 298f
 - complications of, 297
 - contraindications to, 296-297
 - diagnosis of ascitic fluid and, 297,
 - indications for, 296
 - materials for, 297
 - procedure for, 297, 298f
- Peritonitis, organisms responsible and empiric therapy for, 139*t*
- Permax (pergolide), indications, actions, and dosage of, 587
- Permethrin (Elimite; Nix), indications, actions, and dosage of, 153t, 154t, 588
- Permitil (fluphenazine), indications, actions, and dosage of, 541
- Perphenazine (Trilafon), indications, actions, and dosage of, 588
- Petechiae, 21t

Pfizerpen [penicillin G, aqueous	example of, 28-32
(potassium or sodium)],	written, 5
indications, actions, and dosage of,	Physical therapy, for pain management,
586	320
pH	Physostigmine (Antilirium)
of pleural fluid, 299t	for anticholinergic crisis, 470
of urine, 110–111	antidote for, 471
Phalen's test, 26	indications, actions, and dosage
Pharyngitis, organisms responsible and	of, 589
empiric therapy for, 140t	Phytonadione [vitamin K]
Phenazopyridine (Pyridium), indications,	(AquaMEPHYTON)
actions, and dosage of, 588	indications, actions, and dosage of, 589
Phenelzine (Nardil), indications, actions,	in total parenteral nutrition, 231
and dosage of, 588	Pindolol (Visken), indications, actions,
Phenergan (promethazine), indications,	and dosage of, 589
actions, and dosage of, 594	Pinworm infections, drugs for treating,
Phenobarbital	153 <i>t</i>
half-life and therapeutic and toxic levels	Pinworm preparation, 132
of, 631t	Pioglitazone (Actos), indications, actions,
indications, actions, and dosage of, 588	and dosage of, 589
for seizures, 473t	Pipecuronium (Arduan), indications,
Phenylephrine (Neo-Synephrine)	actions, and dosage of, 590
indications, actions, and dosage of,	Piperacillin (Pipracil), indications, actions,
398t, 588–589	and dosage of, 590
infusion guidelines for, 443t	Piperacillin-tazobactam (Zosyn),
Phenytoin (Dilantin)	indications, actions, and dosage of,
half-life and therapeutic and toxic levels	590
of, 631 <i>t</i> –632 <i>t</i>	Pipracil (piperacillin), indications, actions,
indications, actions, and dosage of, 589	and dosage of, 590
interaction with enteral nutrition, 223	Pirbuterol (Maxair), indications, actions,
Phlebotomy, 309-314	and dosage of, 590
materials for, 309, 311 <i>t</i> –312 <i>t</i>	Piroxicam (Feldene)
procedure for, 310, 313-314	indications, actions, and dosage of, 590
Phos-Ex (calcium acetate), indications,	route, effects, and dosage for, 321t
actions, and dosage of, 508	Pitocin (oxytocin), indications, actions,
PhosLo (calcium acetate), indications,	and dosage of, 584
actions, and dosage of, 508	Pitressin (vasopressin)
Phosphate	indications, actions, and dosage of, 617
deficiency of, 192	infusion guidelines for, 443t
excess of, 191-192	Plain catgut sutures, 346t
Phospholine Ophthalmic (echothiophate	Plaques, cutaneous, 21t
iodine), indications, actions, and	Plasmanate (plasma protein fraction), 200t
dosage of, 532	Plasma protein fraction (Plasmanate), 200t
Phosphorus, laboratory diagnosis and, 84	indications, actions, and dosage of, 590
Phrenilin Forte (acetaminophen +	Plasmodium falciparum infections, drugs
butalbital +/- caffeine), indications,	for treating, 153t
actions, and dosage of, 489	Plasmodium malariae infections, drugs
Phthirus pubis infections, drugs for	for treating, 153t
treating, 153t	Plasmodium ovale infections, drugs for
Physical examination, 11–12	treating, 153t

Polycitra-K (potassium citrate + citric

acid), indications, actions, and

Plasmodium vivax infections, drugs for

treating, 153t

Polychromasia, 104

Platelet(s) dosage of, 592 laboratory diagnosis and, 103 Polydioxanone (PDS) sutures, 345, 346t Polyester (Ethibond; Tycron) sutures, 347t for transfusion, 198t transfusions of, 201 Polyethylene glycol [PEG]-electrolyte Plateletpheresis, 194 solution (CoLyte; GoLYTELY), Platinol AQ (cisplatin), indications, indications, actions, and dosage of, actions, and dosage of, 517 590-591 Plavix (clopidogrel), indications, actions, Polyglactin 910 (Vicryl) sutures, 346t and dosage of, 519 Polyglycolic acid 910 (Vicryl Rapide) Plendil (felodipine), indications, actions, sutures, 346t and dosage of, 537 Polyglyconate (Maxon) sutures, 346t Pleural effusion, differential diagnosis of, Polymerase chain reaction (PCR), 132 Polymorphonuclear neutrophils (PMNs) Pleural fluid, differential diagnosis of, bands or stabs, 100 299t, 306 laboratory diagnosis and, 103 Plicamycin (Mithracin) left shift and, 100 for hypercalcemia, 189 Polymox (amoxicillin) indications, actions, and dosage of, indications, actions, and dosage 590-591 of, 496 Pneumococcal vaccine, polyvalent for subacute bacterial endocarditis (Pneumovax-23), indications, prophylaxis, 158t, 159t actions, and dosage of, Polymyxin B + hydrocortisone (Otobiotic Otic), indications, actions, and 590-591 Pneumococcal 7-valent conjugate vaccine dosage of, 590-591 (Prevnar), indications, actions, and Poly-Pred Ophthalmic (neomycin, dosage of, 590-591 polymyxin-B, + prednisolone), Pneumocystis carinii pneumonia indications, actions, and dosage of, diagnosis of, 130 drugs for treating, 153t Polypropylene (Prolene) sutures, 347t Pneumonia, organisms responsible and Polysporin (bacitracin + polymyxin B, empiric therapy for, 135t, topical), indications, actions, and 140t - 141tdosage of, 502 Pneumovax-23 (pneumococcal vaccine, Polysporin Ophthalmic (bacitracin + polyvalent), indications, actions, polymyxin B, ophthalmic), and dosage of, 590-591 indications, actions, and dosage of, Podocon-25 (podophyllin), indications, 502 actions, and dosage of, 148t. Portable chest x-rays, 325 590-591 Portagen, 224t Positive end-expiratory pressure (PEEP), Podofilox, indications and dosage for, 417, 417f, 426 Posteroanterior (PA) chest films, reading, Podophyllin (Condylox; Condylox Gel 0.5%; Podocon-25), indications, 335, 336*f*, 338 actions, and dosage of, 148t, Postop notes, 36-37 590-591 Postrenal renal failure, 433 Poisoning, 471-472 Potassium deficiency of. See Hypokalemia Poliglecaprone 25 (Monocryl) sutures, 346t excess of. See Hyperkalemia

requirement for, 178

Potassium (continued) Prazosin (Minipress), indications, actions, serum, laboratory diagnosis and, 84 and dosage of, 593 spot urine study for, 114 Precordial contusion, 392 Potassium acetate, potassium citrate, + Precordial electrodes, 267, 267f bicarbonate (Tri-K), form and Precose (acarbose), indications, actions, dosage of, 626t and dosage of, 488 Potassium bicarbonate, for renal tubular Pred-G Ophthalmic (gentamicin + acidosis, 168t prednisolone, ophthalmic), Potassium chloride (Kaochlor 10%: indications, actions, and dosage of, Kaochlor S-F 10%; Kaon-Cl; 545 Kaon-Cl 20%: K-Lor: Klorvess: Predictive value, definition of, 645 Klotrix: K-Tab: Micro-K: Slow-Prednicarbate (Dermatop), potency and K), form and dosage of, 626t application of, 630t indications, actions, and dosage of, 592 Prednisolone (Delta-Cortef) Potassium chloride, potassium citrate, and dose, activity, duration, and route for, bicarbonate (Kaochlor Eff), form and dosage of, 626t indications, actions, and dosage of, 603 Potassium citrate (Urocit-K), indications, Prednisone (Deltasone) actions, and dosage of, 590-591 dose, activity, duration, and route for, Potassium citrate + citric acid (Polycitra-627t K), indications, actions, and for hypercalcemia, 189 dosage of, 592 indications, actions, and dosage of, 603 Potassium citrate + potassium gluconate Preemie SMA 20, 225t (Twin-K), form and dosage of, Preemie SMA 24, 225t Pregnancy precautions, 156 Potassium gluconate (Glu-K; Kaon; Kaon Preload, 395, 396f elixir) measurement of, 408, 410 form and dosage of, 626t Premarin (estrogens, conjugated), indications, actions, and dosage of, 592 indications, actions, and dosage of, Potassium hydroxide preparation, 291 Potassium phosphate (K-Phos), for Premarin + Methylprogesterone hypophosphatemia, 192 (estrogens, conjugated + Pound/kilogram conversion, 658, 658t methylprogesterone), indications, Povidone-iodine hand scrub, 340-341 actions, and dosage of, 535-536 PPD test, 303-304 Premarin + Methyltestosterone (estrogens, conjugated + methyltestosterone), Pramipexole (Mirapex), indications, actions, and dosage of, 592 indications, actions, and dosage of, Pramoxine (Anusol Ointment; 536 Proctofoam-NS), indications, Premature atrial contractions (PACs), 372, actions, and dosage of, 592 373f Pramoxine + hydrocortisone (Enzone; Premature infant(s), feeding, 225–226 Proctofoam-HC), indications, formulas for, 225t actions, and dosage of, 592 Premature ventricular contractions Prandin (repaglinide), indications, actions, (PVCs), 375-376, 376f, 377f and dosage of, 598 Preoperative notes, 36 Pravastatin (Pravachol), indications, Prerenal renal failure, 433 actions, and dosage of, 592-593 Prescriptions Prazepam (Centrax), indications, actions, safe, tips for, 39 and dosage of, 593 writing, 37-39, 38f Praziquantel, indications for, 154t Presentation, 5

Procarbazine (Matulane), indications,

actions, and dosage of, 615

actions, and dosage of, 594

Promethazine (Phenergan), indications,

Present illness, history of, 9

of, 633t

indications, actions, and dosage of, 593

infusion guidelines for, 443t

Pressor agents, 480 actions, and dosage of, 593-594 Pressure-limited ventilators, 423 Procardia (nifedipine), indications, Pressure regulated volume control actions, and dosage of, 578 ventilation, 426 Procardia XL (nifedipine), indications, actions, and dosage of, 578 Pressure support ventilation (PSV), 425f, Prochlorperazine (Compazine), 426 Prevacid (lansoprazole), indications, indications, actions, and dosage of, actions, and dosage of, 558 594 Prevalence, definition of, 639 Procrit (epoetin alfa), indications, actions, Prevnar (pneumococcal 7-valent conjugate and dosage of, 533 vaccine), indications, actions, and Proctitis, organism responsible and dosage of, 590-591 empiric therapy for, 135t Priftin (rifapentine), indications, actions, Proctofoam-HC (pramoxine + and dosage of, 598 hydrocortisone), indications, Prilosec (omeprazole), indications, actions, and dosage of, 592 actions, and dosage of, 580-581 Proctofoam-NS (pramoxine), indications, Primacor (milrinone), indications, actions, actions, and dosage of, 592 and dosage of, 571 Proctoscopy, 300 Primaxin (imipenem-cilastin), indications, Procyclidine (Kemadrin), indications, actions, and dosage of, 552 actions, and dosage of, 594 Primidone, half-life and therapeutic and Progesterone, laboratory diagnosis and, 84 toxic levels of, 632t Progesterone receptors, laboratory diagnosis and, 67 Prinivil (lisinopril) for emergency cardiac care, 461 Progestimil, 224t indications, actions, and dosage Proglycem (diazoxide), indications, of, 562 actions, and dosage of, 526 Prograf (tacrolimus), indications, actions, PR interval, 367, 369f Priscoline (tolazoline), indications, and dosage of, 606 actions, and dosage of, 612 Progress notes Pro-Banthine (propantheline), indications, ICU, 389-391 actions, and dosage of, 594 problem-oriented, 34 Probenecid (Benemid), indications, Prohibit (haemophilus B conjugate actions, and dosage of, 593 vaccine), indications, actions, and Problem-oriented progress notes, 34 dosage of, 547 Procainamide (Procan; Pronestyl) Prokine (sargramostim), indications, electrocardiogram and, 386 actions, and dosage of, 600 for emergency cardiac care, 466 Prolactin, laboratory diagnosis and, 85 Prolastin (α_1 -Protease inhibitor), half-life and therapeutic and toxic levels of, 633t indications, actions, and dosage of, indications, actions, and dosage of, 593 infusion guidelines for, 443t Prolene (polypropylene) sutures, 347t Procaine (Novocain), for suturing, 349t Proleukin (aldesleukin), indications, Procan (procainamide) actions, and dosage of, 491 electrocardiogram and, 386 Prolixin (fluphenazine), indications, for emergency cardiac care, 466 actions, and dosage of, 541 half-life and therapeutic and toxic levels Proloprim (trimethoprim), indications,

	rocainamide)	Prostatic acid phosphatase (PAP),
	diogram and, 386	laboratory diagnosis and, 55
	ency cardiac care, 466	Prostatitis, organisms responsible and
	nd therapeutic and toxic levels	empiric therapy for, 144t
of, 633		Prostep (nicotine, transdermal),
indication	s, actions, and dosage	indications, actions, and dosage of,
of, 593		578
	guidelines for, 443t	Prosthetic joint infections, organisms
	(Rhythmol), indications,	responsible and empiric therapy
	ns, and dosage of, 594	for, 134 <i>t</i>
Propanthelin	ne (Pro-Banthine), indications,	Prosthetic valves, anticoagulant standard
	ns, and dosage of, 594	of practice for, 637t
	nasteride), indications, actions,	Prostin VR (alprostadil), indications,
	dosage of, 539	actions, and dosage of, 492
Propine (dip	ivefrin), indications, actions,	Protamine sulfate, indications, actions,
and o	losage of, 528	and dosage of, 595
Propionibac	terium acne, Gram stain	α_1 -Protease inhibitor (Prolastin),
chara	acteristics of, 126t	indications, actions, and dosage of,
Propofol (Di	iprivan), indications, actions,	492
and o	losage of, 594	Protein
Propoxyphe	ne (Darvon), indications,	needs for, 213
actio	ns, and dosage of, 595	serum, laboratory diagnosis and, 87-88
Propoxyphe	ne + acetaminophen	spot urine study for, 115
(Dar	vocet), indications, actions,	in urine, 112, 117-118
	dosage of, 595	Protein electrophoresis
	ne + aspirin (Darvon	serum, laboratory diagnosis and, 85,
Com	pound-65; Darvon-N +	86f, 87t
Aspi	rin), indications, actions, and	urine, laboratory diagnosis and,
dosa	ge of, 595	85, 86 <i>f</i>
Propranolol	(Inderal)	Protein hydrosylate infant formulas, 224t
for emerg	ency cardiac care, 462	Proteus, Gram stain characteristics of,
indication	s, actions, and dosage	124 <i>f</i>
of, 595		Proteus mirabilis, Gram stain
Propylthiour	racil [PTU], indications,	characteristics of, 126t
actio	ns, and dosage of, 595	Proteus vulgaris, Gram stain
Proscar (fina	asteride), indications, actions,	characteristics of, 126t
and o	dosage of, 539	Prothrombin complex, 200t
ProSobee, 22	24 <i>t</i>	Prothrombin time (PT), 107–108
Prosom (esta	azolam), indications, actions,	Protonix (pantoprazole), indications,
and o	dosage of, 534	actions, and dosage of, 585
	n E ₁ [alprostadil] (Prostin	Proventil (albuterol), 364
VR),	indications, actions, and	for anaphylaxis, 469
	ge of, 492	indications, actions, and dosage of, 490
	(oxacillin), indications,	nebulized, for asthmatic attacks, 469
	ns, and dosage of, 582–583	Provera (medroxyprogesterone),
Prostate can	=	indications, actions, and dosage of,
screening	recommendations for, 643t	564
	c, 657–658	Providencia, Gram stain characteristics of
	cific antigen (PSA),	127 <i>t</i>
	ratory diagnosis and, 85	Proximal port, of Swan-Ganz catheter, 399

Prozac (fluoxetine), indications, actions,	algorithm for, 460f
and dosage of, 541	Pulmonary function tests (PFTs),
Pruritus, differential diagnosis of, 50	359–361, 360 <i>f</i>
Pseudoephedrine (Afrinol; Novafed;	differential diagnosis of, 361, 361t
Sudafed), indications, actions, and	Pulmonary vascular resistance (PVR),
dosage of, 595-596	derivation and normal values for,
Pseudo-hyponatremia, 185	437 <i>t</i>
Pseudomonas, Gram stain characteristics	Pulmonic insufficiency (PI), 16t
of, 124 <i>f</i>	Pulmonic stenosis (PS), 16t
Pseudomonas aeruginosa, Gram stain	Pulmozyme (dornase alfa), indications,
characteristics of, 127t	actions, and dosage of, 530
Pseudotumor cerebri, cerebrospinal fluid	Pulseless electrical activity algorithm,
in, 288t	453f
Psoas sign, 26	Pulseless ventricular tachycardia
Psorcon (diflorasone diacetate), potency	algorithm, 452f
and application of, $628t$	Pulse oximetry, for cardiac output
Psychiatric history and physical, 13–14	determination, 413
Psychiatric mental status examination, 13	Pulse pressure, 393
Psychologic examination, for pain evaluation, 319	Pulsus alternans, 26
	Pulsus paradoxus measurement, 298–300
Psychologic intervention, for pain	Pureed diet, 206t
management, 320	Purinethol (mercaptopurine), indications,
Psychosocial history, 10	actions, and dosage of, 566
Psyllium (Effer-Syllium; Metamucil;	Purpura, 21t
Serutan), indications, actions, and	Pustules, 21t
dosage of, 596	P wave, 368
Pulmicort (budesonide), indications,	Pyelonephritis, organisms responsible and
actions, and dosage of, 506	empiric therapy for, 144 <i>t</i>
Pulmonary angiography, 328	Pyrantel pamoate, indications for, $153t$,
Pulmonary artery catheters, 399-410, 400f	154 <i>t</i>
catheterization procedure with,	Pyrazinamide, indications, actions, and
402–404, 403 <i>f</i> –405 <i>f</i> , 406, 407 <i>t</i>	dosage of, 596
catheters for, 399–402, 401f, 402f	Pyridium (phenazopyridine), indications,
clinical applications of, 408, 410	actions, and dosage of, 588
complications of, 406–407	Pyridoxine [vitamin B ₆]
differential diagnosis using, 408, 409t	indications, actions, and dosage of, 596
indications for, 399	in total parenteral nutrition, 231t
measurements using, 407–408	Pyrimethamine, indications for, 154 <i>t</i>
Pulmonary artery occlusion pressure, 407	Pyrimethamine-sulfadoxine, indications
Pulmonary artery pressure, 407	for, 153 <i>t</i>
Pulmonary artery pressure,	Pyrosis, differential diagnosis of, 47
systolic/diastolic (PAS/PAD),	
derivation and normal values for,	
437 <i>t</i>	Q
Pulmonary capillary wedge pressure	QRS axis, 370
(PCWP), derivation and normal	QRS complex, 369
values for, 437t	QRS interval, 367, 369f
Pulmonary disease, total parenteral	QT interval, 367, 369f
nutrition formulation for, 235	Quazepam (Doral), indications, actions,
Pulmonary embolism, 435–436	and dosage of, 596

Queckenstedt's test, 26	Rapamycin [sirolimus] (Rapamune),
Quelicin (succinylcholine), indications,	indications, actions, and dosage of,
actions, and dosage of, 605	602
Questran (cholestyramine), indications, actions, and dosage of, 516	Rapid plasma reagin (RPR), laboratory diagnosis and, 92
Quetiapine (Seroquel), indications,	Raynaud's phenomenon/disease, 27
actions, and dosage of, 596	Reading, 4–5
Quinaglute (quinidine)	Rebetron (ribavirin), indications, actions,
electrocardiogram and, 386	and dosage of, 146t, 148t, 598
half-life and therapeutic and toxic levels	Recombivax-HB (hepatitis B vaccine),
of, 633 <i>t</i>	indications, actions, and dosage of,
indications, actions, and dosage of,	548
596–597	Rectovaginal examination, 290
Quinapril (Accupril), indications, actions,	Red blood cell(s) (RBCs)
and dosage of, 596	abnormalities of, differential diagnosis
Quinidine (Quinaglute; Quinidex)	of, 104
electrocardiogram and, 386	laboratory diagnosis and, 68
half-life and therapeutic and toxic levels	mass of, 177
of, 633 <i>t</i>	morphologic abnormalities of, spot
indications, actions, and dosage of,	urine study for, 114–115
596–597	nucleated, 104
Quinine dihydrochloride, indications for,	transfusions of, 196, 197t, 201
153 <i>t</i>	in urine sediment, 112
Quinine gluconate, indications for, 153t	washed, 197t
Quinine sulfate, indications for, 153t	Red blood cell (RBC) casts, in urine
Quinke's sign, 27	sediment, 114
Quinupristin + dalfopristin (Synercid),	Red cell distribution width (RDW),
indications, actions, and dosage of,	laboratory diagnosis and, 103
597	Red rubber catheter, 307
Q waves, 369	Reducing substances, in urine, 112
in myocardial infarction, 384, 385f	Refludan (lepirudin), indications, actions, and dosage of, 559
	Reglan (metoclopramide), indications,
R	actions, and dosage of, 569
Rabeprazole (Aciphex), indications,	Regranex Gel (becaplermin), indications,
actions, and dosage of, 597	actions, and dosage of, 503
Racemic epinephrine, 364	Regular diet, 206t
Radiation, for pain management, 320	Regular Iletin II, onset, peak, and duration
Radiation terminology, 646	of effect of, 622t
Radovici's sign, 27	Relafen (nabumetone), indications,
RA latex test, laboratory diagnosis and, 88	actions, and dosage of, 574
Raloxifene (Evista), indications, actions,	Relenza (zanamivir), indications, actions,
and dosage of, 597	and dosage of, 147t, 619
Ramipril (Altace)	Remeron (mirtazapine), indications,
for emergency cardiac care, 461	actions, and dosage of, 572
indications, actions, and dosage of, 597	Remicade (infliximab), indications,
Random urine studies, 114–115	actions, and dosage of, 553
Ranitidine (Zantac)	Renal cancer, staging of, 652–653
for anaphylaxis, 469	Renal failure
indications actions and dosage of 597	acute, 207t, 432-433

diet for, 207t Retinoic acid [tretinoin, topical] (Avita; hypercalcemia with, 188 Retin-A), indications, actions, and renal, 433 dosage of, 613 total parenteral nutrition formulation Retinol-binding protein (RBP), laboratory for, 235-236 diagnosis and, 88 Renal scans, 334 Retrograde pyelography (RPG), 329 Renal tubular acidosis, diagnosis and Retrograde urethrography (RUG), 329 management of, 168t Retroperitoneal computed tomography, Renin, laboratory diagnosis and, 88 330 ReoPro (abciximab) Revia (naltrexone), indications, actions, for emergency cardiac care, 464 and dosage of, 575 indications, actions, and dosage of, 488 Review of systems (ROS), 10-11 Repaglinide (Prandin), indications, Rheomacrodex (dextran 40), indications, actions, and dosage of, 598 actions, and dosage of, 525 Repan (acetaminophen + butalbital +/-Rheumatoid factor, laboratory diagnosis caffeine), indications, actions, and and, 88 dosage of, 489 Rheumatrex (methotrexate) Rescriptor (delayirdine), indications, half-life and therapeutic and toxic levels actions, and dosage of, 523-524 Residents, 1-2 indications, actions, and dosage Residual volume (RV), 361, 361t, 416 of, 568 Resin uptake, laboratory diagnosis and, 90 Rhinocort (budesonide), indications, Respiratory acidosis, 164t, 169-170 actions, and dosage of, 506 differential diagnosis of, 169-170 Rho Gam, 199t treatment of, 170 Rhythmol (propafenone), indications, Respiratory agents, 487 actions, and dosage of, 594 Rib(s), x-rays of, 325 Respiratory alkalosis, 164t, 170-171 differential diagnosis of, 170 Ribavirin (Rebetron; Virazole), treatment of, 170-171 indications, actions, and dosage of, Respiratory inhalants, 487 146t, 148t, 598 Respiratory isolation, 155 Riboflavin, in total parenteral nutrition, Respiratory procedures, subacute bacterial 231tendocarditis prophylaxis for, 158t Rickettsia rickettsii infections. Respiratory syncytial virus (RSV), drug of characteristics and treatment of, choice for treating infections by, 156t - 157t148t Rifabutin (Mycobutin), indications, Respiratory therapy, 359 actions, and dosage of, 598 Responsibility, 5-6 Rifampin (Rifadin), indications, actions, Restoril (temazepam), indications, actions, and dosage of, 598 and dosage of, 607 Rifapentine (Priftin), indications, actions, Reteplase (Retavase), indications, actions, and dosage of, 598 and dosage of, 598 Right atrial enlargement (RAE), Reticulocyte count, 100-101 electrocardiogram and, 380, 381f Retin-A (tretinoin, topical), indications, Right atrial pressure (RAP), derivation actions, and dosage of, 613 and normal values for, 437t Retinitis, cytomegalovirus, drugs of Right bundle branch block (RBBB), 379, choice for treating, 146t Retinoic acid [tretinoin, systemic] Right shift, 100 (Vesanoid), indications, actions, Right ventricular ejection catheters, 401

Right ventricular ejection fraction, 408

and dosage of, 613

Right ventricular end-diastolic volume Rofecoxib (Vioxx) indications, actions, and dosage of, 599 index, 408 route, effects, and dosage for, 321t Right ventricular hypertrophy (RVH), electrocardiogram and, 381, 382f Roferon-A (interferon alfa-2a), indications Right ventricular pressure (RVP), and dosage for, 146t, 554 Rogaine (minoxidil), indications, actions, derivation and normal values for. 437tand dosage of, 572 Rimantadine (Flumadine), indications, Romazicon (flumazenil) actions, and dosage of, 148t, for benzodiazepine poisoning, 471 598-599 for emergency cardiac care, 462 Rimexolone (Vexol Ophthalmic), indications, actions, and dosage of, 540 indications, actions, and dosage of, Romberg's test, 27 597-598 Rosiglitazone (Avandia), indications, Rimso 50 (dimethyl sulfoxide), actions, and dosage of, 599-600 indications, actions, and dosage of, Roth's spots, 27 Rounds, 3-4 Ringworm, organisms responsible and Roundworm infections, drugs for treating, empiric therapy for, 142t 153t Riopan (magaldrate), indications, actions, Rovsing's sign, 27 and dosage of, 564 Rowasa (mesalamine), indications, Risedronate (Actonel), indications, actions, and dosage of, 566 actions, and dosage of, 599 Roxanol (morphine) Risperidone (Risperdal), indications, for emergency cardiac care, 465 actions, and dosage of, 599 indications, actions, and dosage of, 573 Ritonavir (Norvir), indications, actions, route, effects, and dosage for, 321t and dosage of, 150t, 599 Roxicodone (oxycodone), indications, Rivastigmine (Exelon), indications, actions, and dosage of, 583 actions, and dosage of, 599 Rubex (doxorubicin), indications, actions, Rizatriptan (Maxalt), indications, actions, and dosage of, 531 and dosage of, 599 Rufen (Ibuprofen) Robaxin (methocarbamol), indications, indications, actions, and dosage of, 551 actions, and dosage of, 568 route, effects, and dosage for, 321t "Rule of nines," for calculating extent of Robetron (interferon alfa-2B + ribavirin combination), indications, actions, burns, 182f, 183 "Rule of sixes," for calculating fluids in and dosage of, 554 Robinson catheter, 307 children, 179, 181t Robitussin (guaifenesin), indications, "Rule of thumb" method, for calculating actions, and dosage of, 546 caloric needs, 213 Robitussin A-C (guaifenesin + codeine). R wave, 369 indications, actions, and dosage of, Rocaltrol (calcitriol), indications, actions, and dosage of, 508 Salem-sump tubes, 272 Rocephin (ceftriaxone), indications, Salmeterol (Serevent), indications, actions, and dosage of, 513 actions, and dosage of, 600 Rocky Mountain spotted fever (RMSF) Salmonella, Gram stain characteristics of, antibodies to, laboratory diagnosis and, 124f, 127t

characteristics and treatment of,

156t-157t

Sandimmune (cyclosporine)

of, 634t

half-life and therapeutic and toxic levels

indications, actions, and dosage of,

differential diagnosis of, 50

Seldinger technique, for femoral artery

characteristics of, 127t

521-522 cannulation, 245 Sandoglobulin (immune globulin, Selegiline (Eldepryl), indications, actions, intravenous), indications, actions, and dosage of, 600 and dosage of, 552 Selenium, in total parenteral nutrition, Sandostatin (octreotide), indications, 232t actions, and dosage of, 580-581 Selenium sulfide (Exsel Shampoo; Selsun Saquinavir (Fortovase), indications, Blue Shampoo; Selsun Shampoo), actions, and dosage of, 150t, 600 indications, actions, and dosage of, Sarafem (fluoxetine), indications, actions, and dosage of, 541 Selsun Blue Shampoo (selenium sulfide), Sarcoptes scabiei infections, drugs for indications, actions, and dosage of, treating, 154t Sargramostim [GM-CSF] (Leukine; Selsun Shampoo (selenium sulfide), Prokine), indications, actions, and indications, actions, and dosage of, dosage of, 600 Scabies, drugs for treating, 154t Semen analysis, laboratory diagnosis and, Scales, cutaneous, 21t 88-89 Scalpels, 240, 242f Sengstaken-Blakemore tubes, 273 Sensitivity, definition of, 645 Scalp vein needles, 280 Scars, 21t Sensoricaine (bupivacaine) Schedules of controlled substances, indications, actions, and dosage of, 507 475-476 for suturing, 349t Schistocytes, 104 Sentinel loop, 27 Schlichter test, 133 Sepsis Schmorl's nodes, 27 total parenteral nutrition for, 236 Scoliosis, 27 total parenteral nutrition formulation Scopolamine, indications, actions, and for, 236 dosage of, 600 transfusions and, 202, 203 Scopolamine, transdermal (Transderm Septic arthritis organisms responsible and empiric Scop), indications, actions, and dosage of, 600 therapy for, 134t Scotch tape test, 132 synovial fluid interpretation and, 250, Scout films, 326 251tScreen film mammography, 326 Septic shock, 414, 431 Secobarbital (Seconal), indications, Septra (trimethoprim-sulfamethoxazole), actions, and dosage of, 600 indications, actions, and dosage of, Second-degree heart block, 377-378, 379f 153t, 615 Secretion precautions, 156 Serax (oxazepam), indications, actions, Sectral (acebutolol), indications, actions, and dosage of, 583 and dosage of, 488 Serentil (mesoridazine), indications, actions, and dosage of, 567 Sedapap-10 Two-dyne (acetaminophen + Serevent (salmeterol), indications, actions, butalbital +/- caffeine), indications, actions, and dosage of, and dosage of, 600 489 Seroquel (quetiapine), indications, actions, Sedative hypnotics, 481 and dosage of, 596 Sedimentation rate, 108 Serratia, Gram stain characteristics of, Segs, 100 124f, 127t Seizures, 472, 473t Serratia marcescens, Gram stain

Sertraline (Zoloft), indications, actions,	Simvastatin (Zocor), indications, actions,
and dosage of, 601	and dosage of, 601
Serum(s), 485	Sinemet (carbidopa + levodopa),
Serum bactericidal level, 133	indications, actions, and dosage of,
Serutan (psyllium), indications, actions,	509-510
and dosage of, 596	Sinequan (doxepin)
Serzone (nefazodone), indications,	half-life and therapeutic and toxic levels
actions, and dosage of, 576	of, 634t
Shigella, Gram stain characteristics of,	indications, actions, and dosage of, 530
124 <i>f</i> , 127 <i>t</i>	Single donor plasma, 199t
Shock, 413-414, 431	Single-photon emission computed
algorithm for, 460f	tomography (SPECT), 335
Shock lung, 429–431	Singulair (montelukast), indications,
Shunt fraction (Qs/Qt), 419-423,	actions, and dosage of, 573
420 <i>f</i> –422 <i>f</i>	Singultus, differential diagnosis of, 48
derivation and normal values	Sinography, 328
for, 438 <i>t</i>	Sinus arrhythmia, 372
Sibutramine (Meridia), indications,	Sinus bradycardia, 371–372, 375f
actions, and dosage of, 601	Sinus films, 326
Sickling, 104	Sinusitis, organisms responsible and
Sigmoidoscopy, 300–302	empiric therapy for, 141t
complications of, 302	Sinusoidal pattern, 276
indications for, 300	Sinus rhythms, on electrocardiograms,
materials for, 300	371–372, 372 <i>f</i> –373 <i>f</i>
procedure for, 200–201, 201f	Sinus tachycardia, 371, 375f
Signal sentinel sign, 27	SI prefixes and symbols, 646
Sildenafil (Viagra), indications, actions,	Sirolimus [rapamycin] (Rapamune),
and dosage of, 601	indications, actions, and dosage of,
Silent heart algorithm, 454f	602
Silk sutures, 347t	Sister Mary Joseph's sign/node, 27
Silvadene (silver sulfadiazine),	Skelaxin (metaxalone), indications,
indications, actions, and dosage of,	actions, and dosage of, 567
601	Skin
Silver nitrate (Dey-Drop), indications,	innervation of, 22 <i>f</i> –23 <i>f</i>
actions, and dosage of, 601	melanoma of, staging of, 654–655
Silver sulfadiazine (Silvadene),	Skin biopsy, 302
indications, actions, and dosage of,	Skin infections, organisms responsible and
601	empiric therapy for, 141 <i>t</i> –142 <i>t</i>
Simethicone (Mylicon), indications,	Skin precautions, 155
actions, and dosage of, 601	Skin staples, 252, 258f
Similac 13, 224t	Skin stapies, 252, 256) Skin testing, 303–304
Similac 20, 224 <i>t</i>	Skull films, 326
Similac 24, 224 <i>t</i>	Slow-K (potassium chloride)
Similac 24, 224 <i>t</i> Similac 27, 224 <i>t</i>	form and dosage of, 626t
Similac PM 60/40, 224 <i>t</i>	indications, actions, and dosage of, 592
Similac Special Care 20, 225 <i>t</i> Similac Special Care 24, 225 <i>t</i>	SMA 20, 224 <i>t</i>
Simple acid-base disorders, 163	Small bowel follow-through (SBFT), 329
Simple acid-base disorders, 163 Simulect (basiliximab), indications,	Small cells, 97, 100
actions, and dosage of, 502	SOAP, 34 Social history, 10
actions, and dosage of, 302	Social ilistoly, 10

Sodium	indications, actions, and dosage of,
deficiency of, 185-186, 237	603-604
excess of, 184-185	Solu-Medrol (methylprednisolone sodium
requirement for, 178	succinate)
serum, laboratory diagnosis and, 89	dose, activity, duration, and route for,
spot urine study for, 114	627 <i>t</i>
total parenteral nutrition for deficiency of, 237	indications, actions, and dosage of, 603 Soma (carisoprodol), indications, actions,
Sodium bicarbonate	and dosage of, 510
for cyclic antidepressant poisoning, 471	Somatic pain, deep, 315
for emergency cardiac care, 466	Somophyllin (theophylline)
for hyperkalemia, 187	half-life and therapeutic and toxic levels
indications, actions, and dosage of, 602	of, 632 <i>t</i>
pediatric, for emergency cardiac care,	indications, actions, and dosage
466	of, 609
for renal tubular acidosis, 168t	Sonata (zaleplon), indications, actions,
Sodium citrate (Bicitra), indications,	and dosage of, 619
actions, and dosage of, 602	Sorbitol
Sodium nitroprusside (Nipride;	for hyperkalemia, 187
Nitropress)	indications, actions, and dosage of, 602
for emergency cardiac care, 465-466	for poisoning, 472
for hypertensive crisis, 470	Sorbitrate (isosorbide dinitrate),
indications, actions, and dosage of, 579	indications, actions, and dosage of,
infusion guidelines for, 442t	555–556
Sodium phosphate (Fleet's Phospho-soda),	Soriatane (actretin), indications, actions,
for hypophosphatemia, 192	and dosage of, 488
Sodium polystyrene sulfonate	Sotalol (Betapace), indications, actions,
(Kayexalate)	and dosage of, 602
for hyperkalemia, 187	Soy infant formulas, 224t
indications, actions, and dosage of, 602	Specific gravity, of urine, 111
Sodium-potassium phosphate (Neutra-	Specificity, definition of, 645
Phos)	Spectazole (econazole), indications,
for hypercalcemia, 189	actions, and dosage of, 531-532
for hypophosphatemia, 192	Speculum examination
Sodium salicylate (aspirin)	bimanual examination, pelvic, 290
for emergency cardiac care, 461	pelvic, 290
indications, actions, and dosage of,	Spermatozoa, in urine sediment, 112
499–500	Spherocytes, 104
route, effects, and dosage for, 321t	Spinal headache, 286
Sodium Sulamyd (sulfacetamide),	Spine computed tomography, 331
indications, actions, and dosage of,	Spine magnetic resonance imaging, 333
605	Spiral computed tomography, 331
Soft diet, mechanical, 206t	Spirometry, incentive, 363-364
Soft tissue infections, organisms	Spironolactone (Aldactone), indications,
responsible and empiric therapy	actions, and dosage of, 603
for, 141 <i>t</i> –142 <i>t</i>	Splenomegaly, differential diagnosis of,
Solu-Cortef (hydrocortisone)	49
dose, activity, duration, and route for,	Sporanox (itraconazole), indications,
627 <i>t</i>	actions, and dosage of, 151t,
for hypercalcemia, 189	556–557

Stool leukocyte stain, 128 Sporotrichosis, systemic drug for treating, Straight-leg-raising sign, 26 152tSpot urine studies, 114-115 Strep screen, 131 Sputum, Gram stain of, 122 Streptase (streptokinase) Sputum culture, 130 for emergency cardiac care, 466 Square knots, 355f, 356f indications, actions, and dosage of, 604 Stab cells, 100 Streptococcus, Gram stain characteristics Stadol (butorphanol), indications, actions, of, 123f, 125t and dosage of, 507 Streptococcus agalactiae, Gram stain Staining techniques, 121-128 characteristics of, 123f Stainless steel sutures, 347t Streptococcus bovis, Gram stain characteristics of, 125t Staphylococcus, Gram stain characteristics of, 123f, 125t Streptococcus faecalis, Gram stain Staphylococcus agalactiae, Gram stain characteristics of, 125t characteristics of, 125t Streptococcus mutans, Gram stain Staphylococcus aureus, Gram stain characteristics of, 123f characteristics of, 123f, 125t Streptococcus pneumoniae, Gram stain Staphylococcus epidermidis, Gram stain characteristics of, 123f, 125t characteristics of, 123f, 125t Streptococcus pyogenes, Gram stain characteristics of, 123f, 125t Staphylococcus saphrophyticus, Gram stain characteristics of, 123f, 125t Streptococcus viridans, Gram stain Staples, skin, 252, 258f characteristics of, 125t Startle reflex, 26 Streptokinase (Kabikinase; Streptase) Staticin Topical (erythromycin, topical), for emergency cardiac care, 466 indications, actions, and dosage of, indications, actions, and dosage 534 of, 604 Status epilepticus, 472, 473t Streptomycin, indications, actions, and Stavudine (Zerit), indications, actions, and dosage of, 604 dosage of, 603 Streptozocin (Zanosar), indications, Stelazine (trifluoperazine), indications, actions, and dosage of, 604 actions, and dosage of, 614 Streptozyme, laboratory diagnosis and, 57 Stellwag's sign, 27 Stress ulcers, 433 Strict isolation, 155 Stentrophomonas maltophilia, Gram stain characteristics of, 127t Stroke volume, measurement of, 408, 410 Sterile technique, 339 Strongyloidiasis, drugs for treating, 154t Strontium-89, 334 Steroids, systemic. See also specific steroids Subacute bacterial endocarditis (SBE). dose, activity, duration, and route for, prophylaxis of, 155, 158t-159t Subarachnoid hemorrhage, 286 cerebrospinal fluid in, 288t indications, actions, and dosage of, 603-604 Subcutaneous injections, 276, 277 Steroids, topical. See also specific steroids Sublimaze (fentanyl) indications, actions, and dosage of, 604 indications, actions, and dosage of, 538 potency and application of, 628t-630t route, effects, and dosage for, 321t Stimate (desmopressin), indications, Succimer (Chemet), indications, actions, actions, and dosage of, 524 and dosage of, 604-605 Stomach cancer, staging of, 656 Succinylcholine (Anectine; Quelicin; Stool cultures, 130-131 Sucostrin), indications, actions, Stool for occult blood, laboratory and dosage of, 605

Sucostrin (succinylcholine), indications,

actions, and dosage of, 605

diagnosis and, 89

Stool for ova and parasites, 131

Sucralfate (Sufenta), indications, actions, Sustiva (efavirenz), indications, actions, and dosage of, 605 and dosage of, 532 Sudafed (pseudoephedrine), indications, Suturing, 345-358 actions, and dosage of, 595-596 materials for, 345, 346t-347t Sudan stain, of pleural fluid, 299t patterns for, 348, 350, 351f-354f Sufenta (sucralfate), indications, actions, procedure for, 345, 348, 349t, 350t and dosage of, 605 surgical knots for, 350, 355f-357f Sular (nisoldipine), indications, actions, suture removal and, 350, 353, 358f and dosage of, 579 Swan-Ganz catheters, 399-402, 401f, 402f Sulfacetamide (Bleph-10; Cetamide; S wave, 369 Sodium Sulamyd), indications, Sweat chloride, laboratory diagnosis and, actions, and dosage of, 605 89-90 Sulfacetamide + prednisolone Symmetrel (amantadine), indications, (Blephamide), indications, actions, actions, and dosage of, 148t, 494 and dosage of, 605 Sympathetic nervous system, 395, 397, Sulfadiazine, indications for, 154t 397t, 398t Sulfasalazine (Azulfidine), indications, Sympathomimetic drugs, actions of, 398t actions, and dosage of, 605-606 Synalar (fluocinolone acetonide), potency Sulfinpyrazone (Anturane), indications, and application of, 628t, 629t actions, and dosage of, 606 Synalar-HP (fluocinolone acetonide), Sulindac (Clinoril), indications, actions, potency and application of, 628t, and dosage of, 606 Sumatriptan (Imitrex), indications, Synchronous intermittent mandatory actions, and dosage of, 606 ventilation (SIMV), 424, 425f Sumycin (tetracycline) Syncope, differential diagnosis of, 51 indications, actions, and dosage of, Synercid (quinupristin + dalfopristin), 153t, 609 indications, actions, and dosage of, interaction with enteral nutrition, 223 Superchar (activated charcoal) Synovial fluid, interpretation of, 249-250, clinical use of, 472 indications, actions, and dosage of, 514 Synthroid (levothyroxine), indications, actions, and dosage of, 560-561 Superficial pain, 315 Suprapubic bladder aspiration, Syntocinon (oxytocin), indications, percutaneous, 309, 310f actions, and dosage of, 584 Supraventricular tachycardia algorithms Syphilis, organism responsible and for narrow complex SVT, 457f empiric therapy for, 143t for stable SVT, 458f Systemic inflammatory response Suprax (cefixime), indications, actions, syndrome (SIRS), 414 and dosage of, 511 Systemic vascular resistance (SVR). Surfak (docusate calcium), indications, derivation and normal values for, actions, and dosage of, 529 437tSystolic heart murmurs, 393-394 Surgery, nutritional support following, 223 Surgical cricothyrotomy, 263-264 Systolic hypertension, 392 Surgical hand scrub, 340-341 Surmontil (trimipramine), indications, actions, and dosage of, 615 Survanta (beractant), indications, actions, and dosage of, 504 Tabloid (6-thioguanine), indications,

actions, and dosage of, 609

Tachycardia, 276, 371

algorithm for, 456f

Susceptibility testing, microbiologic, 133

Sus-Phrine. See Epinephrine (Adrenalin;

Sus-Phrine)

Technetium-99m DTPA

Tacrine (Cognex), indications, actions,

and dosage of, 606 (diethylenetriamine pentaacetic Tacrolimus [FK 506] (Prograf), acid), 334 indications, actions, and dosage of, Technetium-99m glucoheptonate, 334 Technetium-99m Taenia saginata infections, drugs for mercaptoacetylthiglycine (MAG3), treating, 154t Taenia solium infections, drugs for Technetium-99m pyrophosphate cardiac scans, 333 treating, 154t Tagamet (cimetidine), indications, actions, Technetium-99m sulfur colloid scans, 333 and dosage of, 516 Technetium-99m ventriculography, Talwin (pentazocine), indications, actions, 333-334 and dosage of, 586-587 Teeth Tambocor (flecainide) emergencies involving, 470 half-life and therapeutic and toxic levels eruption of, 17, 19f of, 633t Tegopen (cloxacillin), indications, actions, indications, actions, and dosage and dosage of, 519 of. 539 Tegretol (carbamazepine) Tamiflu (oseltamivir), indications, actions, half-life and therapeutic and toxic levels and dosage of, 147t, 582 of, 631t Tamoxifen (Nolvadex), indications, indications, actions, and dosage of, 509 actions, and dosage of, 606-607 route, effects, and dosage for, 322t Tamsulosin (Flomax), indications, actions, Telangiectasia, 21t and dosage of, 607 Telmisartan (Micardis), indications, Tapazole (methimazole), indications, actions, and dosage of, 607 actions, and dosage of, 568 Temazepam (Restoril), indications, Tapeworms, drugs for treating, 154t actions, and dosage of, 607 Temovate (clobetasol propionate), potency Target cells, 104 Tavist (clemastine fumarate), indications, and application of, 628t actions, and dosage of, 518 Temperature conversion, 646, 649t Taxol (paclitaxel), indications, actions, Tenecteplase (Tnkase), indications, and dosage of, 584 actions, and dosage of, 607 Tenex (guanfacine), indications, actions, Taxotere (docetaxel), indications, actions, and dosage of, 529 and dosage of, 547 Tazarotene (Tazorac), indications, actions, Teniposide [VM-26] (Vumon), and dosage of, 607 indications, actions, and dosage of, Tazicef (ceftazidime), indications, actions, 607-608 and dosage of, 513 Tenoretic (atenolol + chlorthalidone), Tazidime (ceftazidime), indications, indications, actions, and dosage of, actions, and dosage of, 513 500 Tazorac (tazarotene), indications, actions, Tenormin (atenolol) and dosage of, 607 for emergency cardiac care, 462 Teamwork, 2 indications, actions, and dosage of, 500 Tears Naturale (artificial tears), Tensilon (edrophonium), indications, indications, actions, and dosage of, actions, and dosage of, 532 Tequin (gatifloxacin), indications, actions, Technetium-99-labeled red cell scans, 333 and dosage of, 544 Terazol (terconazole), indications, actions, Technetium-99m DMSA (dimercaptosuccinic acid), 334 and dosage of, 608

Terazosin (Hytrin), indications, actions,	6-Thioguanine [6-TG] (Tabloid),
and dosage of, 608	indications, actions, and dosage of,
Terbinafine (Lamisil), indications, actions,	609
and dosage of, 608	Thioridazine (Mellaril), indications,
Terbutaline (Brethine; Bricanyl),	actions, and dosage of, 609-610
indications, actions, and dosage of,	Thio-Tepa (triethylenetriphosphoramide),
608	indications, actions, and dosage of,
Terconazole (Terazol), indications,	614
actions, and dosage of, 608	Thiothixene (Navane), indications,
TESPA (triethylenetriphosphoramide),	actions, and dosage of, 610
indications, actions, and dosage of,	Third-degree heart block, 378–379
614	Third heart sound (S_3) , 17t
Testosterone, laboratory diagnosis	Thoracentesis, 304–306
and, 90	complications of, 306
Tetanus immune globulin, indications,	contraindications to, 304
actions, and dosage of, 608	differential diagnosis of pleural fluid
Tetanus prophylaxis, 350t	and, 299t, 306
Tetanus toxoid, indications, actions, and	indications for, 304
dosage of, 608-609	materials for, 304
Tetracycline (Achromycin V; Sumycin)	procedure for, 305f, 305-306
indications, actions, and dosage of,	Thoracic catheters, 261
153t, 477, 609	Thoracostomy, closed (tube). See Chest
interaction with enteral nutrition, 223	tube placement
Teveten (eprosartan), indications, actions,	Thorazine (chlorpromazine), indications,
and dosage of, 533	actions, and dosage of, 515
Thallium-201 cardiac scans, 333	Three-cell differential count, 97, 100
Thayer-Martin medium, 129, 291	Throat cultures, 131
Theophylline (Somophyllin; Theo-Dur;	Thrombin time, 108
Theolair)	Through-and-through technique, for
half-life and therapeutic and toxic levels	arterial line placement, 244
of, 632 <i>t</i>	Thyrocalcitonin, laboratory diagnosis and,
indications, actions, and dosage	61
of, 609	Thyroglobulin, laboratory diagnosis and,
Thera Cys (BCG [bacillus Calmette-	90
Guérin]), indications, actions, and	Thyroid agents, 482
dosage of, 503	Thyroid cancer, staging of, 656–657
Therapeutic apheresis, 194	Thyroid scans, 335
Thermal dilution technique, for cardiac	Thyroid-stimulating hormone (TSH),
output determination, 410	laboratory diagnosis and, 90
Thermistor, of Swan-Ganz catheter, 400	Thyroid ultrasound, 330
Thermography, for pain evaluation, 319	Thyroxine, laboratory diagnosis and, 90–91
Thiabendazole, indications for, 153t	Thyroxine-binding globulin (TBG),
Thiamine [vitamin B ₁]	laboratory diagnosis and, 91
indications, actions, and dosage	Thyroxine-binding globulin ratio,
of, 609	laboratory diagnosis and, 90
for seizures, 472	Thyroxine index, free (FTI), laboratory
in total parenteral nutrition, 231t	diagnosis and, 91
Thiethylperazine (Torecan), indications,	Tiagabine (Gabitril), indications, actions,
actions, and dosage of, 609	and dosage of, 610

indications, actions, and dosage of, 611

Tiazac (diltiazem)

for emergency cardiac care, 464

for emergency cardiac care, 462 Tissue adhesives, 358 201Tl cardiac scans, 333 indications, actions, and dosage of, 528 infusion guidelines for, 439t Tnkase (tenecteplase), indications, actions, and dosage of, 607 TIBC (iron-binding capacity, total), laboratory diagnosis and, 78 TNM classification system, 646, 649-658 Ticarcillin (Ticar), indications, actions, Tobradex (tobramycin + dexamethasone, and dosage of, 610 ophthalmic), indications, actions, Ticarcillin + potassium clavulanate and dosage of, 611 (Timentin), indications, actions, Tobramycin (Nebcin) and dosage of, 610 half-life and therapeutic and toxic levels TICE (BCG [bacillus Calmette-Guérin]), indications, actions, and dosage of, indications, actions, and dosage of, 611 Tick-borne diseases. See also specific Tobramycin + dexamethasone, ophthalmic (Tobradex), indications, actions, diseases characteristics and treatment of. and dosage of, 611 156t - 157tTobramycin, ophthalmic (AK Tob; Ticlodipine (Ticlid), indications, actions, Tobrex), indications, actions, and dosage of, 611 and dosage of, 610 Tidal volume (TV), 360, 361t, 415 Tobrex (tobramycin, ophthalmic), Tigan (trimethobenzamide), indications, indications, actions, and dosage of, actions, and dosage of, 615 611 Tilade (nedocromil), indications, actions, Tocainide (Tonocard), indications, actions, and dosage of, 576 and dosage of, 611 Timed hand scrubs, 340-341 α Tocopherol, in total parenteral nutrition, Time management, 6-7 Timentin (ticarcillin + potassium Tofranil (imipramine), indications, clavulanate), indications, actions, actions, and dosage of, 552 and dosage of, 610 Tolazamide (Tolinase), indications, Timolol (Blocadren), indications, actions, actions, and dosage of, 611 and dosage of, 610 Tolazoline (Priscoline), indications, Timolol, ophthalmic (Timoptic), actions, and dosage of, 612 indications, actions, and dosage of, Tolbutamide (Orinase), indications, actions, and dosage of, 612 Tinactin (tolnaftate), indications, actions, Tolectin (tolmetin), indications, actions, and dosage of, 612 and dosage of, 612 Tinea capitis, organisms responsible and Tolinase (tolazamide), indications, actions, empiric therapy for, 142t and dosage of, 611 Tinea corporis, organisms responsible and Tolmetin (Tolectin), indications, actions, empiric therapy for, 142t and dosage of, 612 Tinea unguium, organisms responsible and Tolnaftate (Tinactin), indications, actions, empiric therapy for, 142t and dosage of, 612 Tinel's sign, 27 Tolterodine (Detrol; Detrol LA), Tine test, 303 indications, actions, and dosage of, Tinidazole, indications for, 153t, 154t Tioconazole (Vagistat), indications, Tonocard (tocainide), indications, actions, actions, and dosage of, 611 and dosage of, 611 Tirofiban (Aggrastat) Toothaches, 470

Tooth emergencies, 470

Topamax (topiramate), indications,	Trace elements, for total parenteral
actions, and dosage of, 612	nutrition, 231, 232 <i>t</i>
Topicort (desoximetasone), potency and	Tracrium (atracurium), indications,
application of, 628t	actions, and dosage of, 501
Topiramate (Topamax), indications,	Tramadol (Ultram), indications, actions,
actions, and dosage of, 612	and dosage of, 613
Topotecan (Hycamtin), indications,	Trandate (labetalol)
actions, and dosage of, 612	for emergency cardiac care, 462
Toprol XL (metoprolol)	for hypertensive crisis, 470
for emergency cardiac care, 462	indications, actions, and dosage of, 557
indications, actions, and dosage of, 569	infusion guidelines for, 441t
Toradol (ketorolac), indications, actions,	Trandolapril (Mavik), indications, actions,
and dosage of, 557	and dosage of, 613
Forch battery, laboratory diagnosis and, 91	Transcutaneous electrical nerve
Torecan (thiethylperazine), indications,	stimulation (TENS), 323
actions, and dosage of, 609	Transcutaneous pacing, 468
Fornalate (bitolterol), indications, actions,	Transderm-Nitro (nitroglycerin)
and dosage of, 505	for emergency cardiac care, 465
Forsemide (Demadex), indications,	indications, actions, and dosage of, 579
actions, and dosage of, 613	Transderm Scop (scopolamine,
Total blood volume, 177	transdermal), indications, actions,
Total body water, 177	and dosage of, 600
Total CO ₂ , laboratory diagnosis and, 59,	Transferrin, laboratory diagnosis and, 91
61–62	Transfusion reactions, 202–203
Total lung capacity (TLC), 360, 361t	Transfusion teactions, 202–203 Transfusion therapy. See Blood
Fotal parenteral nutrition (TPN), 227–237,	component therapy
434	Transgrow medium, 129
	Transgrow medium, 129 Transrectal ultrasound, 330
additives for, 231 <i>t</i> , 231–232, 232 <i>t</i> assessing, 234	
<u>.</u>	Transtracheal aspirate, 130
calculation of caloric requirements in	Transudative ascites, 297
stressed patients and, 228	Tranxene (clorazepate), indications,
complications of, 236–237	actions, and dosage of, 519
disease-specific formulations for,	Trasylol (aprotinin), indications, actions,
235–236	and dosage of, 499
fat emulsions for, 232–233	Traube's sign, 27
indications for, 227	Trauma, total parenteral nutrition
nitrogen balance and, 229	formulation for, 236
nutritional components in, 228	Traumatic tap, 286
peripheral, 230–231	cerebrospinal fluid in, 288t
solutions for, 229–230, 230t	Trazodone (Desyrel)
starting, 233–234	half-life and therapeutic and toxic levels
stopping, 234	of, 634 <i>t</i>
Toxic granulation, of white blood cells, 104	indications, actions, and dosage of, 613 Tremors, differential diagnosis of, 51
Toxocara canis infections, drugs for	Trendelenburg's test, 27
treating, 154t	Trental (pentoxifylline), indications,
Toxoids, 485	actions, and dosage of, 587
Toxolas, 403 Toxoplasma gondii infections, drugs for	Tretinoin, systemic [retinoic acid]
treating, 154t	(Vesanoid), indications, actions,
Toxonlasmosis drugs for treating 154t	and dosage of 613

700
Tretinoin, topical [retinoic acid] (Avita;
Retin-A), indications, actions, and
dosage of, 613
Triamcinolone acetonide (Aristocort;
Kenalog), potency and application
C 1
of, 630 <i>t</i>
Triamcinolone + nystatin (Mycolog-II),
indications, actions, and dosage of,
613
Triamterene (Dyrenium), indications,
actions, and dosage of, 613–614
Triapin Axocet (acetaminophen +
butalbital +/- caffeine), indications,
actions, and dosage of, 489
Triazolam (Halcion), indications, actions,
and dosage of, 614
Trichinosis, drugs for treating, 154t
Trichomonas infection
drugs for treating, 154t
organism responsible and empiric
therapy for, 145 <i>t</i>
test for, 291
vaginal, 145 <i>t</i> , 291
Trichostrongylus colubriformis infections,
drugs for treating, 154t
Trichuriasis, drugs for treating, 154 <i>t</i>
Tricor (fenofibrate), indications, actions,
and dosage of, 537
Tricuspid insufficiency (TI), 16t
Tridil (nitroglycerin), infusion guidelines
for, 442 <i>t</i>
Triethanolamine (Cerumenex),
indications, actions, and dosage of,
614
Triethylenetriphosphoramide (TESPA;
Thio-Tepa; TSPA), indications,
actions, and dosage of, 614
Trifluoperazine (Stelazine), indications,
actions, and dosage of, 614
Trifluridine (Viroptic), indications,
actions, and dosage of, 147t,
614
Trigeminy, 375
Triglycerides
laboratory diagnosis and, 91–92

in pleural fluid, 299t

Trihexyphenidyl (Artane), indications,

Triiodothyronine (T3 RIA), laboratory

diagnosis and, 92

actions, and dosage of, 614

actions, and dosage of, 588 Trileptal (oxcarbazepine), indications, actions, and dosage of, 583 Tri-Levlen 21, 28, 625t Trimethobenzamide (Tigan), indications, actions, and dosage of, 615 Trimethoprim (Proloprim; Trimpex), indications, actions, and dosage of, Trimethoprim-sulfamethoxazole [cotrimoxazole] (Bactrim; Septra), indications, actions, and dosage of, 153t, 615 Trimetrexate (Neutrexin), indications, actions, and dosage of, 615 Trimipramine (Surmontil), indications, actions, and dosage of, 615 Trimpex (trimethoprim), indications, actions, and dosage of, 615 Tri-Norinyl 21, 28, 625t Triphasil-21, 625t Trivora-28, 625t Troponin, cardiac-specific, laboratory diagnosis and, 92 Trousseau's sign, 27 T3 RU, laboratory diagnosis and, 90 Trusopt (dorzolamide), indications, actions, and dosage of, 530 Trypanosoma cruzi infections, drugs for treating, 154t Trypanosomiasis, drugs for treating, 154t TSPA (triethylenetriphosphoramide), indications, actions, and dosage of, 614 T4 total, laboratory diagnosis and, 90-91 T-tube cholangiography, 329 Tube feeding, 213, 214–223 complications of, 218, 223 contraindications to, 214t enteral products for, 214, 215t-216t, initiating, 217–218, 218t–222t Tuberculin skin testing (TST), 303-304 Tuberculosis, organism responsible and empiric therapy for, 143t Tube thoracostomy. See Chest tube placement Tubular casts, in urine sediment, 114

Trilafon (perphenazine), indications,

Tucks Pads (witch hazel), indications,	Unasyn (ampicillin-sulbactam),
actions, and dosage of, 618	indications, actions, and dosage of,
Tumors. See Malignancies; Neoplasms	497
Tums (calcium carbonate)	Univasc (moexipril), indications, actions,
for hypocalcemia, 190	and dosage of, 573
indications, actions, and dosage of, 508	Universal/international advanced cardiac
Turner's sign, 27	life support algorithm, 450f
T wave, 369	Universal Pedi-Packs, 197t
24-hour urine studies, 116–118	Universal precautions, 239–240, 344
Twin-K (potassium citrate + potassium	Upper gastrointestinal (UGI) series, 329
gluconate), form and dosage of,	Urate, laboratory diagnosis and, 92
626t	Urecholine (bethanechol), indications,
Two-dimensional echocardiography, 330	actions, and dosage of, 504–505
Tycron (polyester) sutures, 347t	Urethritis
Tylenol (acetaminophen)	organism responsible and empiric
antidote for, 471	therapy for, $135t$
indications, actions, and dosage of, 488,	organisms responsible and empiric
621 <i>t</i>	therapy for, $143t-144t$
route, effects, and dosage for, 321 <i>t</i> Tylenol No. 1, No. 2, No. 4	Urex (methenamine), indications, actions, and dosage of, 568
(acetaminophen + codeine),	Uric acid, laboratory diagnosis and, 92
indications, actions, and dosage of,	Urinalysis
489	differential diagnosis for, 110-112
Tylox (oxycodone + acetaminophen),	normal values for, 110
indications, actions, and dosage of,	procedure for, 109-110
583–584	Urinary agents, 487
Tzanck smear, 128	Urinary incontinence, differential
	diagnosis of, 48
	Urinary tract infections, organisms
	responsible and empiric therapy
U	for, 143 <i>t</i> –144 <i>t</i>
Ulcers	Urine
cutaneous, 21t	bilirubin in, 111
gastrointestinal, organism responsible	blood in, 111
and empiric therapy for, 144t	clean catch specimens of, 308-309
stress, 433	color of, 110
Ultracef (cefadroxil)	glucose in, 111
indications, actions, and dosage of, 511	in-and-out catheterized, 308
for subacute bacterial endocarditis	ketones in, 111
prophylaxis, 158t	leukocyte esterase in, 112
Ultralente, onset, peak, and duration of	nitrite in, 111
effect of, 622t	output of, 119
Ultram (tramadol), indications, actions,	pH of, 110–111
and dosage of, 613	protein electrophoresis of, 119
Ultrase (pancreatin + pancrelipase),	protein in, 112
indications, actions, and dosage of,	reducing substances in, 112
585	specific gravity of, 111
Ultrasound, 329-330	urobilinogen in, 112
Ultravate (halobetasol), potency and	Urine cultures, 131–132
application of 620t	Urine sediment 112 113f 114

Urine studies, 109-119	Valium (diazepam)
creatinine and creatinine clearance,	indications, actions, and dosage of,
115–116	525-526
drug abuse screen, 118	for seizures, 472, 473 <i>t</i>
indices useful in diagnosing oliguria,	Valproic acid (Depakene)
119 <i>t</i>	half-life and therapeutic and toxic levels
spot (random), 114-115	of, 632t
24-hour, 116–118	indications, actions, and dosage of, 616
urinalysis, 109-112	Valrubicin (Valstar), indications, actions,
urine sediment, 112, 113f, 114	and dosage of, 616
xylose tolerance test, 118-119	Valsartan (Diovan), indications, actions,
Urispas (flavoxate), indications, actions,	and dosage of, 616
and dosage of, 539	Valstar (valrubicin), indications, actions,
Urobilinogen, in urine, 112	and dosage of, 616
Urocit-K (potassium citrate), indications,	Valtrex (valacyclovir), indications, actions,
actions, and dosage of,	and dosage of, 147t, 148t, 616
590-591	Valvular heart disease, anticoagulant
Urokinase (Abbokinase), indications,	standard of practice for, 637t
actions, and dosage of, 615	Vancenase Nasal Inhaler
Uterine cancer, staging of, 657	(beclomethasone), indications,
UUN levels, 228	actions, and dosage of, 503
	Vancomycin (Vancocin; Vancoled)
	half-life and therapeutic and toxic levels
V	of, 631 <i>t</i>
Vaccines, 485	indications, actions, and dosage of, 616
Vacutainer system, 313	for subacute bacterial endocarditis
tubes for, 311 <i>t</i> –312 <i>t</i>	prophylaxis, 159t
Vaginal bleeding, differential diagnosis of,	Vanillylmandelic acid, in urine, 118
51	Vantin (cefpodoxime), indications,
Vaginal candidiasis	actions, and dosage of, 512
organisms responsible and empiric	Vaqta (hepatitis A vaccine), indications,
therapy for, 144t	actions, and dosage of, 548
systemic drugs for treating, 151t	Variable decelerations, in fetal heart rate,
Vaginal discharge, differential diagnosis	276
of, 51	Varicella, drugs of choice for treating,
Vaginal infections	148 <i>t</i>
organisms responsible and empiric	Varicella immune globulin (VZIG),
therapy for, $144t-145t$	indications and dosage for, 148t
tests for, 291	Varicella virus vaccine (Varivax),
Vaginal preparations, 485	indications, actions, and dosage of,
Vaginal saline (wet) preparation, 291	616
Vaginosis, bacterial, organism responsible	Varicella zoster virus (VZV)
and empiric therapy for, $145t$	cultures for, 132
Vagistat (tioconazole), indications,	drugs of choice for treating infections
actions, and dosage of, 611	by, 148 <i>t</i> –149 <i>t</i>
Valacyclovir (Valtrex), indications,	Varivax (varicella virus vaccine),
actions, and dosage of, 147t, 148t,	indications, actions, and dosage of,
616	616
Valisone (betamethasone valerate),	Vascar (bepridil), indications, actions, and
potency and application of, 628t	dosage of, 504

Vascular catheters. See also Central	Ventricular fibrillation, 377, 378f
venous catheterization;	algorithm for, 452f
Peripherally inserted central	Ventricular septal defect (VSD), 17t
catheter (PICC) lines; Pulmonary	Ventricular tachycardia, 376–377, 378f
artery catheters	algorithm for, 452f
sepsis of, 435	Ventriculography, technetium-99m,
Vasodilators, 480	333–334
Vasopressin [antidiuretic hormone]	Vepesid (etoposide), indications, actions,
(Pitressin)	and dosage of, 537
indications, actions, and dosage of, 617	Verapamil (Calan; Isoptin)
infusion guidelines for, 443t	for emergency cardiac care, 467
Vasotec (enalapril)	indications, actions, and dosage of, 617
for emergency cardiac care, 449	Versed (midazolam)
indications, actions, and dosage of, 532	indications, actions, and dosage of, 571
Vasoxyl (methoxamine), indications,	for seizures, 472
actions, and dosage of, 568-569	Vertebral radiography, 326
Vecuronium (Norcuron), indications,	Vertigo, differential diagnosis of, 51
actions, and dosage of, 617	Vesanoid (tretinoin, systemic), indications
Veetids (penicillin V), indications, actions,	actions, and dosage of, 613
and dosage of, 585	Vesicles, 21t
Veillonella, Gram stain characteristics of,	Vexol Ophthalmic (rimexolone),
125 <i>t</i>	indications, actions, and dosage of,
Velban (vinblastine), indications, actions,	597–598
and dosage of, 617	Viadar, 559
Velbe (vinblastine), indications, actions,	Viagra (sildenafil), indications, actions,
and dosage of, 617	and dosage of, 601
Velosef (cephradine), indications, actions,	Vibramycin (doxycycline), indications,
and dosage of, 514	actions, and dosage of, 153t, 531
Velosulin, onset, peak, and duration of	Vibrio cholerae, Gram stain characteristics
effect of, 622t	of, 127 <i>t</i>
Venereal Disease Research Laboratory	Vicodin (hydrocodone + acetaminophen),
(VDRL) test, 92	indications, actions, and dosage of,
Venipuncture, 309-314	549
materials for, 309, 311t-312t	Vicoprofen (hydrocodone + ibuprofen),
procedure for, 310, 313-314	indications, actions, and dosage of,
Venlafaxine (Effexor), indications,	550
actions, and dosage of, 617	Vicryl Rapide (polyglycolic acid 910)
Venography, peripheral, 329	sutures, 346t
Venous oxygen saturation (S _{VO2}), for	Vicryl (polyglactin 910) sutures, 346t
cardiac output determination, 412,	Videx (didanosine), indications, actions,
413 <i>f</i>	and dosage of, 526-527
Ventilation, 414–416, 415f–417f	Vinblastine (Velban; Velbe), indications,
mechanical. See Mechanical ventilation	actions, and dosage of, 617
Ventolin (albuterol), 364	Vincasar PFS (vincristine), indications,
for anaphylaxis, 469	actions, and dosage of, 617-618
indications, actions, and dosage of, 490	Vincristine (Oncovin; Vincasar PFS),
nebulized, for asthmatic attacks, 469	indications, actions, and dosage of,
Ventricular arrhythmias, on	617–618
electrocardiograms, 375-377,	Vinorelbine (Navelbine), indications,
376 <i>f</i> –378 <i>f</i>	actions, and dosage of, 618

Vioxx (rofecoxib) indications, actions, and dosage of, 599	indications, actions, and dosage of, 516 intoxication by, hypercalcemia with,
route, effects, and dosage for, 321t	188
Viracept (nelfinavir), indications, actions,	in total parenteral nutrition, 231t
and dosage of, 150t, 576	Vitamin E, in total parenteral nutrition,
Viral cultures and serology, 132	231 <i>t</i>
Viral infections. See also specific	Vitamin K
infections	indications, actions, and dosage of, 589
cerebrospinal fluid in, 287t	in total parenteral nutrition, 231
pathogens and drugs of choice for	Vitrasert (ganciclovir), indications,
treating, 146 <i>t</i> –149 <i>t</i>	actions, and dosage of, 146t,
Viramune (nevirapine), indications,	543-544
actions, and dosage of, 577	Vitravene (fomivirsen), indications and
Virazole (ribavirin), indications, actions,	dosage for, 146t
and dosage of, 146t, 148t, 598	Vitrobacter, Gram stain characteristics of,
Virchow's node, 27	126 <i>t</i>
Viroptic (trifluridine), indications, actions,	Vivonex tubes, 273
and dosage of, 147t, 614	Voiding cystourethrography (VCUG), 329
Visceral larva migrans, drugs for treating,	Voltaren (diclofenac)
154 <i>t</i>	indications, actions, and dosage of, 526
Visceral pain, 316	route, effects, and dosage for, 321t
Visken (pindolol), indications, actions,	Volume expanders, 484
and dosage of, 589	Volume limited ventilators, 423
Vistaril (hydroxyzine), indications, actions, and dosage of, 551	Volume overload, transfusions and, 202, 203
Vistide (cidofovir), indications, actions,	Vomiting, differential diagnosis of, 49
and dosage of, 146t, 516	von Graefe's sign, 27
Visual Analogue Scale (VAS), 319	V/Q scans, 334
Vital capacity (VC), 361, 361t, 416, 416f	Vumon (teniposide), indications, actions,
Vitamin(s), for total parenteral nutrition,	and dosage of, 607-608
231, 231 <i>t</i>	
Vitamin A, in total parenteral nutrition,	
231 <i>t</i>	W
Vitamin B ₁	Warfarin (Coumadin)
indications, actions, and dosage of, 609	indications, actions, and dosage of, 618
for seizures, 472	interaction with enteral nutrition, 223
in total parenteral nutrition, 231t	Washed red blood cells, 197t
Vitamin B ₆	Water balance, 177-178
indications, actions, and dosage of, 596	Water loss, hypernatremia and, 184-185
in total parenteral nutrition, 231t	Waxy casts, in urine sediment, 114
Vitamin B ₁₂	Wayson stain, 128
blood level of, laboratory diagnosis and,	Weaning, from mechanical ventilation,
92–93	427–429, 428 <i>t</i>
indications, actions, and dosage of, 521	Weber-Rinne test, 27
laboratory diagnosis and, 92-93	Weight conversion, 658, 658t
in total parenteral nutrition, 231t	Weight loss, differential diagnosis of, 52
Vitamin C, in total parenteral nutrition,	Welchol (colesevelam), indications,
231 <i>t</i>	actions, and dosage of, 520
Vitamin D	Wellbutrin (bupropion), indications,
deficiency of, hypocalcemia and, 189	actions, and dosage of, 507

X-ray studies contrast, 326–329

Wellcovorin (leucovorin), indications,

actions, and dosage of, 559	contrast, 326-329
Wenckebach heart block, 377-378,	noncontrast, 325-326, 335-338
379f	Xylocaine. See Lidocaine (Anestacon
Westcort (hydrocortisone valerate),	Topical; Xylocaine)
potency and application of, 629t	Xyvox (linezolid), indications, actions,
Whaid's maneuver, 280	and dosage of, 561
Wheals, 21t	
Wheezing, differential diagnosis of, 52	
Whipple's triad, 27	Y
White blood cell(s) (WBCs)	Yeast, in urine sediment, 112
differential, 96–97, 97t	Yersinia enterocolitica, Gram stain
morphologic changes in, 104	characteristics of, 127t
three-cell differential count, 97, 100	Yersinia pestis, Gram stain characteristics
transfusions of, 201	of, 127 <i>t</i>
in urine sediment, 112	
White blood cell (WBC) casts, in urine	
sediment, 114	Z
Whole blood, for transfusion, 197t	Zafirlukast (Accolate), indications,
Witch hazel (Tucks Pads), indications,	actions, and dosage of, 619
actions, and dosage of, 618	Zalcitabine (Hivid), indications, actions,
Wolff-Parkinson-White syndrome, on	and dosage of, 619
electrocardiograms, 388, 388f	Zaleplon (Sonata), indications, actions,
Wound care, medications for, 487	and dosage of, 619
Wound healing, 345	Zanamivir (Relenza), indications, actions,
Wound precautions, 155	and dosage of, 147t, 619
Wright's stain, 95, 96	Zanosar (streptozocin), indications,
Wrist, arthrocentesis of, 248, 249f	actions, and dosage of, 604
Written history and physical, 5	Zantac (ranitidine)
example of, 28–32	for anaphylaxis, 469
Wuchereria bancrofti infections, drugs for	indications, actions, and dosage of, 597
treating, 153 <i>t</i>	Zarontin (ethosuximide)
Wycillin (penicillin G procaine),	half-life and therapeutic and toxic levels
indications, actions, and dosage of,	of, 631 <i>t</i>
585	indications, actions, and dosage of, 536
Wytensin (guanabenz), indications,	Zaroxolyn (metolazone), indications,
actions, and dosage of, 546–547	actions, and dosage of, 569
	Zebeta (bisoprolol), indications, actions,
W.	and dosage of, 505
X	Zefazone (cefmetazole), indications,
Xalatan (latanoprost), indications, actions,	actions, and dosage of, 511
and dosage of, 558	Zenapax (dacliximab), indications,
Xanax (alprazolam), indications, actions,	actions, and dosage of, 522
and dosage of, 492 Xanthochromia, 286	Zerit (stavudine), indications, actions, and
	dosage of, 603
Xanthomonas maltophilia, Gram stain characteristics of, 127t	Zestril (lisinopril) for emergency cardiac care, 461
· · · · · · · · · · · · · · · · · · ·	indications, actions, and dosage of, 562
Xeromammography, 326 Xopenex (levalbuterol), indications,	Ziagen (abacavir), indications, actions,
actions, and dosage of, 559	and dosage of, 488
actions, and dosage of, 559	and dosage of, 400

- Zidovudine (Retrovir), indications, actions, and dosage of, 619
- Zidovudine + lamivudine (Combivir), indications, actions, and dosage of, 619
- Zileuton (Zyflo), indications, actions, and dosage of, 619
- Zinacef (cefuroxime), indications, actions, and dosage of, 513

Zinc

laboratory diagnosis and, 93 in total parenteral nutrition, 231, 232t

Zinecard (dexrazoxane), indications, actions, and dosage of, 525

Zithromax (azithromycin)

indications, actions, and dosage of, 501 for subacute bacterial endocarditis prophylaxis, 158t

- Zocor (simvastatin), indications, actions, and dosage of, 601
- Zofran (ondansetron), indications, actions, and dosage of, 580–581
- Zoladex (goserelin), indications, actions, and dosage of, 546
- Zolmitriptan (Zomig), indications, actions, and dosage of, 620
- Zoloft (sertraline), indications, actions, and dosage of, 601
- Zolpidem (Ambien), indications, actions, and dosage of, 620

- Zomig (zolmitriptan), indications, actions, and dosage of, 620
- Zonalon (doxepin, topical), indications, actions, and dosage of, 531
- Zonisamide (Zonegran), indications, actions, and dosage of, 620
- Zoster. See also Varicella zoster virus (VZV) drugs of choice for treating, 148t,
 - 149t
- Zostrix (capsaicin), indications, actions, and dosage of, 509
- Zosyn (piperacillin-tazobactam), indications, actions, and dosage of, 590
- Zovia 1/35E 21, 28, 624t
- Zovia 1/50E 21, 28, 624t
- Zovirax (acyclovir), indications, actions, and dosage of, 147t, 148t, 149t, 490
- Zyban (bupropion), indications, actions, and dosage of, 507
- Zyflo (zileuton), indications, actions, and dosage of, 619
- Zyloprim (allopurinol), indications, actions, and dosage of, 491
- Zyprexa (olanzapine), indications, actions, and dosage of, 580–581
- Zyrtec (cetirizine), indications, actions, and dosage of, 514

Eptification (Integrilin)	ACS: 180 µg/kg IV bolus then 2 µg/kg/min. PCt: 135 µg/kg IV bolus then 0.5 µg/kg/min; bolus again in 10 min.
Esmool (Brevbioc)	0.5 mg/kg over 1 min, then 0.05 mg/kg/min
Heparin (Unfractionated)	Solus 50 TUNg (max 4000 TU); then 12 TUNg/h (max 1000 TUN for patients >70 kg) round to nearest 50 TU; keep PTT 1.5-2.0 - control 48 h or until anglography
(andmoteure of (production)	2-10 jugilman titraria
abetaloi (Trandate)	10 mg fV over 1-2 min, repeat or double dose q 10 min (150 mg max); or initial bolus, then 2-5 µg/min
docarre	Cardiac arrest from VPVT: Initial: 1.0-1.5 mg/kg IV. Refractory VP: additional 0.5-0.75 mg/kg IV push, repeat in 5-10 min, max total 3 mg/kg. ET: 2-4 mg/kg. Partnaling stable VT, wide complex tachycardia or ectopy: 1.0-1.5 mg/kg IV push; repeat 0.5-0.75 mg/kg q 5-10 mir; max total 3 mg/kg; Maint 1-4 mg/min (30-50 mg/min).
Magnesium Sulfate	Cardiac arrest: 1-2 g IV push (2-4 mt, 50% solution) in10 mt, D5W AMB: Load 1-2 g in 50-100 mt, D ₁ W, over 5-50 min IV; then 0.5-1.0 g/h IV up to 24 h
Metoproid (Lopressor)	5 mg slow IV q 5 min, total 15 mg
Morphine	2-4 mg fV (page 1-5 min) every 5-30 min FV bolius: 12.5-35 μg, infuse at 10-20 μg/min. St; 0.3-0.4 mg, repeat q 5 min.
Proceinamide (Pronestyl)	Recurrent VF/VT: 20-50 mg/min Nr, max total 17 mg/kg. Others: 20 mg/min IV until one these arthstrina stooped, inpotension, CRS widens >50%, total 17 mg/kg; then
Propanoid (Inderal)	0.1 mg/kg stow TV push, divided 3 equal doses q 2-3 min, max 1 mg/min; repeat in 2 min PRN
Reteplase, recombinant (Retevase)	10 U IV bolus over 2 mir; 30 min later, 10 U IV bolus over 2 min NS flush before and after each dose
Sodum Bicarbonate	1 mEg/kg IV bokus, repeat ¼ dose g 10 min PRN
Streptocoppe	1.5 million IU in a 1-h inf
Techtoen (Aggrastat):	ACS or PCI 0.4 µg/kg/min IV for 30 min, then 0.1 µg/kg/min
Verapamil (Verapamil)	2.5-5.0 mg IV over 1-2 min; repeat 5-10 mg, in 5-30 min PRN; or 5-mg bolus q 15 min (max 30 mg):