The ROYAL MARSDEN
NHS Foundation Trust

The Royal Marsden Hospital Manual of

Clinical Nursing Procedures

Eighth Edition

Edited by Lisa Dougherty and Sara Lister

WILEY-BLACKWELL

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Eighth Edition

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Foreword to The Eighth Edition

As the Chief Nurse of the Royal Marsden Hospital NHS Foundation Trust and a contributor and clinical user for many years, it is a special pleasure and honour to be asked to introduce the eighth edition of *The Royal Marsden Hospital Manual of Clinical Nursing Procedures*. The manual is internationally renowned and used by nurses across the world to ensure their practice is evidence based and effective. As information becomes ever more available to the consumers of healthcare it is essential that the manual is updated frequently so that it reflects the most current evidence to inform our clinical practice.

More than ever in 2011, nurses need to be able to assure the public, patients and their families that care is based on the best available evidence. As nurses seeking to improve our care it is essential that we are able to critically analyse our judgements in the light of current knowledge. For all of us working with patients and their families there is an imperative to question and renew our practice using the many sources of knowledge available to us. In the busy world of clinical practice in a ward, unit or in the community it can be challenging to find time to search for the evidence and this is where *The Royal Marsden Hospital Manual of Clinical Nursing Procedures* is a real practical help.

As in the seventh edition, reviewing the evidence or sources of knowledge has been made more explicit with each level of evidence graded. This grading provides the reader with an understanding of whether the reference comes from a randomized controlled trial, national or international guidance or from expert opinion. At its best, clinical nursing care is an amalgam of a sensitive therapeutic relationship coupled with effective care based on the best evidence that exists. Some areas of practice have attracted international research such as cardiopulmonary resuscitation and infection prevention and control; other areas of practice have not attracted such robust research and therefore it is more of a challenge to ensure evidence-based care. Each time the next edition of the manual is prepared we reflect on the gaps in research and knowledge; this provides the impetus to start developing new concept analyses and develop further research studies. This year there are new areas covered including a chapter on risk management and a section on preparing the patient for diagnostic investigations such as endoscopy or CT scans.

As you look at the list of contributors to the manual you will see that this

edition has continued to ask clinically active nurses to share their practice in their chapters. This has the double advantage of ensuring that this manual reflects the reality of practice but also ensures that nurses at the Royal Marsden Hospital NHS Foundation Trust are frequently reviewing the evidence and reflecting upon their care.

A textbook devoted to improving and enhancing clinical practice needs to be alive to the clinical practitioner. You will see that this edition has a new overall format designed to make the manual more effective in clinical care.

As I commend this eighth edition of *The Royal Marsden Hospital Manual of Clinical Nursing Procedures* to you I am aware that it will be used in many different countries and settings. Having had the privilege of visiting and meeting nurses across the world I know that there are more commonalities than differences between us. The common theme is, of course, the need to ensure that we as nurses provide care that is individually and sensitively planned and that it is based on the best available evidence. *The Royal Marsden Hospital Manual of Clinical Nursing Procedure*s is a wonderful resource for such evidence and I hope it will be widely used in all clinical settings across the world.

Finally, I would like to pay a warm tribute to the amazing amount of work undertaken by the two editors, Lisa Dougherty and Sara Lister, and to all the nurses and allied health professionals at the Royal Marsden Hospital who have worked so hard on this eighth edition.

Shelley Dolan
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Introduction and Guidelines for Use

The first edition of *The Royal Marsden Hospital Manual of Clinical Nursing Procedures* was produced in the early 1980s as a core procedure manual for safe practice within The Royal Marsden Hospital, the first cancer hospital in the world. Thirty years and eight editions later the staff of the hospital are still working together to keep it updated, ensuring that only current evidence-based practice is recommended.

The type of evidence that underpins procedures is made explicit by using a system to categorize the evidence, which is broader than that generally used. It has been developed from the types of evidence described by Rycroft-Malone *et al*. (2004) in an attempt to acknowledge that 'in reality practitioners draw on multiple sources of knowledge in the course of their practice and interaction with patients' (Rycroft-Malone *et al*. 2004, p. 88).

The sources of evidence, along with examples, are identified as follows:

1. *Clinical experience* (*E*):

- Encompasses expert practical know-how, gained through working with others and reflecting on best practice.
- If there is no written evidence to support clinical experience as a justification for undertaking a procedure the text will be referenced as an E but will not be preceded by an author's name.
- Example: (Dougherty 2008: *E*). This is drawn from the following article that gives expert clinical opinion: Dougherty, L. (2008) Obtaining peripheral vascular access. In: *Intravenous Therapy in Nursing Practice* (eds L. Dougherty & J. Lamb), 2nd edn. Blackwell Publishing, Oxford.

2. *Patient* (*P*):

- Gained through expert patient feedback and extensive experience of working with patients.
- Example: (Diamond 1999: *P*). This has been gained from a personal account of care written by a patient, Diamond, J. (1999) *C: Because Cowards Get Cancer Too*. Vermilion, London.

3. *Co*ntext (*C*):

- May include Audit and Performance data, Social and Professional Networks, Local and National Policy, guidelines from Professional Bodies

(e.g. Royal College of Nursing; RCN) and manufacturer's recommendations.

- Example: (DH 2001: *C*). This document gives guidelines for good practice: DH (2001) *Reference Guide to Consent for Examination or Treatment*. Department of Health, London.

4. *Research (R):*

- Evidence gained through research.
- Example: (Fellowes *et al*. 2004: R1a). This has been drawn from the following evidence: Fellowes, D., Wilkinson, S. & Moore, P. (2004) Communication skills training for healthcare professionals working with cancer patients, their families and/or carers. *Cochrane Database Syst Rev*, 2, CD003751. DOI: 10.10002/14651858.CD003571.pub2.

The levels that have been chosen are adapted from Sackett, Strauss and Richardson (2000) as follows:

1.

a. Systematic reviews of randomized controlled trials (RCTs).

b. Individual RCTs with narrow confidence limits.

2.

a. Systematic reviews of cohort studies.

b. Individual cohort studies and low quality RCTs.

3.

a. Systematic reviews of case-controlled studies.

b. Case-controlled studies.

4. Case series and poor quality cohort and case-controlled studies.

5. Expert opinion.

The rationale for the system and further explanation is discussed in more detail in Chapter 1.

The Manual is informed by the day-to-day practice in The Royal Marsden NHS Foundation Trust and conversely is the corporate policy and procedure document of the organization. It therefore does not cover all aspects of acute nursing practice or those relating to children's or community nursing. However, it does contain the procedures and changes in practice that reflect modern acute nursing practice.

Core to nursing, wherever it takes place, is the commitment to care for individuals and to keep them safe. Increasing use is being made of the internet to

record and access information essential in maintaining this safe environment. This edition of *The Royal Marsden Hospital Manual of Clinical Nursing Procedures* has been significantly revised to reflect the move in professional life to utilize electronic records and web-based information in the process of providing patient care.

A more detailed uniform structure has been introduced for all chapters so that there is a balance to the information included. The number of chapters has been reduced, grouping together similar procedures related to an aspect of human functioning. This is to avoid the need to duplicate material and to make it easier for the reader to find.

The chapters have been organized into four broad sections that represent as far as possible the needs of a patient along their care pathway. The first section, *Managing the patient journey*, presents the generic information that the nurse needs for every patient who enters the acute care environment. The second section, *Supporting the patient with human functioning*, relates to the support a patient may require with normal human functions such as elimination, nutrition, respiration. The third section, *Supporting the patient through the diagnostic process*, includes procedures that relate to any aspects of supporting a patient through the diagnostic process from the simple procedures such as taking a temperature, to preparing a patient for complex procedures such as a liver biopsy. The final section, *Supporting the patient through treatment*, includes the procedures related to specific types of treatment or therapies related to the disease or illness of the patient.

Structure of chapters

The structure of each chapter is consistent throughout the book:

- *Overview*: As the chapters are larger and have considerably more content, each one begins with an overview to guide the reader, informing them of the scope and the sections included in the chapter.
- *Definition*: Each section begins with a definition of the terms and explanation of the aspect of care, with any technical or difficult concepts explained.
- *Anatomy and physiology*: Each section includes a discussion of the anatomy and physiology that relates to the aspect of nursing care in the chapter. If appropriate, this is illustrated with diagrams so the context of the procedure

can be fully understood by the reader.

- *Related theory*: If an understanding of theoretical principles is more appropriate background information to help carry out a procedure, this has been included.
- *Evidence-based approaches:* This provides background and presents the research and expert opinion in this area. If appropriate the indications and contraindications are included as well as any principles of care.
- *Legal and professional issues:* This outlines any professional guidance, law or other national policies that may need to be known about in respect to the procedures. If necessary this includes any professional competences or qualifications that are required in order to perform the procedures.
- *Preprocedural considerations:* When carrying out any procedure there are certain actions that may need to be completed, equipment prepared or medication given beforehand. These are made explicit under this heading.
- *Procedure:* Each chapter includes the current procedures that are used in the acute hospital setting. They have been drawn from the daily nursing practice at The Royal Marsden NHS Foundation Trust. Only procedures where the authors have the knowledge and expertise have been included.

Each procedure gives detailed step-by-step actions, supported by rationale, and, where available, the known evidence underpinning this rationale has been indicated. Within procedure guidelines, any action steps of the procedure that are a nursing responsibility are highlighted with colour shading, using the same colour as for the headings in that chapter. The manual also includes a few procedures where the primary role of the nurse is to assist another health care practitioner. Within those procedure guidelines, where action steps are carried out by either a doctor or other expert practitioner, rather than being a nursing responsibility, the action steps are highlighted with grey shading, for example, Procedure guideline 10.4: Chest drain: insertion.

- *Problem solving and resolution*: If relevant, each procedure will be followed by a table of potential problems that may be encountered while carrying out the procedure and suggestions as to the cause, prevention and any action that may help resolve the problem.
- *Postprocedural considerations*: Care for the patient doesn’t end with the procedure. This new section details any documentation the nurse may need to complete, education/ information that needs to be given to the patient,

ongoing observations or referrals to other members of the multiprofessional team.

- *Complications:* Any ongoing problems or potential complications are discussed in a final section and includes evidence-based suggestions for resolution.
- *Illustrations*: The number of colour illustrations has been increased and where relevant they have been used to illustrate the steps of some procedures. This will enable the nurse carrying out the procedures to see in greater detail, for example, the correct position of hands or the angle of a needle.
- *Reference list*: The chapter finishes with a reference list. Only recent texts from the last 10 years have been included unless they are seminal texts. For the first time a list of websites has also been included.

This book is intended as a reference and a resource, not as a replacement for practice-based education. None of the procedures in this book should be undertaken without prior instruction and subsequent supervision from an appropriately qualified and experienced professional. We hope that *The Royal Marsden Hospital Manual of Clinical Nursing Procedures* will continue to be a resource and a contribution to 'continually improving the overall standard of clinical care' (NHSE 1999, p. 3).

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Quick Reference to the Procedure Guidelines Abdominal paracentesis

Anaesthesia: caring for patient in anaesthetic room Antiembolic stockings: assessment, fitting and wearing Apheresis

Arterial blood gas sampling: arterial cannula Arterial cannula insertion: preparation and setting up of monitoring set Arterial cannula: removal

Arterial puncture: radial artery

Artificial eye care: insertion

Artificial eye care: removal

Aseptic technique, for example, changing a wound dressing Bed bathing a patient

Blood component administration

Blood components: collection and delivery to the clinical area Blood cultures: central venous access device Blood cultures: peripheral (winged device collection method) Blood glucose monitoring

Blood pressure measurement (manual)

Blood product request
Blood sampling antimicrobial drug assay Blood sampling: pretransfusion
Bone marrow aspiration and trephine biopsy Bone marrow harvest

Cardiopulmonary resuscitation

Care of the patient during bladder irrigation Central venous access devices: taking a blood sample for syringe sampling Central venous access devices: taking a blood sample for vacuum sampling Central venous access devices: unblocking an occlusion Central venous catheter (skin-tunnelled): surgical removal Central venous catheter: insertion site dressing change Central venous pressure measurement

Cervical uterine smear using an endocervical brush Cervical uterine smear using liquid-based cytology Cervical uterine smear using a wooden spatula Chest drain: changing the bottle

Chest drain: insertion

Chest drain: priming ambulatory chest drain bag Chest drain: removal

Chest drainage: suction

Commencing bladder irrigation

Commode use: assisting a patient

Compression bandaging (standard multilayer): bandaging a leg and the toes Compression bandaging (standard multilayer): bandaging an arm and the fingers Compression therapy: limb volume calculation: lower limbs Compression therapy: limb volume calculation: upper limbs Contact lens removal: hard lenses

Contact lens removal: soft lenses

Continent urinary diversion stoma drainage tubes: flushing Continent urinary diversion stoma: self-catheterization Continuous positive airway pressure

Cytotoxic spillage management

Cytotoxic therapy: education for patients on oral cytotoxic drugs Cytotoxic therapy: intramuscular administration of cytotoxic drugs (Z-track) Cytotoxic therapy: intraperitoneal instillation of cytotoxic drugs Cytotoxic therapy: intrapleural instillation of cytotoxic drugs Cytotoxic therapy: intravenous administration of cytotoxic drugs Cytotoxic therapy: intraventricular administration of cytotoxic drugs via an intraventricular access device (Ommaya reservoir) Cytotoxic therapy: intravesical instillation of cytotoxic drugs Cytotoxic therapy: topical application of cytotoxic drugs Digital rectal examination

Discharge planning

Discharge planning for patients with epidural/intrathecal catheter *in situ* for chronic cancer pain Donning a sterile gown and gloves: closed technique Donning sterile gloves: open technique

Dressing a wound

Early mobilization of the patient in bed Elastic compression garments: application to the arm Elastic compression garments: application to the leg Electrocardiogram

Enema administration

Enteral feeding tubes: unblocking

Enteral feeding tubes: administration of feed Enteral feeding tubes: administration of medication Entonox administration

Epidural/intrathecal analgesia top-up (bolus) Epidural/intrathecal catheter insertion Epidural/intrathecal catheter removal

Epidural/intrathecal exit site dressing change Epidural/intrathecal infusion: setting up and utilizing an ambulatory pump Epidural/intrathecal sensory blockade: assessment Extravasation management: peripheral cannula Extravasation: performing flush-out following an extravasation Eye irrigation

Eye swabbing

Faecal sampling

Feeding an adult patient

Fluid input: measurement

Fluid output: measuring output from drains Fluid output: monitoring output from bowels Fluid output: monitoring output from gastric outlets, nasogastric tubes, gastrostomy Fluid output: monitoring output from stoma sites Fluid output: monitoring/measuring output if the patient is catheterized Fluid output: monitoring/measuring output if the patient is not catheterized Hand decontamination using alcohol handrub Handwashing

Humidification for respiratory therapy

Implanted ports: insertion and removal of non-coring needles Intra-arterial administration of cytotoxic drugs Jejunostomy feeding tube care

Last Offices

Log rolling for suspected/confirmed cervical spinal instability Log rolling for suspected/confirmed thoracolumbar spinal instability Lumbar puncture

Manual evacuation of faeces

Measuring the weight and height of the patient Medication: administration by inhalation using a metered dose inhaler Medication: administration by inhalation using a nebulizer Medication: continuous infusion of intravenous drugs Medication: controlled drug administration Medication: ear drop administration

Medication: eye administration

Medication: injection (bolus or push) of intravenous drugs Medication: injection administration

Medication: intermittent infusion of intravenous drugs Medication: intradermal injection

Medication: intramuscular injection

Medication: multidose vial: powder preparation using a venting needle Medication: multidose vial: powder preparation using equilibrium method Medication: nasal drop administration

Medication: oral drug administration

Medication: self-administration

Medication: single-dose ampoule: powder preparation Medication: single-dose ampoule: solution preparation Medication: subcutaneous administration using a Graseby syringe driver Medication: subcutaneous administration using a McKinley T34

Medication: subcutaneous infusion of fluids Medication: subcutaneous injection

Medication: topical applications

Medication: transdermal applications

Medication: vaginal administration

Midline catheter insertion

Mouth care

Moving from sitting to standing: assisting the patient Nasogastric intubation with tubes using an introducer Nasogastric intubation with tubes without using an introducer, for example, a Ryle’s tube Nasopharyngeal wash: syringe method

Nasopharyngeal wash: vacuum-assisted aspirate method Negative pressure wound therapy

Neurological observations and assessment Operating theatre procedure

Oxygen therapy

Pain assessment and education of patients prior to surgery Pain assessment chart: chronic pain recording Patients in PACU

Peak flow reading using a manual peak flow meter Penile sheath application

Percutaneous endoscopically placed gastrostomy (PEG) tube care Peripheral cannula insertion

PICC insertion using a standard introducer PICC insertion using modified Seldinger technique (with or without ultrasound) PICC removal

Positioning for suspected/confirmed cervical spinal instability: pelvic twist to right Positioning the neurological patient with tonal problems Positioning the patient to maximize V/Q matching for widespread pathology in a self-ventilating patient Positioning the patient to maximize V/Q matching with unilateral lung disease in a self-ventilating patient Positioning the patient: in a chair/wheelchair Positioning the patient: lying down to sitting up Positioning the patient: side-lying

Positioning the patient: sitting in bed Positioning the patient: supine

Positioning the preoperative and postoperative amputee patient Positioning the unconscious patient or patient with an airway in side-lying Positioning the unconscious patient or patient with an airway in supine Positioning to maximize the drainage of secretions Preoperative care: theatre checklist

Protective isolation: entering the isolation room Protective isolation: preparing the room Pulse measurement

Putting on and removing a disposable apron Putting on and removing a disposable mask or respirator Putting on and removing non-sterile gloves Putting on or removing goggles or a face shield Radiation protection: cardiac arrest of patient who has received unsealed radioactive source therapy Radiation protection: contamination of bare hands by radioactive body fluids Radiation protection: death of patient who has received unsealed radioactive source therapy Radiation protection: evacuation due to fire of patients who have received unsealed radioactive source therapy Radiation protection: major spillage of radioactive body fluids through incontinence and/or vomiting Radiologically inserted gastrostomy (RIG) tube care Respiratory assessment and pulse oximetry Safe disposal of foul, infected or infested linen Scalp cooling

Sealed source therapy: caesium sources (manual or afterloading): patient care Sealed source therapy: insertion of sealed radioactive sources into the oral cavity Sealed source therapy: low dose-rate Selectron treatment Sealed source therapy:

Selectron applicator removal Semen collection

Short-term central venous catheter (non-cuffed/tunnelled) insertion Short-term central venous catheter (non-cuffed/tunnelled): removal Slipper bedpan use: assisting a patient Source isolation: entering the isolation room Source isolation: leaving the isolation room Source isolation: preparing an isolation room Source isolation: transporting infected patients outside the source isolation area Sputum sampling

Staple removal

Stoma bridge or rod removal

Stoma care

Suppository administration

Suture removal

Suturing a simple wound
Swab sampling: ear
Swab sampling: eye
Swab sampling: nose
Swab sampling: penis
Swab sampling: rectum
Swab sampling: skin
Swab sampling: throat
Swab sampling: vagina
Swab sampling: wound

Temperature measurement
Tracheostomy: dressing change
Tracheostomy: inner cannula change
Tracheostomy: suctioning a patient
Tracheostomy: tube change

Transfer to PACU

Unsealed radioactive sources for diagnostic investigations: patient care Unsealed source therapy: entering and leaving the room of a patient who has received an unsealed radioactive source Unsealed source therapy: iodine-131 (oral capsule/liquid): administration Unsealed source therapy: iodine-131 mIBG treatment: patient care Urinalysis: reagent strip procedure

Urinary catheter bag: emptying

Urinary catheter removal

Urinary catheterization: female

Urinary catheterization: intermittent self-catheterization: female Urinary catheterization: intermittent self-catheterization: male Urinary catheterization: male

Urine sampling: 24-hour urine collection Urine sampling: catheter specimen of urine (CSU) Urine sampling: midstream specimen of urine: female Urine sampling: midstream specimen of urine: male Urine sampling: sampling from an ileal conduit Vascular access devices: maintaining patency Venepuncture

Voice prosthesis: changing a Blom-Singer exdwelling duckbill voice prosthesis Voice prosthesis: cleaning *in situ* Wound drain removal (closed drainage system, for example, Redivac or concertina) Wound drain shortening (open drainage systems, for example, Penrose, Yates or corrugated) Wound drainage systems: changing the dressing around the drain site and observation/management Wound drainage systems: changing the vacuum bottle of a closed drainage system

Acknowledgements

A book is a team effort and never more so than with this edition of *The Royal Marsden Hospital Manual of Clinical Nursing Procedures*.

Since the first edition was published in 1984, the range of procedures within the manual has grown in complexity and the depth of the theoretical content underpinning them has increased considerably, more so in this edition as the structure has been totally revised. This has demanded more from every author, as they have had to research and write new material as well as revising the evidence base of the existing content. This has been a collaborative task carried out by knowledgeable, expert nurses in partnership with members of the multidisciplinary team including pharmacists, physiotherapists, occupational therapists, dietitians, speech therapists, radiographers and psychological care.

So, we must thank every member of the 'team' who have helped to produce this edition, for their time, effort and perseverance. An additional challenge has been to co-ordinate the increased number of contributors to each chapter. This responsibility has fallen to the lead chapter authors, so, for this, they deserve a special acknowledgement and thanks for their ability to integrate all the contributions and create comprehensive chapters.

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List of Abbreviations

5-FU	5-fluorouracil
AAC	augmentive or alternative communication
A&E	Accident and Emergency
ABG	arterial blood gas
ABPI	Ankle to Brachial Pressure Index
ADH	antidiuretic hormone
ADL	activities of daily living
ADR	adverse drug reaction
AED	automated external defibrillator
AFO	ankle foot orthosis
AHP	allied health professional
AIDS	acquired immune deficiency syndrome
ALARP	as low as reasonably practicable
ALS	advanced life support
ALT	alanine aminotransferase
ANH	acute normovolaemic haemodilution
ANP	atrial natriuretic peptide
ANS	autonomic nervous system
ANTT	aseptic non-touch technique
AORN	Association of Perioperative Registered Nurses
AP	anteroposterior
APTR	activated partial thromboplastin ratio
ARDS	acute/adult respiratory distress syndrome
ARSAC	Administration of Radioactive Substances Advisory Committee
AST	aspartate aminotransferase
AT	anaerobic threshold
ATC	around the clock
AV	atrioventricular
BAL	bronchoalveolar lavage
BCG	bacille Calmette-Guárin
BCSH	British Committee for Standards in Haematology
BIA	bio-electrical impedance analysis
BLS	basic life support
BMA	British Medical Association
BME	black and minority ethnic
BMI	Body Mass Index
BNF	British National Formulary
BOC	British Oxygen Company

BPI	Brief Pain Inventory
BSE	bovine spongiform encephalopathy
CAD	coronary artery disease
CARES	Cancer Rehabilitation Evaluation System
CAUTI	catheter-associated urinary tract infections
CCU	coronary care unit/critical care unit
CD	controlled drug
cfu	colony-forming units
CJD	Creutzfeldt–Jakob disease
CML	chronic myeloid leukaemia
CMV	cytomegalovirus
CNS	central nervous system
CO	cardiac output
COAD	chronic obstructive airways disease
COMA	Committee on Medical Aspects of Food Policy
COPD	chronic obstructive pulmonary disease
COSHH	Control of Substances Hazardous to Health
CPAP	continuous positive airway pressure
CPET	cardiopulmonary exercise testing
CPR	cardiopulmonary resuscitation
CRP	C-reactive protein
CSAS	Chemotherapy Symptom Assessment Scale
CSF	cerebrospinal fluid/colony-stimulating factor
CSS	Central Sterile Services
CSU	catheter specimen of urine
CT	computed tomography
CVAD	central venous access device
CVC	central venous catheter
CVP	central venous pressure
CXR	chest X-ray
DBE	deep breathing exercises
DF	dorsiflexion
DH	Department of Health
DIC	disseminated intravascular coagulation
DM	diabetes mellitus
DMSO	dimethyl sulphoxide
DNA	deoxyribonucleic acid
DNAR	do not attempt resuscitation
DPI	dry powder inhaler
DRE	digital rectal examination
DVLA	Driver and Vehicle Licensing Agency
DVT	deep vein thrombosis
EAPC	European Association of Palliative Care

EBM	evidence-based medicine
EBN	evidence-based nursing
EBP	evidence-based practice
EBRT	external beam radiotherapy
EBV	Epstein–Barr virus
ECF	extracellular fluid
ECG	electrocardiogram
ECM	extracellular matrix
EDTA	ethylenediaminetetra-acetic acid
EGFR	epidermal growth factor receptor
EIA	Equality Impact Assessment
ELISA	enzyme-linked immunosorbent assay
EMLA	eutectic mixture of local anaesthetics
ENT	ears, nose and throat
EPO	erythropoietin
ERV	expiratory reserve volume
ETT	endotracheal tube
EUPAP	European Pressure Ulcer Advisory Panel
F(Fr)	French (gauge)
FBC	full blood count
FEES	fibreoptic endoscopic evaluation of swallowing
FFI	fatal familial insomnia
FFP	fresh frozen plasma
FRC	functional residual capacity
FTSG	full-thickness skin graft
FVC	forced vital capacity
GCS	Glasgow Coma Scale
G-CSF	granulocyte-colony stimulating factor
GFR	glomerular filtration rate
GGT	gamma-glutamyl transferase
GI	gastrointestinal
GMC	General Medical Council
GM-CSF	granulocyte macrophage-colony stimulating factor
GP	general practitioner
GSL	general sales list
GTN	glyceryl trinitrate
HBsAg	hepatitis B surface antigen
HBV	hepatitis B virus
HCA	healthcare assistant
HCAI	healthcare-acquired/associated infection
HCV	hepatitis C virus
HDN	haemolytic disease of the newborn
HDR	high dose rate

HDU	high-dependency unit
HEPA	high-efficiency particulate air
HIV	human immunodeficiency virus
HLA	human leucocyte antigen
HME	heat and moisture exchange(r)
HOOF	home oxygen ordering form
HPA	Health Protection Agency
HR	heart rate
HSC	Health Service Circular/Health and Safety Commission
HSE	Health and Safety Executive
IASP	International Association for the Study of Pain
IBCT	incorrect blood component transfused
IC	inspiratory capacity
ICD	implantable cardioverter defibrillator
ICF	intracellular fluid
ICP	intracranial pressure
ICRP	International Commission on Radiological Protection
ICS	intraoperative cell salvage
ICSI	intracytoplasmic sperm injection
ICU	intensive care unit
IgM	immunoglobulin M
IJV	internal jugular vein
ILCOR	International Liaison Committee on Resuscitation
IMV	intermittent mandatory ventilation
INR	international normalized ratio
IPCT	infection prevention and control team
IPEM	Institute of Physics and Engineering in Medicine
IRMER	Ionizing Radiation (Medical Exposure) Regulations
IRR	infra-red radiation
IRV	inspiratory reserve volume
ISC	intermittent self-catheterization
IV	intravenous
IVC	inferior vena cava
IVF	in vitro fertilization
IUI	intrauterine insemination
JPAC	Joint UKBTS/NIBSC Professional Advisory Committee
KGF	keratinocyte growth factor
KVO	keep vein open
LANSS	Leeds Assessment of Neuropathic Symptoms and Signs
LBC	liquid-based cytology
LCT	long-chain triglyceride
LDR	low dose rate
LMA	laryngeal mask airway

LMN	lower motor neurone
LMWH	low molecular weight heparin
LPA	Lasting Power of Attorney
MAC	*Mycobacterium avium intracellulare*
MAOI	monoamine oxidase inhibitor
MAP	mean arterial pressure
MBP	mean blood pressure
MC&S	microscopy, culture and sensitivity
MCT	medium-chain triglyceride
MDA	Medical Devices Agency
MDI	metered dose inhaler
MDT	multidisciplinary team
ME	medical examiner
MET	medical emergency team
MEWS	Modified Early Warning System
MHRA	Medicines and Healthcare Products Regulatory Agency
MI	myocardial infarction
MIC	minimum inhibitory concentration
MLD	manual lymphatic drainage
MPQ	McGill Pain Questionnaire
MRI	magnetic resonance imaging
MRSA	meticillin-resistant *Staphylococcus aureus*
MSAS	Memorial Symptom Assessment Scale
MSCC	metastatic spinal cord compression
MSU	midstream specimen of urine
NANDA	North American Nursing Diagnosis Association
NBTC	National Blood Transfusion Committee
NCEPOD	National Confidential Enquiry into Patient Outcome and Death
NG	nasogastric
NHS	National Health Service
NHSCSP	NHS Cervical Screening Programme
NHSE	National Health Service Executive
NICE	National Institute for (Health and) Clinical Excellence
NIV	non-invasive ventilation
NMC	Nursing and Midwifery Council
NMDA	N-methyl-D-aspartate
NPSA	National Patient Safety Agency
NPWT	negative pressure wound therapy
NRS	numerical rating scales
NRT	nicotine replacement therapy
NSAID	non-steroidal anti-inflammatory drug
NSF	National Service Framework
ODP	operating department practitioner

OGD	oesophagogastroduodenoscopy
ONS	Oncology Nursing Society
OSCE	objective structured clinical examination
OT	occupational therapist
OTC	over the counter
OTFC	oral transmucosal fentanyl citrate
P	pharmacy medicines
PA	posterior anterior
$PaCO_2$	partial pressure of carbon dioxide
PACU	peri-anaesthesia care unit
PAD	preoperative autologous donation
PART	patient-at-risk team
PC	*Pneumocystis carinii*
PCA	patient-controlled analgesia
PCEA	patient-controlled epidural analgesia
PCS	postoperative cell salvage
PDPH	postdural puncture headache
PDT	percutaneous dilatational tracheostomy
PE	pulmonary embolism/pulmonary embolus
PEA	pulseless electrical activity
PEEP	positive end-expiratory pressure
PEF(R)	peak expiratory flow (rate)
PEG	percutaneous endoscopically placed gastrostomy
PEP	postexposure prophylaxis
PET	positron emission tomography
PF	plantar flexion
PGD	patient group direction
PGSGA	patient-generated subjective global assessment
PHCT	primary healthcare team
PICC	peripherally inserted central catheter
PN	parenteral nutrition
PNS	peripheral nervous system
POA	preoperative assessment
POCT	point-of-care testing
POM	prescription-only medicine
PPE	personal protective equipment
PrP	prion protein
PSAR	Pain and Assessment Records
PSCC	primary/benign spinal cord compression
PSD	patient-specific direction
psi	pounds per square inch
PT	physiotherapist
PTFE	polytetrafluoroethylene

PTFE	polytetrafluoroethylene
PTHrp	parathormone-related polypeptide
PUO	pyrexia of unknown origin
PVC	polyvinylchloride
PVD	peripheral vascular disease
PWO	partial withdrawal occlusion
RA	right atrium
RAP	right atrial pressure
RAS	reticular activating system
RBC	red blood cell
RCA	root cause analysis
RCN	Royal College of Nursing
RCS	Royal College of Surgeons of England
RCUK	Resuscitation Council UK
RIG	radiologically inserted gastrostomy
RNI	reference nutrient intake
RSV	respiratory syncytial virus
RTO	Resuscitation Training Officer
RTOG	Radiation Therapy Oncology Group
RV	residual volume
SA	sinoatrial
SABRE	Serious Adverse Blood Reactions and Events
SARS	severe acute respiratory syndrome
SBAR	Situation-Background-Assessment-Recommendations
SBO	small bowel obstruction
SCC	spinal cord compression
SCI	spinal cord injury
SCNS	Supportive Care Needs Survey
SDF	stromal cell-derived factor
SGA	subjective global assessment
SHOT	Serious Hazards of Transfusion
SI	Système International
SIMV	simulated intermittent mandatory ventilation
SIRS	systemic inflammatory response syndrome
SL	semi-lunar
SLD	simple lymphatic drainage
SLE	systemic lupus erythematosus
SLT	speech and language therapist
SNRI	serotonin-norepinephrine reuptake inhibitor
SOP	standard operating procedure
SPI	Social Problems Inventory
SPN	Safer Practice Notice
SRHH	Self Report Health History

SSG	split-thickness or split skin graft
SSI	surgical site infection
SSRI	selective serotonin reuptake inhibitor
SUI	serious untoward incident
SV	stroke volume
SVC	superior vena cava
swg	standard wire gauge
TACO	transfusion-associated circulatory overload
TA-GVHD	transfusion-associated graft-versus-host disease
TB	tuberculosis
TCA	tricyclic antidepressant
TCI	target-controlled infusion
TED	thromboembolic deterrent
TENS	transcutaneous electrical nerve stimulation
TIVA	total intravenous anaesthesia
TLC	total lung capacity
TLD	thermoluminescent
TPI	*Treponema pallidum* immobilization
TPN	total parenteral nutrition
TRALI	transfusion-related acute lung injury
TRSC	Therapy Related Symptom Checklist
TSE	transmissible spongiform encephalopathy
TSS	toxic shock syndrome
TTO	to take out
TURP	transurethral resection of prostate
TV	tidal volume
UH	unfractionated heparin
UMN	upper motor neurone
UTI	urinary tract infection
V/Q	ventilation/perfusion
VAD	vascular access device
VAP	ventilator-associated pneumonia
VAT	venous assessment tool
VC	vital capacity
vCJD	variant Creutzfeldt–Jakob disease
VDRL	Venereal Disease Research Laboratory
VDS	verbal descriptor scales
VEGF	vascular endothelial growth factor
VF	ventricular fibrillation
VPF	vascular permeability factor
VT	ventricular tachycardia
VTE	venous thromboembolism
VTM	viral transport medium

WBC	white blood cell
WBP	wound bed preparation
WHO	World Health Organization
WOB	work of breathing
WR	Wassermann reaction

Part one

Managing the patient journey

1 The context of nursing

2 Assessment, discharge and end of life care

3 Infection prevention and control

4 Risk management

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Part two

Supporting the patient with human functioning

5 Communication

6 Elimination

7 Moving and positioning

8 Nutrition, fluid balance and blood transfusion

9 Patient comfort

10 Respiratory care

Enemas

Definition

An enema is the administration of a substance in liquid form into the rectum, either to aid bowel evacuation or to administer medication (Higgins 2006).

Evidence-based approaches

Rationale

Indications

Enemas may be prescribed for the following reasons.

- To clean the lower bowel before surgery, X-ray examination of the bowel using contrast medium or before endoscopy examination.
- To treat severe constipation when other methods have failed.
- To introduce medication into the system.
- To soothe and treat irritated bowel mucosa.
- To decrease body temperature (due to contact with the proximal vascular system).
- To stop local haemorrhage.
- To reduce hyperkalaemia (calcium resonium).
- To reduce portal systemic encephalopathy (phosphate enema).

Contraindications

Enemas are contraindicated under the following circumstances.

- In paralytic ileus.
- In colonic obstruction.
- Where the administration of tap water or soap and water enemas may cause circulatory overload, water intoxication, mucosal damage and necrosis, hyperkalaemia and cardiac arrhythmias.
- Where the administration of large amounts of fluid high into the colon may cause perforation and haemorrhage.
- Following gastrointestinal or gynaecological surgery, where suture lines may be ruptured (unless medical consent has been given).
- Frailty.
- Proctitis.
- The use of microenemas and hypertonic saline enemas in patients with inflammatory or ulcerative conditions of the large colon.
- Recent radiotherapy to the lower pelvis unless medical consent has been given (Davies 2004).

Evacuant enemas

An evacuant enema is a solution introduced into the rectum or lower colon with the intention of it being expelled, along with faecal matter and flatus, within a few minutes. The osmotic activity increases the water content of the stool so that rectal distension follows and induces defaecation by stimulating rectal motility (Barrett 1992, Roe 1994).

The following solutions are often used.

- Phosphate enemas with standard or long rectal tubes in single-dose disposable packs. Although these are often used for bowel clearance before X-ray examination and surgery, there is little evidence to support their use due to the associated risks and contraindications. Davies (2004) and Bowers (2006) highlight the risk of phosphate absorption resulting from pooling of the enema due to lack of evacuation and also the risk of rectal injury caused by the enema tip. Studies have found that if evacuation does not occur, patients may suffer from hypovolaemic shock, renal failure and oliguria. When using this type of enema, it is vital that good fluid intake is encouraged and maintained.
- Dioctyl sodium sulphosuccinate 0.1% and sorbitol 25% in single-dose disposable packs are used to soften impacted faeces.
- Sodium citrate 450 mg, sodium alkylsulphoacetate 45 mg and ascorbic acid 5 mg in single-dose disposable packs.

Retention enemas

A retention enema is a solution introduced into the rectum or lower colon with the intention of being retained for a specified period of time. Two types of retention enema are in common use.

- Arachis oil (may be obtained in a single-dose disposable pack). This needs to be used cautiously as it is contraindicated in patients with peanut allergies (Day 2001).
- Prednisolone.

Enemas containing arachis oil enhance the lubricating process, as well as softening impacted faeces (Butler 1998). These work by penetrating faeces, increasing the bulk and softness of stools. They work most effectively when warmed to body temperature and retained for as long as possible (Clarke 1988).

All types of enemas need to be prescribed and checked against the prescription before administration. It is essential that the implications and procedure are fully explained to the patient, so as to relieve anxiety and embarrassment.

Legal and professional issues

Administration requires skill and knowledge from the practitioner and adherence to the Nursing and Midwifery Council's (NMC 2008c) *Standards for Medicines Management*.

Procedure guideline 6.14 Enema administration

Essential equipment

- Disposable incontinence pad
- Disposable gloves
- Topical swabs
- Lubricating jelly
- Rectal tube and funnel (if not using a commercially prepared pack)
- Solution required or commercially prepared enema

Preprocedure

Action	**Rationale**
1 Explain and discuss the procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (NMC 2008a, **C**).
2 Wash hands.	For infection prevention and control (Fraise and Bradley 2009, **E**).
3 Ensure privacy.	To avoid unnecessary embarrassment and to promote dignified care (NMC 2008b, **C**).
4 Allow patient to empty bladder first if necessary.	A full bladder may cause discomfort during the procedure (Higgins 2006, **E**).
5 Ensure that a bedpan, commode or toilet is readily available.	In case the patient feels the need to expel the enema before the procedure is completed. **P**

Procedure

6 Warm the enema to room temperature by immersing in a jug of hot water.	Heat is an effective stimulant of the nerve plexi in the intestinal mucosa. An enema at room temperature or just above will not damage the intestinal mucosa. The temperature of the environment, the rate of fluid administration and the length of the tubing will all have an effect on the temperature of the fluid in the rectum (Higgins 2006, **E**).
7 Assist the patient to lie on the left side, with knees well flexed, the upper higher than the lower one, and with the buttocks near the edge of the bed.	This allows ease of passage into the rectum by following the natural anatomy of the colon. In this position gravity will aid the flow of the solution into the colon. Flexing the knees ensures a more comfortable passage of the enema nozzle or rectal tube (Higgins 2006, **E**).
8 Place a disposable incontinence pad beneath the patient's hips and buttocks.	To reduce potential infection caused by soiled linen. To avoid embarrassing the patient if the fluid is ejected prematurely following administration. **P**
9 Wash hands and put on disposable gloves.	For infection prevention and control (Fraise and Bradley 2009, **E**).
10 Place some lubricating jelly on a topical swab and lubricate the nozzle of the enema or the rectal tube.	This prevents trauma to the anal and rectal mucosa which reduces surface friction (Higgins 2006, **E**).
11 Expel excessive air from enema and introduce the nozzle or tube slowly into the anal canal while separating the buttocks. (A small amount of air may be introduced if bowel evacuation is desired.)	The introduction of air into the colon causes distension of its walls, resulting in unnecessary discomfort to the patient. The slow introduction of the lubricated tube will minimize spasm of the intestinal wall (evacuation will be more effectively induced due to the increased peristalsis). **C**
12 Slowly introduce the tube or nozzle to a depth of 10.0–12.5 cm.	This will bypass the anal canal (2.5–4.0 cm in length) and ensure that the tube or nozzle is in the rectum. **C**
13 If a retention enema is used, introduce the fluid slowly and leave the patient in bed	To avoid increasing peristalsis. The slower the rate at which the fluid is introduced, the less pressure is exerted on the intestinal

with the foot of the bed elevated by 45° for as long as prescribed.	wall. Elevating the foot of the bed aids in retention of the enema by the force of gravity. **C**
14 If an evacuant enema is used, introduce the fluid slowly by rolling the pack from the bottom to the top to prevent backflow, until the pack is empty or the solution is completely finished.	The faster the rate of flow of the fluid, the greater the pressure on the rectal walls. Distension and irritation of the bowel wall will produce strong peristalsis which is sufficient to empty the lower bowel (Higgins 2006, **E**).
15 If using a funnel and rectal tube, adjust the height of the funnel according to the rate of flow desired.	The forces of gravity will cause the solution to flow from the funnel into the rectum. The greater the elevation of the funnel, the faster the flow of fluid. **E**
16 Clamp the tubing before all the fluid has run in.	To avoid air entering the rectum and causing further discomfort. **E**
17 Slowly withdraw the tube or nozzle.	To avoid reflex emptying of the rectum. **E**
18 Dry the patient's perineal area with a gauze swab.	To promote patient comfort and avoid excoriation. **P**
19 Ask the patient to retain the enema for 10–15 minutes before evacuating the bowel.	To enhance the evacuant effect. **C**
20 Ensure that the patient has access to the nurse call system, is near to the bedpan, commode or toilet, and has adequate toilet paper.	To enhance patient comfort and safety. To minimize the patient's embarrassment. **P**
Postprocedure	
21 Remove and dispose of equipment.	
22 Wash hands.	For infection prevention and control (Fraise and Bradley 2009, **E**).
23 Record in the appropriate documents that the enema has been given, its effects on the patient and its results (colour, consistency, content and amount of faeces produced), using the Bristol Stool Form Chart (see Figure 6.2).	To monitor the patient's bowel function (Gill 1999, **C**).
24 Observe patient for any adverse reactions.	To monitor the patient for complications (Peate 2003, **C**).

Problem-solving table 6.5 Prevention and resolution (Procedure guideline 6.14)

Problem	Cause	Prevention	Action
Unable to insert the nozzle of enema pack or rectal tube into the anal canal	Tube not adequately lubricated. Patient in an incorrect position	Ensure patient is relaxed and in the correct position	Apply more lubricating jelly. Ask the patient to draw knees up further towards the chest. To ensure the patient is relaxed before inserting the nozzle or rectal tube
	Patient apprehensive and embarrassed about the situation. Patient unable to relax anal sphincter		Ensure adequate privacy and give frequent explanations to the patient about the procedure. Ask the patient to take deep breaths and 'bear down' as if defaecating.
Unable to advance the tube or nozzle into the anal canal	Spasm of the canal walls	Ask the patient to take slow deep breaths to help them relax	Wait until spasm has passed before inserting the tube or nozzle more slowly, thus minimizing spasm. Ask patient to take slow deep breaths to help them to relax.
Unable to advance the tube or nozzle into the rectum	Blockage by faeces		Withdraw tubing slightly and allow a little solution to flow and then insert the tube further
	Blockage by tumour		If resistance is still met, stop the procedure and inform a doctor.
Patient complains of cramping or the desire to evacuate the enema before the end of the procedure	Distension and irritation of the intestinal wall produce strong peristalsis sufficient to empty the lower bowel	Encourage the patient to retain the enema	Stop instilling the enema fluid and wait with the patient until the discomfort has subsided.
Patient unable to open bowels after an evacuant enema	Reduced neuromuscular response in the bowel wall		Inform the doctor that the enema was unsuccessful and reassure the patient.

Suppositories

Definition

A suppository is a medicated solid formulation that melts at body temperature when inserted into the rectum (Moppett and Parker 1999).

Evidence-based approaches

Rationale

Indications

The use of suppositories is indicated under the following circumstances.

- To empty the bowel prior to certain types of surgery and investigations.
- To empty the bowel to relieve acute constipation or when other treatments for constipation have failed.
- To empty the bowel before endoscopic examination.
- To introduce medication into the system.
- To soothe and treat haemorrhoids or anal pruritus.

Contraindications

The use of suppositories is contraindicated when one or more of the following pertain.

- Chronic constipation, which would require repetitive use.
- Paralytic ileus.
- Colonic obstruction.
- Malignancy of the perianal region.
- Low platelet count.
- Following gastrointestinal or gynaecological operations, unless on the specific instructions of the doctor.

Methods of administration of suppositories

The use of suppositories dates back to about 460 BC. Hippocrates recommended the use of cylindrical suppositories of honey smeared with ox gall (Hurst 1970). The torpedo-shaped suppositories commonly used today came into being in 1893, when it was recommended that they were inserted apex (pointed end) first (Moppett 2000).

This practice has been questioned by Abd-el-Maeboud *et al.* (1991) who suggest that suppositories should be inserted blunt end first. This advice is based on anorectal physiology; if a suppository is inserted apex first, the circular base distends the anus and the lower edge of the anal sphincter fails to close tightly. The normal squeezing motion (reverse vermicular contraction) of the anal sphincter therefore fails to drive the suppository into the rectum. These factors can lead to anal irritation and expulsion of the suppository (Moppett 2000). The study by Abd-el-Maeboud *et al.* (1991) remains the only research evidence supporting this practice. Whilst their work demonstrated that patients found insertion and retention of suppositories much easier and more comfortable using the base-first method, the isolated nature of this research means that manufacturers' instructions continue to recommend apex end first. Therefore this area of practice remains somewhat unclear: the Abd-el-Maeboud *et al.* (1991) study, coupled with the anatomical and physiological rationale, would imply that blunt end first is preferable.

Types of suppository

There are several different types of suppository available. Retention suppositories are designed to deliver drug therapy, for example analgesia, antibiotic, non-steroidal anti-inflammatory drug (NSAID). Those designed to stimulate bowel evacuation include glycerine, bisacodyl and sodium bicarbonate. Lubricant suppositories, for example glycerine, should be inserted directly into the faeces and allowed to dissolve. They have a mild irritant action on the rectum and also act as faecal softeners (BNF 2001). However, stimulant types, such as bisacodyl, must come into contact with the mucous membrane of the rectum if they are to be effective as they release carbon dioxide, causing rectal distension and thus evacuation.

Procedure guideline 6.15 Suppository administration

Essential equipment

- Disposable incontinence pad
- Disposable gloves
- Topical swabs or tissues
- Lubricating jelly
- Suppository(ies) as required (check prescription before administering a medicinal suppository, *e.g.* aminophylline)

Preprocedure

Action	**Rationale**
1 Explain and discuss the procedure with the patient. If you are administering a medicated suppository, it is best to do so after the patient has emptied their bowels.	To ensure that the patient understands the procedure and gives their valid consent (NMC 2008a, **C**. To ensure that the active ingredients are not prevented from being absorbed by the rectal mucosa and that the suppository is not expelled before its active ingredients have been released (Moppett 2000, **E**).
2 Wash hands.	To ensure the procedure is as clean as possible and for infection control reasons (Fraise and Bradley 2009, **E**).
3 Ensure privacy.	To ensure privacy and dignity for the patient (NMC 2008b, **C**).
4 Ensure that a bedpan, commode or toilet is readily available.	In case of premature ejection of the suppositories or rapid bowel evacuation following their administration. **P**
Procedure	
5 Assist the patient to lie on the left side, with the knees flexed, the upper higher than the lower one, with the buttocks near the edge of the bed.	This allows ease of passage of the suppository into the rectum by following the natural anatomy of the colon. Flexing the knees will reduce discomfort as the suppository is passed through the anal sphincter (Moppett 2000, **E**).
6 Place a disposable incontinence pad beneath the patient's hips and buttocks.	To avoid unnecessary soiling of linen, leading to potential infection and embarrassment to the patient if the suppositories are ejected prematurely or there is rapid bowel evacuation following their administration. **E**
7 Wash hands.	For infection prevention and control (Fraise and Bradley 2009, **E**).
8 Place some lubricating jelly on the topical swab and lubricate the blunt end of the suppository if it is being used to obtain systemic action. Separate the patient's buttocks and insert the suppository blunt end first, advancing it for about 2–4 cm. Repeat this procedure if a second suppository is to be inserted.	Lubricating reduces surface friction and thus eases insertion of the suppository and avoids anal mucosal trauma. Research has shown that the suppository is more readily retained if inserted blunt end first (Abd-el-Maeboud *et al.* 1991 **R2b**). (For further information, see Suppositories.) The anal canal is approximately 2–4 cm long. Inserting the suppository beyond this ensures that it will be retained (Abd-el-Maeboud *et al.* 1991, **R2b**).
9 Once the suppository(ies) has been inserted, clean any excess lubricating jelly from the patient's perineal area.	To ensure the patient's comfort and avoid anal excoriation (Moppett 2000, **E**).
10 Ask the patient to retain the suppository(ies) for 20 minutes, or until they are no longer able to do so. If a medicated suppository is given, remind the patient that its aim is not to stimulate evacuation and to retain the suppository for at least 20 minutes or as long as possible.	This will allow the suppository to melt and release the active ingredients. Inform patient that there may be some discharge as the medication melts in the rectum (Henry 1999, **E**).
Postprocedure	

11 Remove and dispose of equipment. Wash hands.	For infection prevention and control (Fraise and Bradley 2009, **E**).
12 Record that the suppository(ies) have been given, the effect on the patient and the result (amount, colour, consistency and content, using the Bristol Stool Chart – see Figure 6.2) in the appropriate documents.	To monitor the patient's bowel function (Gill 1999, **C**).
13 Observe patient for any adverse reactions.	To monitor for any complications (Peate 2003, **E**).

Digital Rectal Examination

Definition

A digital rectal examination (DRE) is an invasive procedure that can be carried out, as part of a nursing assessment, by a qualified nurse who has received suitable education and training (RCN 2006). The procedure involves the nurse inserting a lubricated gloved finger into the rectum.

Evidence-based approaches

Rationale

Indications

This examination should only be performed in the following circumstances (RCN 2006).

- To establish whether faecal matter is present in the rectum and if so, to assess the amount and consistency.
- To assess the need for rectal medication and to evaluate its efficacy in certain circumstances, for example in patients who have diminished anal/rectal sensation.
- For digital stimulation to trigger defaecation by stimulating the rectoanal reflex (RCN 2006, Weisner and Bell 2004).
- To assess anal sphincter function and tone.
- To assess anal/rectal sensation.

Legal and professional issues

This examination should not be a primary investigation for constipation but should only be performed after a full assessment. Discussion with medical staff should occur to confirm diagnosis and jointly plan appropriate interventions to treat the constipation (RCN 2006). As nursing roles develop, clinical nurse specialists and nurse practitioners may be increasingly involved in areas of care that necessitate undertaking DRE as part of a physical assessment or procedure. Such instances may include:

- the assessment of prostate size, consistency, mobility and anatomical limits
- during procedures such as the placement of a rectal probe/sensor prior to urodynamic studies or the placement of catheters used in the treatment of constipation or anismus (RCN 2006).

Preprocedural considerations

Specific patient preparations

Before carrying out a DRE, the perineal and perianal area should be checked for signs of rectal prolapse, haemorrhoids, anal skin tags or lesions, foreign bodies or infestations. The condition of the skin should be noted, as should the type and amount of any discharge or leakage. If any of these abnormalities are seen, a DRE should not be carried out until advice is taken from a specialist nurse or medical practitioner (RCN 2006).

Precautions

Special care should be used in performing DRE in patients when disease processes or treatments in particular affect the anus or the bowel mucosa. These conditions include (RCN 2006):

- active inflammation of the bowel, for example ulcerative colitis
- recent radiotherapy to the pelvic area
- rectal/anal pain
- rectal surgery or trauma to the anal/rectal area
- obvious rectal bleeding
- spinal injury patients, because of autonomic dysreflexia
- patients with known allergies, for example latex
- patients with a history of abuse.

Procedure guideline 6.16 Digital rectal examination

Essential equipment

- Disposable incontinence pad
- Disposable gloves (check if patient allergic to latex)
- Lubricating gel
- Tissues or topical swabs

Preprocedure	
Action	**Rationale**
1 Explain and discuss procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (NMC 2008a, **C**).
2 Ensure privacy.	To avoid unnecessary embarrassment to the patient and to promote dignity and privacy (NMC 2008b, **C**).
3 Ensure that a bedpan, commode or toilet is readily available.	DRE can stimulate the need for bowel movement (Weisner and Bell 2004, **E**).
Procedure	
4 Assist the patient to lie in the left lateral position with knees flexed, the upper knee higher than the lower knee, with the buttocks towards the edge of the bed.	This allows ease of digital examination into the rectum by following the natural anatomy of the colon. Flexing the knees reduces discomfort as the examining finger passes the anal sphincter (Kyle *et al.* 2005b, **C**).
5 Place a disposable incontinence pad beneath the patient's hips and buttocks.	To reduce potential infection caused by soiled linen. To avoid embarrassing the patient if faecal staining occurs during or after the procedure. **E**
6 Wash hands with bactericidal soap and water or bactericidal alcohol handrub and put on disposable gloves.	For infection prevention and control (Fraise and Bradley 2009, **E**).
7 Place some lubricating gel on a swab and gloved index finger. Inform patient you are about to proceed.	To minimize discomfort as lubrication reduces friction and to ease insertion of the finger into the anus/rectum. Lubrication also helps minimize anal mucosal trauma (Kyle *et al.* 2005b, **C**. Assists with patient co-operation with the procedure (NMC 2008b, **C**).
8 Observe anal area prior to the insertion of the finger into the anus for evidence of skin soreness, excoriation, swelling, haemorrhoids, rectal prolapse and infestation. Proceed to insert finger into the anus/rectum.	May indicate incontinence or pruritus. Swelling may be indicative of possible mass or abscess. Abnormalities such as bleeding, discharge or prolapse should be reported to medical staff before any examination is undertaken (RCN 2006, **C**).
9 On insertion of finger, assess anal sphincter control; resistance should be felt.	Digital insertion with resistance indicates good internal sphincter tone, poor resistance may indicate the opposite (Addison 1999b, **E**).
10 Digital examination may feel faecal matter within the rectum; note consistency of any faecal matter.	May establish loaded rectum and indicate constipation and the need for rectal medication (RCN 2006, **C**).
11 Clean anal area after the procedure.	To prevent irritation and soreness occurring. Preserves patient dignity and personal hygiene.
Postprocedure	
12 Remove gloves and dispose of equipment in appropriate clinical waste bin. Wash hands with bactericidal soap and water.	For infection prevention and control (Fraise and Bradley 2009, **E**).
13 Assist patient into a comfortable position and offer toilet facilities as appropriate.	To promote comfort. **P**

14 Document findings and report to medical team.	To ensure continuity of care and ensure appropriate corrective action may be initiated (RCN 2006, **C**).

Manual Evacuation

Definition

Manual evacuation of the rectum is an invasive procedure involving digital removal of faeces, which should only be performed when necessary, generally as a last resort, and after individual assessment (RCN 2006, Rigby 2003).

Related theory

Managing bowel problems such as constipation and prolonged bowel evacuation in patients following spinal cord injury requires a multimodality approach. This includes dietary fibre, digital stimulation, enemas, suppositories, stool softeners and abdominal massage (Addison and White 2002, Amir *et al.* 1998). Digital stimulation is a method of initiating the defaecation reflex by dilating the anus, with either a finger or an anal dilator (Weisner and Bell 2004), but is only useful if the rectum is full.

Autonomic dysreflexia is unique to patients with spinal cord injury. It is an abnormal response from the autonomic nervous system to a painful (noxious) stimulus perceived below the level of spinal cord injury (Harrison 2000, Powell and Rigby 2000). Distended bowel caused by constipation or impaction can lead to autonomic dysreflexia and therefore it is important that an effective programme of bowel management is established and followed (Harrison 2000).

Evidence-based approaches

Rationale

Advances in oral, rectal and surgical treatments have reduced the need for manual evacuations to be performed; however, for certain groups of patients, such as those with spinal injuries, spina bifida or multiple sclerosis, this procedure may be the only suitable bowel-emptying technique forming a long-standing, integral part of their bowel routine (Kyle *et al.* 2005b).

Manual evacuation of faeces can be distressing, it may be painful and it can be a dangerous procedure. In particular, stimulation of the vagus nerve in the rectal wall can slow the patient's heart, in addition to the risk of bowel perforation and bleeding (Kyle *et al.* 2005b, Powell and Rigby 2000).

Indications

Indications for assisted evacuation of bowels (manual evacuation or digital stimulation) include (RCN 2006):

- faecal impaction/loading
- incomplete defaecation
- inability to defaecate
- if other bowel-emptying techniques have failed
- neurogenic bowel dysfunction
- patients with spinal injury.

Patients are at risk of rectal trauma if these procedures are not performed with care or knowledge. The nurse should be aware of any conditions that may contraindicate performance of these procedures (see Precautions, Digital rectal examination).

Legal and professional issues

Nurses who have received appropriate training may perform manual evacuation and, in addition, they should ensure that their employer has defined policies and procedure for undertaking this role (RCN 2006, Withell 2000). If appropriate, the patient and their personal carer may wish for the carer to maintain their established programme of bowel management (Harrison 2000).

Preprocedural considerations

Specific patient preparations

If this procedure is used as an acute intervention, the patient's pulse rate should be recorded before and during the process. Patients with a spinal injury should also have their blood pressure measured before, during and at the end of the procedure. A baseline blood pressure measurement should be available for comparison (RCN 2006). Every time the procedure is performed, the consistency of the stool should be noted before continuing. If the stool is hard and dry, lubricant suppositories should be inserted and left for 30 minutes before commencing. If the stool is too soft to remove effectively, consider delaying the procedure for 24 hours to allow further water reabsorption to occur. During the procedure the nurse should observe the patient for signs of:

- distress, pain or discomfort
- bleeding
- autonomic dysreflexia: hypertension, bradycardia, headache, flushing above the level of the spinal injury, sweating, pallor below the level of spinal injury, nasal congestion (Harrison 2000)
- collapse (RCN 2006).

Procedure guideline 6.17 Manual evacuation of faeces

Essential equipment

- Disposable incontinence pad
- Disposable gloves (check if patient is allergic to latex)
- Lubricating gel
- Receiver and/or yellow bag
- Specimen pot (if required)
- Bedpan or commode (if appropriate)
- Tissues or topical swabs

Preprocedure

Action	**Rationale**
1 Explain and discuss procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (NMC 2008a, **C**).
2 Ensure privacy.	To avoid unnecessary embarrassment to the patient.
Procedure	
3 Take the patient's pulse. In spinal injury patients a blood pressure reading should also be taken (RCN 2006, **C**).	Provides a baseline measurement. Stimulation of the vagus nerve in the rectal wall can lead to a reduction in pulse rate (Powell and Rigby 2000, **E**. In spinal cord injury, stimulus below the level of injury may result in symptoms of autonomic dysreflexia including hypertension (Kyle *et al.* 2005b, **C**).
4 Assist the patient to lie in the left lateral position with knees flexed, the upper knee higher than the lower knee, with the buttocks towards the edge of the bed.	This allows ease of digital insertion into the rectum, by following the natural anatomy of the colon. Flexing the knees reduces discomfort as the finger passes the anal sphincter (Kyle *et al.* 2005b, **C**).
5 Place a disposable incontinence pad beneath the patient's hips and buttocks.	To reduce potential infection caused by soiled linen. To avoid embarrassing the patient if faecal staining occurs during or after the procedure.
6 Wash hands with bactericidal soap and water or bactericidal alcohol handrub and put on disposable gloves.	For infection prevention and control (Fraise and Bradley 2009, **E**).
7 Place some lubricating gel on a swab and gloved index finger.	To minimize discomfort as lubrication reduces friction and to ease insertion of the finger into the anus/rectum. Lubrication also helps minimize anal mucosal trauma (Kyle *et al.* 2005b, **C**).
8 Inform the patient you are about to proceed.	Assists with patient co-operation with the procedure (NMC 2008b, **C**).
9 Observe anal area prior to the insertion of the finger into the anus for evidence of skin soreness, excoriation, swelling, haemorrhoids or rectal prolapse.	May indicate incontinence or pruritus. Swelling may be indicative of possible mass or abscess. Abnormalities such as bleeding, discharge or prolapse should be reported to medical staff before any examination is undertaken (RCN 2006, **C**).
10 Proceed to insert finger into the anus/rectum. Proceed with caution in those patients with spinal cord injury.	The majority of spinal cord injury patients will not experience any pain (Kyle *et al.* 2005b, **C**).
11 If the stool is type 1 (see Figure 6.2), remove one lump at a time until no more faecal matter is felt.	To relieve patient's discomfort (Kyle *et al.* 2005b, **C**).
12 If a solid faecal mass is felt, split it and remove	To relieve patient discomfort (Kyle *et al.* 2005b, **C**).

small pieces with hooked finger until no more faecal matter is felt.	
13 Check the patient's pulse at least once during the procedure. In spinal injury patients a blood pressure reading should also be taken at least once during the procedure or at any sign of distress (RCN 2006, **C**. If the patient is displaying a reduction in pulse rate or change in rhythm, or in the spinal cord injury patient, a raised blood pressure, STOP the procedure and if possible sit the patient up and administer appropriate medications as prescribed (Kyle *et al.* 2005b, **C**).	Stimulation of the vagus nerve in the rectal wall can lead to a reduction in pulse rate (Powell and Rigby 2000). In spinal cord injury, stimulus below the level of injury may result in symptoms of autonomic dysreflexia, including hypertension (Kyle *et al.* 2005b, **C**).
14 If faecal mass is too hard to break up, or more than 4 cm across, stop the procedure and discuss with the multidisciplinary team.	To avoid unnecessary pain and damage to the anal sphincter. The patient may require the procedure to be carried out under anaesthetic (Kyle *et al.* 2005b, **C**).
15 As faeces is removed, it should be placed in an appropriate receiver.	To assist in appropriate disposal and reduce contamination or cross-infection risk.
16 Encourage patients who receive this procedure on a regular basis to have a period of rest or, if appropriate, to assist using the Valsalva manoeuvre.	Patient and nurse education is required to use this technique safely and so further guidance should be sought before introducing this manoeuvre as it may lead to complications such as haemorrhoids (Kyle *et al.* 2005b, **C**).
17 Wash and dry the patient's anal region and buttocks.	To ensure patient feels comfortable and clean. **P**
Postprocedure	
18 Remove gloves and dispose of equipment in appropriate clinical waste bin. Wash hands.	For prevention and control of infection (Fraise and Bradley 2009, **E**).
19 Assist patient into a comfortable position.	To promote comfort. **P**
20 Document findings and report to medical team.	To ensure continuity of care and assist in nursing diagnosis so appropriate actions may continue (RCN 2006, **C**).

Stoma Care and Intestinal (Bowel) Obstruction and Ileus

Stoma Care

Definition

Stoma is a word of Greek origin meaning mouth or opening (Taylor 2005).

Anatomy and physiology

The gastrointestinal tract stretches from the mouth to the anus (See Figure 6.16). It is responsible for absorption of carbohydrates, proteins, fats, water, electrolytes, vitamins and bile salts.

The small bowel is divided into three sections: the duodenum, the jejunum and the ileum. Its primary function is digestion and absorption of nutrients, vitamins, minerals, fluids and electrolytes.

The colon (large bowel) consists of the caecum, ascending colon, transverse colon, descending colon, sigmoid colon, rectum and anal canal. It is about 1.5–1.8 metres long and approximately 6 cm in diameter (Thibodeau and Patton 2007). The colon has four main functions (Nazarko 2007).

- *Reabsorption*: around 1 litre of water in 24 hours and bile salts that are secreted from the liver to enable digestion to happen.
- *Creation of vitamins and biotin*: the bacteria in the colon form vitamin K, essential for blood clotting, vitamin B_5, necessary for the manufacture of neurotransmitters and hormones, and biotin, a substance required in glucose metabolism.
- *Elimination*: of indigestible residue of food and excess metabolites.
- *Formation and storage of faeces*: as the end-products of digestion pass through the colon, they become thicker and more formed and are stored in the colon until they can be eliminated.

The rectum and anal canal include internal and external sphincters which are the mechanisms responsible for controlling bowel function. Therefore disturbance of this results in loss of bowel control and incontinence.

An understanding of the relevant anatomy and physiology is key to understanding the functions of different types of stoma formation.

Related theory

Approximately 13,500 people undergo stoma formation surgery every year in the UK (Baxter and Salter 2000). The most common underlying conditions resulting in the need for stoma surgery are colorectal cancer, bladder cancer, ulcerative colitis and Crohn's disease. Other causes of stoma surgery include:

- cancer of the bowel
- cancer of the pelvis, for example gynaecological cancer
- trauma
- neurological damage
- congenital disorders
- ulcerative colitis
- Crohn's disease
- diverticular disease
- familial polyposis coli
- intractable incontinence
- fistula
- radiation enteritis.

Therefore stoma surgery affects many people regardless of gender, age and culture.

Types of stoma

Colostomy

A colostomy may be formed from any section of the large bowel. Its position along the colon will dictate the output and consistency of faeces. Therefore an understanding of the anatomy and physiology is essential to fully care for stoma patients.

The most common site for a colostomy is on the sigmoid colon. This will produce a semi-solid or formed stool and is generally positioned in the left iliac fossa and is flush to the skin (Black 2000). Stomas formed higher up along the colon will produce a slightly more liquid stool. A colostomy tends to act on average 2–3 times per day, but this can vary between individuals.

Colostomies can either be permanent (end) (Figures 6.19 and 6.20) or temporary (loop) (Figures 6.21 and 6.22). Permanent (end) colostomies are often formed following removal of rectal cancers, as in abdominoperineal resections of the rectum, whereas a temporary (loop) colostomy may be formed to divert the faecal output, to allow healing of a surgical join (anastomosis) or repair, or to relieve an obstruction or bowel injury (Taylor 2005). This type of stoma is often referred to as a defunctioning stoma, which indicates that the bowel distal to the stoma is being rested (Black 2000, Taylor 2000).

Figure 6.19 Sigmoid ‘end’ colostomy.

Figure 6.20 End ileostomy.

With permission from Dansac Ltd.

Figure 6.21 (a) Transverse colostomy. (b) Ileostomy.

Figure 6.22 Loop colostomy with bridge *in situ*.

As is evident from Figures 6.20 and 6.22, end and loop colostomies are very different in appearance. An end colostomy tends to be flush to the skin and sutured to the abdominal wall and consists of an end-section of bowel, whereas a loop colostomy is larger in size. During the perioperative period it is supported by a stoma bridge or rod (Figure 6.22). This is placed under the section of bowel and is generally left in place for 3–10 days following surgery and then removed (Wright and Burch 2008).

Ileostomy

Ileostomies are formed when a section of ileum is brought out onto the abdominal wall. This is generally positioned at the end of the ileum on the right iliac fossa, but can be anywhere along the ileum. Consequently, the output tends to be looser, more liquid stool, as waste is being eliminated before the water is absorbed from the large bowel (colon). Due to the more acidic, abrasive nature of the stool at this stage, a spout is formed with this type of stoma. The ileum is everted to form a spout which allows the effluent to drain into an appliance, without coming into contact with the peristomal skin (Black 2000) (Figure 6.23). This prevents skin breakdown and allows for better management. The average output from an ileostomy is 200–600 mL per day.

Figure 6.23 End colostomy.

With permission from Dansac Ltd.

Ileostomies can also be either permanent (end) (Figure 6.23) or temporary (loop). Permanent ileostomies are often formed following total colectomies (removal of the entire colon) for diverticular disease. Loop ileostomies are more common and are often formed to allow healing of a surgical join (anastomosis) lower down, to allow healing of an ileo-anal pouch or to aid healing of diseased bowel (Taylor 2005). These are sometimes held in place by a stoma bridge or rod. Refer to Procedure guideline 6.19 for more information on bridge/rod care and removal.

Evidence-based approaches

Stoma care has developed greatly over the years and is mainly based on experiential learning. Although an evidence base for this does exist, it mainly centres around clinical practice and experience.

Stoma care is very individual and requires full holistic patient assessment. The primary aim is to promote patient independence by providing care and advice on managing the stoma, therefore allowing the patient to continue with all the necessary activities of daily living.

Rationale

Indications

Stoma care is essential:

- to collect faeces or urine in an appropriate appliance
- to achieve and maintain patient comfort and security
- to maintain psychological adaptation and independence of the patient.

Legal and professional issues

As already discussed, stoma care is primarily based on experience and therefore the development of skills. It is a basic nursing task that all qualified nurses should be able to carry out. It has recently been recognized that many of the basic nursing skills are being carried out by healthcare assistants and carers. Therefore there is an increasing demand for education in this area. Stoma care often develops due to nurses who have an interest in this area and then further build on their skills. Due to the increasing demand for good effective stoma care, many courses and conferences now exist to improve patient care and enhance interest.

Preprocedural considerations

Equipment

Many of the appliances now available are very similar in style, colour and efficiency and often there is very little to choose between them when the time comes for the ostomate to decide what to wear.

The aim of good stoma care is to return patients to their place in society (Black, 1994). One of the ways in which this can be facilitated is to provide them with a safe, reliable appliance. This means that there should be no fear of leakage or odour and the appliance should be comfortable, unobtrusive, easy to handle and disposable. The ostomate should be allowed a choice from the management systems available. It is also important to identify and manage early on problems with the stoma or peristomal skin. When choosing the appropriate management system for the new ostomate, factors which need to be considered include:

- type of stoma
- type of effluent
- patient's cognitive ability
- manual dexterity
- lifestyle
- condition of peristomal skin
- siting of stoma
- patient preference (Black 2000, Kirkwood 2006).

Pouches

Although some people whose stomas were created several years ago are wearing non-disposable rubber bags, most appliances used today are made from an odour-proof plastic film. These pouches usually adhere to the body by a hydrocolloid wafer or flange (Taylor 2000). Pouches may be opaque or clear and often have a soft backing to absorb perspiration. They usually have a built-in integral filter containing charcoal to neutralize any odour. The type of pouch used will depend on the type of stoma and effluent expected. Refer to Figure 6.24 to assist pouch selection.

Figure 6.24 Flow chart for choosing appliances. International Ostomy Forum group (2006) Observation Index. Dansac Ltd.

What is the stoma type?
COLOSTOMY
ILEOSTOMY
NOT KNOWN
UROSTOMY
Is the output FAECES or URINE?
FAECES
URINE
Is the output FORMED?
Is the output LOOSE?
CLOSED APPLIANCE
Transparent (clear) or non-transparent (opaque).
One- or two-piece systems.
Different sizes available.
Single use.
Change when half full.
Flushable pouches available.
UROSTOMY APPLIANCE
Must have a tap.
Can connect to a night drainage bag.
Transparent (clear) or non-transparent (opaque).
One- or two-piece systems.
Empty when about half full.
Change every 1 to 3 days.
DRAINABLE APPLIANCE
Transparent (clear) or non-transparent (opaque).
One- or two-piece systems.
Different sizes available.
Empty when about half full.
Change every 1 to 3 days.

Choosing the right size

It is important that the flange of the appliance fits snugly around the stoma within 0.3 cm of the stoma edge (Kirkwood 2006). This narrow edge is left exposed so that the appliance does not rub on the stoma. Stoma appliances usually come with measuring guides to allow for choice of size. During the initial weeks following surgery, the oedematous stoma will gradually reduce in size and the appliances will be changed accordingly.

Fear of malodour when using pouches

Pouches usually have a built-in integral filter containing charcoal to neutralize any odour when flatus is released; therefore, smell is only noticeable when emptying or changing an appliance (Rudoni and Sica 1999). There are also various deodorizers available. These come in the form of drops or powders that may be put into the pouch or sprays, which can be sprayed into the air just before changing or emptying the pouch (Burch and Sica 2005). The individual should be reassured that any problems with odour or leakage will be investigated and that in most circumstances the problem will be solved with alternative appliances or accessories (Black 1997, Bryant 1993).

Drainable pouches are used when the effluent is fluid or semi-formed, that is, ileostomy or transverse colostomy (Figure 6.25a). These pouches have specially designed filters, which are less likely to become blocked or leak faecal fluid. They need to be emptied regularly and the outlet rinsed carefully and then closed with a clip or ‘roll-up’ method. They may be left on for up to 3 days.

Figure 6.25 Stoma equipment. (a) Drainable bowel stoma pouch. (b) Urostomy pouch. (c) Closed bag.

Urostomy pouches have a drainage tap for urine and should be emptied regularly (Figure 6.25b). They can be attached to a large bag and tubing for night drainage. These pouches can remain on for up to 3 days.

Closed pouches are mainly used when formed stool is expected, for example sigmoid colostomy (Figure 6.25c). They have a flatus filter and need to be changed once or twice a day.

One-or two-piece systems

All types of pouch (closed, drainable or with a tap) fall into one of two broad categories: one-piece or two-piece systems.

- *One-piece*: this comprises a pouch attached to an adhesive wafer that is removed completely when the pouch is changed. This is an easier system for an ostomate with dexterity problems, for example arthritis, peripheral neuropathy, to handle.
- *Two-piece*: this comprises a wafer onto which a pouch is clipped or stuck. It can be used with sore and sensitive skin because when the pouch is removed, the flange is left intact and so the skin is left undisturbed.

Plug system

Patients with colostomies may be able to stop the effluent by inserting a plug into the stoma lumen. This plug swells in the moist environment and behaves as a seal. This system should only be introduced by a stoma nurse specialist (Taylor 2000).

Solutions for skin and stoma cleaning

Mild soap and water, or water only, is sufficient for skin and stoma cleaning. It is important that all soap residues are removed as they may interfere with pouch adhesion. Detergents, disinfectants and antiseptics cause dryness and irritation and should not be used. The stoma is not a wound or a lesion and should be regarded as a resited urethra or anus.

See Table 6.5 for for a summary of products used in managing problems associate with stoma.

Table 6.5 A summary of products used for problems associated with stoma

Accessory	Product example	Use	Precautions
Creams	Chiron barrier cream (ABPI 1999)	Sensitive skin as a protective measure	Grease from creams can prevent adherence of the appliance
Protective films	Cavilon no sting barrier film, LBF	To prevent irritation and give protection	If contains alcohol, avoid on broken skin
Protective wafers	Stomahesive	To cover and protect skin	Allergies (rare)
Seals/washers	Cohesive seals Hollister barrier rings	Provide skin protection around the stoma. Useful to fill gaps and dips in skin	Allergies (rare)
Pastes	Stomahesive adapt paste	Useful to fill gaps and dips in skin and provide a smoother surface for applying the pouch	If contains alcohol, avoid on broken skin Should not be used as a solution to an ill-fitting pouch
Protective paste	Orabase paste	Protect raw, sore areas	
Powders	Ostoseal protective powder	Protect sore, wet areas and aid healing	Can sometimes affect adherence
Adhesive preparations	Saltair solution	To improve adherence of product	Should not be used as a solution to an ill-fitting pouch
Adhesive removers	Appeel Adhesive remover aerosols	Aids removal of pouch if patient experiencing pain when pouch removed	Some contain alcohol and should not be used on broken skin
Stoma baseplate securing tape	Hydroframe	To improve patient security. Useful for patients with parastomal hernias	Should not be used as a solution to an ill-fitting pouch
Thickening agents	Gel-X capsules, Ostosorb gel	To help solidify loose stoma output	If output is loose, cause should be investigated
Convex devices	Adapt ring convex inserts, soft seal	Useful for retracted stomas	Bruising and ulceration if used incorrectly
Aerosols	Limone, FreshAire	To mask and absorb odour	Avoid patient associating aerosol spray with stoma
Drops and powders	Nodor S Drops	Deodorizing bag contents	

Deodorants

Aerosols

Use: To absorb or mask odour. *Method*: One or two puffs into the air before emptying or removing appliance. *Examples*: Limone, Naturcare, FreshAire.

Drops and powders

Use: For deodorizing bag contents. *Method*: Before fitting pouch or after emptying and cleaning drainable pouch, squeeze tube two or three times. *Examples*: Ostobon deodorant powder, Nodor S drops, Saltair No-roma.

Preoperative assessment and care

Preoperative care can be divided into two sections: physical and psychological.

Physical

- Firstly, physical care consists of surgical preparation, which can be in the form of bowel preparation where patients are required to take laxatives to cleanse their bowel prior to surgery. This arguably improves surgical visibility and prevents contamination. This depends on the surgeon's preference and needs to be checked with the patient's surgical team on admission.
- Due to the current developments regarding reducing patients' hospital stay, many hospitals are carrying out enhanced recovery programmes for colorectal patients. This involves intensive input preoperatively, where selected patients are required to take nutritional drinks and develop skills in changing a stoma bag. This will improve recovery and management and consequently reduce hospital stay. These enhanced recovery programmes are relatively new and are still being trialled in many centres.
- Finally, stoma siting is one of the most important tasks to be carried out by a doctor, stoma care nurse or ward nurse or anyone with appropriate knowledge and skills. This minimizes future difficulties such as the stoma interfering with clothes or skin problems caused by leakage of the appliance due to a badly sited stoma (Bass *et al.* 1997, Qin and Bao-Min 2001).

Patient assessment is necessary taking into account:

- physical problems
- disabilities
- mental state
- visual impairment
- manual dexterity
- lifestyle
- work
- leisure/sporting activities
- ethnicity.

The following guidelines should be adhered to when siting a stoma.

- Locate the rectus muscle: this reduces the risk of herniation later (Myers 1996). The muscle can be identified by asking the patient to lie flat and raise their head. The muscle may also be palpated and easily felt when the patient coughs.
- Identify a flat area of skin on the abdomen, as this facilitates safe adhesion

of the appliance.

- Avoid skin creases, especially in the region of the groin or the umbilicus, to avoid urine or faecal matter tracking along the skin creases.
- Avoid any previous or proposed scars, which may lead to skin creases and difficulty applying a bag.
- Avoid bony prominences and pendulous breasts as this may hinder vision of the stoma.
- Avoid the waistline or belt areas, as the patient's clothing may put pressure on the stoma which may lead to leaks or trauma of the stoma.
- Ideally the patient should be able to see their stoma as this will make postoperative self-care easier.

All these factors need to be carefully considered and discussed with the patient whilst siting the stoma. Patient involvement is important as it allows the patient control and enhances their coping strategies. Make sure that you get the patient to adopt various positions before making a final decision on the stoma site, for example lying flat, sitting, standing, bending, as this sometimes changes the decision based on skin creases and patient comfort. Consideration must be given to any bending or lifting involved with the patient's work and any other activities in which the patient partakes. Account must also be taken of any weight gain or loss in the postoperative period, as this may change the contours of the abdomen and hence the position of the stoma.

Once the site has been chosen, it should be clearly marked with a permanent marker pen, preferably a few days before the surgery. Offering the patient a bag to wear prior to surgery allows them time to adapt to their proposed surgery. This procedure should then be documented in the medical notes, stating any complications or issues discussed.

Psychological

Psychological preparation of the individual facing stoma surgery should begin as soon as surgery is considered, preferably by utilizing the skills of a trained stoma care nurse. It is important that the information and discussions are tailored to the individual's needs, taking into account their level of anxiety and distress (Borwell 1997).

It is important that patients meet all members of the multidisciplinary team who are involved in their care and that they fully understand the need for the stoma surgery. This needs to be explained in order to obtain informed consent. It is beneficial if the patient is met in preassessment or at home prior to surgery to discuss the implications of stoma care and the patient's role in rehabilitation. At this point it is also helpful to provide the patient with written information and access to self-help support groups.

Stoma counselling is often best carried out by the specialist stoma care nurse involved in the patient's care. This provides an ideal opportunity to discuss issues such as:

- body image
- family relationships
- sexual relationships
- depression and anger
- fears and concerns.

It is often beneficial to provide patients with some patient information/literature to take home. This gives them an opportunity to digest the information and write down any questions that they have. There are many different aids available, such as information booklets, samples of various products, diagrams, DVDs and internet websites. These help to reinforce and clarify the verbal information given to the patient.

Specific patient preparation

Patient education

Patients undergoing stoma formation have to make major physical and psychological adjustments following surgery. If surgery is elective, patient education should begin in the preoperative period (O'Connor 2005). Adequate pre-and postoperative support is mandatory to improve quality of life for stoma patients (Bloeman *et al.* 2009). Individual holistic patient assessment is key as it is important to identify appropriate teaching strategies for each patient. One of the most important ways in which a nurse can support the patient is to teach them stoma care, ensuring independence before discharge (Burch and Sica 2005). It is important that the patient is able to independently change their stoma bag, recognize problems and obtain support and supplies once discharged home. Providing patients with adequate information and input helps to promote patient decision making by allowing them control (Henderson 2003).

You will wear gloves when changing an appliance. This practice should be explained to patients so that they do not feel it is just because they have a stoma that gloves are worn. (It is recognized that it could be difficult to attach an appliance with gloves *in situ*, due to adhesive, but once the stoma has been cleaned of excreta and blood, gloves may be removed to apply bag.)

Procedure guideline 6.18 Stoma care

Essential equipment

Clean tray holding:

- Tissues, wipes
- New appliance
- Measuring device/template
- Scissors
- Disposal bags for used appliances, tissues and wipes
- Relevant accessories, for example adhesive remover, protective film, seals/washers
- Bowl of warm water
- Soap (if desired)
- Jug for contents of appliance
- Gloves

Preprocedure

Action	**Rationale**
1 Explain and discuss the procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (NMC 2008a, **C**. To familiarize the patient with the procedure.
2 Ensure that the patient is in a suitable and comfortable position where they will be able to watch the procedure, if well enough. A mirror may be used to aid visualization.	To allow good access to the stoma for cleaning and for secure application of the stoma bag. The patient will become familiar with the stoma and will also learn much about the care of the stoma by observation of the nurse (Bryant 1993, **P**).
3 Use a small protective pad to protect the patient's clothing from drips if the effluent is fluid and apply gloves for nurse's protection.	Avoids the necessity for renewing clothing or bedclothes and demoralization of the patient as a result of soiling. **E**
Procedure	
4 If the bag is of the drainable type, empty the contents into a jug before removing the bag.	For ease of handling the appliance and prevention of spillage. **E**
5 Remove the appliance. Peel the adhesive off the skin with one hand while exerting gentle pressure on the skin with the other.	To reduce trauma to the skin. Erythema as a result of removing the appliance is normal and quickly settles (Broadwell 1987, **C**).
6 Fold appliance in two to ensure no spillage and place in disposal bag.	To ensure safe disposal according to environmental policy (DH 2005a, **C**).
7 Remove excess faeces or mucus from the stoma with a damp tissue.	So that the stoma and surrounding skin are clearly visible. **E**
8 Examine the skin and stoma for soreness, ulceration or other unusual phenomena. If the skin is unblemished and the stoma is a healthy red colour, proceed.	For the prevention of complications or the treatment of existing problems. **E**
9 Wash the skin and stoma gently until they are clean.	To promote cleanliness and prevent skin excoriation. **E**
10 Dry the skin and stoma gently but thoroughly.	The appliance will attach more securely to dry skin. **E**, **C**
11 Measure the stoma and cut appliance leaving 3 mm clearance. Apply a clean appliance.	Appliance should provide skin protection. The aperture should be cut just a little larger than the stoma so that effluent cannot cause skin damage. This should be no more

	than 3 mm from the stoma (Kirkwood 2006, **C**).
Postprocedure	
12 Dispose of soiled tissues and the used appliance in a disposable bag and place it in an appropriate plastic bin. At home the bag should be placed in a plastic bag, tied and disposed of in a rubbish bag.	To ensure safe disposal. **E**
13 Wash hands thoroughly using bactericidal soap and water or bactericidal alcohol handrub.	To prevent spread of infection by contaminated hands (Fraise and Bradley 2009, **E**).

Procedure guideline 6.19 Stoma bridge or rod removal

Essential equipment

Clean tray holding:

- Tissues
- New appliances
- Disposal bags for used appliances and tissues
- Relevant accessories, for example belt
- Bowl of warm water
- Soap if desired
- Jug for contents of appliance
- Gloves

Preprocedure

Action	**Rationale**
1 Explain and discuss the procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (NMC 2008a, **C**).
2 Ensure the patient is in a suitable and comfortable position.	To allow good access to the stoma for cleaning and for secure application of stoma bag. **E**
3 Apply gloves.	To reduce risk of cross-infection (Fraise and Bradley 2009, **E**).
4 If the bag is of the drainable type, empty the contents into a jug before removing the bag.	For ease of handling the appliance and prevention of spillage. **E**
Procedure	
5 Remove the appliance. Peel the adhesive off the skin with one hand while exerting gentle pressure on the skin with the other.	To reduce trauma to the skin. Erythema as a result of removing the appliance is normal and quickly settles (Broadwell 1987, **C**).
6 Remove excess faeces or mucus from the stoma with a damp tissue.	So that the stoma and surrounding skin are clearly visible. **E**
7 Slide the bridge gently to one side to ensure the mobile wing of the bridge is away from the stoma. Turn this wing so that it becomes flush with the bridge. Gently slide the bridge through the stoma loop (see Action Figure 7).	To prepare bridge for removal. **E**
8 Fold the bridge in half so that the bridge appears in a 'C' shape. Gently slide the bridge through the stoma loop (see 6.29).	
9 Examine the skin and stoma for soreness, ulceration or other unusual phenomena. If the skin is unblemished and the stoma is a healthy red colour, proceed. If the skin is red and/or broken, apply barrier cream. If the stoma is not a healthy red colour inform medical and/or stoma care nurse.	For the prevention of complications or the treatment of existing problems (see Table 6.5). **E**
10 Wash the skin and stoma gently until they are clean.	To promote cleanliness and prevent skin excoriation. **E**
11 Dry the skin and stoma gently but thoroughly.	The appliance will attach more securely to dry skin. **E**
12 Apply a clean appliance.	To contain effluent from the stoma. **E**

13 Dispose of soiled tissues, the bridge and the used bag.	To prevent environmental contamination. **E**
14 Wash hands with bactericidal soap and water or bactericidal alcohol handrub.	To reduce risk of cross-infection (Fraise and Bradley 2009, **E**).

Action Figure 7 Removal of stoma bridge or rod.

Postprocedural considerations

Immediate care

Colostomy function

In the first few days a sigmoid colon stoma will produce haemoserous fluid and wind. By day 5 there should be some faecal fluid and then by day 7–14, semi-formed stool (Cottam 1999). A closed appliance may be used. In the case of a stoma formed in the transverse colon, only a small amount of water will be reabsorbed from the faecal matter, so the faecal matter will be unformed. This means a drainable pouch will need to be used.

Patients with a sigmoid colostomy may find that wholemeal foods assist in producing a formed stool once or twice daily (Black 1998, Myers 1996). Medications that reduce peristaltic action, for example codeine phosphate, may also be used to control diarrhoea. The only means of controlling a sigmoid colostomy, however, is by regular irrigation or by use of a Conseal plug system. Stoma care nurses will need to assess patients before teaching them how to perform the irrigation procedure or to use Conseal plugs.

Ileostomy function

For the first few days the stoma will produce haemoserous fluid and wind. By days 5–10 there will be brown faecal matter (Cottam 1999). The fluid output after surgery can be as much as 1500 mL/24 hours but this will gradually reduce to 500–850 mL/24 hours as the bowel settles down (Black 2000). Sometimes the output from a stoma remains high (>1000 mL/24 hours), which may be due to the amount of small bowel removed at surgery or an underlying bowel condition; these patients require careful management.

It is important that fluid balance recordings are made and serum electrolytes are measured as patients are at risk of sodium and/or magnesium depletion (Burch 2004). Patients with a high-output stoma may need to be managed by specialist teams which include gastroenterologists, dietitians and stoma care nurses. The effluent takes on a porridge-like consistency when a normal intake of food is established. A drainable appliance is therefore used. The effluent contains enzymes, which will excoriate the skin, so if the pouch leaks, it must be changed promptly to prevent skin breakdown. The effluent cannot be controlled and is often more active after meals (Black 1997, Myers 1996). Sometimes medication, for example codeine or loperamide, which reduces peristaltic action, may be used to control excessive watery output.

Urostomy/ileal conduit function

Urine will dribble from the stoma every 20–30 seconds and it starts draining immediately. Normal output is 1500 mL/24 hours (Cottam 1999), but may be less after periods of reduced fluid intake, for example at night. Urinary stents (fine-bore catheters) may be in place from the ureters past the anastomosis and out of the stoma. They are placed to maintain patency and protect the suturing until primary healing is completed (Black 2000). Stents are left *in situ* for 7–10 days.

Postoperative stages

Stage I

In theatre, an appropriately sized transparent drainable appliance should be applied, which should be left on for approximately 2 days. For the first 48 hours postoperatively, the stoma should be observed for signs of ischaemia or necrosis and the stoma colour (a pink and healthy appearance indicates a good blood supply), size and stoma output should be noted, as should the presence of any devices, such as ureteric stents or bridge with a loop stoma (Kirkwood 2006).

Table 6.6 recommends the most appropriate bag type to use on each type of stoma and the expected output. The drainable appliance should always be emptied frequently, gas should be allowed to escape and the appliance should not be allowed to get more than half full with effluent. If the appliance becomes too full, leaks may occur and the weight from the effluent or the pressure from gas may cause the appliance to fall off (Black 1997). A leak-proof, odour-resistant well-fitted appliance does much to promote patient confidence at this time (Kirkwood 2006). The first time a bowel stoma acts, the type, appearance, quantity and consistency of the matter passed should be recorded; this includes any flatus that may be passed (Kirkwood 2006).

Table 6.6 Decision tool to use when selecting appropriate bag/pouch

Type of stoma	Expected postoperative output	Recommended bag to be used	Expected stoma output on discharge	Recommended bag to be used on discharge
Colostomy	Haemoserous fluid Flatus Liquid/loose stool	Clear drainable bag	Soft formed stool Bowel action 1–3 times a day	Closed opaque bag
Ileostomy	Haemoserous fluid Liquid/loose stool Flatus	Clear drainable bag	Loose stool Approximately >600 mL per day	Opaque drainable bag
Urostomy	Urine Mucus	Clear drainable bag with tap	Urine 0.5 mL/kg/h	Opaque drainable bag with tap

Immediately postoperatively patients would not be expected to perform their own stoma care but would be encouraged to observe the nurse caring for them and discuss it with the nurse. During appliance changes, observations should be made of the following.

- *Stoma*: colour, size and general appearance: oedematous, flush with abdomen, retracted.
- *Peristomal skin*: presence of any erythema, broken areas, rashes.
- *Stoma/skin margin (mucocutaneous margin)*: sutures intact, tension on sutures, separation of stoma edge from skin (mucocutaneous separation).

Any abnormalities should be reported to the stoma care nurse and medical staff (Black 2000, Burch 2004, Kirkwood 2006) (Figure 6.26).

Figure 6.26 Observational index.

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Ostomy Forum - Observation index

Stoma / Status

A		Normal	above skin level
B		Flush	mucosa level with the skin
C		Retracted	below skin level
D		Prolapsed	notable increasing length of stoma
E		Hernia	bowel entering parastomal space
F		Stenosis	tightening of stoma orifice
G		Granulomes	nodules/granulation on stoma
H		Separation	mucocutaneous separation
I		Recessed	stoma in a skin fold or a crease
J		Necrosis	lack of blood supply causing partial or complete tissue death
K		Laceration	mucosa that is jagged/torn or ulcerated due to trauma
L		Oedematous	gross swelling of the stoma
Z		Others	

Skin / Condition

A		Normal	as rest of skin
B		Erythema	red
C		Macerated	excoriated; moist
D		Eroded	excoriated; moist and bleeding
E		Ulcerated	skin defect reaching in to subcutaneous layer
F		Irritated	irritant causing skin to be inflamed, sore, itchy and red
G		Granuloma	nodules/over granulation tissue on skin
H		Predisposing factors	underlying diseases, e.g. eczema and psoriasis
I		CPD*	greyish, nodules on skin, often caused by urine
J		Infected	e.g. fungus, folliculitis
Z		Others	e.g. Pyoderma gangrenosum

* Chronic Papillomatous Dermatitis

Output / Consistency

A	Normal	For patient and stomatype
B	Fluid	
C	Thick	
D	Solid	
E	Hard	
F	High output	Uro>2500ml/24 hrs Ileo>1500ml/24 hrs
G	Too low output	Uro<1200ml/24 hrs Ileo<500ml/24 hrs
H	Excessive flatus	
I	Excessive odour	
J	Excessive mucus production	
K	Blood	
L	Non functioning stoma	(e.g sub-ileus)
Z	Others	

Psychological

A	Normal for patients based on HTF
B	Low in spirits
C	Worry about diagnosis/disease
D	Worry about stoma management
E	Previous emotional problems (coping strategies, earlier problems/losses/diseases)
F	Body image/self perception
G	Others

Social

A	Resumed normal social activity for patient based on HTF
B	Started working/schooling/education
C	Avoiding working/schooling/education
D	Avoiding social gatherings due stoma related problems and fears (leakage/odour/noise)
E	Financial worries/concerns
F	Social isolation
Z	Others

Sexuality

A	Normal for patient based on the HTF
B	Physical post surgery difficulties 1. abdominal, surgical pain 2. discharge/seepage problems 3. erectile dysfunction 4. lubrication 5. dyspareunia 6. retrograde ejaculations
C	Psychological post surgery difficulties: 1. fear of failure 2. fear of pain 3. fear of leakage from pouch/rectum 4. fear of odor/noise 5. fear of rejection from partner 6. fear of forming new relationships 7. loss of sexual desire
Z	Other

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Viewing the stoma may be difficult for the patient, who may be very aware of other people's reaction to it (Price 1990). The patient's reaction to their stoma should be observed and recorded.

Stage II

As the patient's condition improves, they should be encouraged to participate in the care of their stoma. A demonstration change of the appliance should be given with a full explanation of the principles of stoma care. This will be followed by further opportunities to discuss any problems or raise new queries. Care procedures should be divided into small successive stages and patients should be given support to work through these stages until they are able to take on the care of their stoma. Provided the patient agrees, it is useful to involve the patient's partner or close friends or relatives at this stage. Their acceptance of the stoma may encourage the patient and help to restore the patient's self-esteem (Salter 1995). They may now be ready to discuss appliances and choose the one that they wish to use at home. Preparation for discharge will be discussed (Black 1994, Heywood Jones 1994).

Stage III

Ideally, the patient should now be independent, eating a normal diet, be ready for discharge and should be competent in stoma care. If the family or close friends are closely involved during all stages and are supportive, patients are better able to adapt to the threat of mutilating surgery and altered pattern of elimination (Price 1990). The family or close friends are also likely to require support and information so that they are in a position to help the ostomate. Acceptance of the stoma is a gradual process and, on discharge from hospital, patients may only be beginning to adapt to life with a stoma (Salter/RCN 1997).

Ongoing care

Body image

Stoma formation creates many issues for the patient and many struggle with body image. Studies suggest that this is often overlooked (Opus 2010). The circumstances in which the stoma is formed will influence psychological recovery (Black 2000). Communication is key and it is important to allow the patient and family to discuss their concerns and anxieties. Therefore stoma care nurses play a vital role in supporting the patient and family. It is important to promote patient independence and acceptance.

Diet

All patients should be encouraged to eat a wide variety of foods. Our digestive system reacts in an individual way to different foods and so it is important that patients try a wide range of foods on several occasions and that none should be specifically avoided (Bridgewater 1999). Patients can then make decisions about different foods based on their own experience of their own reaction. Explanations should be given of how the gut functions, how it has been changed since surgery and the effects certain foodstuffs may cause.

Colostomy and ileostomy formation means the loss of the anal sphincter so passage of wind cannot be controlled. High-fibre foods such as beans and pulses produce wind as they are broken down in the gut; hence individuals who eat large quantities of these foodstuffs may be troubled by wind. There are several non-food causes of wind, such as chewing gum, eating irregularly and drinking fizzy drinks, which should be considered before blaming a particular food (Bridgewater 1999). Eating yoghurt or drinking buttermilk may help reduce wind for these patients. Green vegetables, pulses and spicy food are examples of foods that may cause colostomy and ileostomy output to increase or become watery. Boiled rice, smooth peanut butter, apple sauce and bananas are some of the foods that may help thicken stoma output (Black 2000, Bridgewater 1999).

Some foods, for example tomato skin and pips, may be seen unaltered in the output from an ileostomy (Black 1997, Blackley 1998, Hulten and Palselius 1996). Celery, dried fruit, nuts and potato skins are some of the foods which can temporarily block ileostomies (Black 2000, Bridgewater 1999). The blockage is usually related to the amount eaten (Wood 1998). The offending food can be tried at another time in small quantities, ensuring it is chewed well and not eaten in a hurry (Bridgewater 1999).

There are no dietary restrictions with a urostomy. It must be stressed, however, that an adequate fluid intake must be maintained to minimize the risk of urinary tract infection. The recommended fluid intake for all individuals is 1.5–2.0 litres per day (Bridgewater 1999). Fluid intake should be increased in hot weather or at times when there is an increase in sweating, for example exercise, fever. Beetroot, radishes, spinach and some food dye may discolour urine; some drugs may also have this effect, for example metronidazole, nitrofurantoin. Urine may develop a strong odour following consumption of asparagus or fish (Bridgewater 1999).

Fear of malodour

This is a common fear for patients with bowel stomas, often based on hearsay or experience with other ostomists in hospital or the community. Appliances are odour free when fitted correctly. Flatus may be released via charcoal filters and deodorizers are available. The individual must be reassured, however, that any problems that occur postoperatively will be investigated, with a good possibility of their being solved by such means as the use of alternative appliances (Black 2000, Burch 2004).

Sex and the ostomate

The possibility of sexual impairment for both men and women after stoma surgery depends on the nature of the operation, and the ensuing damage to the nerves and tissues involved. The psychological impact of the surgery and its effect on the individual's body image must also be taken into consideration. Surgery that results in physical sexual disability will have psychological repercussions, while some sexual difficulties may be of psychological origin (Black 2004, Borwell 1997, Salter 1996). Impairment may be permanent or temporary. In the latter case, resolution of the difficulty may take anything up to 2 years. Pre-and postoperative counselling should be offered for both patient and partner.

All patients may experience loss of libido and sexual desire. Ejaculatory disturbances occur following cystectomy so men facing this surgery should be offered sperm banking prior to surgery. Erectile dysfunction is a common complication of pelvic surgery and there are a number of treatment options available. These include oral medications (sildenafil, tadalafil, vardenafil), sublingual apomorphine, intraurethral and intracavernosal alprostadil, vacuum devices and penile implants (Ashford 1998, Kirby *et al.* 1999, Newey 1998).

Female patients may experience dyspareunia; this may be due to narrowing or shortening of the vagina, a reduction in the volume of vaginal secretions or changes in genital sensations (Black 2004, Borwell 1997, Schover 1996). The use of a lubricant, adopting different positions during lovemaking or encouraging greater relaxation by extending foreplay may help resolve painful intercourse (Black 2004, Borwell 1997, Bryant 1993).

Discharge planning

Discharge planning for the patient with a stoma should commence once the patient is admitted. It is important to set a provisional discharge date and set realistic goals with the patient. The patient needs to be discharged home with:

- adequate stoma supplies (approx. 2 weeks' supply)
- contact details of community stoma care nurse
- prescription details of products being used
- information on delivery company, if relevant.

Continuity of care for these patients is crucial. Effective communication and collaboraton between healthcare professionals are key to psychological adaptation and successful rehabilitation (Borwell 2009).

Follow-up support

The patient is discharged with adequate supplies until a prescription is obtained from the general practitioner. Written reminders are provided of how to care for the stoma, how to obtain supplies of appliances, and any other information that may be required. The patient should have details of non-medical stoma clinics, details about the relevant agencies and information about voluntary associations. Arrangements should also have been made for a home visit from the stoma care nurse and/or the community nurse (Blackley 1998, Cronin 2005). Figure 6.27 provides an example of a discharge checklist.

Figure 6.27 Discharge checklist.

From The Royal Marsden Hospital NHS Foundation Trust, Stoma Care Pathway.

		Tick Box	Date, Signature & Print Name
1.	Planned date of discharge: _____	Yes ☐ No ☐	
2.	Is the patient independent with stoma care	Yes ☐ No ☐	
3.	Community stoma care nurse informed	Yes ☐ No ☐	
4.	District nurses informed if necessary	Yes ☐ No ☐ N/A ☐	
5.	Date of first home visit by community stoma care nurse	**Date:**	
6.	Patient given contact details of community stoma care nurse Nurses NAME: _____ Contact telephone number: _____	Yes ☐ No ☐	
7.	If patient has chosen to use a delivery company, company informed and first order placed	Yes ☐ No ☐	
8.	Outpatient appointment made: _____	Yes ☐ No ☐	
9.	Patient given two weeks supply of stoma products	Yes ☐ No ☐	

Obtaining supplies

All NHS patients with a permanent stoma are entitled to free prescriptions for their stoma care products, and should complete the relevant forms for exemption from payment. Appliances can then be obtained from the local chemist, free home delivery services or directly from the appropriate manufacturers.

Complications

As a healthcare professional providing support and care to stoma patients, it is important to be able to distinguish normal from abnormal. The observational index (See Figure 6.27) provides a reference guide to use when observing, recording and reporting. If any of the complications are noted, it is important to ensure that the medical team and/or stoma care nurse is informed. Advice on how to manage these problems should be obtained from your specialist stoma care nurse. Recognition of problems and complications early can prevent more serious complications later.

Intestinal (Bowel) Obstruction and Ileus

Definition

Intestinal obstruction occurs when the passage of contents through the bowel lumen is inhibited, either by mechanical (anatomical) or non-mechanical causes.

The alternative term ‘ileus’ is sometimes used to describe the failure of passage of intestinal contents in the absence of any mechanical obstruction (Morton *et al.* 2005).

Related theory

Intestinal obstructions can be divided into those which occur in the large or small bowel, and can be further subdivided into the types of intestinal obstruction detailed in Table 6.7.

Table 6.7 Types of bowel obstruction

Type of obstruction	Causes
Mechanical – extrinisic causes	Tumours (benign or malignant), intussusceptions, adhesions (malignant, postoperative or radiation injury), bands (congenital), stenosis, hernias, malrotation/volvulus, aneurysm/embolus/telangiectasia/haematoma, abdominal trauma
Mechanical – intrinsic causes	Tumours, tuberculosis enteritis, Crohn's disease, toxic megacolon, radiation injury, diverticulitis, malrotation/volvulus, mesenteric cysts, congenital defects, Meckel's diverticulum, haematoma
Mechanical – intraluminal causes	Faecal impaction, gallstone ileus, ingested foreign objects, gastric bezoars, meconuim ileus, barium impaction
Neurogenic	Hirschsprung's disease, abdominal trauma, constipation secondary to spinal cord damage or compression, chemotherapy, severe electrolyte imbalance
Pseudo-obstruction (Ogilvie's syndrome)	Abdominal malignancy/carcinomatosis, chest infection, myocardial infarction, cerebrovascular accident, renal failure, puerperium, severe electrolyte imbalance

Adapted from Yamada (2009).

Intestinal obstructions are caused by a physical narrowing or internal blockage of the gut lumen, extrinsic compression of the bowel, or a disruption or failure in motility. In cancer patients, malignant bowel obstruction can be either partial or complete, with acute or gradual onset of symptoms (Letizia and Norton 2003).

Obstruction can occur at a single site or, in the case of disseminated intra-abdominal disease, such as intra-abdominal carcinomatosis, in multiple sites (Lynch and Sarazine 2006). Bowel obstruction is a common complication in patients with end-stage cancer, in particular where the primary tumour is abdominal or pelvic in origin. The reported incidence of the condition is between 5% and 42% in advanced ovarian cancer and from 4% to 24% in advanced colorectal cancer (Ripamonti *et al.* 2001).

Intestinal obstruction is a potentially devastating complication for the patient, with a vast number of possible clinical causes, and is a condition which can rapidly progress to cause life-threatening complications (Shih *et al.* 2003). Intestinal obstruction precipitates a cascade of pathophysiological events which lead to complex and unpleasant symptoms. Thoughtful nursing assessment and evaluation, and meticulous symptom control, can make an important

contribution to improving the experience of the patient in bowel obstruction.

Small bowel obstruction

Aetiology

The most common cause of small bowel obstruction (SBO) in adults is adhesions, accounting for approximately 65–75% of cases, and it is estimated that 93–100% of patients who undergo transperitoneal surgery will develop postoperative adhesions (Menzies and Ellis 1990). The second most common cause of SBO is hernias, which are thought to account for around 25% of cases (Turnage and Bergen 2002). SBO by primary small bowel neoplasm is uncommon (3% of cases), but approximately 10% of SBO are caused by luminal compression from gastric, pancreatic, gynaecological or colonic neoplasms.

Pathophysiology

When the small bowel becomes obstructed or static, large volumes of fluid and swallowed air accumulate in the lumen of the intestine, proximal to the obstruction. Oral fluid intake, saliva and gastric, biliary and pancreatic juices contribute to the accumulated fluid. Swallowed air is high in nitrogen and is not well absorbed by the bowel lumen. Initially peristalsis continues but in an unco-ordinated fashion, propelling luminal contents toward the site of obstruction (Ripamonti and Mercadente 2004). These bursts of peristalsis above the level of obstruction cause pain, which is often cramping and intermittent in nature (Morton *et al.* 2005).

Over time, as the obstructive process progresses, the bowel wall and lumen become oedematous and distended. The permeability of capillaries in the bowel wall is increased by the building pressure in the gut lumen, which in turn forces fluid and electrolytes from the capillaries into the abdominal cavity. This extravasation of fluid and electrolytes, coupled with fluid loss from vomiting, can precipitate hypovolaemia, hyponatraemia and hypokalaemia. Furthermore, the distension and hyperactive state of the bowel cause damage to the epithelial cells of the bowel wall, initiating an inflammatory response, activating cyclo-oxygenase pathway and release of prostaglandins (Murphy-Ende 2001).

In proximal SBO, the abdominal pain tends to be more severe, abdominal distension is typically minimal, and emesis is frequent, bilious and tends to relieve pain. It is commonly more frequent early in the course of obstruction. Nausea may be described as building in ‘waves’ and may be relieved after vomiting (Scott Brown *et al.* 2007). Distal SBO tends to present with moderate abdominal distension and intermittent or constant pain. Vomiting is typically intermittent.

As obstruction progresses further, eventually peristaltic action of the bowel decreases, and this stasis encourages proliferation of bacteria. If the patient continues to eat and drink, bacterial fermentation causes gas production, leading to further abdominal distension. This bacterial overgrowth can cause the bowel contents proximal to the obstruction to become faeculent and malodorous within hours of the obstruction developing (Morton *et al.* 2005).

Large bowel obstruction (colonic obstruction)

Aetiology

By contrast, most obstructions of the large intestine (colon) are caused by malignant neoplasms, sigmoid diverticulitis and volvulus. These three causes account for 90% of cases of large bowel obstruction. In a study in the USA, malignancy was found to be the most common cause of colonic obstruction, contributing to 50% of cases (Turnage and Bergen 2002). Ten percent to 28% of patients with colorectal cancer will go on to develop a malignant obstruction in the course of their disease, and 20–50% of patients with ovarian cancer present with large bowel obstruction (Ripamonti *et al.* 2008).

Pathophysiology

The process of large bowel obstruction mimics that of small bowel obstruction. Normal colonic flora continue to produce methane and ammonia which contribute to distension of the bowel. In the presence of a competent ileocaecal valve, accumulating fluid and gas are unable to decompress into the adjacent small bowel. As a result, the intraluminal pressure builds and when this pressure exceeds that of the capillary pressure, ischaemia can occur. In colonic obstruction, changes in intestinal flora and translocation of bacteria from the mesentery can also cause sepsis.

Figure 6.28 illustrates the 'cascade' process of bowel obstruction.

Figure 6.28 Cascade process of bowel obstruction.

Reproduced from Ripamonti et al. (2008).

Evidence-based approaches

The nursing management of the patient in bowel obstruction is multidimensional. Whilst there are essentially two basic approaches to resolving bowel obstruction (surgery or medical management), the nurse should work with the multidisciplinary team to provide care appropriate to the individual. The nurse can play an important role in assessing, evaluating and treating the side-effects of bowel obstruction, and in supporting and educating the patient. This section outlines the risks and benefits of medical and surgical management and provides an evidence-based approach to addressing some of the common

symptoms of intestinal obstruction.

Surgical or medical management

Where possible, small bowel obstruction is medically treated with supportive measures (Morton *et al.* 2005). A Norwegian study of 154 patients by Fevang *et al*. (2002) supported this; 91 patients in their study had small bowel obstruction without evidence of strangulation and, following conservative management, 79% of these obstructions were successfully resolved. Where ileus or pseudo-obstruction (e.g. Ogilvie's syndrome) is the cause of symptoms, surgical management is not appropriate.

By contrast, colonic obstruction more commonly requires relieving by a surgical approach, although in the instance of a volvulus, decompression by colonoscopy may be possible. Endoscopic placement of colonic stent may be used as a palliative relief of obstruction by inoperable tumours of the colon, and studies have shown clinical improvement in symptoms in over 75% of patients (Camunez *et al.* 2000, Mainar *et al.* 1999). If the patient's condition fails to improve following medical management of colonic obstruction, or if the patient has a complete obstruction and competent ileocaecal valve, surgical management is recommended.

The medical/pharmacological approach is particularly favoured in the management of malignant bowel obstruction, where surgery may be contraindicated by complications such as diffuse intra-abdominal spread of disease, massive ascites, poor nutritional status and poor performance status (Lynch and Sarazine 2006). A multidisciplinary steering group for the European Association for Palliative Care (EPAC) concluded that surgery to relieve malignant obstruction should not be routinely undertaken in patients with poor prognostic criteria (Ripamonti *et al.* 2001). Pharmacological management of intestinal obstruction revolves around use of analgesics, antispasmodics and antiemetics to manage symptoms. Corticosteroids have also been used to successfully reverse obstruction in malignant obstruction (Feuer and Broadley 1999). They reduce peritumoural and perineural oedema, thereby helping to relieve obstruction, and have an antiemetic action (Ripamonti *et al.* 2001).

Principles of care

Nursing care of the patient in bowel obstruction is focused on competent assessment and treatment of symptoms and on supporting the patient through what can be a traumatic experience, which may have life-changing consequences. The nurse should work with the whole multidisciplinary team in endeavouring to control the patient's symptoms. The nurse should advocate for the patient, both informing and involving the patient in decisions about their care whenever possible throughout the episode.

Preprocedural considerations

Pharmacological support

Analgesia

Good pain relief is an essential part of the management of bowel obstruction. Where pain can be effectively managed, an episode of bowel obstruction may be less distressing for the patient. Pain should be regularly assessed using an appropriate assessment tool, allowing the patient to describe and rate their pain, to that analgesia can be appropriately titrated.

The pain associated with bowel obstruction is usually described by patients as severe. With reference to the World Health Organization analgesic ladder, such pain should be treated with opioids (Lynch and Sarazine 2006). Opioids can be effectively delivered via the subcutaneous route, allowing for 24-hour infusion and intermittent bolus breakthrough dose administration. Intravenous administration produces rapid analgesia but of short duration, necessitating 4-hourly administration of doses. In addition, buccal or transdermal opioids may be appropriate, as both avoid the oral route, although the transdermal route should be reserved for when opioid requirements are stable. The opioid dose must always be carefully titrated against the effect and should usually be administered parenterally (Hanks *et al.* 2001).

Antiemesis

The nausea and vomiting associated with bowel obstruction can be very distressing for the patient. The nurse has a role in supporting the patient, providing reassurance, and assessing and managing symptoms appropriately.

Antiemesis in bowel obstruction is focused on decompression of the bowel, management of gastrointestinal secretions, and management of bowel spasm. A wide-bore nasogastric tube, such as a Ryle's tube, may be inserted to decompress the stomach. This can be used to aspirate stomach contents to relieve nausea and distension. Nasogastric tubes should not be used for long-term management of bowel obstruction as they are associated with pain, epistaxis, infection and psychological distress (Ripamonti and Mercadente 2004) and can cause pressure ulcers on the nose if they are in place long term. If long-term gastric decompression is required in the patient with irreversible malignant bowel obstruction, a venting gastrostomy may be placed. Palliative venting gastrostomy reduces episodes of emesis and allows patients with bowel obstruction near the end of life to drink a free fluid diet which they may find comforting, improving their quality of life at a distressing time (Lynch and Sarazine 2006).

Antiemetics should be prescribed with care. Prokinetic antiemetics which promote gastric emptying and peristalsis, such as metoclopramide or domperidone, should be avoided in patients with complete obstruction. The prokinetic action of these drugs stimulates bowel contraction and can cause increased pain as they contribute to the dysrhythmic, spasmodic contraction of bowel. Antiemesis can be better achieved using a dopamine receptor agonist such as prochlorperazine or haloperidol, blocking chemoreceptor trigger zones and preventing transmission to the vomiting centre in the brain. In addition, corticosteroids may be used to reduce inflammation and oedema in the bowel, and have the benefit of both an antiemetic effect and co-analgesic properties (Feur and Broadley 1999). Studies have shown that corticosteroids may play a role in relieving obstruction in the patient with malignant bowel obstruction, by reducing peritumour oedema (Laval *et al.* 2000). The subcutaneous infusion route provides an opportunity to provide constant delivery of antiemesis, avoiding the oral route.

Increased production of secretions can also contribute to nausea, and a somatostatin analogue, such as octreotide, has antivasointestinal properties and may help to reduce bowel secretions (Ripamonti and Mercadente 2004).

Octreotide inhibits release and activity of GI hormones, modulates GI function by reducing gastric acid secretion, reduces intestinal motility and decreases bile flow but increases mucus production. It plays an important role in reducing GI contents and increasing absorption of water and electrolytes at intracellular level (Ripamonti *et al.* 2008). Consequentially, secretions throughout the whole GI tract are reduced and patients may suffer from a dry mouth; therefore diligent and regular mouthcare is necessary to alleviate the discomfort associated with dry mouth, and the possible increased risk of oral infections because of reduced saliva production.

Non-pharmacological support

Hydration

Fluid resuscitation should be commenced and essential electrolytes such as potassium should be replaced as indicated by blood results. Patients in bowel obstruction can become profoundly dehydrated from vomiting and as fluid and electrolytes leave the oedematous bowel and enter the abdominal cavity. This causes hypotension, tachycardia and derangement of electrolytes. The nurse should make an assessment of the patient's hydration status (see Chapter 8) and keep an accurate record of fluid input and output, remembering to record nasogastric losses.

In the patient with bowel obstruction receiving end-of-life care, thought should be given to whether it is appropriate to commence intravenous hydration, as artificially hydrating such patients may be contraindicated, and the benefits and burdens of IV hydration should be discussed with the patient and their family (Lynch and Sarazine 2006).

Nutrition

Enteral feeding is usually contraindicated in bowel obstruction so the patient in bowel obstruction is at risk of nutritional deficiency. In order to prevent exacerbation of nausea and vomiting, and abdominal pain and distension, the benefits of total parenteral nutrition (TPN) may be considered. The indication for TPN is to maintain or restore a patient's nutritional status, and the prevention and correction of complications associated with malnutrition. The nutritional benefits of TPN are greater if it is delivered over an extended period, and it is not particularly beneficial for short-term use (Bozzetti *et al.* 2001).

In patients with inoperable bowel obstruction due to malignancy, the use of TPN is controversial as it can lead to complications and can make prolonged hospital stay necessary, which can be a barrier to timely and appropriate discharge at the end of life (Philip and Depczynski 1997).

Food and eating are often of great importance to patients emotionally, socially and culturally, as well as physically. For those patients who are unable to eat or drink due to inoperable and irreversible malignancy, long-term gastric decompression offers effective palliation of distension and vomiting, whilst allowing the patient to drink and eat for comfort, venting the stomach when necessary to alleviate symptoms. This may allow them to continue an active lifestyle without the discomfort, aesthetic problems and inconvenience of a nasogastric tube (Ripamonti *et al.* 2001).

Psychosocial and emotional care

The nurse can play a crucial role in supporting the obstructed patient with psychosocial, emotional and cultural issues surrounding bowel obstruction. For some patients and their families, it can be a difficult subject to discuss and the nurse can help facilitate good communication about the condition. For the patient who has an operable obstruction, there is the possible challenge of a stoma to contemplate, and the psychosocial, emotional, cultural and psychosexual implications of this.

For many patients, the eating and sharing of food have great emotional, social and cultural significance, and when these activities are curtailed by obstruction, the patient may experience a sense of loss. The nurse can work in conjunction with the patient and their family to try and control symptoms, and help to restore as normal a lifestyle as possible. Patients at the end of life should be given choices about how they would like their condition managed, and where possible should be treated in such a way that their care can be given at home if this is clinically and practically feasible.

Websites

MedicAlert Foundation: www.medicalert.org.uk

Sexual Dysfunction Association:

www.sexualdysfunctionassociation.com

Urostomy Association: www.uagbi.org

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Parenteral Nutrition

Definition

Parenteral nutrition (PN) is the direct infusion into a vein of solutions containing the essential nutrients in quantities to meet all the daily needs of the patient (Furst *et al.* 2001).

Related theory

The basic components of a PN regimen are provided by solutions including the following.

- *Amino acids (nitrogen source).* Commercially available solutions provide both essential amino acids, usually in proportions to meet requirements, and non-essential amino acids, such as alanine and glycine. They may also contain conditionally essential amino acids such as glutamine for use in critical care (Goeters *et al.* 2002, Jian *et al.* 1999, Mertes *et al.* 2000).
- *Glucose (carbohydrate energy source).* Glucose is the carbohydrate source of choice. It provides 3.75 kcal/g (15.5 kJ/g) and usually provides 50% of non-nitrogen energy.
- *Fat emulsion (fat energy source).* Fat generates 9 kcal/g (37 kJ/g) and its inclusion in PN is necessary to provide essential fatty acids. Fat usually provides 50% of non-nitrogen energy. Nitrogen:non-nitrogen energy is usually provided in the ratio of 1:150–200. An insufficient energy supply from carbohydrate and fat will encourage the use of nitrogen for energy.
- *Electrolytes*, for example sodium, potassium, calcium, magnesium and phosphate.
- *Vitamins and minerals*. Both water-soluble and fatsoluble vitamins are required as part of a standard bag.
- *Trace elements*, for example zinc, copper, chromium, selenium (Thomas and Bishop 2007).

Evidence-based approaches

Rationale

Parenteral nutrition should only be used when it is not possible to meet nutritional requirements via the gastrointestinal tract. PN is an invasive and relatively expensive form of nutrition support and, in inexperienced hands, can be associated with risks from catheter placement, catheter infections, thrombosis and metabolic disturbance. Careful consideration is therefore needed when deciding to whom, when and how this form of nutrition support should be given. It should be planned and managed by healthcare professionals with the relevant expertise. Whenever possible, patients should be aware of why this form of nutrition support is needed and its potential risks and benefits.

Parenteral nutrition may be used in combination with enteral nutrition where some gut function is present but this is insufficient to meet nutritional requirements, for example in intestinal failure where the patient can eat but absorptive capacity may be insufficient to maintain nutritional status.

Indications

The indications for parenteral nutrition are:

- failure of gut function (e.g. with obstruction, ileus, dysmotility, fistulae, surgical resection or severe malabsorption) to a degree that definitely prevents adequate gastrointestinal absorption of nutrients
- the consequent intestinal failure has either persisted for several days (e.g. >5 days) or is likely to persist for many days (e.g. 5 days or longer) before significant improvement.

(Bozzetti *et al.*, 2009, Braga *et al.* 2009, NCCAC 2006)

Examples of the use of PN include for patients with prolonged gastrointestinal ileus, intractable vomiting, multiorgan failure where requirements cannot be met by the enteral route and proximal high-output fistula.

Contraindications

If the gut can be used or an attempt to use it has not yet been considered, then PN should be withheld pending the outcome of using the enteral system. PN should also not be used if the perceived risk to the patient outweighs the benefits anticipated (NCCAC 2006).

Contents of parenteral nutrition

Parenteral nutrition provides nutrients in a form that can be used directly by the body when they are infused intravenously. Nitrogen (protein) is provided as free amino acids in a ratio designed to meet requirements for essential amino acids. Specific amino acid profiles may be used for some disease states. Energy is usually provided from carbohydrate and fat. Carbohydrate is present as glucose and fat is provided as a lipid emulsion providing essential fatty acids. The lipid source may be provided by long-chain and/or medium-chain triglycerides with different manufacturers using various lipid blends. Fluid, electrolytes, vitamins, minerals and trace elements are also provided by parenteral nutrition.

Choice of a parenteral nutrition regimen

Parenteral nutrition is usually administered from a single infusion container in which all the requirements for a 24-hour feed are premixed. Such infusions are available as standard ready-prepared bags that require the addition of vitamins, minerals and trace elements or individual bags may be made to a particular prescription and purchased from a compounding unit.

The regimen for a particular patient should be formulated according to their needs for energy and nitrogen. The majority of commercial vitamin and mineral preparations aim to meet both short-and long-term requirements although appropriate monitoring is required to ensure that nutritional requirements are met in the longer term as clinically indicated by the monitoring guidelines. Standard PN regimens may be suitable for some patients who require short-term nutritional support or do not appear to have excessively altered nutritional requirements.

The choice of such regimens depends on the patient’s bodyweight and nutritional requirements. To allow for the possible need to vary the constituents of the infusion in response to changes in the patient’s electrolyte or nutritional requirements, PN solutions should be ordered daily. Once compounded, most PN preparations last up to 7 days (Weinstein and Plumer 2007) and need to be stored in a refrigerator. However, some triple-chamber PN bags can be stored at ambient temperatures and require mixing prior to administration. These bags generally require the addition of vitamins, minerals and trace elements under aseptic conditions.

Parenteral nutrition should be introduced slowly in the seriously ill or injured,

with no more than 50% of requirements given in the first 24–48 hours due to the risk of refeeding syndrome (NCCAC 2006).

Methods of administration

The traditional method of access is via a central venous catheter. Central venous access is required because PN solutions are hyperosmolar and there is a risk of thrombophlebitis associated with feeding into peripheral veins (Springhouse 2002, Wilson and Jordan 2001). However, it has been shown that with care and attention, peripheral veins can be used to provide short-term peripheral PN (NCCAC 2006). This would be via a midline or a peripheral cannula. For the administration of PN, the device should be placed in the largest vein possible, usually in the forearm away from a joint, with rotation of the site every 48–72 hours (Shaw 2008). For insertion see Chapter 18.

A skin-tunnelled catheter is the catheter of choice for long-term nutrition but peripherally inserted central cannulas (PICCs) or non-tunnelled central venous catheters can also be used in the short term. The number of lumens will depend on the patient's peripheral venous access and the number of additional therapies required. It is recommended that the minimum number of lumens is used but if additional intravenous access is required then a double-or triple-lumen catheter should be inserted and then one lumen should be dedicated for use with PN. If using a single-lumen device, routine blood sampling and additional infusions should be carried out independently, using a separate cannula if necessary (Davidson 2005).

For setting up an infusion, see Chapter 16 (Procedure guideline 16.23).

Postprocedural considerations

Ongoing care

Administration sets should always be changed every 24 hours (Pratt *et al.* 2007, Springhouse 2002, Wilson and Jordan 2001). Existing injection sites on the administration set should never be used for giving additional medications as PN is incompatible with numerous medications. Drugs may bind to the nutrients or the PN bag, reducing their availability. If any additional medications, blood products or central venous pressure (CVP) readings are required then they should be given or taken via a separate lumen or via a peripheral device (Mirtallo *et al.* 2004).

A volumetric infusion pump must be used to ensure accurate delivery of PN. No bag should be used for longer than 24 hours (Springhouse 2002, Wilson and Jordan 2001).

If the infusion must be discontinued, the catheter should be flushed to maintain patency. The risk of infection increases if the infusion is disconnected from the central venous device; therefore, it is not advisable to disconnect PN until the whole daily requirement has been administered (Pratt *et al.* 2007).

During intravenous feeding, monitoring is necessary to detect and minimize complications. Once feeding is established and the patient is biochemically stable then the frequency of monitoring may be reduced if the clinical condition of the patient permits (see Table 8.8). Additional patient monitoring such as 24-hour urine collection for urinary urea, nitrogen and checking serum trace element levels may be carried out where indicated, for example in severe malnutrition or when PN is used for prolonged periods of time (Weinstein and Plumer 2007).

Table 8.8 Monitoring in nutrition support

Parameter	Frequency of monitoring	Rationale	Interpretation
Catheter entry site	Daily	Signs of infection/inflammation	Interpret with knowledge of infection control
Skin over position of catheter tip	Daily	Signs of thrombophlebitis	
General condition	Daily	To check tolerance of feed and that feed and route continue to be appropriate	
Temperature/blood pressure	Daily, then as needed	Sign of infection, fluid balance	
Sodium, potassium, urea, creatinine	Baseline, then daily until stable, then 1–2 times a week	Assessment of renal function, fluid status	Interpret with knowledge of fluid balance and medication Urinary sodium may be helpful in complex cases with gastrointestinal fluid loss
Glucose	Baseline, then 1–2 times daily until stable (more if needed), then weekly	Glucose intolerance is common	Good glycaemic control is necessary
Magnesium, phosphate	Baseline, then daily if risk of refeeding syndrome, then three times a week until stable, then weekly	Depletion is common and under-recognized	Low concentrations indicate poor status
Liver function tests	Baseline, then twice weekly until stable, then weekly	Abnormalities common during PN	Complex. May be due to sepsis, other disease or nutritional intake
Calcium, albumin	Baseline, then weekly	Low or high levels may occur	Correct measured serum calcium concentration for albumin Hypocalcaemia may be secondary to magnesium deficiency Low albumin reflects disease not protein status
C-reactive protein	Baseline, then 2 or 3 times a week until stable	Assists interpretation of protein, trace element and vitamin results	To assess the presence of an acute-phase reaction The trend of results is important
Zinc, copper	Baseline, then every 2–4 weeks depending on results	Deficiency is common, especially with increased losses	People most at risk when anabolic Zinc decreases and copper increases in acute-phase reaction
Selenium	Baseline if risk of depletion, further testing depending on this	Deficiency is likely in severe illness and sepsis, or long-term nutrition support	Decreases in acute-phase reaction Long-term status better assessed by glutathione peroxidase
Full blood count	Baseline, then 1 or 2 times a week until stable, then weekly	Anaemia due to iron or folate deficiency is common	Effects of sepsis may be important
Iron, ferritin	Baseline, then every 3–6 months	Iron deficiency is common in long-term PN	Iron status is difficult to assess in acute-phase reaction Iron decreases, while ferritin increases
Folate, vitamin B_{12}	Baseline then every 2–4 weeks	Iron deficiency is common	Serum folate/B_{12} sufficient with full blood count
Manganese	Every 3–6 months if on home PN	Excess provision to be avoided, more likely in liver disease	Red blood cell or whole blood better measure of excess than plasma
Vitamin D	Six monthly if on long-term PN	Low levels if housebound	Requires normal kidney function for effect
Bone densitometry	On starting home PN, then every 2 years	Diagnosis of metabolic bone disease	Together with lab tests for metabolic bone disease

Adapted from NCCAC (2006), pp. 23–25.

Home parenteral nutrition

There are a few indications for home PN. It may be necessary in patients who have complete intestinal failure or insufficient functioning bowel to maintain an adequate nutritional status via the enteral route, for example short bowel syndrome due to Crohn's disease or radiation enteritis.

This is a complicated and specialist treatment, requiring 24-hour access to advice and support, and should be co-ordinated through a specialist centre.

No patient should be considered for home PN without a multidisciplinary discussion of the patient and the formulation of a clear management plan. If continuation of hospital-initiated PN is considered essential, the implications must be discussed with the multiprofessional team, including the medical consultant, dietetics, pharmacy, IV therapy team, complex discharge co-ordinator and patient.

There is national guidance on the training, provision and appropriate support for such patients, which should be consulted prior to any discharge of patients receiving PN (BAPEN 2003a, NHS National Commissioning Group 2008). However, in England there are plans to develop a national clinical network of expert regional units to provide support for patients requiring home PN to ensure that their needs are met appropriately (NHS 2009). Patients require an extensive period of specialized training to manage PN in the home environment and this should be undertaken by such units and clinical teams.

It is important that all members of the multidisciplinary team, including the dietitian, nurse, doctor, pharmacist, catering department and community services, are involved in the patient's nutritional care to ensure a thorough and co-ordinated approach to nutritional management (BAPEN 2003a, NCCAC 2006).

Termination of parenteral nutrition

Parenteral nutrition should not be terminated until oral or enteral tube feeding is well established (NCCAC 2006, Weinstein and Plumer 2007). PN should be weaned off to half rate before stopping, to prevent rebound hypoglycaemia, as well as to ensure adequate nutritional intake via an alternative route. It is important that all members of the multidisciplinary team are involved in the decision to terminate PN and that enteral intake is monitored sufficiently.

Complications

Metabolic complications should be detected by appropriate monitoring. Some of the more common complications are as follows.

Fluid overload

This may occur when other blood products and fluids are given concurrently. It may be possible to reduce the volume of a 24-hour bag of PN while maintaining the nutritional content. A pharmacist and dietitian can advise on the feasibility of creating such regimens.

Hyperglycaemia

This may occur due to stress-induced insulin resistance or carbohydrate overload. A simultaneous sliding scale insulin infusion may be required. Failure to recognize hyperglycaemia may result in osmotic diuresis.

Hypoglycaemia

Abrupt cessation of PN may result in a rebound hypoglycaemia. A reduction in infusion to half the rate prior to stopping the infusion may help prevent this occurring.

Azotaemia

Raised plasma urea may indicate renal dysfunction or dehydration. Alterations in the nitrogen and non-protein energy content of the PN may be required, or an increase in fluid input (Payne-James *et al.* 2001).

Hypophosphataemia

This is associated with excessive glucose infusion and the refeeding syndrome in malnourished patients (NCCAC 2006, Solomon and Kirby 1990). It is necessary to correct phosphate levels by providing additional phosphate prior to feeding. Phosphate levels should be monitored daily at the start of feeding.

Other complications such as metabolic acidosis, electrolyte disturbances, hypernatraemia, hypokalaemia and hypomagnesaemia may require a review of the PN solution, rate of administration, additional fluids, blood products and drugs.

Transfusion of Blood and Blood Components

Definition

Blood transfusion is the administration of a blood component-or plasma-derived product to the patient (Gray *et al.* 2007). Blood is a raw material from which different therapeutic products are made (McClelland 2007).

Anatomy and physiology

ABO blood groups and rhesus types

In 1901, Landsteiner discovered that human blood groups existed and developed the ABO system which marked the start of safe blood transfusion (Bishop 2008). There are four principal blood groups: A, B, AB and O. Each group relates to the presence or absence of surface antigens on the red blood cells and antibodies in the serum which dictate blood compatibility (Table 8.9).

Table 8.9 Blood group compatibility

Group	Antigens	IgM antibodies	Compatible donor for	Compatible recipient of
A	A	Anti B	A AB	A O
B	B	Anti A	B AB	B O
AB	A and B	None	AB	A B AB O
O	None	Anti A Anti B	A B AB O	O

Table 8.10 Blood and blood products used for transfusion

Type	Description	Indications	Cross-matching	Shelf life	Average infusion time	Technique	Special considerations
Red cells in optimal additive solutions (SAGM)[a]	Red cells with plasma removed: 100 mL additive fluid used as replacement to give optimal red cell preservation; haematocrit 60–65% leuco-depleted	Correction of anaemia	ABO and Rh compatible (not necessarily identical)	35 days at 2–6°C	1–2 hours/unit. Transfusion to be completed within 4 hours of component's removal from storage	Give via a blood administration set	If more than half blood volume is replaced with red cells in SAGM, use of FFP should be considered to replace clotting factors
Washed red blood cells	Red cells centrifuged and re-suspended twice in 0.9% sodium chloride Leuco-depleted	Correction of anaemia where patient may react to plasma components, for example in IgA deficiency	As above	Prepared by non-sterile process, therefore to be used within 24 hours	1–2 hours/unit	As above	–
Frozen red blood cells	Red cells of very rare phenotype Leuco-depleted	To treat patients with very rare antibody	As above	Stored frozen cells: 3 years. Use within 12 hours of thawing	2–3 hours/unit	As above	–
White blood cells (buffy coat or apheresed granulocytes)[b]	Mainly granulocytes obtained by leucophoresis or by 'creaming off' the white blood cell layer from fresh blood	To treat patients with life-threatening granulocytopenia	As above	24 hours after preparation. Stored at room temperature	60–90 minutes/unit	Administer via a blood administration set	White blood cell infusion induces fever, may cause hypotension, rigors and confusion. Treat symptoms and reassure patient Preparation is always irradiated to prevent initiation of transfusion-associated graft-versus-host disease (TA-GVHD). *Do not* give to patients receiving amphotericin B. Indications for granulocyte transfusions should be when possible benefits are thought to outweigh considerable hazards of the treatment option (Brozovis *et al.*, 1998)
Platelets[a]	Platelets in 200–300 mL plasma. May be pooled from 5 donors or apheresed from a single donor Leuco-depleted	To treat thrombocytopenia	No cross-matching necessary	Up to 7 days after collection. Storage is at 22°C, with continuous gentle agitation	20–30 minutes/unit	Administration using a platelet administration set. Use a new set for each transfusion. Do not use micro-aggregate filters	General guide to use: 1 Count less than 10×10^9/L 2 Count $10–20 \times 10^9$/L with haemorrhage and/or persistent pyrexia 3 Count $20–50 \times 10^9$/L in special cases or pre-invasive procedure

Fresh frozen plasma	Citrated plasma separated from whole blood	To treat a deficiency in clotting factors due to dilution effects, consumption (in DIC), liver failure or overdose of coumarin anticoagulant	No cross-matching necessary	2 years at –30°C. Once thawed, kept at 4°C, to be used as soon as possible but within 24 hours	15–45 minutes/unit (approx. 250 mL)	Administer rapidly via a blood administration set	FFP should be considered if patient has received more than half their blood volume in red cells, to prevent dilutional hypocoagulability
Albumin 4.5% (HAS)	Solution of albumin from pooled plasma in a buffered, stabilized 0.9% sodium chloride diluent. Supplied in 250 mL or 500 mL bottle	To treat hypovolaemic shock or hypoproteinaemia due to burns, trauma, surgery or infection. Sourced outside UK to reduce risk of transmission of vCJD	Unnecessary. Not blood group specific	5 years at room temperature Kept in dark	30–60 minutes/unit	Administer via a standard solution administration set	The solution should be crystal clear with no deposits
Albumin 20% (HAS)	Heat-treated, aqueous, chemically processed fraction of pooled plasma	To treat hypovolaemic shock or hypoproteinaemia due to burns, trauma, surgery or infection. To maintain appropriate electrolyte balance	Unnecessary	5 years at room temperature Kept in dark	30–60 minutes/unit	Administer via a blood administration set undiluted or diluted with 0.9% sodium chloride or 5% glucose solution. Slower administration is advised if a cardiac disorder is present to avoid gross fluid shift	The solution should be crystal clear with no deposits

Cryoprecipitate	Cold-insoluble portion of plasma recovered from FFP: rich in factor VIII, von Willebrand's factor and fibrinogen. Available as single packs (20–40 mL) or 5 units pooled (120–140 mL)	To control bleeding disorders due to lack of factor VIII or fibrinogen, for example haemophilia, von Willebrand's disease, DIC	No cross-matching necessary	2 years at –30°C. Use immediately after thawing	15–30 minutes via infusion, 10–15 minutes via intravenous push	Administer rapidly via syringe or blood administration set
Cryo-depleted plasma	FFP with cryoprecipitate removed	Useful in treating thrombotic thrombocytopenic purpura: patients are plasma-exchanged daily to reduce circulating von Willebrand's factor	No cross-matching necessary	2 years at –30°C. Once thawed, kept at 4°C, to be used as soon as possible but within 24 hours	Time varies on machine average ±2.5 hours	Via apheresis machine

[a]Most commonly used blood products.

[b]See leucocyte depletion.

People with the blood group **AB** have red cells with A and B surface antigens, but they do not have any anti-A or anti-B immunoglobulin M (IgM) antibodies in their serum. Therefore, they are able to receive blood from any group, but can

only donate to other people from group AB.

People with group **O** red cells do not have either A or B surface antigens but they do have anti-A and anti-B IgM antibodies in their serum. They are only able to receive blood from group **O**, but can donate to A, B, O and AB groups.

People with group **A** red cells have type A surface antigens, and they have anti-B IgM antibodies in their serum. They are only able to receive blood from groups **A** or **O** and can only donate blood to people from A and AB groups.

People with group **B** red cells have type B surface antigens and they have anti-A IgM antibodies in their serum. They are therefore only able to receive blood from groups **B** or **O** and can only donate blood to people from B and AB groups.

In addition to the ABO system, the rhesus (Rh) system was discovered in 1940; again, these are surface antigens and they are another essential system used in transfusion therapy (Mollison *et al.* 1997). The Rh D antigen is the most immunogenic of the Rh antigens (Porth 2005). However, many other red cell antigens exist and exposure to them may stimulate the development of corresponding antibodies (McClelland 2007).

Related theory

Blood group incompatibility

The transfusion of ABO incompatible red cells can lead to intravascular haemolysis where the recipient's IgM antibodies bind to the corresponding surface antigens of the transfused cells (McClelland 2007). Complement activation results in lysis of the transfused cells and the haemoglobin that is released precipitates renal failure, with the fragments of the lysed cells activating the clotting pathways, which in turn leads to the development of disseminated intravascular coagulation (DIC) (Mollison *et al.* 1997). Transfusion of rhesus-positive cells to a rhesus-negative individual will result in immunization and the appearance of anti-D antibodies (Hoffbrand *et al.* 2006). However, on any subsequent exposure extravascular haemolysis occurs when rhesus antibody-coated red cells are destroyed by macrophages in the liver and spleen (McClelland 2007).

A patient's rhesus status is of particular importance in pregnancy as haemolytic disease of the newborn (HDN) can occur when the mother is rhesus negative and the developing foetus is rhesus positive as exposure to foetal blood can stimulate anti-D activation in the mother, which in turn can cross the placenta, causing haemolysis (McClelland 2007).

Blood groups in haemopoietic stem cell transplantation

The human leucocyte antigen (HLA) is used to determine compatibility for organ transplantation, including bone marrow and peripheral blood stem cells. However, because ABO blood groups and HLA tissue types are determined genetically, it is not uncommon to find a suitable HLA donor who is ABO and/or rhesus incompatible with the recipient. In such circumstances, major transfusion reactions can be avoided by red cell and/or plasma depletion of the donor cells in the laboratory before reinfusion (Mollison *et al.* 1997). Occasionally, if the recipient has a very high titre of anti-A or anti-B lytic antibody and the donor marrow or peripheral blood stem cells are blood group A, B or AB, then plasmapheresis of the recipient may be performed to lower the titre of this antibody to safe limits. This is necessary because it is not possible to remove all the red cells from the donor product and those remaining may cause a major transfusion reaction in this situation (Mollison *et al.* 1997).

Evidence-based approaches

The transfusion of blood components is a complex multi-step process involving personnel from diverse backgrounds with differing levels of knowledge and understanding. Errors made in the process of transfusion present a significant risk to patients.

Although there is little evidence to support the efficacy for set procedures to manage this risk, current professional opinion has been provided by the British Committee for Standards in Haematology (BCSH) in collaboration with the Royal College of Nursing (RCN) and the Royal College of Surgeons of England (RCS) (BCSH 1999, Gray and Illingworth 2005). As a result of this guidance, every hospital should have a policy in place for the administration of blood and blood components including identification of the patient, blood sampling, special blood requirement requests, processing of blood samples, the storage, collection and transportation of blood products, administration of blood products and the care and monitoring of the transfused patient. Furthermore, hospitals are also required to manage and report any adverse events or near misses, with a statutory requirement to hold a record of every step of the transfusion process including the final fate of each blood product for 30 years (James 2005). Only staff authorized to do so should be involved at any stage in the transfusion process.

Nurses in the UK are normally the healthcare professionals ultimately responsible for the bedside check and arguably have the final opportunity to prevent errors occurring when patients receive blood transfusions (Wilkinson and Wilkinson 2001). Errors in the requesting, collection and administration of blood components (red cells, platelets and plasma concentrates) lead to significant risks for patients. Since its launch in 1996, the Serious Hazards of Transfusion (SHOT) scheme has continually shown that ‘wrong blood into patient’ episodes are a frequently reported transfusion hazard. These wrong blood incidents are mainly due to human error arising from misidentification of the patient during blood sampling, blood component collection and delivery or administration which can lead to life-threatening haemolytic transfusion reactions and other significant morbidity (BCSH 2009).

The National Comparative Audits (NCA) of bedside transfusion practice in England and North Wales (2003, 2005 and 2009) show that patients continue to be placed at risk of avoidable complications of transfusion through misidentification and inadequate monitoring of the patient.

Rationale

Blood transfusion is an essential part of modern medicine and healthcare. However, it should be prescribed only to treat conditions associated with significant morbidity or mortality that cannot be prevented or managed by other means (WHO 2005).

Recent publications and legislation have created greater awareness of the need to continue to improve transfusion practice in many ways. Blood and blood products are no longer regarded as safe unlimited resources. There are risks inherent in transfusion practice and therefore unnecessary exposure to blood products should be avoided. This is of particular importance for patients who may only have one transfusion in their lifetime, such as surgical patients. Therefore, these patients should only receive a transfusion when it is absolutely necessary. Furthermore, the appropriate use of products is essential for the conservation of blood supplies. Regularly updated guidance on the safe appropriate use of blood and blood products is now available online at www.transfusionguidelines.org.uk and these should be consulted in collaboration with local hospital and blood transfusion service guidelines.

Indications

Anaemia is defined as a haemoglobin concentration in blood that is below the expected value, when age, gender, pregnancy and certain environmental factors, such as altitude, are taken into consideration. In general, anaemia is a consequence of one or more of the following generic causes:

- increased loss of red blood cells
- decreased production of red blood cells
- increased destruction of red blood cells
- increased demand of red blood cells
- increased production of abnormal red blood cells,

which may be due to nutritional deficits, blood loss, kidney disease, medication or chronic diseases (Fields and Meyers 2006, Moftah 2005).

A minimum transfusion trigger has not been well established because of the variability of patient co-morbidities and anaemia tolerance. Evidence suggests that most patients can safely tolerate anaemia of 7 g/dL of Hb in the absence of active bleeding (Tolich 2008). However, surveys of the UK population show that most blood recipients are relatively elderly; many will have cardiovascular disease and may be less tolerant of low haemoglobin levels than younger, fitter patients. A low transfusion threshold may therefore be unwise, as older patients may also be at greater risk of congestive cardiac failure due to volume overload when blood and other fluids are infused (Blood Safety and Quality Regulations 2005, McClelland 2007).

Blood donation and testing

All blood donated in the UK is given voluntarily. The successful selection of a donor must protect them from any harm that may be caused by the donation process and also protect the possible recipient of products derived from the donor's blood. Donors of blood for therapeutic use should be in good health; if there is any doubt about their suitability, the donation should be deferred and they should be fully assessed by a designated medical officer. All donors of blood or its components (via apheresis) should be assessed in accordance with the Joint UKBTS/NIBSC Professional Advisory Committee (JPAC) donor selection guidelines (JPAC 2007). The assessment of fitness to donate includes a questionnaire relating to general health, lifestyle, past medical history and medication. Donation may be temporarily or permanently deferred for a variety of reasons including cardiovascular disease, central nervous system diseases, malignancy and some infectious diseases, all of which are detailed in the JPAC (2007) guidelines. Donors are also screened for risk of exposure to transmissible infectious diseases, and specific guidance is provided for donors receiving therapeutic drugs.

Prevention of transmission of infection is determined by donor selection criteria and laboratory testing. In the UK, all blood donations are tested for infections which could be passed on to the recipient. However, concern about transfusion-related variant Creutzfeldt–Jakob disease (vCJD) transmission is now supported by clinical evidence (Ludlam and Turner 2006) and, despite continuing research, a screening test for preclinical human infection has yet to be developed (Brown 2005). Therefore, donor exclusion criteria remain an important precautionary measure (Cervenakova and Brown 2004). When a donor has been successfully screened, they must validate the information they have provided and record that they have given consent to proceed.

Autologous donation

Since the 1980s there has been interest in autologous donation (blood and blood components collected from an individual and intended solely for subsequent autologous transfusion to that same individual) (Blood Safety and Quality Regulations 2005). This has largely been attributed to high-profile infection risks: human immunodeficiency virus (HIV), hepatitis C and more recently vCJD (James and Harrison 2002). However, autologous donation is not risk free, with 28 cases of adverse events being reported to SHOT in 2008, the majority of which arose through cell salvage events. Autologous donation is contraindicated in certain circumstances. Furthermore, there has been significant concern about the efficacy of some methods (Carless *et al.* 2004, Henry *et al.* 2002). Three principal methods of autologous donation exist.

Preoperative autologous donation (PAD)

This requires the patients to donate up to four units of blood whilst simultaneously taking iron supplements in the month preceding surgery. However, the efficacy of this method has been questioned by systematic review (Henry *et al.* 2002) and is only indicated in very specific circumstances such as patients with very rare blood types, patients donating bone marrow and fit patients who have a significant fear of receiving allogeneic blood products such that it is preventing them from seeking necessary surgery (James 2004).

Acute normovolaemic haemodilution (ANH)

This involves the donation of up to three units of blood immediately prior to surgery. The patient is then given crystalloids to dilute the circulating volume. This method is only indicated for surgery where considerable blood loss is expected on the principle that the number of red cells lost will be reduced and the patient’s autologous whole blood can be returned after surgery; however, little evidence exists to support the efficacy of ANH (Harrison 2004).

Intraoperative cell salvage (ICS)

Blood loss during surgery is collected, anticoagulated, filtered and held in a sterile reservoir. The collected blood is then processed, washed and suspended in

saline for return. Although ICS is not without risks such as embolism, bacterial contamination and enhanced inflammatory responses through reinfusion of inflammatory mediators (Harrison 2004), it has been recommended as the most effective form of autologous transfusion to assist in the conservation of blood supplies (James 2004). Trials in orthopaedic surgery indicate that salvage can reduce the proportion of patients who receive allogeneic red cell transfusions. Results in cardiac surgery trials have also shown a slight reduction in the use of allogeneic red cell transfusions (McClelland 2007).

The 2008 SHOT report recorded 28 cases of reported adverse events, 25 from ICS and three from postoperative cell salvage (PCS). There were five hypotensive reactions reported from ICS, but no major mortality or morbidity.

Monitoring of patients receiving autologous transfusion is as important as it is for those receiving allogeneic transfusion (SHOT 2008).

Blood component donation

Donors of blood components by automated apheresis are subject to the same selection criteria used for donating whole blood and any exception to this must be decided by a designated medical officer. Apheresis can be used to collect plasma, red cells and platelets. Leucopheresis procedures are used for the collection of granulocytes, lymphocytes and peripheral blood progenerator cells (James 2005).

Appropriate use of donated blood components

Donated blood components are a precious gift; they are not a limitless resource and must be used appropriately. The BCSH has guidelines in place for the use of red cell, platelet, fresh frozen plasma, cryoprecipitate and cryosupernatant transfusions, available on the BCSH website www.bcshguidelines.com.

The decision to transfuse must be based on a thorough clinical assessment of the patient and their individual needs. Each blood component should only be given after careful consideration, when there is valid clinical indication or when there are no alternative treatment options available (Oldham *et al.* 2009).

Blood and blood products have varying shelf-lives and storage requirements. The range of products currently available, indications for use and recommendations for administration are listed in Table 8.10.

Anticipated patient outcomes

Blood component transfusion can be a life-saving and life-enhancing treatment when used appropriately and when patients are cared for safely and by knowledgeable, skilled practitioners (Oldham *et al.* 2009).

Legal and professional issues

Blood safety and quality in the UK

Approximately 3.4 million blood products are administered in the UK every year (Gray and Illingworth 2005). The transfusion of blood and its components is usually safe and uneventful; however, there are associated risks and there have been significant developments over recent years to improve the quality and safety of transfusion practice in the UK. The Blood Safety and Quality Regulations came into effect in February 2005 and were fully implemented on 8 November 2005. These Regulations cover the collecting, testing, processing, storing and distributing of blood and blood components (Blood Safety and Quality Regulations 2005). The official government agency with jurisdiction for these regulations is the Medicines and Healthcare Products Regulatory Agency (MHRA).

The principal requirements of these Regulations in relation to transfusion practice are as follows.

- *Traceability*: whereby hospitals must have a system to record and retain information on the fate of each unit of blood/blood component for a period of 30 years.
- *Haemovigilance*: an organized surveillance procedure relating to serious adverse or unexpected events or reactions. The reporting of such events can be done via the online Serious Adverse Blood Reactions and Events (SABRE) system which is maintained by the Medical Device Adverse Incident Reporting Centre. This will usually be done by a designated member of laboratory staff and therefore clinical staff must ensure that all incident reporting is conducted in line with hospital policy.

The MHRA defines such events as follows.

- A **serious adverse event** is defined as an unintended occurrence associated with the collection, testing, processing, storage and distribution of blood or blood components that might lead to death or life-threatening, disabling or incapacitating conditions for patients or which results in, or prolongs, hospitalization or morbidity.
- A **serious adverse reaction** is defined as an unintended response in a donor or in a patient associated with the collection or transfusion of blood components that is fatal, life-threatening, disabling or incapacitating, or

which results in or prolongs hospitalization or morbidity.

(MHRA 2005)

Prior to these regulations, Better Blood Transfusion initiatives aimed to ensure that such guidance became an integral part of NHS care, making blood transfusion safer, ensuring that all blood used in clinical practice is necessary and improving the information both patients and the public receive about blood transfusion (NMC 2008b). Therefore it is a key requirement that all staff involved in the process of transfusion maintain their awareness of all appropriate guidance.

Competencies

The transfusion of any blood product carries with it the potential of reaction and risk (SHOT 2005). All staff involved in the transfusion of blood and/or blood products must have the knowledge and skills to ensure the process is completed safely. Therefore, the nurse caring for those receiving transfusion therapy must do so within his or her sphere of competence, always acting to minimize risk to the patient (NMC 2008a).

Practitioners must understand the theory and reasoning behind the necessity to follow the correct transfusion procedures and practices (Pirie and Gray 2007). In November 2006, the NPSA, the Chief Medical Officer's National Blood Transfusion Committee (NBTC) and SHOT, working in collaboration, developed strategies aimed at ensuring that blood transfusions are carried out safely, and issued the Safer Practice Notice (SPN) No. 14, *Right Patient, Right Blood*. One of the key action points in this notice was for all NHS and independent sector organizations involved in administering blood transfusions to develop and implement an action plan for competency-based training and assessments for all staff involved in blood transfusions. The current guideline is for all staff involved in the blood transfusion process to have completed their initial competency assessments by November 2010 (BCSH 2009, Blood Safety snd Quality Regulations 2005).

There are three key principles which underpin every stage of the blood component transfusion process:

- patient identification
- documentation
- communication (BCSH 2009).

Consent

Providing the patient with information before a procedure and ascertaining that the patient understands the procedure and has consented to it is the responsibility of the healthcare professional carrying out the procedure as well as those prescribing it (NMC 2008b). Although blood components may not be prescribed as they are not medicinal products (Green and Pirie 2009), a blood component transfusion must be treated as any prescribed medicine, that is, patients (or guardian) must be informed of the indication for the transfusion, advised of the risks and benefits, of alternatives to blood transfusion including autologous transfusion (BCSH 1999), be given the opportunity to ask questions and have the right to refuse to receive it in accordance with local and national guidance (NMC 2008b, RCN 2006). One of the key objectives of the HSC 2007/001 Better Blood Transfusion was to improve information provided to patients and to ensure that those who are likely to receive a blood transfusion will be well informed of their choices. There are a number of information leaflets issued by the NHS Blood and Transplant Service for both patients and healthcare professionals.

The issue of consent for blood transfusion is currently being considered by the Advisory Committee on the Safety of Blood, Tissues and Organs (SaBTO). Patients have the right to refuse transfusion and to be treated with respect. Staff must be sensitive to individual patient needs, acknowledging their values, beliefs and cultural background and exploring alternative treatments if appropriate and available (Oldham *et al.* 2009). There is increasing public concern about blood transfusion safety and the need to accommodate some patients' religious beliefs (John *et al.* 2008).

Jehovah's Witnesses and blood transfusion

The role of blood in Jehovah's Witnesses' spiritual belief is based on scripture and followers are usually well informed on both their beliefs and their rights. Many Jehovah's Witnesses carry information with them regarding any objection and therefore the need to ensure informed consent is very important. Staff caring for patients must ensure that decisions to consent to or refuse treatment are respected and recorded appropriately (McClelland 2007). Furthermore, in individual circumstances, practitioners should endeavour to consider non-blood or autologous methods as described previously, where appropriate (McClelland

2007).

Blood product request

The details on the blood component request form and the sample tube are the only direct contact between the clinical area and the blood transfusion laboratory. The accuracy and completeness of this information are therefore of vital importance (BCSH 2009). Incorrect or inadequate patient identification leading to a sample for blood grouping being taken from, or labelled for, the wrong patient may result in fatal ABO incompatible transfusions (SHOT annual reports 1996–2007). Inadequately or mislabelled samples are up to 40 times more likely to contain blood from the wrong patient (BCSH 2009).

The collection of the blood sample from the patient and the subsequent labelling of the sample tube should be performed as a continuous, uninterrupted event at the patient's (bed)side, involving one patient and one member of staff only (BCSH 2009).

The Chief Medical Officer's National Blood Transfusion Committee for England and North Wales has produced a standardized 'Indication Codes' for transfusion which may be incorporated into the request process (BCSH 2009).

Preprocedural considerations

Equipment

Intravenous access

Blood components may be administered through peripheral cannulas or via a central venous access device. Where possible, one lumen should be reserved for the taking of blood specimens and blood component administration for the duration of therapy.

Administration sets

All blood components must be transfused through a sterile blood component administration set with an integral mesh filter (170–200 micron). Blood administration sets should be changed at least every 12 hours or after every second unit for a continuing transfusion (Gray and Illingworth 2005); please refer to local guidance. Administration sets used for blood components must be changed immediately upon suspected contamination or when the integrity of the product or system has been compromised. Platelets and plasma components may be administered through a normal blood administration set or through a platelet or cryoprecipitate set. Platelets should never be administered through an administration set that has previously been used for red cell transfusion or other blood component as this may cause aggregation of platelets in the administration set (McClelland 2007). Administration sets used for blood components must be changed using aseptic technique and observing universal precautions, in line with manufacturer's instructions (RCN 2010).

Infusion devices

Either gravity or electronic infusion devices may be used for the administration of blood components. There are a variety of electronic infusion devices available and it is therefore essential that individuals using any type of infusion device are competent in their use. Only blood component administration sets compatible with the infusion device should be used. Rapid infusion devices that are CE marked may be used when large volumes have to be infused rapidly. Typically, devices can infuse from 6 to 30 litres an hour and usually incorporate a blood-warming device (BCSH 2009, McClelland 2007).

Blood-warming devices

The warming of blood and blood products is generally not recommended as it is of limited benefit and can be dangerous. Blood warmers are only indicated when:

- massive, rapid transfusion could result in cooling of cardiac tissue, causing potentially fatal dysrhythmia (McClelland 2007). If the rate of transfusion is greater than 100 mL per minute, blood-warming devices should be used (McClelland 2007)
- transfusion is required by patients with cold agglutination disease (Gray and Illingworth 2005)
- exchange transfusion is indicated in the newborn (Weinstein and Plumer 2007)
- thawing of cryopreserved stem cells prior to transfusion (blood or marrow).

Both water baths and dry heat blood warmers are available. However, whichever device is chosen, the temperature should be maintained below 38°C. Warming in excess of this can cause haemolysis of red cells and can denature proteins and increase the risk of bacterial infection. Blood warmers must always be used and maintained according to the manufacturer's guidelines. Blood products must *never* be warmed by improvisation, such as putting the pack into hot water, in a microwave or on a radiator, as uncontrolled heating can damage the contents of the pack (Gray and Illingworth 2005, McClelland 2007). The use of water baths also increases the risk of bacterial contamination. Therefore certain safety measures must be adhered to.

- Water baths must be drained after each use and must be stored dry and empty.

- The blood warmer should be drained after each use and must be stored dry and empty.
- When needed, they should be refilled with sterile water.
- A protective sterile over-bag to thaw blood and blood products reduces the entry of contaminants through microscopic punctures or breaks in the seal.
- The product should be used immediately after it has been thawed.

All devices should be serviced as per hospital health and safety policies, MHRA and manufacturers' guidelines.

Specific patient preparations

In 2007 the NPSA issued a Safer Practice Notice No. 24, *Standardising Wristbands Improves Patient Safety*, stating that only the following core identifiers should be used on patients' identification bands:

- last name
- first name
- date of birth
- NHS number.

Patients should have their identification confirmed on admission to the unit and one wristband attached to their wrist. If a wristband is removed for any reason, for example to gain intravenous access via a cannula, it is the responsibility of the person removing it to ensure that a correctly completed wristband is then reapplied.

The nurse must ensure that the patient has been informed of the proposed transfusion and has had an opportunity to raise any concerns, understands the risks and benefits of the transfusion and has agreed to and is available for the transfusion. Pretransfusion/baseline observations including blood pressure, temperature, pulse and respiratory rate must be undertaken and documented and checked that they are within acceptable parameters and that there is patent venous access prior to administering the transfusion.

Pretransfusion/bedside check

While professional accountability must be taken at every stage by the personnel involved, the final barrier to wrong blood administration is at the bedside. The final link is ensuring the right patient receives the right blood and it is therefore essential that the check is performed thoroughly prior to the transfusion of each component (Oldham *et al.* 2009).

To ensure that each blood component is used to its full advantage, local hospital policy should be followed with regard to correct handling and storage, transportation and administration of blood components. If unused, the component should be returned to the transfusion laboratory as quickly as possible to maximize the opportunity for it to be used for another patient.

The written order for the blood component must be checked to ensure that it is correctly completed and to ensure that it contains the following information.

- Patient core identifiers.

- Date (and time if appropriate) the blood component is required.
- Type of blood component to be administered.
- Any clinical special transfusion requirements, for example irradiated, CMV seronegative, blood warmer.
- Volume or number of units to be transfused (exact number in mL for paediatric transfusions).
- Time over which each unit is to be transfused (exact rate or length of time over which the specified volume is to be transfused for paediatric transfusions).
- Any special instructions, for example concomitant drugs required, such as diuretics.
- Signature of the ‘prescriber’.

Procedure guideline 8.18 Blood product request

Essential equipment

- Blood request form

Procedure

Action	Rationale
1 The following information must be completed on the request form. **(a)** First name **(b)** Surname **(c)** Date of birth **(d)** Gender **(e)** Hospital identification number **(f)** Ward or department	Full demographics are required to minimize the risk of patients with the same or similar names being given the incorrect blood component (McClelland 2007, **C**; SNBTS 2007, **C**). Details on the request form must match the enclosed blood sample. Discrepant samples should not be processed (James 2005, **C**).
2 Complete the following clinical information. **(a)** Diagnosis **(b)** Reason for request; this should include details of any surgical procedure **(c)** Number and type of components requested **(d)** Any special requirements such as irradiated, CMV negative **(e)** If group and screen only **(f)** Date and time required	Enables laboratory staff to assess need against the surgical blood ordering schedule (**E**). Some vulnerable patient groups may have a fatal reaction to wrongly transfused non-irradiated or CMV-positive products (McClelland 2007, **C**). Negative and positive status should always be written in full and not as + or − as they may get defaced and be incorrectly processed (SNBTS 2004, **C**). This allows laboratory staff to plan ahead for complex cross-matches to ensure the required products are available at the correct time (SNBTS 2004, **C**).
3 Each request should also include:	Every step of the transfusion must be fully traceable and the record held for 30 years (James 2005, **C**).

should also include: **(a)** the name of the doctor/nurse requesting the products **(b)** the name and signature of the person who has taken the blood sample	2005, **C**).
4 The following information can also be included if it is available in the patient's clinical record. **(a)** Patient's blood group **(b)** Presence of known antibodies **(c)** Date of last transfusion	This information is useful to laboratory staff (**E**). Negative and positive should always be written in full and not as + or − as they may get defaced and be incorrectly processed (SNBTS 2004, **C**).

Procedure guideline 8.19 Blood sampling: pretransfusion

Essential equipment

- Antimicrobial skin cleanser – the recommended solution is 0.5% chlorhexidine in 70% alcohol
- Needle/winged infusion device
- Appropriate tubes for blood sample collection
- Gauze
- Hypoallergenic tape
- Non-sterile, well-fitting gloves
- Sharps container

Preprocedure

Action	**Rationale**
1 Explain and discuss the procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (NMC 2008b, **C**).
2. Take pretransfusion blood from one patient at a time.	To ensure that samples from different patients are not confused which can have fatal consequences and to minimize this risk (SHOT 2008, **C**).
3. Check all packaging before opening and preparing the equipment.	To ensure there has been no contamination and all equipment is in date. **E**
Procedure	
4 Before taking the sample, ask the patient to state their first name, surname and date of birth. Cross-check these details against the blood request form.	To ensure that the sample obtained corresponds with the request (BCSH 2009, **C**).
5 Check these details against the patient's identity wristband.	To ensure that the patient is positively identified before obtaining a blood sample (BCSH 2009, **C**).
6 Check the patient's hospital number on the wristband against that on the blood request form.	To ensure that the sample obtained corresponds with the request (BCSH 2009, **C**).
7 Obtain the blood sample by direct venepuncture or via central venous access device, in the appropriate tube (see Chapter 11).	To ensure the correct procedure is followed and an adequate sample is obtained. **E**
Postprocedure	
6 Hand-write the sample tube clearly and accurately, ensuring all names are spelled correctly. This should only be done once the sample has been successfully obtained and should be done at patient's (bed)side. **(a)** First name **(b)** Surname **(c)** Date of birth **(d)** Gender **(e)** Hospital identification number **(f)** Ward or department **(g)** Date	To ensure the sample is labelled with the correct patient details. BCSH guidelines do not recommend the use of addressograph (BCSH 1999, **C**). Blood tubes should never be completed in advance as this has been identified as a major cause of patient identification errors (SNBTS 2004, **C**).

Procedure guideline 8.20 Blood components: collection and delivery to the clinical area

Removal of blood components from their storage location continues to be identified as a major source of error in the transfusion process (BCSH 2009). Only those staff who are authorized, trained and competent may remove blood components from storage. A guide to the necessary elements of blood pack labelling is shown in Figure 8.9.

Essential equipment

- Documentation containing the patient's three core identifiers – full name, date of birth and hospital number/unique identifying number – must be held by the person removing the component from storage

Preprocedure

Action	**Rationale**
1 Check that the reason for the transfusion has been documented in the patient notes.	To ensure the transfusion is appropriate and necessary (BCSH 2009, **C**).
2 Check that there is a valid written order for the administration of the component including special requirements – CMV negative or irradiated components.	To ensure the selected component meets the patient's individual requirements (BCSH 2009, **C**).
3 Check the patient is aware of and has 'consented' to the procedure.	To ensure the patient is fully informed (BCSH 2009, **C**).
4 Check the patient is available.	To avoid delays once the component has been removed from storage. **E**
5 Take baseline observations to include blood pressure, temperature, pulse and respiratory rate.	To ensure that any transfusion reaction can be immediately identified, due to changes in baseline (BCSH 2009, **C**), and managed appropriately (SNBTS 2004, **C**).
6 Check the patient has patent venous access.	To avoid any delay in commencement of the transfusion and adhere to 'cold chain' requirements (BCSH 2009, **C**).
7 Check the patient is wearing an identification wristband.	To avoid delays in confirming patient identity (BCSH 2009, **C**).
Procedure	
8 Where possible, the same person who will administer the component should collect from storage.	To minimize the number of people involved in the process (BCSH 2009, **C**).
9 Remove the component (using electronic or manual method) from storage in accordance with trust policy.	To ensure that only authorized, trained and competent staff may collect blood components (BCSH 2009, **C**).
10 Remove one component at a time, unless rapid transportation of large quantities is needed or if blood is being transported to remote areas in specifically designed validated blood transport containers.	To ensure components are stored in the appropriate conditions. **E**
11 Check the component at the point of removal for correct patient-identifying details. A visual inspection of the component should also be performed to check the expiry date and any signs of leakage, clumping or discoloration.	In order to minimize the risk of incorrectly administering the component to the wrong patient (BCSH 2009, **C**). Expired or damaged products must not be used (McClelland 2007, **E**).
12 Deliver the component to the clinical area where an appropriately trained and competent member of staff should check that the correct blood has been delivered.	To ensure the correct component has been received for the patient, to comply with traceability and cold chain requirements (BCSH 2009, **C**).

Figure 8.9 Blood pack labelling

Procedure guideline 8.21 Blood component administration

Essential equipment

- Written order for blood component transfusion
- Blood administration administration set with 170–200 mm macroaggregate filter

Preprocedure

Action	**Rationale**
1 Check that the component has been correctly prescribed, including any special requirements such as irradiated or CMV-negative blood, and if the patient requires any other medications, for example diuretic, premedication.	To prevent Incorrect Blood Component Transfused (IBCT) error: ABO incompatibility or non-irradiated CMV-positive products may cause a fatal reaction if transfused (McClelland 2007, **C**). Negative and positive status should always be written in full and not as + or − as they may get defaced and be incorrectly processed. **E**
2 Check that the patient's baseline vital signs, temperature, pulse, blood pressure and respirations have been recorded.	To ensure that any transfusion reaction can be immediately identified, due to changes in baseline (**E**), and managed appropriately (SNBTS 2004, **C**).
3 Conduct a visual inspection of the component to be used for signs of clumping, discoloration, damage or leaks.	Expired or damaged products must not be used (McClelland 2007, **E**).
4 If there are any discrepancies at this point do not proceed until they have been resolved.	To ensure an IBCT event does not occur. **E**
5 Positively identify the patient by asking them to state the following information. **(a)** First name **(b)** Surname **(c)** Date of birth	This is the final check of identity which must be performed next to the patient prior to transfusion and is absolutely vital in minimizing the risk of IBCT errors (BCSH 2009, **C**; SNBTS 2004, **C**).
6 Check the details given against the patient's nameband and the patient details on the blood component.	To minimize the risk of error (SNBTS 2004, **C**).
7 Check that the information on the compatibility label matches the details on the blood component, checking expiry date, unique component donation number, blood group on the component label against the laboratory-produced label. Check special requirements have been met. If there are any interruptions during this checking procedure, the entire process should be restarted from the beginning.	To minimize the risk of error (BCSH 2009, **C**; SNBTS 2004, **C**).
8 If there are any discrepancies at this point do not proceed until they have been resolved.	To ensure an IBCT event does not occur (SHOT 2008, **C**).
Procedure	
9 Prime the set with blood unless there are concerns about patency of the device, then prime with 0.9% sodium chloride.	Other agents may damage the product components and precipitate transfusion complications (SNBTS 2004, **C**), for example dextrose should never be used to prime a set or flush the blood administration set following a transfusion as this can cause haemolysis (SNBTS 2004, **C**).
10 Set up infusion via a volumetric infusion pump if appropriate. Check the infusion pump and settings prior to use.	To ensure the pump is in working order (BCSH 2009, **C**). Some older infusion pumps can damage the red cells. Blood administration sets for specific infusion pumps must always be used. If none are available the standard blood administration set should be used via gravity and the rate monitored as necessary. **E**

	should be used via gravity and the rate monitored as necessary. **E**
11 Set the desired infusion rate as indicated by the blood component being used and the patient's condition. **Either** *Red cell administration* can range from 5–10 minutes in acute blood loss to the maximum time of 4 hours (from the time the component is removed from storage) in elderly patients (SNBTS 2004). **Or** *Platelets, fresh frozen plasma and cryoprecipitate* should be transfused over 30–60 minutes and must be completed within 4 hours of puncturing the blood component.	The rate of administration is indicated by the patient's clinical condition (SNBTS 2004, **C**; Weinstein and Plumer 2007, **E**). Dictated by current guidelines (SNBTS 2004, **C**).
12 Sign the written order 'prescription' as the person administering the component. The unique component donation number, the date and start time should be recorded in the patient's clinical notes.	To ensure documentation and traceability requirements are met (BCSH 2009, **C**).
13. Fifteen minutes after the commencement of each component, take and record patient observations – blood pressure, temperature, pulse and respiratory rate	Adverse reactions will often occur during the first 15 minutes of transfusion (Gray and Illingworth 2005, **C**). Complaints of serious anxiety, transfusion site pain, loin pain, backache, fever, skin flushing or urticaria could be indicative of a serious transfusion reaction (McClelland 2007, **E**). In such cases the transfusion should be stopped immediately and urgent medical advice sought (SNBTS 2004, **C**).
14. Observe and monitor the patient throughout the transfusion episode. If there are any concerns, undertake additional observations as appropriate.	To monitor for any adverse reactions (McClelland 2007, **E**).
15 Record the finish time of each unit. All units must be completed within 4 hours of removal from storage.	Continuation of a transfusion beyond 4 hours increases the risk of transfusion reaction and complications (BCSH 2009, **C**).
16 Take and record the patient's observations on completion of each unit, ensuring that post-transfusion observations are performed within 60 minutes of completion of the unit.	To ensure the patient's progress is recorded and acts as a baseline for subsequent units (BCSH 2009, **C**).
Postprocedure	
17 Record the time the transfusion finished and the volume of the component transfused on the patient's fluid balance chart.	To ensure an accurate record of fluid is maintained as fluid balance monitoring can identify fluid overload in at-risk patients (Weinstein and Plumer 2007, **E**).
18 Carefully file all transfusion documentation in the patient's clinical record. In line with local policy, return information on the final fate of each blood component to the hospital laboratory manager.	To ensure the transfusion episode has been recorded, maintaining the clinical record for patient safety. To comply with Statutory Instrument No. 50, Blood Safety and Quality Regulations (2005, **C**), where the final fate of all blood components must be held for a duration of 30 years.
19 Return any unused blood components to the laboratory promptly.	Unused components may be reallocated if returned in time. Refer to local guidelines. **E**.
20 Keep all empty blood component bags in the clinical area until the transfusion is completed. Once the transfusion is completed, dispose of in clinical waste.	To ensure transfused bags are available in the event of incident investigation (SNBTS 2004, **C**).
21 For patients receiving ongoing transfusion support, the blood administration set should be changed at least every 12 hours, or after	Minimize risk from bacterial contamination (BCSH 2009, **C**; McClelland 2007, E; SNBTS 2004, **E**).

every second unit transfused. Dispose of used set in clinical waste: refer to local

guidelines/protocols.

Problem-solving table 8.8 Prevention and resolution (Procedure guidelines 8.18, 8.19, 8.20 and 8.21)

Problem	Cause	Prevention	Resolution
Unable to collect patient information	Unknown unconscious patient	Do not transfuse unless clinically essential	Assign unique hospital identification number to all requests and samples
	Major incident	Do not transfuse unless clinically essential	Use unique major incident identification number for all requests and samples
	Patient unable to communicate verbally	Follow hospital policy for identification of patients unable to confirm identity verbally. Consider the introduction of photo identification card Ensure interpreting services are available if appropriate	Confirm identity with a relative or second member of staff (SNBTS 2004)
Patient does not have a nameband	Nameband has been removed or is no longer legible	**Always** follow local policy and **never** use secondary identifiers such as bed numbers, notes or request forms that the patient may be carrying (BCSH 1999). If a person removes a patient's identification band, they are then responsible for ensuring that this is replaced	All inpatients are required to wear a nameband; therefore, replace nameband and reconfirm identity (NPSA 2005, RCN 2005)
	Patient is in an outpatient setting	Follow hospital policy for the identification of patients	Ensure patient has a correctly completed identification wristband prior to commencing a transfusion
Unable to obtain verbal confirmation	Patient unconscious	Ensure hospital policy for the identification of unconscious patients is followed	Confirm identity with a relative or second member of staff or use unique patient identifier
Patient unable to communicate verbally	Due to disease or language barrier	Follow hospital policy for the identification of patients unable to confirm their identity verbally. Consider the introduction of photo identification cards. Ensure interpreting services are available if appropriate	Confirm identity with a relative or second member of staff (SNBTS 2004). Always follow local policy and never use secondary identifiers such as bed numbers, notes or request forms that the patient may be carrying (BCSH 1999)
Infusion slows or stops	Venous spasm due to cold infusion	Apply a heat pad prior to the transfusion to reduce venous spasm	Apply warm compress to dilate the vein and increase the blood flow

	Occlusion	Check patency prior to administration. Always use a pulsatile flush ending with a positive pressure flush	Flush gently with 0.9% sodium chloride and resume infusion. If occlusion persists, consider resiting cannula. For a central venous access device occlusion, see Chapter 18
Elevation in temperature after commencing a unit of blood with no other symptoms. Temperature falls if the blood is slowed/stopped	Pyrogenic reaction	Take history to identify whether patient has had a reaction previously	Observe the patient's temperature, pulse and blood pressure during the transfusion as indicated. If the patient has received multiple transfusions or has previous history, ensure that appropriate medication is prescribed before commencing transfusions

Postprocedural considerations

Immediate care

The patient should be asked to inform a member of staff of any symptoms which may indicate a transfusion-related adverse event, such as feeling anxious, rigors (shivering), flushing, pain or shortness of breath. The patient should be cared for where they can be visually observed and should be shown how to use the nurse call system. The patient should have vital signs monitored as indicated in the Procedure guidelines: however, it may be necessary to take additional observations if clinically indicated, such as if the patient complains of feeling unwell or they develop signs of a transfusion reaction (Gray and Illingworth 2005).

Many drugs may cause a pyretic hypersensitivity reaction (BNF 2011). There is at present insufficient evidence to allow guidance on the co-administration of drugs with red blood cell transfusion. A lack of clinical reporting of reactions in patients cannot be taken to indicate safe practice: adverse reactions may be attributed to other causes, subclinical haemolysis or agglutination may occur undetected and serious adverse effects may be masked by pre-existing illness in the patient (Murdock *et al.* 2009).

Ongoing care

On completion of a blood transfusion episode, observations to include blood pressure, temperature, pulse and respiratory rate should be taken and recorded. The patient's records should be updated to confirm that the transfusion has taken place, including the volume transfused, whether the transfusion achieved the desired effect (either post-transfusion increment rates or an improvement in the patient's symptoms) and the details of any reactions to the transfusion. If intravenous fluids are prescribed to follow the transfusion, these should be administered through a new administration set appropriate for that infusion. The traceability documentation confirming the fate of the component should be returned to the laboratory (Blood Safety and Quality Regulations 2005).

The SHOT report 2008 emphasizes that, on occasion, transfusion reactions can occur many hours and sometimes days after the transfusion is completed. Therefore, for patients receiving a transfusion as a day case, it is important to ensure that they are counselled on the possibility of later adverse reactions and that they have access to clinical advice at all times. The BCSH recommends that day-case and short-stay patients are issued with a contact card facilitating 24-hour access to appropriate clinical advice, similar to the scheme used for patients receiving chemotherapy treatments on an outpatient basis (BCSH 2009).

Complications

Transfusion-associated graft-versus-host disease (TA-GVHD)

Although rare, TA-GVHD is a serious complication for recipients and is often fatal. TA-GVHD is usually caused by an IBCT incident where non-irradiated blood components containing immunocompetent T lymphocytes are given to severely immunocompromised recipients. The donor T lymphocytes engraft and multiply, reacting against the recipient's 'foreign' tissue, causing a graft-versus-host reaction (Davies and Williamson 1998). It is not commonly associated with fresh frozen plasma (FFP) or cryoprecipitate. Onset occurs 1–2 weeks after transfusion and the condition is predominantly fatal (McClelland 2007). Irradiation (25 gray) of blood and blood products, to inactivate T lymphocytes (McClelland 2007), is essential in the prevention of TA-GVHD and is especially important in the following recipients:

- foetuses receiving intrauterine transfusions
- patients undergoing or who have undergone blood or bone marrow progenitor cell transplantation
- immunocompromised recipients.

Bacterial infections

Contamination of blood and blood products can occur during donation, collection, processing, storage and administration. Despite strict guidelines and procedures, the risk of contamination remains. Most common contaminating organisms are skin contaminants such as staphylococci, diphtheroids and micrococci, which enter the blood at the time of venesection (Barbara and Contreras 2009, Provan *et al.* 2009). Bacterial contamination can lead to severe septic reaction.

Viral infections

Viruses transmissible via blood transfusions can be either plasma borne or cell associated (Barbara and Contreras 2009, Williamson *et al.* 1999). Plasma-borne viruses include hepatitis B, hepatitis C, hepatitis A (rarely), serum parvovirus B19, and human immunodeficiency viruses (HIV-1 and HIV-2). Cell-associated viruses include cytomegalovirus (CMV), Epstein–Barr virus, human T cell leukaemia/lymphoma viruses (HTLV-1/HTLV-2) and HIV-1/HIV-2.

Human T cell leukaemia/lymphoma virus type 1 (HTLV-1)

Human T cell leukaemia/lymphoma virus type 1 is an oncogenic retrovirus, associated with the white cells that cause adult T cell leukaemia, and is connected with several degenerative neuromuscular syndromes. The enzyme-linked immunosorbent assay (ELISA) has been recommended because of concerns relating to the transmission of the virus via blood transfusion, and the associated long incubation period of adult T cell leukaemia. In the UK all blood is tested for HTLV (JPAC 2005).

Cytomegalovirus (CMV)

Cytomegalovirus is classified as part of the herpes family and hence has the ability to establish latent infection with reactivation during periods of immunosuppression (Barbara and Contreras 1998, Louis and Heslop 2009). Approximately 50% of the population in the UK has antibodies to CMV. Therefore it is recognized that the virus may be transmitted by transfusion. Although it poses little threat to immunologically competent recipients, CMV infection in vulnerable patient groups can cause significant morbidity and mortality. For example, CMV pneumonitis carries an 85% mortality rate in blood and bone marrow transplant recipients (Mollison *et al.* 1997). Screening of donors and the use of CMV-seronegative or leucocyte-depleted blood and blood products are seen as essential for neonates and immunocompromised recipients who have tested negative to CMV (Louis and Heslop 2009).

Hepatitis B virus (HBV)

Screening for hepatitis B surface antigen (HBsAg) in donor blood is mandatory as it is estimated that there are now more than 325,000 people in the UK with chronic hepatitis B and, allowing for factors such as under-reporting, the figure

may be even higher (Hepatitis B Foundation UK 2007).

Hepatitis C virus (HCV)

Screening for hepatitis C using the ELISA is mandatory in the UK. Hepatitis C is transmitted primarily via contact with blood or blood products (Friedman 2001).

Human immunodeficiency virus (HIV-1 and HIV-2)

The human immunodeficiency virus is a retrovirus that infects and kills helper T cells, also known as CD4-positive lymphocytes. Transmission of the virus can be via most blood products including red cells, platelets, FFP, and factor VIII and IX concentrates. These viruses are not known to be transmitted in albumin, immunoglobulins or antithrombin III products (Barbara and Contreras 2009). The retrovirus invades cells and slowly destroys the immune system, rendering the individual susceptible to opportunistic infections. Since 1983, when it was recognized that the virus could be transmitted via transfusion, actions have been developed to safeguard blood supplies from transmitting the virus that caused acquired immune deficiency syndrome (AIDS). These include the careful screening of donors and the testing of donated blood.

Other infective agents

Parasites

Plasmodium falciparum is the most dangerous of the human malarial parasites (Barbara and Contreras 2009). Prevention is maintained by questioning donors about foreign travel, in particular those who have visited areas where the disease is prevalent (Bishop 2008).

Prion diseases

Known as transmissible spongiform encephalopathies (TSEs), these are a rare group of conditions which cause progressive neurodegeneration in humans and some animal species (Box 8.5). Prion diseases are believed to be caused by the presence of an abnormal form of a cellular protein (Aguzzi and Collinge 1997, Barbara and Contreras 2009, Vamvakas 1999). These abnormal proteins have an altered cellular shape, and become infectious and multiply by converting normal cellular protein to the irregular form. This irregular form is resistant to digestion and breakdown and, once accumulation occurs, can result in the formation of plaque in brain tissue. Transmission is thought to be by direct contact with infected brain or lymphoreticular tissue (Aguzzi and Collinge 1997, Barbara and Contreras 2009, Vamvakas 1999).

There is evidence to suggest that in TSEs, of which vCJD is one, leucocytes, particularly lymphocytes, are the key cells in the transportation of the putative infectious agent to the brain (Aguzzi and Collinge 1997, Bradley 2009). There were a total of 163 deaths in cases of definite or probable vCJD in the UK up to 31 December 2007. A further three probable cases were alive on 31 December 2007. Analysis of the incidence of vCJD onsets and deaths from January 1994 to December 2007 indicates that a peak has passed. While this is an encouraging finding, the incidence of vCJD may increase again, particularly if different genetic subgroups with longer incubation periods exist (National CJD Surveillance Unit 2008).

In many developed countries, blood undergoes universal leucodepletion for a number of reasons: to reduce the risk of transmission of vCJD, to remove leucocyte-associated viruses such as CMV and to reduce other complications of transfusions related to white cell content (Contreras and Navarrete 2009).

Box 8.5 Prion diseases

Prion diseases in animal species

- Scrapie, a disease of sheep.
- Bovine spongiform encephalopathy (BSE).
- Feline spongiform encephalopathy (FSE).
- Chronic wasting disease of deer, mule and elk.

Prion diseases in humans

- Sporadic: classic Creutzfeldt–Jakob disease (CJD).
- Inherited: CJD, Gerstmann–Sträussler–Scheinker disease, fatal familial insomnia (FFI).
- Acquired: kuru, vCJD.

Sepsis

Sepsis occurs when bacteria enter the blood or blood product that is to be infused. Bacteria can enter at any point from the time of collection, during storage through to administration to the patient. Organisms implicated in transfusion-related sepsis include Gram-negative *Pseudomonas*, *Yersinia* and *Flavobacterium* (Provan *et al.* 2009). Septic reactions usually present with a fever, tachycardia and/or hypotension, and can lead rapidly to systemic inflammatory response syndrome (SIRS) (Porth 2005). This is a serious life-threatening condition, sometimes referred to as septic shock, and requires urgent medical attention.

Transfusion-related acute lung injury (TRALI)

Transfusion-related acute lung injury is most frequently associated with plasma-rich products such as whole blood, platelets and FFP (Federico 2009). TRALI is usually caused by anti-leucocyte antibodies reacting against donor leucocytes. This reaction can result in 'leucoagglutination'. Leucoagglutinins can in turn become trapped in the pulmonary microvasculature, causing severe respiratory distress without evidence of circulatory overload or cardiac failure (Contreras and Navarrete 2009). TRALI presents with a rapid onset of breathlessness, a non-productive cough, distress, chills or fever, cyanosis, hypotension and coma. A chest X-ray will show bilateral nodular infiltrates in a characteristic 'bat wing' presentation (McClelland 2007).

Transfusion-related acute lung injury is usually treated as any adult respiratory distress syndrome (ARDS) and therefore patients who develop TRALI may require ventilatory support (SNBTS 2004) and should be treated as an emergency. Diuretics should not be administered as patients are generally hypotensive and hypovolaemic. Although the symptoms resemble ARDS, TRALI is self-limiting and with most patients improving over a 4-day period, without long-term consequences (Federico 2009). As TRALI is donor related, it is essential that cases are reported to the blood transfusion services so that donors can be contacted and removed from the donor panel (McClelland 2007).

Transfusion-related immune modulation

The infusion of foreign antigen during a packed red blood cell (PRBC) transfusion induces a non-specific immunosuppression, which is known as

transfusion-associated immunomodulation. Allogeneic plasma components, white blood cells, fibrin and accumulants from the storage process have all been implicated (Englesbe *et al.* 2005).

Urticaria

This uncommon reaction is caused by the recipient reacting to protein in the donor plasma (Davies and Williamson 1998). Urticaria is characterized by localized oedematous plaques, hives and itching and is usually mediated by histamines (Porth 2005). Therefore urticarial reactions usually respond well to antihistamines and they should be administered once the patient has been assessed and antihistamine therapy has been prescribed (SNBTS 2004). The infusion can then be recommenced; however, if symptoms return, the infusion should be discontinued.

Transfusion reactions

In November 1996 the SHOT scheme was launched. This voluntary and anonymized reporting scheme collects data from participating hospitals across the UK and Ireland. The purpose of SHOT is to collect data on the serious morbidity related to the transfusion of blood and blood products. These data have since been utilized to inform education programmes, policy development and guideline development, ultimately improving hospital transfusion practice (SNBTS 2004).

Although the Blood Safety and Quality Regulations 2005 have now made the reporting of such events via SABRE mandatory, the SHOT scheme remains active and important and has presented yearly retrospective reports of data collected since its inception. These data demonstrate improved performance in recognizing reporting of transfusion-related incidents and continue to generate key recommendations to improve all transfusion practice (SNBTS 2004). Despite significant improvement in the reduction of risk from transfusion-transmitted infection, human error which results in an IBCT – the transfusion of a blood product that is not suitable for or not intended for the recipient – remains the greatest risk to patients (SNBTS 2004). Figures from the 2008 SHOT report confirm 262 cases in this category.

The prompt management of any adverse transfusion reaction can reduce associated morbidity and can be life saving. Therefore staff caring for patients receiving transfused products must be fully familiar with the immediate management of any suspected reaction. However, specialist advice should always be sought for the diagnosis and ongoing management of transfusion reactions, such as haemolytic, anaphylactic and septic reactions (McClelland 2007, SNBTS 2004).

Minor transfusion reactions

It should always be remembered that the symptoms of a ‘minor’ transfusion reaction may be the prelude to a major, life-threatening reaction. It is essential that staff take any transfusion reaction seriously. Symptomatic patients should have their vital signs monitored closely and they should be clearly observable. Patients with persistent or deteriorating symptoms should always be managed as a major reaction and urgent medical and specialist support should be sought (McClelland 2007, SNBTS 2004).

Allergic and anaphylactic reactions are more common and more severe with transfusion of FFP and platelets than with red blood cells (Domen and Hoeltge 2003).

Symptoms of minor reactions include a temperature rise of up to 1.5°C, rash without systemic disturbance and moderate tachycardia without hypotension (SNBTS 2004). Such reactions may be caused by an immunological reaction to components of the blood product. Whilst it may be possible to manage such symptoms and continue with the transfusion, the following action should always be taken (Contreras and Navarrete 2009).

- Stop the transfusion and inform the responsible medical team.
- Confirm the patient’s identity and re-check their details against the product compatibility label.
- Antihistamines should be considered for skin rashes or urticarial itch.
- Antipyretic agents can be considered for mild fever.

It may be possible to continue with the transfusion at a reduced rate once the patient’s symptoms are controlled; however, it may be necessary to increase the frequency of observations until the transfusion is completed. Some patients who have regular transfusions may experience recurrent febrile reactions and may benefit from an antipyretic premedication. *Note*: aspirin and other non-steroidal anti-inflammatory drugs (NSAIDs) are contraindicated in patients with a thrombocytopenia or coagulopathy (BNF 2011).

Major transfusion reactions

Major transfusion reactions include anaphylaxis, haemolysis and sepsis and may present as a fever of >38.5°C, tachycardia ± hypotension. In such circumstances a severe reaction should always be considered and the transfusion should be stopped until a specialist assessment has been conducted (Box 8.6).

Care should be taken when returning the blood product to the laboratory, to ensure that the product does not leak and that no needles remain attached.

Any further products being held locally for the patient should also be returned to the hospital transfusion laboratory for assessment. The events surrounding the reaction should be clearly documented and reported in the following ways.

- Record the adverse event in the patient's clinical record.
- Complete a detailed incident form as per local policy.
- Follow local, regional and national criteria for reporting via SABRE and SHOT.

Box 8.6 Initial management of a suspected transfusion reaction

- Stop the transfusion and seek urgent medical help.
- Initiate appropriate emergency procedures, for example call resuscitation team.
- Depending on venous access, withdraw the contents of the lumen being used and disconnect the blood product.
- Keep venous access patent.
- Confirm the patient's identity and re-check their details against the product compatibility label.
- Keep the patient and relative informed of all progress and reassure as indicated.
- Initiate close and frequent observations of temperature, pulse, blood pressure, fluid balance.
- Inform the transfusion laboratory and seek the urgent advice of the haematologist for further management.
- Return the transfused product to the laboratory with new blood samples (10 mL clotted and 5 mL ethylenediamine tetra-acetic acid (EDTA)) from the patient's opposite arm (SNBTS 2004) with a completed transfusion reaction notification form (if available) or note the patient's details, the nature and timing of the reaction and details of the component transfused.

Acute haemolytic reactions

These are usually directly related to ABO incompatibilities due to an IBCT where antigen/antibody reactions occur when the recipient's antibodies react with surface antigens on the donor red cells. This reaction causes a cascade of events within the recipient. Such reaction can present with chills/rigors, facial flushing, pain/oozing at cannula site, burning along the vein, chest pain, lumbar or flank pain, or shock (Gillespie and Hillyer 2001, McClelland 2007). Patients may express a feeling of anxiety or doom, which may be associated with cytokine activity. Haemolytic shock can occur after only a few millilitres of blood have been infused. Treatment is often vigorous to reverse hypotension, aid adequate renal perfusion and renal flow to reduce potential damage to renal tubules, and appropriate therapy for DIC reactions (Provan *et al.* 2009). It is important to remember that most acute haemolytic reactions are preventable as they are usually caused by clerical or checking errors at the bedside, and as this is the final check before administration, it presents the last opportunity to identify and avert an error, thus emphasizing the importance of the final check before transfusion (McClelland 2007) (Figure 8.10).

Figure 8.10 Check the compatability label or tie-on-tag against the patient's wristband.

Acute anaphylactic reactions

These are rare and usually occur after only a few millilitres of blood or plasma have been infused (Weinstein and Plumer 2007) and present with bronchial spasm, respiratory distress, abdominal cramps, shock and potential loss of consciousness.

Circulatory overload (transfusion-associated circulatory overload [TACO])

Circulatory overload can occur when blood or any of its components are infused rapidly or administered to a patient with an increased plasma volume, causing hypervolaemia. Patients at risk are those with renal or cardiac deficiencies, the young and elderly (Weinstein and Plumer 2007). Patients with signs of cardiac failure should receive their transfusion slowly with diuretic support (McClelland 2007). The need for concomitant drugs such as diuretics should always be assessed before commencing treatment (SNBTS 2004).

Febrile non-haemolytic reactions

These reactions are due to an immunological response to the transfusion of cellular components such as donor leucocytes. Specific patient groups are at risk of greater sensitization to leucocytes, for example, critically ill patients, those receiving anticancer therapies or patients requiring multiple transfusion therapy (Williamson *et al.* 1999). Such reactions present with a mild fever (up to 1.5°C), rash without systemic disturbance and moderate tachycardia without hypotension (SNBTS 2004).

Hypothermia

Infusing large quantities of cold blood rapidly can cause hypothermia. Patients likely to suffer from this reaction are those who have suffered massive blood loss due to trauma, haemorrhage, clotting disorders or thrombocytopenia (McClelland 2007). Such reactions present with alteration in vital signs, and development of pallor and chills.

Delayed effects

These reactions may occur days, months or even years after transfusion.

Delayed haemolytic reactions

These reactions are caused when immune antibodies react to a foreign antigen. Reactions are classified as primary or secondary. A *primary* reaction is often mild, occurring days or weeks after initial transfusion, and may be indicated by no clinical alteration in haemoglobin following transfusion therapy (Cook 1997a). *Secondary* reactions occur with re-exposure to the same antigen, and on rare occasions may be associated with ABO incompatibilities (Cook 1997a). The patient may present with a fever, mild jaundice and unexplained decrease in haemoglobin value and may require antiglobulin testing (McClelland 2007).

Hyperkalaemia

Hyperkalaemia is a rare complication associated with trauma and the subsequent infusion of large quantities of blood. Potassium is known to leak out of red cells during storage, thereby increasing circulatory levels in recipients receiving blood products (Cook 1997b). The process is exacerbated if products are kept too long at room temperature or gamma irradiated (Davies and Williamson 1998). From starting the infusion to completion, the infusion should take a maximum of 4 hours (McClelland 2007). The patient may present with irritability, anxiety, abdominal cramps, diarrhoea and weakness in the extremities (Cook 1997b). The patient's medical team should be contacted to assess the patient.

Iron overload

Patients who are dependent on frequent transfusion, such as those with thalassaemic, sickle cell and other transfusion-dependent disorders, can become overloaded with iron (McClelland 2007). A unit of red blood cells contains 250 mg iron, which the body is unable to excrete, and as a result patients receiving large volumes of blood are at risk of iron overload (Davies and Williamson 1998). This can result in poor growth, pigment changes, hepatic cirrhosis, hypoparathyroidism, diabetes, arrhythmia, cardiac failure and death. Chelation therapy through the use of desferrioxamine, which induces iron excretion, is used to minimize the accumulation of iron (BNF 2011).

Websites and useful addresses

www.bda.uk.com/resources/Delivering_Nutritional_Care_through_Food_Be

www.bapen.org.uk/ofnsh/OrganizationOfNutritionalSupportWithinHospitals

www.npsa.nhs.uk/nrls/improvingpatientsafety/cleaning-and-nutrition/nutrition/good-nutritional-care-in-hospitals/nutrition-fact-sheets

www.npsa.nhs.uk/nrls/improvingpatientsafety/cleaning-and-nutrition/nutrition/good-nutritional-care-in-hospitals/nutrition-fact-sheets

www.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicy

www.scie.org.uk/publications/guides/guide15/mealtimes

www.bapen.org.uk/pdfs/nsw/nsw07_report.pdf

www.bapen.org.uk/pdfs/nsw/nsw07_report.pdf

www.ageconcern.org.uk/AgeConcern/Hungry_to_be_Heard_August_2006.p

ww.dh.gov.uk/en/Publicationsandstatistics/Publications/PublicationsPolicyA

www.dh.gov.uk/en/SocialCare/Socialcarereform/Dignityincare/

www.dh.gov.uk/PolicyandGuidance/HealthandSocialCareTopics/Specialised

www.espen.org/espenguidelines.html

www.nice.org.uk/nicemedia/pdf/cg032fullguideline.pdf

www.bcshguidelines.com

www.hospital.blood.co.uk

www.mhra.gov.uk

www.shotuk.org

www.transfusionguidelines.org.uk

Age Concern

Telephone: 0800 00 99 66

Website: www.ageuk.org.uk

Patients on Intravenous and Nasogastric Nutrition Therapy (PINNT)

Telephone: 01202 481 625

Website: www.pinnt.com

PINNT is a support group for patients receiving parenteral or enteral nutrition therapy.

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Epidural and Intrathecal Analgesia

Definition

The term ‘spinal analgesia’ refers to both the epidural and intrathecal route (Day 2001, Sloan 2004).The spinal cord rests in a medium of cerebrospinal fluid (CSF), which is contained by the protective membrane of the dura mater. Analgesics applied outside the dura mater are termed epidural analgesia, and medications given into the CSF are termed intrathecal analgesia (Sloan 2004).

Anatomy and physiology

The spinal cord (Figures 9.15 and 9.16) is covered by the meninges; the *pia mater* is closely applied to the cord and the *arachnoid mater* lies closely with the outer, tough covering of the *dura mater* (Behar *et al.* 2007). The epidural space lies outside all three membranes, encasing the spinal cord between the spinal dura and ligamentum flavum. The contents of the epidural space include a rich venous plexus, spinal arterioles, lymphatics and extradural fat.

Figure 9.15 Gross anatomy of the spinal cord. (a) Anterior view and transverse section through spinal cord. (b) Transverse section of the spinal cord within a cervical vertebra.

Reproduced from Tortora and Derrickson (2009).

Figure 9.16 Branches of a typical spinal nerve, shown in cross-section through the thoracic portion of the spinal cord: transverse section.

Reproduced from Tortora and Derrickson (2009).

The intrathecal space (often also termed the subarachnoid space) lies between the arachnoid mater and pia mater and contains the CSF (Chapman and Day 2001).

There are 31 pairs of spinal nerves of varying size. These nerves pass out through the intervertebral foramina between each vertebra (Chapman and Day 2001). There are two main groups of nerve fibres.

- *Myelinated*: myelin is a thin, fatty sheath which protects and insulates the nerve fibres and prevents impulses from being transmitted to adjacent fibres.
- *Unmyelinated*: delicate fibres, more susceptible to hypoxia and toxins than myelinated fibres.

The spinal nerves are composed of a posterior and anterior root, which join to form the nerve.

- *Posterior root*: transmits ascending sensory impulses from the periphery to the spinal cord.
- *Anterior root*: transmits descending motor impulses from the spinal cord to the periphery by means of its corresponding spinal nerve.

(Chapman and Day 2001, Day 2001, Urdan *et al.* 2006)

Specific skin surface areas are supplied/innervated by each of the spinal nerves. These skin areas are known as dermatomes (McCaffery and Pasero 1999) (Figure 9.17).

Figure 9.17 Distribution of dermatomes.

Reproduced from Tortora and Derrickson (2009).

Evidence-based approaches

Epidural analgesia is the administration of analgesics (local anaesthetics and opioids with or without adjuvants such as corticosteroids and clonidine) into the epidural space via an indwelling catheter (Macintyre *et al.* 2010). This technique enables analgesics to be injected close to the spinal cord and spinal nerves where they exert a powerful analgesic effect. It is one of the most effective techniques available for the management of acute pain (Macintyre and Schug 2007, Wheatley *et al.* 2001).

Intrathecal analgesia is the administration of analgesic drugs directly into the CSF in the intrathecal space (Urdan *et al.* 2006). The intrathecal space is also referred to as the subarachnoid space. Analgesic drugs given via this route are 10 times as potent as those given into the epidural space so doses given are much smaller.

The use of drugs via either of these routes can cause both a loss of sensation (anaesthesia) and a loss of pain (analgesia).

Rationale

There are three main advantages to using epidural or intrathecal analgesia.

- It has the potential to provide effective dynamic pain relief for many patients (Wheatley *et al.* 2001).
- The combination of local anaesthetic agents with opioids has a synergistic action that allows the concentration of each drug to be reduced. This limits the unwanted side-effects of each drug (Fotiadis *et al.* 2004).
- There is also evidence that the use of epidural analgesia may reduce the stress response to surgery or trauma, thereby reducing morbidity, recovery time and hospital stay (Kehlet 1997).

Indications

- Provision of analgesia during labour.
- As an alternative to general anaesthesia, for example in severe respiratory disease or for patients with malignant hyperthermia.
- Provision of postoperative analgesia. Epidural analgesia has been used since the late 1940s as a method of controlling postoperative pain (Chapman and Day 2001).
- Provision of analgesia for pain resulting from trauma, for example fractured ribs, which may result in respiratory impairment due to pain on breathing.
- Management of chronic intractable pain in patients with chronic or cancer-related pain who experience the following:
  - unacceptable side-effects with systemic opioids
  - unsuccessful treatment with opioids via other routes despite escalating doses
  - severe neuropathic pain due to tumour invasion or compression of nerves (Day 2001, Mercadante 1999, Smitt *et al.* 1998).
- To relieve muscle spasm and pain resulting from lumbar cord pressure due to disc protrusion or local oedema and inflammation.

For cancer patients who do not obtain pain relief from treatment with opioids administered orally, rectally, by injection or continuous infusion, there is evidence that both epidural and intrathecal analgesia can be effective (Ballantyne and Carwood 2005). Intrathecal analgesia can either be delivered via an external infusion pump or can be part of a fully implantable reservoir system (Dickson 2004).

Contraindications

These may be absolute or relative.

Absolute

- Patients with coagulation defects, which may result in haematoma formation and spinal cord compression, for example iatrogenic (anticoagulated patient) or congenital (haemophiliacs), or thrombocytopenia due to disease or as the result of anticancer treatment (Horlocker and Wedel 1998).
- Local sepsis at the site of proposed epidural or intrathecal injection; the result might be meningitis or epidural abscess formation.
- Proven allergy to the intended drug.
- Unstable spinal fracture.
- Patient refusal to consent to the procedure.

Relative

- Unstable cardiovascular system.
- Spinal deformity.
- Raised intracranial pressure (a risk of herniation if a dural tap occurs).
- Certain neurological conditions, for example multiple sclerosis, where an epidural may result in an exacerbation of the disease (Hall 2000).
- Unavailability of staff trained in the management of epidural or intrathecal analgesia (Macintyre and Schug 2007). Hall (2000) notes that staff managing patients with epidural or intrathecal analgesia should have undertaken a period of formal training to care for patients safely and competently.

Methods of administration

Continuous infusion

Continuous infusions of epidural drugs are the most effective way of providing dynamic pain relief after major surgical procedures (Kehlet and Holte 2001). Continuous infusions of intrathecal analgesic drugs have been shown to be effective in the management of chronic intractable pain (Ballantyne and Carwood 2005). Continuous infusions can be given by either a syringe pump or a designated infusion pump system. The effectiveness of this method of administering drugs is dependent on a number of factors including the combination of drugs used, the position of the spinal catheter at a level appropriate to the site of surgery or pain (Weetman and Allison 2006) and the volume of the local anaesthetic agent infused (Chapman and Day 2001, Hall 2000).

Patient-controlled epidural analgesia

The use of patient-controlled epidural analgesia (PCEA) has gained popularity in recent years because it enables patients to control their analgesia. For patients with postoperative or chronic pain, PCEA is used more effectively in combination with a low-dose background infusion (Wheatley *et al.* 2001). This ensures a baseline level of analgesia which can then be supplemented by the patient when required.

Bolus injections

Bolus injections of opioids and local anaesthetic agents are used infrequently to manage postoperative pain but are more commonly used for managing labour pain (Grond *et al.* 2000). This procedure is usually performed by the doctor. However, bolus doses of low-dose concentrations may be given by nursing or midwifery staff as part of an advanced practice role, according to local policy. This should follow an agreed period of education and supervised practice, which must be documented.

This is a clean aseptic procedure. Most epidural/intrathecal infusion pumps allow a bolus dose to be programmed and delivered from the pump. This prevents the administration line and bacterial filter from being accessed and thus minimizes the risk of introducing infection. Intrathecal bolus doses are usually only given by the doctor.

Classes of epidural and intrathecal drugs and mechanism of action

Three classes of drugs are commonly used to provide epidural or intrathecal analgesia: opioids, local anaesthetic agents and adjuvant drugs such as corticosteroids and clonidine.

Opioids

Whilst a number of different opioids have been used for epidural and intrathecal analgesia, two of the most commonly used are diamorphine and fentanyl (Bannon *et al.* 2001, Cook *et al.* 1997, Romer and Russell 1998). When either of these opioids is injected into the *epidural* space, part of the opioid dose:

- crosses the dura and arachnoid membrane and enters the CSF. From the CSF a proportion of the drug is taken up into the spinal cord and reaches the opioid receptors in the spinal cord. Once bound to the opioid receptors, this results in blocking of pain impulses
- enters the systemic circulation and contributes to analgesia
- binds to the epidural fat and does not contribute to analgesia.

When opioids are placed directly into the CSF in the intrathecal space, they attach directly to the opioid spinal cord receptor sites (Urdan *et al.* 2006).

Fentanyl differs from diamorphine in that it is more lipid soluble. This means that it passes more easily into the CSF, gaining faster access to the opioid receptors and having a more rapid onset of action. Fentanyl also has a shorter duration of action (1–4 hours) as opposed to diamorphine (6–12 hours) (Macintyre and Schug 2007).

Local anaesthetic drugs

Commonly used local anaesthetic agents include bupivacaine, levobupivacaine and ropivacaine. These drugs gain access to the nerve roots and the spinal cord by crossing the dura and subarachnoid membranes (Macintyre and Schug 2007). They inhibit pain transmission by blocking sodium ion channels which are involved in the propagation of electrical impulses along the spinal nerves.

The dose of a local anaesthetic agent will also determine which nerves are blocked. Low concentrations of bupivacaine (e.g. 0.100–0.125%) preferentially block nerve impulses in the smallest diameter nerve fibres, which include the pain and temperature sensory fibres. As the larger diameter motor fibres are less likely to be blocked with concentrations of 0.100–0.125% bupivacaine, the incidence of leg weakness is reduced and the patient is able to mobilize.

Adjuvant drugs

Corticosteroids

Although not licensed for epidural or intrathecal use, corticosteroid injections are often used to relieve pain caused by inflammatory irritation of nerve roots (Papagelopoulos *et al.* 2001).

Clonidine

Clonidine is a mixed alpha-adrenergic agonist. Although its exact mechanism of action is unknown, clonidine is believed to enhance analgesia provided by spinal opioids and local anaesthetic drugs (Smith and Elliott 2001). Clonidine has a specific role in the management of neuropathic pain in patients with advanced cancer (Mercadante 1999).

Drugs and doses for the management of intractable chronic and cancer pain

Epidural/intrathecal infusions of local anaesthetic–opioid combinations are frequently used for the management of intractable chronic and cancer pain. The most commonly used opioids are morphine, diamorphine and fentanyl. Although there is a lack of consensus over the method of converting from a systemic to an epidural/intrathecal opioid, Mercadante (1999) recommends that if converting from oral morphine, a starting dose of roughly 10% of the oral opioid should be given epidurally and then titrated to effect. For example, if a patient was receiving a total daily dose of 180 mg morphine sulphate orally, this would convert to a total daily dose of 18 mg of morphine via the epidural route. Stevens and Ghazi (2000) recommend that the intrathecal dose should be 10% of the calculated epidural dose. Thus, in the above example the intrathecal dose would be the epidural dose (18 mg) divided by 10 which would convert to a total daily dose of 1.8 mg of morphine via the intrathecal route.

Legal and professional issues

There should be formal induction courses and regular updates for doctors, nurses, theatre and recovery staff who will be responsible for supervising patients receiving continuous epidural analgesia (Royal College of Anaesthetists 2004). The acute pain service or a clearly designated consultant anaesthetist from the anaesthesia department will be responsible for the immediate supervision of patients receiving epidural infusions. The National Patient Safety Agency (NPSA 2007) recommends that in addition to routine training and regular updates, additional training occurs when changes are made to protocols, medicine products or medical devices. Routine training should include a programme to help healthcare staff gain competence and confidence in using infusion devices used to deliver epidural/intrathecal analgesia, a theoretical understanding of how the drugs work, and the monitoring required to detect both drug-and procedure-related side-effects and complications (Box 9.16).

Box 9.16. Example of competency role development profile for epidural analgesia for acute pain. Intended learning outcomes and elements of practitioner competency

Knowledge and understanding

You are expected to possess knowledge and understanding of the following.

- The normal anatomy of the spinal cord.
- The physiology of pain and measures of pain management.
- Education and information needs of the patient/family/carer with regard to the implications of having an epidural, to ensure valid consent is given.
- Contraindications for epidural analgesia.
- Infection control considerations before, during and after insertion of an epidural.
- Principles of epidural care and management including side-effects and complications of epidural insertion and epidural analgesia.
- Observations required during the administration of epidural analgesia and the rationale for the frequency of:
  - respiratory rate/sedation levels
  - cardiovascular status
  - temperature
  - epidural site
  - dermatomal blockade
  - pain assessment.
- The standard prescription for epidural analgesia for acute pain management.
- Deviations from the standard prescription available and situations in which they may be used.
- Pharmacology of epidurally administered local anaesthetics and opioids and their side-effects.
- The optimum infusion rate.
- When to stop and remove an epidural catheter.
- Implications of anticoagulant therapy prior to removing the epidural catheter.
- Considerations for analgesia once epidural analgesia is stopped.

Skills

You are expected to possess the following skills.

- Ability to care for the patient before, during and immediately after epidural insertion.
- Ability to check the epidural site; frequency of checks and what problems to look for.
- How to redress the epidural site and frequency of epidural site dressing changes.
- How to assess pain and the frequency of assessment.
- How to carry out a dermatomal blockade assessment and where to document it.
- Ability to change epidural infusion rate.
- Ability to change epidural infusion bag and awareness of the frequency of infusion bag changes.
- Ability to change and prime the infusion administration set and awareness of the frequency of change.
- Ability to deal with equipment problems:
- proximal occlusion alarm
- distal occlusion alarm
- cassette not fitted
- low battery.
- Ability to deal with administration problems:
- catheter disconnection from bacterial filter
- catheter occlusion
- catheter leakage
- the patient still has pain
- side-effects of analgesia
- complications of epidural catheter insertion.
- Procedure for removing an epidural catheter.
- Safe disposal of unused epidural infusion bags after discontinuing therapy.

Preprocedural considerations

Equipment

Epidurals are inserted using:

- a Tuohy needle (a bevelled curved tip needle to reduce the risk of accidental dural puncture, with 1 cm length markings, either 16 G or 18 G)
- an epidural catheter (a relatively stiff catheter made of polyamide, length 1000 mm with clear blue markings completely embedded in the catheter material)
- a bacterial filter (filters provide an additional degree of safety and control to prevent bacterial infections. Minimal dead space enables accurate dosing. A high pressure resistance up to 7 bar enhances safety during manual injection)
- connector (to ensure safe catheter fixation)
- loss of resistance device (to aid clear identification of the epidural space).

The equipment often comes in prepared sterile disposable epidural trays or packs (Parizkova and George 2009).

Dressings

The dressing over the epidural/intrathecal exit site needs to fulfil the following three functions.

- To help secure the epidural/intrathecal catheter.
- To minimize the risk of infection.
- To allow observation of the site without disturbing the dressing.

A transparent moisture-responsive occlusive dressing (e.g. Tegaderm™ or Opsite IV 3000™) fulfils these functions. Opsite IV 3000™ has been found to perform well as an epidural catheter fixation product (Lawler and Anderson 2002). The epidural/intrathecal site should be inspected daily and the dressing changed at least once weekly or more frequently if there is any serous discharge from the site (see Procedure guideline 9.16).

Pharmacological support

Combination of drugs used

Epidural or intrathecal infusions of local anaesthetic and opioid combinations are commonly used in the UK (Baker *et al.* 2004, Wheatley *et al.* 2001). The rationale behind their combined use is based on the observation that better analgesia is achieved with lower doses of each drug, therefore minimizing drug-related side-effects produced by higher concentrations (Curatolo *et al.* 1998, Fotiadis *et al.* 2004). Although the solutions used will vary with the clinical situation, common combinations of fentanyl. The use of premixed bags is recommended to minimize medication errors involving the epidural/intrathecal route (NPSA 2007).

Specific patient preparation

Patients undergoing epidural/intrathecal analgesia should always have a venous access device *in situ* before the procedure. This is because, although rare, a reaction to the opioid or local anaesthetic solution (e.g. respiratory depression or sympathetic blockade) may require immediate access to the venous system. The procedure should be performed in a clinical area with access to full resuscitation equipment.

Patient information and consent prior to using epidural/intrathecal analgesia for intractable chronic or cancer pain

The following issues should be addressed with the patient, family and primary healthcare team prior to using epidural/intrathecal analgesia for intractable chronic or cancer pain.

- *Drug-related side-effects*: the concentration of analgesics needed to provide sufficient analgesia for patients with chronic cancer pain is often higher than the concentrations used postoperatively. As a result, drug-related side-effects such as motor weakness and urinary retention can occur. Some patients find these side-effects unacceptable and may prefer to avoid epidural/intrathecal analgesia altogether. Therefore, a discussion must take place with the patient and family to ensure that they are aware of these potential side-effects and are willing to continue with epidural/intrathecal analgesia (Wallace 2002).
- *Increased time in hospital*: the patient should also be informed that they will need to spend a period of time in hospital following insertion of the catheter, to allow for dose adjustment and ensure that side-effects are minimized and optimum pain management achieved.

Position of epidural or intrathecal catheter

Local anaesthetic drugs block nerve fibres at spinal segments adjacent to their site of administration. To ensure the local anaesthetic agent spreads to the dermatomes or nerves supplying the area of pain (e.g. the surgical site or the pain location caused by a tumour), the tip of the spinal catheter should be placed within the mid-dermatomal distribution of the pain site (Table 9.4). This achieves optimal analgesia using the least amount of drugs. If the catheter is placed below the dermatomes supplying the pain site then analgesia is likely to be inadequate (Macintyre and Schug 2007).

Table 9.4. Optimal catheter location for different surgical sites

Surgical site	Catheter location
Thoracic	T6–T9
Upper abdominal	T7–T10
Lower abdominal	T9–L1
Hip/knee	L1–L4

Procedure guideline 9.11 Epidural/intrathecal catheter insertion

Essential equipment

- Chlorhexidine 0.5% in 70% alcohol
- Local anaesthetic
- Selection of needles and syringes
- Sterile dressing pack
- Facemask
- Tuohy needle or assorted gauge lumbar puncture needles
- Sodium chloride 0.9% 10 mL ampoules
- Epidural/intrathecal catheter
- Bacterial filter
- Moisture-responsive transparent dressing and dressing tape to secure catheter (Cousins *et al.* 2003)

Preprocedure

Action	**Rationale**
1 Explain and discuss the procedure with the patient. If the intention is to provide postoperative analgesia then explanation and consent should have been discussed the day before surgery.	To ensure that the patient understands the procedure and gives their valid consent (NMC 2008a, **C**) and to ensure patient has time to assess information and ask questions.
2 Assist the patient into the required position: ■ Patient should be lying comfortably on a firm surface. ■ Position pillow under patient's head. ■ On side with knees drawn up to the abdomen and clasped by the hands. ■ Support the patient in this position.	To allow identification of the spinal processes and intervertebral discs (Brown 1999, E).
Or sitting: Patient sits on firm surface with arms resting on a table, and with the head resting on the arms.	To ensure maximal widening of the intervertebral spaces which will provide easy access to the epidural/intrathecal space (Brown 1999, **E**).
3 Support, encourage and observe the patient throughout the procedure.	As the procedure takes place behind the patient, reassurance is very important (Chapman and Day 2001, **E**).
4 Assist the doctor as required. The doctor will proceed as follows.	
Procedure	
5 Clean the skin with alcohol-based solution (e.g. chlorhexidine in 70% isopropyl alcohol).	To clean skin and minimize risk of contamination (Hebl 2006, R5; Kinirons *et al.* 2001, R1b).
6 Identify the area to be punctured and inject the skin and subcutaneous layers with local anaesthetic.	To ensure the spinal catheter is inserted at the correct level to provide analgesia and numb the skin prior to insertion of the Tuohy needle (Brown 1999, **E**).
7 Introduce Tuohy or spinal needles, usually between the identified vertebrae.	To access the epidural or intrathecal space (Brown 1999, **E**).
8 Ensure epidural/intrathecal space has been entered.	To prevent anaesthesia being given directly into

	spinal cord or intravenously by means of the dural veins (Brown 1999, **E**).
9 Inject test dose of drug (may be performed).	To ensure the position of the needle (Brown 1999, **E**).
10 Thread spinal catheter through barrel of Tuohy needle.	To facilitate intermittent topping up of anaesthesia and to allow greater control (Brown 1999, **E**).
11 Attach the bacterial filter.	To prevent injection of contaminants into spinal space (Brown 1999, **E**).
12 Apply transparent occlusive dressing and tape to the catheter insertion site.	To prevent the catheter being dislodged, to aid visibility and minimize contamination of the site (Baker *et al.* 2004, **E**).
13 Inject solution into epidural/intrathecal space via catheter.	To provide anaesthesia and analgesia (Brown 1999, **E**).
Postprocedure	
14 Position the patient post procedure according to the doctor's instructions, tilting if appropriate.	To ensure spread of solution to provide optimum effect (Brown 1999, **E**).
15 Take vital signs observations of blood pressure, pulse, respiratory rate and sedation score as dictated by the anaesthetist in the immediate postinsertion period. After this, refer to local guidelines for frequency of observations required (see Box 9.17).	To monitor for signs of hypotension and respiratory depression (Weetman and Allison 2006, **E**).
16 Make the patient comfortable. Usually the patient is nursed flat for the first 3–6 hours, then slowly elevated into a sitting position. Bedclothes should not constrict the feet.	To ensure that any CSF leak is minimized and to prevent the patient developing a headache. To prevent the development of footdrop due to motor and sensory alterations caused by local anaesthetics. **E**
17 Assess pain regularly using a visual analogue scale or pain chart if appropriate. Observe the patient's movements and facial expressions. Discuss insufficient or ineffective analgesia with the anaesthetist.	To ensure optimal pain management and that the patient is involved in their pain management (Macintyre and Schug 2007, **E**).

Box 9.17. Example of frequency of monitoring after epidural insertion and for the duration of therapy

In the Critical Care Unit (CCU) or recovery room

Continuous monitoring of respiratory and cardiovascular function (record 4-hourly observations on epidural analgesia prescription and observation chart in addition to CCU chart).

In the ward

Record observations on epidural analgesia prescription and observation chart.

On return from CCU

- At least **2 hourly** recording of respiratory rate, sedation level (0 awake, 1 dozing intermittently, 2 asleep (rousable), 3 asleep (difficult to rouse)), peripheral tissue oxygen saturation (using the pulse oximeter), pulse and blood pressure **for the first 12 hours.**
- If recordings of the above observations and the epidural infusion rate remain stable, the frequency of observations can then be **reduced to every 2–4 hours**.
- Record the temperature **4 hourly**.

On return from recovery directly to the ward

- **½ hourly** recording of respiratory rate, sedation level (0 awake, 1 dozing intermittently, 2 asleep (rousable), 3 asleep (difficult to rouse)), peripheral tissue oxygen saturation, pulse and blood pressure **for 2 hours**.
- If recordings are stable and the epidural rate remains stable, the frequency of observations can be reduced to **2 hourly for 24 hours.**
- If recordings and the epidural rate remain stable, the frequency can then be reduced to **2–4 hourly** until the epidural infusion is stopped.

These observations must be carried out even if the patient is asleep.

If the epidural infusion rate is increased the observations should be recorded **½ hourly for 2 hours after each change in rate** as this may increase the risk of respiratory depression or hypotension. If the observations remain stable then the frequency of observation can be recorded at the same level as prior to the rate change.

Procedure guideline 9.12 Epidural/intrathecal analgesia top-up (bolus)

Essential equipment

- Antiseptic cleaning agent
- Syringes and needles
- Drug prescribed
- Water or 0.9% sodium chloride for injection as necessary
- Patient's prescription chart
- Sterile hub or bung

Action	Rationale
Preprocedure	
1 Wash hands with soap and water or bactericidal handrub.	To reduce the risk of cross-infection (Preston 2005, **C**).
2 Check the drug to be administered and diluents, according to policy.	To ensure the correct drug, amount and concentration are administered to the correct patient (NMC 2008b, **C**).
3 Draw up the drug as per local policy.	To maintain safe practice in medicines management (NMC 2008b, **C**).
4 Check patient's nameband against prescription.	To ensure the correct drug, amount and concentration is administered to the correct patient (NMC 2008b, **C**).
Procedure	
5 Clean the access portal of the bacterial filter.	To prevent the introduction of contaminants and micro-organisms into the epidural space. **E**
6 Inject drug as prescribed.	To give the drug to the patient. **E**
7 Monitor blood pressure, pulse and respirations at least every 5 minutes for 30–45 minutes.	To monitor for signs of hypotension and respiratory depression (side-effects of local anaesthetic and opioid drugs) (Coniam and Mendham 2005, **C**).
Postprocedure	
8 Dispose of the equipment appropriately.	To prevent injury to patients, staff and to comply with medicines management policy (NMC 2008b, **C**).
9 Document the bolus dose administration in the medical and nursing records.	To aid communication and dissemination of information between members of the multidisciplinary team (NMC 2009, **C**).

Procedure guideline 9.13 Epidural/intrathecal sensory blockade: assessment

Essential equipment

- Ice or single use proprietary cold pack OR
- Ethanol spray
- These can be discarded after each test to reduce cross-infection risk
- Copy of a dermatome distribution figure or chart (see Figure 9.17)

Preprocedure

Action	Rationale
1 Explain and discuss the procedure with the patient. Obtain informed verbal consent from the patient.	To ensure that the patient understands the procedure and gives their valid consent (NMC 2008a, **C**) and to ensure patient has time to assess information and ask questions (NMC 2008a, **C**).
Procedure	
2 Explain to the patient that they need to report: ■ If the temperature of the ice/cold changes or becomes warmer ■ If they cannot feel the ice/cold sensation at all.	This will indicate the dermatome level at which the epidural/intrathecal analgesia is working.
3 Remove any clothing that may restrict the assessment.	The ice or spray needs to be applied directly to the skin to undertake the assessment.
4 Test the ice/cold pack or spray on an area of the body that should not be affected by the epidural/ intrathecal infusion (the face or the back of the hand).	To ensure the patient can feel the cold sensation.
5 Starting at the top of the chest (just above nipple level), place the ice/cold pack/spray above the incision or level of pain and ask the patient if this feels as cold as when placed on the test area. Continue this procedure down the torso and the legs if appropriate for the level of epidural/intrathecal analgesia and on the right and left of the body.	
Postprocedure	
6 Document at what level the patient can detect a change as per the dermatome chart (see Figure 9.17).	

Problem-solving table 9.2 Prevention and resolution (Procedure guidelines 9.11, 9.12 and 9.13)

Problem	Cause	Prevention	Suggested action
Headache	Dural puncture	Expertise of practitioner inserting the epidural	Bedrest: headache will be less severe if patient lies flat. Replacement fluids either intravenously or orally to encourage formation of CSF. Administer analgesics for headache. If headache does not settle, contact the anaesthetic team who may consider an epidural blood patch to seal the puncture (Gaiser 2006)
Sedation and respiratory depression (opioid toxicity) Circumoral tingling and numbness, twitching, convulsions and apnoea (local anaesthetic toxicity)	If catheter migrates into a blood vessel, signs of opioid or local anaesthetic toxicity can occur	Expertise of practitioner inserting the epidural Careful monitoring of the patient to detect early symptoms	Stop epidural infusion Contact pain/anaesthetic team or summon emergency assistance. Treat the patient for complications of opioid or local anaesthetic overdose If necessary, support ventilation (Chapman and Day 2001)
Apnoea, profound hypotension and unconsciousness	If an epidural catheter migrates from the epidural space into the intrathecal space to the CSF, the analgesic solution may reach as high as the cranial subarachnoid space. If this occurs the respiratory muscles are paralysed together with the cranial nerves, resulting in apnoea, profound hypotension and unconsciousness. This is because intrathecal doses are calculated as one-tenth of the epidural dose and migration from the epidural space to the intrathecal space leads to a drug overdose	Expertise of practitioner inserting the epidural Careful monitoring of the patient to detect early symptoms	Stop epidural infusion Summon emergency assistance Prepare emergency equipment to support respiration and ventilate lungs Prepare emergency drugs and intravenous fluids and administer as directed Prepare equipment for intubation
Back pain and tenderness and nerve root pain with sensory and motor weakness.	Epidural haematoma	Assessment of coagulation status before insertion and removal of the epidural/intrathecal catheter	Urgent neurological assessment
			Computed tomography (CT) or magnetic resonance imaging (MRI) scan to accurately diagnose if there is nerve or spinal cord compression. If a haematoma is diagnosed prepare patient for urgent surgey (Chapman and Day 2001)
			To avoid haematoma on removal of epidural in patients treated with prophylactic anticoagulants, see guidelines for timing of removal
Back pain and tenderness May have redness and purulent discharge from catheter exit site May also develop nerve root signs with neuropathic pain and sensory/motor weakness	Epidural abscess	Maintain asceptic technique when accessing the epidural/intrathecal analgesic system Monitor temperature regularly and check insertion site for evidence of infection	If the epidural catheter is still in situ, remove and send tip off for culture and sensitivity Treat with antibiotics Carry out CT or MRI scan and refer for urgent neurosurgery to prevent paraplegia (Chapman and Day 2001)

Headaches, fever, neck stiffness, photophobia	Meningitis	Maintain asceptic technique when accessing the epidural/intrathecal analgesic system Monitor temperature regularly	Assist anaesthetist/doctor to obtain CSF sample for microbiology analysis. Initiate antibiotic therapy as per hospital policy Non-pharmacological measures for symptom management, for example dim lights If the infection does not respond to antibiotics it may be necessary to remove the catheter and convert back to systemic analgesia until meningitis has resolved (Mercadante 1999)
Pain, paraesthesia, numbness in lower extremities that may progress to paresis	Intrathecal catheter granuloma (an inflammatory mass that forms around the catheter tip)	In long-term therapy an intrathecal may be preferable to epidural to minimize the development of a granuloma due to the presence of the CSF	MRI scan to diagnose the problem. Stop infusion (granulomas may resolve on their own once the infusion is stopped (Du Pen 2005))

Procedure guideline 9.14 Epidural/intrathecal catheter removal

Essential equipment

- Dressing pack
- Skin cleaning agent, for example chlorhexidine 0.5% in 70% alcohol
- Alcohol handrub
- Specimen container (if epidural catheter needs to be sent for bacterial culture)
- Occlusive dressing

Preprocedure

Action	**Rationale**
1 Explain and discuss the procedure with the patient.	To ensure the patient understands the procedure and gives their valid consent (NMC 2008a, **C**).
2 Wash hands with bactericidal soap and water or bactericidal alcohol handrub.	To minimize cross-infection (Preston 2005, **C**).
3 Open dressing pack.	
Procedure	
4 Wash hands and remove tape and dressing from catheter insertion site.	To minimize risk of cross-infection (Preston 2005, **C**).
5 Gently, in one swift movement, remove the catheter. Check that the catheter is intact. This can be done by observing that the tip of the catheter is marked blue and that the 1 cm marks along the length of the catheter are all intact.	To ensure the catheter is removed intact with the minimum of discomfort to the patient. **E**
6 Clean around the catheter exit site using skin cleaning agent.	To minimize contamination of site by micro-organisms. **E**
7 Apply an occlusive dressing and leave *in situ* for 24 hours.	To prevent inadvertent access of micro-organisms along the tract. **E**
Postprocedure	
8 The epidural/intrathecal tip may be sent for culture and sensitivity if infection is suspected, or according to local policy.	
9 Document that the catheter was removed intact in nursing notes.	

Procedure guideline 9.15 Epidural/intrathecal infusion: setting up and utilizing an ambulatory pump

This is a clean aseptic technique.

Equipment

- Pump

Procedure

Action	Rationale
1 Check the prescribed drugs and diluent against the prescription. If not dispensed in infusion bags prepared aseptically in a special unit, specific local arrangements should be agreed between anaesthetists, pharmacists and ward/theatre/recovery staff for the preparation of the solution.	To ensure correct infusion is ready to connect. Except in special circumstances, the solutions should be prepared aseptically in a special unit (Royal College of Anaesthetists 2004, **C**).
2 Attach relevant extension set; apply drug information label. Recheck against prescription.	Clear labelling must be used to distinguish solutions for epidural/intrathecal infusion from all other infusions (Royal College of Anaesthetists 2004, **C**).
3 Check patency of epidural/intrathecal catheter as described in local policy or guidelines.	To ensure the catheter is in the correct position. **E**
4 Insert the extension set into the pump and prime the extension set, following the manufacturer's instructions for use of the pump.	To ensure the set is free from air when the infusion is commenced, thus minimizing the risk of air entering the catheter. **E**
5 Open the sterile bacterial filter using a non-touch technique.	To minimize the risk of introducing any contaminants and micro-organisms into the epidural/intrathecal space via the filter. **E**
6 Attach the extension set to the bacterial filter and start the pump.	To ensure the pump is working and the drugs are being delivered. **E**
7 Place pump and infusion bag into the lock box or 'carry bag/pouch', ensuring that the tubing is not kinked.	To ensure comfort for the patient and to avoid obstruction to the infusion. **E**

Procedure guideline 9.16 Epidural/intrathecal exit site dressing change

Essential equipment

- Sterile dressing pack
- Skin cleaning agent, for example chlorhexidine in 70% alcohol
- Transparent occlusive dressing

Action	Rationale
Preprocedure	
1 Explain and discuss the procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (NMC 2008a, **C**).
2 Wash hands with soap and water. Clean trolley (or plastic tray in the community) with chlorhexidine in 70% alcohol with a paper towel.	To minimize cross-infection (Preston 2005, **C**). To provide a clean working surface (Parker 2004, **E**).
3 Position the patient comfortably on their side or sitting forward so that the site is easily accessible without undue exposure of the patient.	To maintain the patient's dignity and comfort. This is especially important when carers are attending to an area that is not visible to the patient (Chapman and Day 2001, **E**).
4 Prepare trolley or tray with sterile field and cleaning solution.	To minimize risk of infection and ensure equipment is available (Preston 2005, **C**).
Procedure	
5 Remove old dressing and place in disposable bag.	To prevent cross-infection (Fraise and Bradley 2009, **E**).
6 Wash hands with bactericidal handrub.	To minimize the risk of microbial contamination (Fraise and Bradley 2009, **E**).
7 Observe site for any signs of infection such as redness, swelling or purulent discharge. If any of these are present contact the hospital anaesthetic/pain team for advice.	To ensure careful monitoring of site to minimize the chance of any infection (Royal College of Anaesthetists 2004, **C**).
8 Clean site with skin-cleaning agent (chlorhexidine in 70% alcohol).	To minimize the risk of infection (Hebl 2006, R5; Kinirons *et al.* 2001, R1b; Mimoz *et al.* 1999, R1b).
9 Apply transparent occlusive dressing over the whole area.	To anchor the epidural/intrathecal catheter, minimize the risk of infection and allow observation of the epidural/intrathecal site (Burns *et al.* 2001, R1b; Royse *et al.* 2006, **E**).
10 Ensure that the patient is comfortable.	
Postprocedure	
11 Dispose of all material in the clinical waste bag.	To prevent environmental contamination (Preston 2005, **C**).
12 Wash hands with soap and water.	To reduce the risk of cross-infection (Preston 2005, **C**).

Procedure guideline 9.17 Discharge planning for patients with epidural/intrathecal catheter *in situ* for chronic cancer pain

An epidural/intrathecal infusion should not be seen as a barrier to the patient leaving hospital.

Patients can be safely managed in the community provided the following areas are addressed.

Procedure

Action	Rationale
1 Convert patient's infusion to one that requires the minimum of changing, such as an infusion bag and ambulatory pump rather than a 20 mL syringe and syringe driver.	This will reduce the workload of the patient/family or district nurse and also minimizes the number of interruptions to the patient circuit, thus minimizing the chance of microbial contamination. **E**
2 Ensure that the patient will not be alone at home.	Epidural/intrathecal catheters can obstruct, become dislodged and the battery can fail on the device; most patients need immediate reassurance and practical help in these situations (Day 2001, **E**).
3 Arrange preparation of epidural/intrathecal drug infusion bags, usually in batches to provide enough delivery for 1 week. This can be arranged at the cancer centre or the referring hospital if they have the appropriate pharmaceutical arrangements.	Pharmacy reconstitution ensures aseptic preparation, thus minimizing the chance of microbial contamination, and reduces the workload and anxiety for family/district nurse. It should also be noted that epidural/intrathecal infusions may contain a combination of drugs and pharmacy reconstitution may help to reduce preparation error. **E**
4 Discuss how the infusion bags will be collected each week; they cannot be posted because they contain controlled drugs.	The method of collection needs to be discussed at an early stage with the family/district nurse to ensure continuity of infusion bag delivery and avoid any anxiety or delay to discharge. **E**
5 The patient/family should be provided with the following equipment to take home. **(a)** Spare battery. **(b)** Bottle of bactericidal handrub. **(c)** Bottle of chlorhexidine in 70% alcohol. **(d)** Sterile gauze. **(e)** Syringes and needles. **(f)** 0.9% Sodium chloride for injection. **(g)** One spare bacterial filter and screw connector. **(h)** One week's supply of reconstituted epidural/intrathecal infusion bags. **(i)** Written advice re contact numbers/troubleshooting and prescription.	To ensure that the first week of therapy continues smoothly.
6 Patient/family and district nurse/general practitioner should be taught and trained in the following areas. **(a)** Setting up the infusion. **(b)** The functions of the ambulatory device, including alarms and visual displays. **(c)** Loading the administration set into the pump and priming the set. **(d)** Observation of the epidural/intrathecal site for signs and symptoms which would indicate an	To reduce anxiety and increase patient comfort and trust. **E** To ensure that the patient/family and community team feel confident: (i) in using the infusion pump; (ii) in troubleshooting pump problems; (iii) about where to seek help if they experience any problems. **E**

infection, for example redness, tenderness, swelling, leakage or pus.

(e) The prescribed therapy for breakthrough pain.

(f) Troubleshooting (see Problem-solving table 9.3).

(g) The procedure for obtaining medical/nursing help locally or at the cancer centre 24 hourly and every day of the week.

(h) Dressing of the epidural/intrathecal site.

7 Arrange any appropriate follow-up. This will be determined by the clinical status of the patient.

Patient may not return to the hospital for follow-up unless there are any problems if the intent is to move the patient's care to the community team, for example, in the terminal phase of illness when the patient may wish to be at home. However, contact with the community team should be maintained to ensure any problems with the epidural/intrathecal system are dealt with swiftly. **E**

Problem-solving table 9.3 Prevention and resolution (Procedure guidelines 9.14, 9.15, 9.16 and 9.17)

Problem	Cause	Prevention	Suggested action
Ambulatory pump auditory alarm	Battery failure is most likely	Only use batteries when ambulatory. Plug machine into mains power source when at rest	Stop pump, remove old and replace with new battery; ensure battery is fitted up snugly to connections. Turn on pump and ensure light indicator is flashing
	Catheter occlusion	Ensure catheter is kept free of obstruction or kinking	Check the catheter and administration set for any kinking or occlusion by equipment. If there is no evidence then stop pump, draw up 0.9% sodium chloride and flush catheter. If catheter clears, reattach pump, press start and ensure light indicator is flashing. If catheter is still obstructed and will not flush, phone cancer centre/general practitioner
Sudden acute pain	Catheter obstruction; catheter movement; change in pathology		Check the catheter for any obvious problems which can be quickly resolved such as catheter disconnection. If the catheter has blocked or migrated outwards, stop the infusion pump and give the patient a breakthrough dose of analgesia orally or subcutaneously. Inform general practitioner and/or hospital anaesthetic/pain team as soon as possible. If the patient has had an exacerbation of pain due to disease progression, follow advice from hospital team (the infusion rate may require titrating or the concentration of drugs may need to be changed)

Increasing pain and leaking noted on patient's clothes	Disconnection of epidural/intrathecal catheter from filter. Patient movement: typically turning in bed at night	Use a fixation device or adhesive tape to secure the catheter to the skin to minimize risk of disconnection from friction and pulling on the catheter	Stop the pump. Wrap the disconnected end of the catheter in a piece of sterile gauze and contact the district nursing/hospital team for advice Suggested procedure for district nursing/hospital team (Langevin *et al.* 1996): ■ Clean approximately 15 cm of the disconnected catheter with chlorhexidine in 70% alcohol. Allow to air dry completely ■ Using sterile scissors, cut the cleaned catheter 10 cm away from the contaminated end ■ Insert the cleaned end of catheter into a sterile screw connector and catheter filter ■ Change the epidural/intrathecal infusion extension set and recommence infusion
Redness, swelling or leakage of discoloured fluid from site	Infection or local irritation at site from skin interaction with the plastic catheter	Maintain aseptic technique when accessing the epidural/intrathecal analgesic system Monitor temperature regularly	Contact general practitioner and hospital anaesthetic/pain team. If infection is suspected, the patient should be started on antibiotics to prevent spread of any infection into the epidural space. It may be necessary to remove the catheter if the patient has a temperature, there is pus at the exit site or if the patient has back pain

Postprocedural considerations

Immediate care

Volume of infusion

As the volume of local anaesthetic agent influences the number of spinal nerves that are blocked, it is important to maintain the hourly infusion rate at a volume which keeps the appropriate nerves blocked (Chapman and Day 2001, Hall 2000).

Monitoring the patient

Effectiveness of blockade

The spinal nerves supply specific areas of skin known as dermatomes (see Figure 9.17). Sensitivity to changes in temperature (such as the cold of ice) along the sensory dermatome can be used to assess the level of epidural/intrathecal block. This level should be checked to ensure that the epidural/intrathecal is providing pain relief by covering the area of the site of pain, but is also necessary to maintain safety during the administration of epidural/intrathecal infusions. If the sensory block is too high (above T4) then there is an increased risk of respiratory and cardiac symptoms as a result of the local anaesthetic effects on nerves at this level, and if it is too dense it will cause unnecessary motor blockade.

Ongoing care

When caring for a patient receiving epidural or intrathecal analgesia, it is important to monitor the patient for the following:

- drug-related side-effects
- pain intensity
- signs of complications due to the epidural or intrathecal procedure (see Problem-solving table 9.2)
- equipment-related problems, such as the epidural/intrathecal catheter or the infusion pump (see Problem-solving table 9.3).

Drug-related side-effects

There are a number of drug-related side-effects associated with epidural/intrathecal opioids and local anaesthetic agents.

Opioids

- *Respiratory depression*: this is due to the action of opioids on the respiratory centre. Respiratory depression may occur at two different time intervals.
  - – *Early*: usually within 2 hours of the opioid injection. This may occur if high blood levels of the opioid follow absorption from the epidural space into the systemic circulation (Macintyre and Schug 2007).
  - – *Late*: this may not be seen for 6–12 hours after an opioid is given. It results from rostral migration of the drug in the CSF to the brainstem and respiratory centre (Macintyre and Schug 2007). This is less likely to occur with lipid-soluble opioids such as fentanyl.
- *Sedation*: although there may be many different causes of sedation, epidural/intrathecal opioids can cause sedation owing to their effect on the central nervous system. Opioid-induced sedation is often an early warning sign of respiratory depression.
- *Nausea and vomiting*: nausea and vomiting is caused by the action of opioids on the vomiting centre in the brainstem and stimulation of the chemoreceptor trigger zone in the fourth ventricle of the brain.
- *Pruritus*: although the exact mechanism is unknown, pruritus is presumed to be centrally mediated and a consequence of activation of opioid receptors in the spinal cord (Sands *et al.* 1998).
- *Urinary retention*: this is due to opioid inhibition of the micturition reflex which is evoked by increases in bladder volume.

Local anaesthetic agents

- *Hypotension*: this can be caused by two mechanisms. Firstly, local anaesthetic agents can spread outside the epidural/intrathecal space, blocking the sympathetic nerves. This results in peripheral vasodilation and hypotension. It is most likely to occur if a bolus dose of local anaesthetic agent (e.g. 10 mL of 0.25% bupivacaine) is given to improve pain control (Macintyre and Schug 2007). Secondly, if the local anaesthetic agent spreads above the T4 dermatome (nipple line), the cardio-accelerator nerves may become blocked, leading to bradycardia and hypotension (Macintyre and Schug 2007).
- *Motor blockade*: this will depend on the concentration and total dose of local anaesthetic agent used and the position of the epidural/intrathecal catheter (Hall 2000). Motor blockade occurs when the local anaesthetic agent blocks the larger diameter motor nerves. Leg weakness will occur if the motor nerves supplying the legs are blocked.
- *Urinary retention*: as with epidural/intrathecal opioids, blockade of the nerves supplying the bladder sphincter can cause urinary retention.

Routine monitoring of the patient for these side-effects must be carried out to facilitate early management. The patient's blood pressure, respiratory rate and peripheral tissue oxygenation should be monitored continuously initially and then according to local policy and as the patient's condition dictates.

For guidance on managing the side-effects associated with epidural/intrathecal opioids and local anaesthetic agents, see Table 9.5.

Table 9.5 Epidural/intrathecal infusions of local anaesthetic agents and opioids: management of side-effects

Problem	Cause	Suggested action
Respiratory depression	Increasing age	If respiratory rate falls to 8 breaths a minute or below:
	Elderly patients are more susceptible to the side-effects of opioids due to age-related alterations in the distribution, metabolism and excretion of drugs	**(a)** Stop the epidural/intrathecal infusion **(b)** Summon emergency assistance **(c)** Commence oxygen via facemask and encourage the patient to take deep breaths **(d)** Review current analgesic prescription and consider reducing opioid and local anaesthetic doses before resuming the infusion (Macintyre *et al.* 2010)
	Concurrent use of systemic opioids or sedatives Patients receiving opioids by epidural/intrathecal infusion should not be given opioids by any other route unless given in the	**1** Stop the epidural/intrathecal infusion **2** Stay with the patient and monitor respiratory rate, sedation score and peripheral tissue oxygenation (using a pulse oximeter) continuously

	palliative care setting for breakthrough pain	**3** Commence oxygen therapy **4** Consider giving naloxone if prescribed by anaesthetist or patient unrousable and naloxone already prescribed (when utilized for acute pain management) **5** Review analgesia: stop any other opioids prescribed and consider changing parameters of epidural/intrathecal infusion (McCaffery and Pasero 1999)
Sedation: *Mild:* patient drowsy but easy to rouse *Severe:* patient difficult to rouse	See Respiratory depression	**1** If patient has mild sedation, consider reducing the rate of the infusion or the dose of opioid or taking the opioid out of the infusion **2** If patient is difficult to rouse and opioid toxicity/overdose is suspected, follow management for respiratory depression
Hypotension	Patients with hypovolaemia Patients with a high thoracic epidural in whom the concentration of local anaesthetic agent and volume of infusion cause blockade of the cardio-accelerator nerves	If blood pressure falls suddenly: **(a)** Stop the epidural/intrathecal infusion **(b)** Summon emergency assistance **(c)** Administer oxygen via facemask or nasal cannula **(d)** Stay with the patient and monitor blood pressure at 5-minute intervals **(e)** Ensure polyfusor of Haemaccel or Gelofusine is readily available and use if prescribed by the anaesthetist **(f)** Vasoconstrictor agents such as ephedrine or metaraminol may need to be given by the anaesthetic team if hypotension does not respond to a fluid challenge of Haemaccel or Gelofusine (Macintyre and Schug 2007)
Motor blockade	More likely to occur when higher concentrations of local anaesthetic agents are given by continuous infusion If a high concentration of a local anaesthetic agent is administered via a low lumbar epidural/intrathecal catheter then the lumbar motor nerves are likely to be blocked, causing leg weakness	Do not attempt to mobilize patient if leg weakness is evident Contact pain or anaesthetic team for advice: reducing the concentration of the local anaesthetic agent or the rate of the epidural/intrathecal infusion may help to resolve this problem (Pasero and McCaffrey 1999)
Nausea and vomiting	Previous episodes of nausea and vomiting with opioids Exacerbated by low blood pressure	Regular administration of antiemetics Treat other causes, for example low blood pressure Consider use of non-pharmacological methods (e.g. stimulation of the P6 acupressure point)
Pruritus (usually more marked over the face, chest and abdomen)	Previous pruritus with opioids	Administer an antihistamine such as chlorpheniramine (may be contraindicated in patients who are becoming increasingly sedated) or a small dose of naloxone (administer with caution as this can easily reverse analgesia) If pruritus does not resolve, consider switching to another opioid or removing the opioid from the infusion (McCaffery and Pasero 1999)
Urinary retention	More likely to occur if opioids and local anaesthetic agents are infused in combination	Catheterize patient

Assessment of pain for patients with epidural analgesia

Pain should be assessed (at rest and on movement) at the same time that the

patient's routine observations are carried out. Simple numerical (e.g. 0–10 where 0 is no pain and 10 is the worst pain imaginable) or verbal rating scales (e.g. none, mild, moderate, severe, or very severe) can be used.

Inadequate postoperative pain management can lead to physiological complications (respiratory, cardiovascular, gastrointestinal and endocrine systems) and adverse effects (behavioural, such as reduced mobility, and psychological, such as increased anxiety and reduced mood) (Macintyre and Schug 2007). Thus, when patients are assessed the practitioner should ensure the patient can take a deep breath and cough and mobilize with a minimal level of pain to reduce the impact of the physiological, behavioural and psychological effects of undertreated acute pain.

When used for chronic pain management, the aim of epidural/intrathecal analgesia is to improve the overall quality of life of the patient. Although it is acceptable to use simple pain assessment rating scales, a more in-depth pain assessment scale may be used such as the BPI (Cleeland 1991).

Equipment and prescription safety checks

When a patient is receiving a continuous infusion of epidural/intrathecal analgesia it is advisable to carry out the safety checks given in Table 9.6 at least once per shift.

Table 9.6 Epidural/intrathecal analgesia: safety checklist

Checklist	**Rationale**
Check the prescription and rate of the epidural/intrathecal infusion	To ensure epidural/intrathecal drugs are being administered correctly
Check the epidural/intrathecal infusion/syringe pump extension set is connected to the epidural catheter and not to any other access device	To ensure drugs are administered via the correct route
Check the bacterial filter is securely attached to the epidural/intrathecal catheter	To prevent accidental disconnection of the catheter from the filter
Check that the dressing over the epidural/intrathecal catheter exit site is secure	To prevent catheter dislodgement and minimize the risk of contamination of the catheter site

Removal of epidural/intrathecal catheter

Before an epidural/intrathecal catheter is removed, it is essential to consider the clotting status of the patient's blood. If the patient is fully anticoagulated a clotting profile must be performed and advice sought from the medical staff as to when the catheter can be removed. If the patient is receiving a prophylactic anticoagulant the following guidelines are recommended (Horlocker and Wedel 1998, Rowlingson and Hanson 2005, Vandermeulen *et al.* 1994).

Low-dose low molecular weight heparin

If this is given once daily, the epidural/intrathecal catheter should be removed at least 12 hours after the last injection and several hours prior to the next dose. The timing will depend on the manufacturer's recommended guidelines; for example, for Tinzaparin (Leo Laboratories Ltd) it is recommended that epidural or spinal catheters are removed a minimum of 4 hours before the next dose.

Unfractionated heparin

The epidural/intrathecal catheter should be removed following local guidelines and the advice of the anaesthetic/pain management team.

Ongoing care for patients with intractable chronic and cancer pain

Monitoring after insertion

For the first 24 hours after epidural/intrathecal insertion, the patient should be monitored for signs of drug-related side-effects or uncontrolled pain. Intravenous access should be maintained for at least 24 hours so that emergency drugs and fluids can be given if necessary.

After 24 hours, providing the patient's condition is stable, routine monitoring of respiratory rate and cardiac function is not usually required unless indicated clinically by the patient's condition or by local policy guidelines. This allows monitoring for patient safety immediately post insertion whilst minimizing invasive procedures in patients with chronic pain problems. Ongoing assessment of pain and observation for any signs of infection (temperature monitoring and observation of the catheter exit site) should be continued for the duration of epidural/intrathecal analgesia.

Minimizing infection

Infection is a complication with long-term epidural or intrathecal analgesia.

Tunnelling the epidural/intrathecal catheter

To minimize the risk of a serious infection (e.g. epidural abscess, meningitis), it is common to tunnel the epidural/intrathecal catheter during insertion. This reduces the speed at which a local infection can spread along the catheter before reaching the epidural/intrathecal space (Baker *et al.* 2004). Once a local infection is suspected at the tunnelled site, treatment with antibiotics should be prompt to prevent a systemic infection. See Complications specific to intrathecal analgesia, Meningitis.

Epidural/intrathecal bacterial filter changes during longer term infusions

De Cicco *et al.* (1995) found that the use of bacterial filters during prolonged epidural catheterization maintained an unmodified antimicrobial function for more than 60 days when perfused with reduced volumes of drugs. It is recommended that bacterial filters should only be changed every 4–6 weeks unless blocked (De Cicco *et al.* 1995, Mercadente 1999). More frequent filter changes have been associated with an increased risk of microbial colonization as a direct result of the manipulations (De Cicco *et al.* 1995).

Discharge planning

If it is anticipated that the patient will go home with a continuous epidural or intrathecal infusion, the patient's general practitioner and community nursing team should be consulted at the outset to determine whether they are willing to be involved and/or trained in the management of epidural/intrathecal analgesia care.

Arrangements should also be made with the primary healthcare team for the provision of a suitable epidural/intrathecal pump and the supply of reconstituted syringes/infusion bags. Primary care teams, patients and their families will need to be trained and supplied with the appropriate equipment, drugs, catheter filters, information about the infusion pump, how to identify a catheter-related or systemic infection and what to do if pain occurs or complications arise. Contact numbers must be available in case specialist advice is needed.

Complications

If pain is not controlled and the infusion has already been titrated according to hospital guidelines, the pain/anaesthetic team should be contacted for advice after checking the following.

- The catheter is still *in situ*.
- The catheter is still connected to the bacterial filter.
- There are no leaks within the system.
- The height of the epidural/intrathecal block. This will indicate whether the block has fallen below the upper limit of the incision or pain site. To check the height of the block, use a small piece of ice or cold solution (ethyl alcohol). Start at the top of the chest above the patient's incision or pain site. Gently dab the ice (or apply the cold solution) down each side of the patient's body (one side and then the other). Use a dermatome map to assess the upper and lower limits of where the sensation changes (see Figure 9.17).

If the height of the block has fallen below the upper limit of the incision or pain site, the pain/anaesthetic team may undertake the following: give the patient a bolus dose of local anaesthetic agent to re-establish the block and reposition the epidural catheter. If either of these fails, other methods of analgesia need to be considered.

Haematoma

An epidural haematoma can arise from trauma to an epidural blood vessel during catheter insertion or removal. Although the incidence of a haematoma occurring is extremely rare, particular care must be taken in patients receiving thromboprophylaxis (see Procedure guideline 9.14). Initial symptoms include back pain and tenderness. As the haematoma expands to compress the nerve roots or the spinal cord, this proceeds to sensorimotor weakness (Chapman and Day 2001).

Abscess formation

Wheatley *et al.* (2001) note that infection can be introduced into the epidural space from an exogenous source via contaminated equipment or drugs or from an endogenous source, leading to bacteraemia which seeds to the insertion site or catheter tip. Alternatively, the catheter can act as a wick through which the infection tracks down from the entry site on the skin to the epidural/intrathecal space. Symptoms include back pain and tenderness accompanied by redness with a purulent discharge from the catheter exit site (Day 2001).

Complications specific to epidural analgesia

Dural puncture

This usually occurs when the dura mater is inadvertently punctured during the placement of the epidural catheter. The incidence of a dural puncture arising during placement of the catheter is approximately 0.32–1.23% (Wheatley *et al.* 2001). The main symptom is a headache, which arises from leakage of CSF through the dura.

Catheter migration

Catheter migration is extremely rare, occurring in less than 0.2% of patients (Wheatley *et al.* 2001). The catheter may migrate into either a blood vessel or the CSF. If it migrates into a blood vessel, opioid or local anaesthetic toxicity will occur. Opioid toxicity results in sedation and respiratory depression. Local anaesthetic toxicity results in circumoral tingling, numbness, twitching, convulsions and apnoea (Pasero and McCaffrey 1999). If the catheter migrates into the CSF, the epidural opioids and local anaesthetic agents may reach as high as the cranial subarachnoid space. If this occurs the respiratory muscles are paralysed together with the cranial nerves, resulting in apnoea, profound hypotension and unconsciousness (Macintyre and Schug 2007).

Complications specific to intrathecal analgesia

Meningitis

Meningitis is a rare complication of intrathecal analgesia. The epidural route is often considered safer as the intact dura serves as an effective barrier to the spread of infection to the subarachnoid space. In fact, similar infection rates are reported with both intrathecal and epidural administration (Mercadante 1999). The incidence of major infections varies widely but is reported by Ballantyne and Carwood (2005) as zero and as approximately 5% by Sloan (2004) for epidural and intrathecal therapy with external pump systems. If the patient presents with headaches, fever, neck stiffness or photophobia, they must be reviewed as a matter of urgency by the medical/anaesthetic team, as if meningitis is suspected CSF samples can be obtained and sent to microbiology for analysis, and antiobiotic therapy initiated promptly (Baker *et al.* 2004, Day 2001).

Entonox Administration

Definition

Entonox (BOC 1995), a gaseous mixture of 50% nitrous oxide (N_2O) and 50% oxygen (O_2), is a patient-controlled, inhaled analgesic which is used for the short-term relief of acute pain (Stannard and Booth 1998). Nitrous oxide is a colourless, sweet-smelling gas with powerful analgesic properties, supplied in premixed cylinders (Bruce and Franck 2000). The gas is inhaled and self-administered by the patient using a demand valve system attached to a facemask or a mouthpiece. The nitrous oxide component of the gas acts as a powerful analgesic producing similar physiological effects to opioids (Gillman and Lichtigfeld 1994), whilst the oxygen component has an antihypoxic effect (Faddy and Garlick 2005) and ensures good cerebral perfusion and enhanced recovery (Peate and Lancaster 2000).

Related theory

Although the exact mechanism of nitrous oxide is unknown, its effects take place within the pain centres of the brain and spinal cord and are related to the release of endogenous neurotransmitters such as opioid peptides and serotonin and the activation of certain opioid receptors (Fang *et al.* 1997, Gillman and Lichtigfeld 1998). N-methyl-D-aspartate (NMDA) receptor currents are inhibited by nitrous oxide and it is known that these receptors are involved with many central nervous system pathways (Jevtovic-Todorovic *et al.* 1998). The release of these neurotransmitters is thought to activate descending pain pathways which modulate pain transmission in the spinal cord (Maze and Fujinaga 2000). Pulmonary transfer of nitrous oxide is rapid, with onset of effect in seconds and full analgesic effect within 1–2 minutes. It is also rapidly eliminated from the blood, via the lungs, when inhalation ceases (Trojan *et al.* 1997).

Evidence-based approaches

Rationale

There are several advantages to using Entonox.

- As the gas is inhaled, it is painless when compared to systemic methods of administering analgesia (such as injections).
- It has a rapid onset of effect.
- The side-effects are few and are self-limiting as the gas is self-administered.
- It does not depress respiratory or cardiovascular function when used as directed.
- Effects wear off rapidly, usually within 5 minutes.
- The patient is in full control, which can reduce anxiety (BOC 2001).

Because of these properties, Entonox is an ideal agent for short-term pain relief following injury or trauma and during therapeutic and investigative procedures. It is used in a variety of settings including accident and emergency (O'Sullivan and Benger 2003), obstetrics (Rosen 2002), paediatrics (Bruce and Franck 2000, Pickup and Pagdin 2001), endoscopy/biopsy procedures (Forbes and Collins 2000, Manikandan *et al.* 2003) and the ambulance service.

Indications

- Wound and burn dressing, wound debridement and suturing.
- Normal labour.
- Changing or removing of packs and drains.
- Removal of sutures from sensitive areas, for example the vulva.
- Invasive procedures such as catheterization and sigmoidoscopy.
- Removal of radioactive intracavity gynaecological applicators.
- Altering the position of a patient who experiences incident pain.
- Manual evacuation of the bowel in severe constipation.
- Acute trauma, for example applying orthopaedic traction following pathological fracture, reduction of joint dislocation.
- Physiotherapy procedures, particularly postoperatively.

Contraindications

Entonox should not be used with any of the following conditions.

- Maxillofacial injuries (BOC 2000), as the patient may not be able to hold the mask tightly to the face or use the mouthpiece adequately. There is a risk of causing further damage to facial wounds and there may also be a significant risk of blood inhalation.
- Head injuries with impairment of consciousness.
- Heavily sedated patients, as they would be unable to breathe in the Entonox on demand and to potentiate sedation further may be hazardous.
- Intoxicated patients, as drowsiness and aspiration would be a hazard in the event of vomiting.
- Any condition in which gas is entrapped withina a body and where its expansion may be dangerous such as:
  - Pneumothorax (artificial, traumatic or spontaneous)
  - Air embolism
  - Severe bullous emphysema
  - Abdominal distension or bowel obstruction
  - Decompression sickness or following a recent dive
  - Following air encephalography
  - During myringoplasty
  - In patients who have received recent intraocular injection of gas (BOC 2009).
  - The nitrous oxide constituent of Entonox passes into any air-filled cavity within the body faster than nitrogen passes out. As the gas expands this is likely to result in a build-up of tension, which will increase the patient's symptoms.
- Laryngectomy patients, as they will be unable to use the apparatus.
- Temperatures of below –6°C as the gases separate (BOC 1995). If this occurs the cylinders will initially deliver a high concentration of oxygen but will eventually deliver nearly pure nitrous oxide.

Use during pregnancy and lactation

It has been suggested that prolonged exposure to high levels of nitrous oxide may affect a woman's ability to become pregnant (Axelsson *et al.* 1996). Mild skeletal teratogenic changes have been observed in pregnant rat embryos when the dam (pregnant mother) has been exposed to high levels of nitrous oxide during the period of organogenesis. However, no increased incidence of fetal malformation has been discovered in eight epidemiological studies and case reports in humans (BOC 2009). No published material shows that nitrous oxide is toxic to the human fetus. Therefore, there is no absolute contraindication to its use in the first 16 weeks of pregnancy.

There are no known adverse effects to using Entonox during the breast-feeding period (BOC 2009).

Principles of care

Cautions

Prior to Entonox use, consideration should be given to the following.

- The high level of oxygen (50%) in Entonox may depress respiration in patients who have chronic obstructive pulmonary disease and are carbon dioxide (CO_2) retainers.
- Entonox should not be used as a replacement for intravenous analgesia or general anaesthesia in procedures requiring increased levels of medical intervention.
- If Entonox is used as the sole analgesic/sedative agent, the British Oxygen Company (BOC) 1995 data sheet recommends that driving or operating complex machinery is not recommended until:
  - the healthcare professional has judged that the patient has returned to normal mental status (Entonox can cause psychotropic effects)
  - the patient feels they are competent to drive after the relevant procedure is completed
  - at least 30 minutes has elapsed after the administration of Entonox has ceased.
- Additional care is needed when Entonox is administered to a patient who has been given concomitant medication.

Legal and professional issues

Healthcare professionals involved in the assessment, administration and continuing care of patients receiving Entonox should have undergone training to do so. They should be able to demonstrate knowledge of the properties of the gas, precautions to be taken, actions in the event of an emergency and the correct operating procedures for equipment. It is important that staff are given appropriate theoretical and practical training (BOC 1998; Peate and Lancaster 2000). This can be supplied by BOC Medical and certificated.

Prescribing of Entonox

In a number of healthcare settings, nurses, midwives and physiotherapists may be able to administer Entonox without a written prescription from a doctor providing there is a local patient group direction to allow this. Where this is the case, Entonox can be used more readily and time is not wasted waiting for a medical prescription. Non-medical prescribers who have completed the relevant training as an independent prescriber may also prescribe Entonox if this is within their area of competence.

Preprocedural considerations

Equipment

Cylinders

Entonox cylinders are available from the BOC in a variety of sizes. All cylinders have blue and white markings on their shoulder (Figure 9.18). The lightweight smaller cylinders have the following advantages.

Figure 9.18 Entonox CD-size cyclinder.

Courtesy of BOC Healthcare.

- They are easier to carry.
- They have a live contents gauge.
- Changing an empty cylinder is simple because it is not necessary to fit a regulator or use a cylinder key.

The smaller size cylinders tend to be used in ambulances and by midwives for their portability in home births. Some clinical areas may have piped Entonox, such as accident and emergency departments, high-dependency units and critical care units. The larger cylinders which require a trolley to move them around are more suitable for ward areas.

Demand apparatus

There are a number of different companies that supply the demand apparatus for self-administered Entonox use. Examples of these include the Ease demand valve (Sabre Medical) and the Carnet single patient use demand valve (Figure 9.19).

Figure 9.19 Example of a demand valve apparatus.

Courtesy of BOC Healthcare.

Bacterial filters and mouthpieces/facemasks

Because Entonox equipment is a potential source of cross-infection, bacterial filters (single-use only) should be fitted between the facemask or mouthpiece and demand valve if the demand valve is not for single use (Chilvers and Weisz 2000). Facemasks and mouthpieces must also be single-use only and disposable once therapy ceases. Local policies must also be followed for the cleaning/sterilization of non-disposable equipment between patient use.

Assessment

The patient's ability to administer Entonox safely and effectively (particularly the very young or old) must be assessed prior to use. Patients should be able to:

- understand the instructions for Entonox use
- hold the demand valve to self-administer the gas
- inhale the gas through the mask or mouthpiece whilst breathing normally (patients who have impaired lung function may not be able to inhale the gas sufficiently to provide adequate analgesia).

Pharmacological support

Entonox is designed for self-administration by the patient. This method of administration makes use of a demand unit which safeguards the patient from excess inhalation of Entonox. The demand unit ensures that gas can be obtained only by the patient inhaling from the mouthpiece or mask and producing a negative pressure. The gas flow stops when the patient stops inhaling and removes the mouthpiece or mask from their face. Thus patients are able to self-regulate the dose of Entonox (a method of patient-controlled analgesia). Therefore, the patient must hold the mask firmly over the face or mouthpiece to the lips to produce an airtight fit and breathe in before the gas will flow. Expired gases escape by the expiratory valve on the handpiece. It is essential to adhere to this method of self-administration as it is then impossible for patients to overdose themselves because, if they become drowsy, they will relax their grip on the handset and the gas flow will cease when no negative pressure is applied. However, should inhalation continue, light anaesthesia supervenes and the mask drops away as the patient relaxes. Entonox may be self-regulated, but additionally may be administered by attendant medical personnel trained in its use, for example within obstetric/accident and emergency units, and accident ambulances.

Entonox has an oxygen content two-and-a-half times that of air and is therefore a good way of giving extra oxygen as well as providing analgesia.

Duration and frequency of administration

The duration and frequency of Entonox administration should always be tailored to individual patient needs. Because prolonged exposure to Entonox causes inactivation of vitamin B_{12}, impaired folate metabolism and pernicious anaemia (BOC 2009), it is recommended that:

- Entonox is used on a short-term rather than a long-term basis
- it should not be used for more than a total of 24 hours, or more frequently than once every 4 days (BOC 2009)
- if daily use is required for more than 4 days, this should be accompanied by close supervision and haematological monitoring (blood tests) to check for changes in red and white blood cells (BOC 2009). Consideration should also be given to the administration of B_{12} and folate supplements.

Procedure guideline 9.18 Entonox administration

Essential equipment

- Entonox cylinder and head
- Facemask and/or mouthpiece
- Sterile bacterial filter
- Method of documentation

Preprocedure

Action	**Rationale**
1 Explain and discuss the procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (NMC 2008a, **C**). To reduce patient anxiety (Royal College of Anaesthetists 2006, **C**). To ensure the patient has no underlying medical problems that contraindicate the use of Entonox (BOC 2009, **C**).
Procedure	
2 Turn on the Entonox supply from the cylinder.	To ascertain whether there is any Entonox in the cylinder (BOC 1999, **C**).
3 Examine the gauge to determine how much gas is in the cylinder.	To ensure an adequate supply of gas throughout the procedure (BOC 1999, **C**).
4 Ensure that the patient is in as comfortable a position as possible.	To promote patient comfort (BOC 1999, **C**).
5 Demonstrate how to use the apparatus by holding the mask tightly to your face, replacing the mask/mouthpiece that you have used. Explain to the patient that when they breathe in and out regularly and deeply, a hissing sound will be heard, indicating that the gas is being inhaled.	To ensure that the patient understands what to do and what to expect before any painful procedure commences (BOC 1999, **C**).
6 Allow the patient to practise using the apparatus.	To enable the patient to adopt the correct technique and for the nurse to observe the analgesic effect of the gas before the procedure commences (BOC 1999, **C**).
7 Encourage the patient to breathe gas in and out for at least 2 minutes before commencing any painful procedure.	To allow sufficient time for an adequate circulatory level of nitrous oxide to provide analgesia. When the patient inhales, gas enters first the lungs then the pulmonary and systemic circulations. It takes 1–2 minutes to build up reasonable concentrations of nitrous oxide in the brain (BOC 1999, **C**).
8 During the procedure encourage the patient to breathe in and out regularly and deeply.	To maintain adequate circulatory levels, thus providing adequate analgesia (BOC 1999, **C**).
9 Evaluate the effectiveness of Entonox with the patient throughout and following the procedure, by verbal questioning and encouraging the patient to self-assess the analgesic effect.	To establish whether the Entonox has been a useful analgesic for the procedure. This should then be documented to assist any subsequent procedures, for example dressing changes (BOC 1999, **C**).
10 At the end of the procedure observe the patient every 5–10 minutes until the effects of the gas have worn off. Observe the patient for up to 30 minutes.	Some patients may feel a transient drowsiness or giddiness and should be discouraged from getting out of bed until these effects have worn off. It is rare for the patient to experience transient amnesia (BOC 1999, **C**).
Postprocedure	
11 Turn off the Entonox supply from the cylinder.	To avoid potential seepage of gas from the apparatus (BOC 1999, **C**).

12 Depress the diaphragm under the demand valve.	To remove residual gas from tubing (BOC 1999, **C**).
13 Follow local policies/guidelines for the cleaning and sterilization of expiratory valve and tubing, and facemask (or disposal if single use). Filters and mouthpieces should be discarded after use.	To reduce the risk of cross-infection (BOC 1999, **C**).
14 Record the administration on appropriate documentation.	To promote continuity of care, maintain accurate records and provide a point of reference in the event of any queries (BOC 1999, **C**; NMC 2005, **C**).

Problem-solving Table 9.4 Prevention and resolution (Procedure guideline 9.18)

Problem	Cause	Prevention	Suggested action
Patient not experiencing adequate analgesic effect	Entonox cylinder empty. Apparatus not properly connected	Check before procedure commences	Change to a full cylinder
	Patient not inhaling deeply enough (BOC 2000)	Education of patient prior to starting procedure	Encourage the patient to breathe in until a hissing noise can be heard from the cylinder. Reassess suitability of patient for Entonox use. The patient may not be strong enough to inhale deeply or may have reduced lung capacity
	Patient inhaling pure oxygen, that is, cylinder has been stored below –6°C and nitrous oxide has liquified and settled at the bottom of the cylinder	All cylinders should be stored horizontally at a temperature of 10°C or above for 24 hours before use (BOC 1995)	Initially safe, but later the patient may inhale pure nitrous oxide and be asphyxiated. Discontinue the procedure. Ensure adequate warming of the cylinder and inversion of the cylinder to remix the gases adequately
	Not enough time has been allowed for nitrous oxide to exert its analgesic effect	Allow at least 2 minutes of Entonox use before commencing the procedure	Stop procedure. Allow 2 minutes of Entonox use. Re-start procedure
Patient experiences generalized muscle rigidity	Hyperventilation during inhalation (BOC 2000)	Education of patient prior to starting procedure	Discontinue Entonox and allow the patient to recover. Explain the procedure again, stressing deep and regular inspiration. Use a mouthpiece in place of a mask
Patient unable to tolerate a mask	Smell of rubber, feeling of claustrophobia	Assess patient preference to use either mask or mouthpiece before Entonox use	Use a mouthpiece in place of a mask
Patient feels nauseated, drowsy or giddy	Effect of nitrous oxide accumulation (BOC 2000)	None	Discontinue Entonox administration: the effect will then rapidly disappear. Re-start Entonox use; if the same effect occurs stop using Entonox and use alternative analgesia
Patient afraid to use Entonox	Associates gases with previous hospital procedures, for example anaesthesia before surgery (BOC 2000)	Assess suitability of patient for Entonox use. Address fear and anxiety issues before starting Entonox use	Reassure patient and reiterate instructions for use and short-term effects

Complications

Events such as euphoria, disorientation, sedation, nausea, vomiting, dizziness and generalized tingling are commonly described. These events are generally minor and rapidly reversible (BOC 2009).

Inappropriate inhalation of Entonox will ultimately result in unconsciousness, passing through stages of increasing light-headedness and intoxication. The treatment is removal to fresh air, mouth-to-mouth resuscitation and, if necessary, the use of an oxygen resuscitator (BOC 1995).

Abdominal Paracentesis

Definition

Abdominal paracentesis is a technique used to drain a pathological collection of ascitic fluid from the abdomen (Campbell 2001). This technique is performed to help diagnose the cause of ascites (diagnostic paracentesis) or to relieve the discomfort associated with this condition (therapeutic paracentesis) (McGibbon *et al.* 2007).

Anatomy and physiology

The peritoneum is a semi-permeable serous membrane consisting of two separate layers: the parietal layer and the visceral layer. The parietal layer covers the abdominal and pelvic walls and the undersurface of the diaphragm. The visceral layer lines and supports the abdominal organs and the parietal peritoneum (Figure 9.20). The space between the parietal and visceral layers is known as the peritoneal cavity (Thibodeau and Patton 2007). The normal peritoneal cavity has a small amount of free fluid of approximately 50 mL (McGibbon *et al.* 2007).

Figure 9.20 Peritoneum of female in lateral view.

In a healthy individual fluid is produced from the capillaries lining the peritoneal cavity and is drained by lymphatic vessels under the diaphragm. The fluid is collected by the right lymphatic duct which drains into the vena cava. The peritoneum forms the largest serous membrane in the body (Tortora and Derrickson 2009). However, in patients with malignant ascites, this balance of

production and drainage is disrupted and ascitic fluid collects in the peritoneal cavity (Box 9.18).

Box 9.18. Functions of the peritoneum

- The peritoneum is a serous membrane that enables the abdominal contents to glide over each other without friction.
- It forms a partial or complete cover for the abdominal organs.
- It forms ligaments and mesenteries which help to keep the organs in position.
- The mesenteries contain fat and act as a store for the body.
- The mesenteries can move to engulf areas of inflammation and this prevents the spread of infection.
- It has the power to absorb fluids and exchange electrolytes.

(Thibodeau and Patton 2007, Tortora and Derrickson 2009).

Related theory

Ascites can be caused by non-malignant conditions such as cirrhosis of the liver, advanced congestive heart failure and chronic pericarditis and nephrotic syndrome. Cirrhosis of the liver is the most common cause of ascites and in this clinical condition the development of ascites indicates a poor prognosis (Hou and Sanyal 2009, Sargent 2006).

Malignant conditions such as metastatic cancer of the ovary, stomach, colon or breast can also cause ascites. The incidence of ascites in patients with cancer is not well recorded but it is known to occur in many different cancer types (Cope 2005). Malignant ascites accounts for about 10% of ascites, of which 34–54% are from ovarian cancers (Winkelman 2004). It should be noted that in about one-third of patients with cancer, ascites has a non-malignant cause (Hosttetter *et al.* 2005). In patients with advanced cancer, malignant ascites is the most likely diagnosis of an abdominal fluid collection and often reflects end-stage disease. However, in some cases such as ovarian cancer and lymphoma, ascites can be an early presentation and efforts to obtain tumour shrinkage and prolongation of survival should be undertaken (Marincola and Schwartzentruber 2001). If a definitive diagnosis is needed to establish cause to aid staging and possible surgical intervention then a peritoneal tap and analysis of fluid will be useful (Marincola and Schwartzentruber 2001).

The pathogenesis of ascites differs depending on its primary related factors. Cirrhotic ascites is more recently believed to be related to portal hypertension (Hou and Sanyal 2009, Lee and Grap 2008). The increased pressure occurs due to fibrosis and scarring of the liver from chronic liver disease, causing obstruction to venous flow (Whiteman and McCormick 2005). In the case of heart failure and constrictive pericarditis, the heart loses its ability to pump blood and this causes a back-up of blood and increases pressure into the portal venous system, leading to portal hypertension and ascites (Lee and Grap 2008).

The pathogenesis of malignant ascites is not as well understood as non-cancer related ascites is (Seike *et al.* 2007) but cytokines, mechanical obstruction and hormonal influence are thought to be related. Cytokines such as vascular endothelial growth factor (VEGF) and vascular permeability factor (VPF) regulate vascular permeability. The obstruction of lymphatic drainage by the disseminating malignant cells in the peritoneal cavity reduces absorption of peritoneal exudates (Seike *et al.* 2007). This reduction activates the renin-

angiotensin-aldosterone system and leads to sodium retention, which then further exacerbates the ascites. Lee and Grap (2008) explain that in peritoneal carcinomatosis, tumour cells line the peritoneal cavity and produce a protein-like fluid. Extracellular fluid is drawn into the cavity due to increased oncotic pressure of the peritoneal fluid. Fluid also develops in liver metastases and hepatocellular cancer due to portal hypertension. Portal hypertension develops when stenosis or occlusion of the portal vein occurs by thrombosis or tumour nodules (Lee and Grap 2008).

Ascites is often accompanied by debilitating symptoms as large amounts of fluid collect in the peritoneal cavity, causing an increase in intra-abdominal pressure and resulting in pressure on internal structures. The fluid accumulation may occur over several weeks or rapidly over a few days (Lee and Grap 2008). Symptoms initially include vague abdominal discomfort, which can go on to affect the respiratory and gastrointestinal systems, depending on the amount of fluid present. Pressure on the diaphragm decreases the intrathoracic space and causes shortness of breath. Gastric pressure may cause anorexia, indigestion or hiatus hernia. Intestinal pressure may result in constipation, bowel obstruction or decreased bladder capacity. Patients also become increasingly fatigued, finding simple daily tasks difficult (Winkelman 2004). Additionally, body image can be affected even when minimal distension is present.

Cytological confirmation of malignant cells is difficult with only a 50% chance of success (Fentiman 2002).

Evidence-based approaches

Rationale

There is much debate about whether it is safe to drain large volumes of fluid rapidly from the abdomen. One concern is that profound hypotension may follow because of the sudden release of intra-abdominal pressure and consequent possible vasodilation (Lee *et al.* 2000). However, following a local study and literature search, Stephenson and Gilbert (2002) suggest that up to 5 litres of fluid may be safely drained over a few hours. They also state that it is not necessary to drain the abdomen until dry. McNamara (2000) supports this by pointing out that the maximum relief of symptoms may be achieved after the initial few litres are drained. This is further supported by Moorsom (2001) who suggests that several litres can be drained on free flow over 1 hour.

It is generally not necessary to have intravenous fluid or albumin replacement. However, patients with ascites who have large tumours, cirrhosis of the liver or renal impairment may require slower drainage of fluid and possible fluid replacement, depending on their clinical condition. Abdominal and peritoneal tumours can cause ascites to develop independently of the circulatory system and therefore hypotension is not usually seen as the ascites is drained (Klee 2004).

A small study has shown that the success of blind paracentesis is directly related to the amount of fluid present (44% with 300 mL and 78% with 500 mL) (McGibbon *et al.* 2007). The literature suggests the use of ultrasound-guided paracentesis to confirm the presence of ascites and also to identify the best site to perform paracentesis, particularly when a small amount of fluid is present (McGibbon *et al.* 2007).

Indications

- To obtain a specimen of fluid for analysis for diagnostic purposes (diagnostic paracentesis).
- To relieve the symptoms associated with ascites, both physical and psychological (therapeutic paracentesis).
- To administer substances such as cytotoxic drugs (e.g. bleomycin, cisplatin) or other agents into the peritoneal cavity, to achieve regression of serosal deposits responsible for fluid formation (Hosttetter *et al.* 2005).

Contraindications

- *Relative contraindications:* pregnancy, severe bowel distension and previous extensive abdominal or pelvic surgery (McGibbon *et al.* 2007). When relative contraindications are present paracentesis without the assistance of ultrasound (blind paracentesis) is not recommended (McGibbon *et al.* 2007).
- *Absolute contraindication*: clinically evident fibrinolysis or disseminated intravascular coagulation (McGibbon *et al.* 2007).

Preparatory investigations

The patient's clinical condition and purpose of the procedure must be taken into account when deciding what investigations are necessary but most preprocedure investigations include a blood screen and ultrasound examination. To keep intrusion to a minimum for palliative patients, fewer investigations may be performed. Blood is usually checked for full blood picture, urea and electrolytes, creatinine, liver function test, plasma proteins and coagulation screen (Hewish 2006). In the case of a diagnostic paracentesis, the ascitic fluid should be analysed for cell count, bacterial culture, total protein and albumin (Hou and Sanyal 2009).

Methods of managing ascites

Interventions used to treat ascites range from an aggressive approach to a purely palliative approach. There have been few definitive studies that have evaluated the different approaches in the treatment of malignant ascites (Hosttetter *et al.* 2005). While paracentesis is effective, ascites recurs, requiring repeated procedures. This fact imposes a further burden on patients and their families (Mercadante *et al.* 2008). Treatment for ascites may include use of diuretics, paracentesis, diet low in sodium, instillation of peritoneal agents or the insertion of long-term catheters. However, the literature available is mostly generated from studies with patients suffering from acute or chronic liver failure; this should be taken into account when managing patients with non-malignant ascites.

- *Paracentesis*: the most common way of managing ascites as it has an immediate effect in 90% of cases (Campbell 2001, Marincola and Schwartzentruber 2001).
- *Sodium-restricted diet*: the amount of fluid retained in the body depends on the balance between sodium ingested in the diet and sodium excreted in the urine. A reduced sodium intake of 2 g/day is considered a realistic goal (Sargent 2006).
- *Diuretics*: useful mainly in cirrhotic-type ascites. This may be used for malignant ascites together with a restriction of salt and fluid intake, and has been found to be effective in about one-third of patients (Hosttetter *et al.* 2005). Additionally, it appears to be more effective for management of patients with small-volume ascites (only diagnosed by ultrasound). Spironolactone is the diuretic of choice (Hou and Sanyal 2009). The most effective way of monitoring the fluid loss is by weighing the patient daily (Sargent 2006).
- *Instillation of intraperitoneal agents*: cytotoxics, sclerosants and biological substances have been tried in an attempt to control the recurrence of ascites. To date, intraperitoneal agents have not been proven, unequivocally, to have a greater beneficial effect than the use of diuretics (Fentiman 2002).
- *Long-term catheters*:
- **Peritoneovenous shunt**: generally used in patients with long-term prognosis. These shunts drain ascitic fluid into the superior vena cava and require a general anaesthesia for insertion (Mamada *et al.* 2007, Seike *et al.*

2007).

- **PleurX drain**: tunnelled catheter placed under ultrasound and fluoroscopic guidance. This device is associated with low rates of serious adverse clinical events, catheter failure, discomfort and electrolyte imbalance (Courtney *et al.* 2008). Additionally, it may allow patients to avoid spending added time in hospital for repeated paracentesis.
- **Peritoneal port-catheter**: similar but larger than central venous access ports in order to make access easier and to decrease possible catheter occlusion (Ozkan *et al.* 2007). Very limited number of studies supporting its use.

Anticipated patient outcomes

Nursing and medical care of patients with malignant abdominal ascites should be aimed at improving quality of life by relieving suffering caused by the symptoms (Cope 2005). Each patient should be carefully assessed with consideration of their individual circumstances, maintaining respect for their wish to have or not have interventional treatment (Campbell 2001).

Legal and professional issues

Competencies

The procedure is performed by a doctor or a trained practitioner in paracentesis assisted by a nurse throughout. In most cases medical professionals do not require specific training in paracentesis as learning occurs throughout their career. However, there is recognized training which all professionals wishing to perform paracentesis are expected to complete.

Preprocedural considerations

Equipment

The equipment should be prepared by the health professional performing the paracentesis or by a colleague familiar with the technique. The essential equipment includes a sterile abdominal paracentesis set, a sterile dressing pack, a sterile receiver, a sterile specimen pot, a local anaesthetic, needles and syringes, chlorhexidine 0.5% in 70% alcohol, an adhesive dressing, a large sterile drainage bag or container, gate clamps and sterile gloves.

Nurses should describe the equipment to be used during paracentesis to the patient. This may be more relevant when looking after a patient undergoing the procedure for the first time to whom the size of the catheter used may be very impressive.

Assessment and recording tools

A detailed and consistent nursing assessment is important when caring for patients requiring paracentesis. Nurses should pay particular attention to the cause of the ascites and the frequency with which the procedure is occurring. For some patients the provision of information about counselling and other support strategies is of great benefit as recurrent ascites can be linked with poor prognosis in an oncology setting. The involvement of the palliative care team can at this stage be indicated. In cases of ascites secondary to cirrhosis, nurses should pay special attention to unresolved issues surrounding alcohol abuse, offering support and information to the patient and family.

In preparation for the paracentesis, nurses should measure the patient's girth around the umbilicus and check the patient's weight before the procedure. The same chart should be used to record all subsequent measurements so a comparison can be made.

Pharmacological support

Reassurance about the use of local anaesthetics is essential as patients are often anxious about this being a painful procedure. For a number of patients muscle relaxants may be of benefit prior to the procedure.

Non-pharmacological support

Nurses should enquire about the patient's fears and concerns regarding paracentesis. For some patients, music or relaxation tapes, physical relaxation and visualization techniques are of great benefit so a referral to these services should be considered, if available.

Specific patient preparation

Education

Nursing interventions for patients undergoing abdominal paracentesis include education about the nature of the procedure, what results can realistically be expected, and the risks and benefits. Information should also be given about postprocedure care of the puncture site and about the importance of diet and fluid intake to replace proteins and fluid lost in the ascitic fluid. It is essential that the patient, family and carer are involved in the discussion so that an informed and joint decision may be made in order to achieve the best possible outcome.

Procedure guideline 9.19 Abdominal paracentesis

Essential equipment

Sterile abdominal paracentesis set containing forceps, scalpel blade and blade holder, swabs, towels, suturing equipment, trocar and cannula (or other approved catheter and introducer), connector to attach to the cannula and guide fluid into the container.

- Sterile dressing pack
- Sterile receiver
- Sterile specimen pots
- Local anaesthetic
- Needles and syringes
- Chlorhexidine 0.5% in 70% alcohol
- Adhesive dressing
- Large sterile drainage bag or container (with connector if appropriate to attach to cannula)
- Gate clamps
- Sterile gloves

Optional equipment

- Weighing scales
- Tape measure

Preprocedure

Action	Rationale
1 Explain and discuss the procedure with the patient.	To ensure that the patient is involved in the decision and understands the procedure, the agreed aim, the risks and benefits. Informed consent may then be obtained (Campbell 2001, R5; Cope 2005, R5; NMC 2008a, **C**).
2 Ask the patient to empty their bladder.	If the bladder is full there is a chance of it being punctured when the trocar is introduced (McGibbon *et al.* 2007, **E**).
3 Weigh patient before procedure and record.	To assess weight changes and the fluid loss. **E**
4 Ensure privacy.	To maintain dignity (DH 2006, **C**).
5 Measure patient's girth around umbilicus before procedure and record. Mark the position.	This provides an indication of fluid shift and how much fluid has reaccumulated. **E**
6 Lie the patient supine in bed with the head raised 45–50 cm with a backrest.	Normally the pressure in the peritoneal cavity is no greater than atmospheric pressure, but when fluid is present, pressure becomes greater than atmospheric pressure. This position will aid gravity in the removal of fluid and the fluid will drain of its own accord until the pressure is equalized. **E**
Procedure	
7 Prepare the abdomen aseptically and drape with sterile towels. Administer local anaesthetic.	To reduce the risk of local and/or systemic infection. The peritoneal cavity is normally sterile (Fraise and Bradley 2009, **E**; Lee *et al.* 2000, R5).
8 Once the anaesthetic has taken effect, the doctor will make an incision into the skin of abdomen (the position may have been marked previously in radiology following ultrasound).	To minimize pain during the procedure and thus maximize patient comfort and facilitate co-operation. **E**
9 The trocar and cannula are inserted via the incision.	
10 The trocar is removed and disposed of in a sharps container.	
11 A closed drainage system is attached to the cannula using a connector if appropriate. A secure dry dressing should be applied to ensure the drain site is protected and taped firmly in position.	A sterile container with a non-return valve is necessary to maintain sterility. To reduce local and/or systemic infection. **E**
12 Ascitic fluid is collected from the cannula with a syringe (20–100 mL as instructed by the doctor) and sent for cytology.	If necessary, in order to diagnose the cause of ascites (Fentiman 2002; Hosttetter *et al.* 2005, R5).
13 If the cannula is to remain in position, sutures may be inserted adjacent to the cannula and looped around it to prevent it becoming dislodged and to prevent local trauma to the patient.	To ensure cannula remains *in situ*. To reduce risk of trauma to the patient. **E**

Postprocedure	
14 Monitor the patient's blood pressure, pulse and respirations and observe the rate and nature of the drainage. A clamp should be available on the tubing to reduce the flow of fluid if necessary.	To observe for signs of shock and/or infection and to ensure unobstructed drainage. **E**
15 Monitor the patient's fluid balance.	After removal of large amounts of peritoneal fluid, fluid moves from the vascular space and reaccumulates in the peritoneal cavity. Ascitic fluid contains protein in addition to sodium and potassium. Problems of dehydration and electrolyte imbalance may be present. **E**
16 Drainage of fluid may be free flowing up to 5 litres unless adverse symptoms present. Alternatively, drainage may be controlled at 2 litres every 4 hours.	If patient shows adverse signs then clamp drain, inform medical team and reopen after medical intervention and advice (Stephenson and Gilbert 2002, **R3b**).
17 Weigh patient after procedure and record.	To assess weight changes and fluid loss. **E**
18 Measure patient's girth around umbilicus after procedure and record.	This provides an indication of fluid shift and how much fluid has reaccumulated. **E**

Problem-solving Table 9.5 Prevention and resolution (Procedure guideline 9.19)

Problem	Cause	Prevention	Suggested action
Patient exhibits shock	Major circulatory shift of fluid or sudden release of intra-abdominal pressure, vasodilation and subsequent lowering of blood pressure	Monitor blood pressure and consider administration of intravenous fluid if volumes larger than 5 litres are expected to drain	Clamp the drainage tube with a gate clamp to prevent further fluid loss. Record the patient's vital signs. Refer to the medical staff for immediate intervention

Cessation of drainage of ascitic fluid	Abdomen is empty of ascitic fluid		Check the total output of ascitic fluid given on the patient's fluid balance chart. Measure the patient's girth; compare this measurement with the preabdominal paracentesis measurement. Suggest to medical staff that the cannula should be removed. Discontinue the drainage system
	Patient's position is inhibiting drainage	Teach patient to avoid exerting pressure on the drainage tubing	Change the patient's position, that is, move the patient upright or onto their side to encourage flow by gravity. Encourage patient to mobilize
	The ascitic fluid has clotted in the drainage system	Keep drainage bag on a stand and lower than the puncture site to facilitate drainage by gravity	'Milk' the tubing. If this is unsuccessful, change the drainage system aseptically Refer to the medical staff
Cannula becomes dislodged	Ineffective sutures or trauma at the puncture site	Collaborate with medical staff when putting suture or alternatively apply secure dressing. Tube is taped to the skin further down to prevent pulling with movement at the puncture site	Apply a secure dry dressing. Reassure patient. Inform the medical staff
Pain	Pressure of ascites or position of drain	Offer analgesia 30 minutes prior to procedure. Apply dressing, allowing enough padding around the puncture site but avoiding drain movement within abdomen	Identify cause. Anchor drain securely to avoid pulling at insertion site or movement within abdomen. Assist patient with repositioning. Administer appropriate prescribed analgesic, monitor the patient's response and inform medical staff

Postprocedural considerations

Immediate care

Observations must be carried out every half an hour for 2 hours and hourly for 4 hours to detect early signs of shock, cardiovascular compromise and infection so that medical staff can be informed and action can be taken promptly. Drainage of the fluid must be monitored regularly, volumes recorded on a fluid balance chart and blockages detected and managed. Patients may require assistance to move and position themselves, and may experience pain, requiring careful repositioning or appropriate analgesia. The drain should be taken out when the desired amount of fluid has been removed; this can take up to 2 days.

Ongoing care

The patient's renal function should be checked following this procedure to ensure that any signs of dehydration or pre-renal failure are treated as early as possible.

Education of patient and relevant others

Patients should be informed that leakage following removal of drain may happen and should be reported promptly.

Complications

- *Bleeding*: manifest as either an abdominal wall haematoma or a haemoperitoneum. The risk of requiring a transfusion following paracentesis is less than 1% (McGibbon *et al.* 2007).
- *Local infection or peritonitis*: there is the theoretical risk of introducing infection into the ascitic fluid, which can be minimized by the use of sterile technique. A swab from the site of the cannula should be obtained for culture review and a dry dressing applied.
- *Bowel or bladder perforation*: this risk is decreased by ensuring the patient has an empty bladder and avoiding areas of scarring where there may be underlying adherent bowel.

Compression Therapy in the Management of Lymphoedema

Definition

Lymphoedema is defined as a chronic oedema caused by a failure of the lymphatic drainage system (International Society of Lymphology 2003).

Anatomy and physiology

The lymphatic system works closely with the cardiovascular system to maintain fluid balance within the body. The cardiovascular system transports nutrients and oxygen to the body's cells via blood vessels. As the blood flows through the vessels, nutrients and water pass into the spaces between the cells, known as the interstitial spaces, to form interstitial fluid (CREST 2008).

The lymphatic system moves this interstitial fluid, now known as 'lymph', via a network of superficial and deep lymphatic vessels in a unidirectional flow towards the two main ducts, the thoracic duct and the right lymphatic duct, before emptying back into the venous system.

Lymph drainage commences with the superficial vessels, called initial lymphatics, which are found in the connective tissue spaces. Movement of lymph in the initial lymphatics is dependent upon muscle activity and changes in tissue pressure (Stanton *et al.* 2000). The larger, deeper lymph vessels act as collecting vessels and contain smooth muscle and valves enabling them to contract and propel lymph in a unidirectional flow. Lymph nodes are situated in groups within the larger lymph vessels and act as filters to collect and destroy bacteria and viruses.

The balance between tissue fluid formation and reabsorption is dependent upon pressures across the capillary wall, known as Starling's forces. Any change can affect fluid levels in the tissues and result in the appearance of oedema (Mortimer 2003a).

Dependency or gravitational oedema is commonly seen in the immobile patient when a failure to activate the muscle pump causes an increase in capillary filtration and reduced lymph drainage in the dependent limb (Mortimer 2003a). Swelling can also occur in chronic venous disease of the lower limbs as a result of lymph drainage failure and increased capillary filtration (Mortimer 2003a). A reduction in the drainage routes of the lymphatic system can occur following cancer-related treatment in lymph node areas and oedema can appear in the adjacent limb or truncal quadrant of the body.

In summary, the lymphatic system has the following main functions.

- To regulate homoeostasis by returning large molecules to the circulation and draining excess fluid from the interstitium.
- To dispose of unwanted cellular byproducts.
- To defend the body from infection by absorbing micro-organisms and

generating an autoimmune response when necessary.

Related theory

The oedema occurs because the lymphatics are reduced in number, obstructed, obliterated or simply fail to function (Browse 2003). Tissue swelling then appears due to the failure of lymph drainage (Mortimer 2003a). Primary lymphoedema occurs when there is an abnormality in the lymphatic system and is classified according to the time of onset (Kinmouth 1982). Secondary lymphoedema arises from the influence of an external factor affecting the function of the lymphatic system and most commonly occurs following treatment for cancer involving the removal or irradiation of lymph node areas. Other causes of secondary lymphoedema include infection, inflammation and trauma to the lymphatic channels or vessels (Keeley 2000).

Lymphoedema is most commonly seen in cancer patients as a result of damage to lymph nodes following surgery and/or radiotherapy, but it can also occur as a result of local tumour obstruction in lymph node areas. The reported incidence of lymphoedema following cancer treatment varies between studies. In breast cancer patients, the prevalence of chronic arm oedema is reported as being between 12% and 60% and in patients treated for gynaecological cancers, it is between 28% and 47% (Lymphoedema Framework 2006c). The incidence of lymphoedema increases with time and 70–80% of patients with long-term lymphoedema present within 12 months of treatment (National Breast and Ovarian Cancer Centre 2008).

Lymphoedema can affect any part of the body including the face and head, but it most commonly affects a limb. The swelling can have physical, psychological and psychosocial implications for the patient and is associated with a number of complications arising from its development (Towers *et al.* 2008). Limb heaviness may lead to impaired function, reduced mobility and musculoskeletal problems (Tobin *et al.* 1993, Woods 1993). Skin and tissue changes develop with increased lymph stasis in the oedematous limb and give rise to the characteristic deepened skinfolds and skin thickening and over time, complex skin conditions can occur (Lymphoedema Framework 2006b). There is an increased risk of local and systemic infection as a result of poor lymph drainage and recurrent acute inflammatory episodes are common (Mortimer 2003b).

Compression therapy in the management of lymphoedema involves the use of compression garments or low-stretch bandages (Asmussen and Strossenreuther 2003, Partsch and Mosti 2008) and is the mainstay of conservative management

for lymphoedema.

Evidence-based approaches

Rationale

Compression therapy initiates physiological effects within the arterial, venous and lymphatic systems (Hafner *et al.* 2000) in order to:

- ensure that lymphatic fluid in the tissues travels through the lymphatic channels towards the root of the limb
- reduce the formation of excess tissue fluid and decrease lymphatic load
- contain the tissues of the swollen limb and help to maintain a normal shape to the limb
- increase blood flow in the microcirculation and initiate a softening of fibrotic tissue
- maximize the effect of the muscle pump (Partsch 2003).

The type of material from which the bandages or garments are made can determine the degree of pressure exerted on the tissues below (Partsch *et al.* 2008), although the level of pressure achieved is also dependent upon a complex combination of other factors including the size and shape of the limb and the activity of the wearer (Clark 2003).

Inelastic and low-stretch bandages are indicated when the lymphoedema is moderate to severe and the limb has swollen out of shape (Williams and Keller 2005). They are also effective when fibrosis of the subcutaneous tissues is present, due to the massaging effect on the tissues caused by the low resting pressures and high working pressures (Foldi *et al.* 2005).

Elastic compression garments are usually used when the lymphoedema is mild and uncomplicated and to maintain the reduced size of a swollen limb after the use of low-stretch bandages (Lymphoedema Framework 2006a).

Principles of care

Compression therapy in the management of lymphoedema can be approached in two phases: the intensive phase and the maintenance phase (Hopkins 2008).

The intensive phase of treatment is a short period of therapist-led treatment usually planned over a 2–3-week period in which specific aims are identified, discussed and agreed between the patient and the therapist. Depending upon the oedema present, however, the treatment may be planned over a longer or shorter time frame. During the intensive or reduction phase of treatment, short-stretch, inelastic bandages are applied to the swollen limb each day and left in place for a period of 23 hours as part of a multilayer system to provide a semi-rigid encasement to the limb (Lymphoedema Framework 2006e). This aspect of treatment is usually combined with other elements of treatment including:

- a skincare regimen to minimize the risks of infection
- specific exercises to promote lymph drainage
- manual lymphatic drainage (MLD) administered by a specially trained therapist to stimulate lymph drainage (Lymphoedema Framework 2006e).

During the maintenance phase, the concept of self-care is promoted to encourage the patient to become independent in the long-term management and control of their swelling. Elastic compression garments are worn for a period of time each day and the therapist evaluates progress at regular intervals to ensure that the garments remain appropriate and that any problems can be identified at an early stage (Lymphoedema Framework 2006a). This aspect of treatment is also combined with other elements of treatment including:

- a skincare regimen to minimize the risks of infection
- specific exercises to promote lymph drainage
- simple lymphatic drainage (SLD), taught to the patient by a therapist to stimulate normal draining lymphatics (British Lymphology Society 2001).

Not all patients will follow both phases of treatment, and many may only need to follow the maintenance phase. The decision concerning the most appropriate phase of treatment for the patient should be made by a skilled therapist taking the patient’s wishes into consideration.

Assessment of the Patient with Lymphoedema and Calculation of Limb Volume

Evidence-based approaches

Rationale

When the use of compression therapy is being considered, a full and careful assessment will highlight the patient's main problems and any co-existing complications. This information is then used to set realistic treatment goals and to determine the most suitable approach to compression therapy treatment. Clinical and physical indications determined during a full assessment of the patient will facilitate the most appropriate choice of compression therapy for the individual patient. A number of treatments are used in combination during the management of lymphoedema and their choice and usefulness can be determined by the therapist and patient at the time of assessment. The experience of living with lymphoedema as a long-term chronic condition is a unique experience for each patient and can have an impact on many areas of the individual's life (Towers *et al.* 2008). The physical and psychological effects are not short-lived and enormous motivation and perseverance coupled with adaptation are demanded in order to achieve control or reduction of the swelling (Mason 2000).

Clarifying the influence of the lymphoedema on the patient's lifestyle, occupation and chosen social activities will help to identify patient-focused problem areas that may require adjustment. By gaining an understanding of the impact that the swelling may be having upon personal feelings and emotions, relevant supportive strategies can be identified (Woods 2007a).

Principles of care

Assessment should include the following elements.

- *Details of the patient's medical history*: to determine whether compression therapy can be used safely. Arterial insufficiency of the lower limb must always be excluded prior to the use of compression therapy. Palpation of the pedal pulses alone is an unreliable predictor of adequate arterial supply. The measurement of the Ankle to Brachial Pressure Index (ABPI) is recommended if there is any doubt about the patient's peripheral arterial status (Lymphoedema Framework 2006d, Woods 2007a). If patients have a history of diabetes or cardiac failure, a medical assessment should also be completed prior to the commencement of treatment with close supervision followed during its progress (Eagle 2001).
- *Physical assessment*: to determine the cause of the swelling and any symptoms or complicating factors. This includes the cause and extent of the oedema, an assessment of the skin condition and limb shape, the patient's disease status and the presence of any pain or altered sensations within the limb (Woods 2007a). The patient's ability to follow a treatment plan, including compression therapy, should also be assessed.
- Figure 9.21 is an example of mild, uncomplicated lymphoedema of the arm and Figure 9.22 is an example of severe, uncomplicated lymphoedema of the arm.

Figure 9.21 Mild, uncomplicated lymphoedema of the arm.

Figure 9.22 Severe, uncomplicated lymphoedema of the arm.

- *Psychosocial assessment*: to determine the influence of the swelling upon the patient's life. This includes the influence upon limb function and mobility, employment, hobbies, activities and personal roles (Lymphoedema Framework 2006d, Woods 2007a).
- *Psychological assessment*: to determine the effect of the swelling on the patient. This includes an assessment of the effect of the lymphoedema upon relationships, personal concerns and fears (Lymphoedema Framework 2006d, Woods 2007a).
- *Problem identification*: to determine actual and potential patient-focused problem areas combined with patient strengths and preferences.

Assessment should also include the following.

- *Planning*: to improve problems and utilize patient strengths. The healthcare professional should work in partnership with the patient to enable them to take appropriate action in order to manage their lymphoedema and work towards long-term control. Planning should focus on the patient's objectives

so that immediate problems can be addressed. Long-and short-term goals can then be identified and agreed with the patient.

- *Implementation*: to determine the appropriateness of interventions and modify where required. An individualized, holistic approach will incorporate education and support, particularly if personal changes are required to minimize the risk of complications developing. Success will be achieved when the patient possesses positive motivational factors and is an active participant in the management of their lymphoedema (Mason 2000).
- *Evaluation*: to assess progress, modify and stop the intervention if necessary. In order to evaluate the outcome of a plan of treatment, suitable outcome indicators are required (Jenns 2000). No standardized method of evaluating the outcome of a plan of treatment has been determined but the measurement of limb volume using surface measurement is the most frequently used means of assessing response to treatment in lymphoedema management (Jenns 2000). The effect of treatment on the patient's psychological and psychosocial well-being should, however, also be monitored, and this is frequently achieved in a more subjective manner where the patient's views are sought (Woods 2002).

Methods of measuring limb volume

A frequently used method of establishing alterations in limb size and shape is the circumferential measurement of limb size (Stanton *et al.* 2000). This can be established by recording and comparing measurements taken of both limbs with a tape measure positioned at fixed points on a limb, usually the wrist and 10 cm above and below the point of the elbow (olecranon process) or 15 cm above and below the superior pole of the patella (Piller 1999). Although this method is easy and quick to complete, its use is primarily to track broad changes in limb circumference only and the method is prone to error if the tape measure is not positioned in the same place on each consecutive occasion.

A more accurate method of assessing response to treatment is the measurement of limb volume (Figure 9.23). Multiple circumferential measurements taken of both limbs at 4 cm intervals and applied to the formula for the volume of a cylinder provide a reliable method of determining the size of the limb and a useful, objective means of determining response to treatment. This is the most widely used method of establishing limb volume (Lymphoedema Framework 2006d, Taylor *et al.* 2006). Reproducibility is accurate if care is taken with the procedure and a standard format for the recording of the measurements is used (Woods 2007b).

Figure 9.23 Measurement of limb volume.

A variety of methods to measure limb volume have been used.

- Volume measured by water displacement (Bernas *et al.* 1996, Engler and Sweat 1962, Kettle *et al.* 1958).
- Volume measured using an optoelectronic device (Stanton *et al.* 1997).
- Volume calculated from circumferential measurements (Sitzia 1995).

Each of these methods has advantages and disadvantages. However, the calculation of limb volume from circumferential measurements, taken with a tape measure, is uncomplicated and inexpensive (Table 9.7).

Table 9.7 Using limb volume measurements

Indications	**Contraindications**
To determine the total excess volume of the swollen limb compared to the patient's contralateral normal limb	In palliative care, the tracking of limb volume changes in a limb may not be appropriate and simple circumferential limb measurements can provide an alternative means of assessment
To establish the distribution of the swelling along the limb	In the presence of infection or open wounds
To provide information to assist in the choice of compression therapy (Woods 2007a)	To detect early lymphoedema. Consideration should be given to other symptoms including patterns of transient swelling and any sensation changes (Stanton *et al.* 2006)
To provide an objective method of determining response to treatment by indicating: ▪ changes in the size and shape of the limb over time ▪ changes in the excess volume ▪ the distribution of any volume loss or gain in the limb (Sitzia 1995)	

Preprocedural considerations

The sequential circumferential measurement of a limb for the calculation of limb volume should not be confused with simple limb measurements used in the choice of compression garment for a patient. These are recorded at set points on the limb and used to guide the therapist in choosing the correct size garment for the patient.

The principles in Table 9.8 should be considered when using surface measurements in order to calculate limb volume (Woods 2007b).

Table 9.8 Points for consideration when calculating limb volume

Action	Rationale
Ensure that the same position is used for the same patient each time the limb is measured	The position of the limb will affect the measurements taken because the degree to which muscles are flexed or relaxed will influence the shape and size of the limb
The limb should be marked afresh on each measuring occasion with a washable ink, even when measuring on consecutive days	Any increase or decrease in limb volume will influence the position of the marks on the limb
Tension should not be exerted on the tape measure during measuring	If tension is applied it will vary between measurers and recordings will not be consistent
The tape measure should be positioned so that it is horizontal around the limb, taking care to ensure that it is not pulled tightly	To minimize inaccuracies in measurement
The same number of measurements should be taken on both limbs each time measurements are taken	The normal limb acts as a control in patients with unilateral swelling
The starting point for the taking of measurements should be clearly identified by measuring and clearly recording the distance from the tip of the middle finger to the wrist	This starting point on the wrist should be used each time
A standard format for the recording of measurements should be adopted	To ensure that key points can be referred to

Procedure guideline 9.20 Compression therapy: limb volume calculation: lower limbs

Essential equipment

- Ruler, preferably 30 cm or longer
- Tape measure; avoid those made from fabric which tends to stretch
- Washable skin marker for marking the limb
- Record chart and pen

Preprocedure

Action	**Rationale**
1 Explain and discuss the proposed procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (NMC 2008a, **C**).
2 Place the patient in a sitting position with the legs outstretched horizontally, preferably on a firm couch with adjustable height.	To ensure the lower limbs are relaxed and supported and the adjustable height means that the measurer can work without straining their back. **E**
Procedure	
3 Standing on the outside of the leg, ask the patient to flex the foot to a right angle. Measure the distance from the base of the heel to the ankle, along the inside of the leg; mark the ankle, allowing at least 2 cm of leg to lie below the mark, and record the distance on the chart.	To establish and clearly record a reproducible fixed starting point for all subsequent measurements (Badger 1993, **C**). Note: the marks represent a point midway through each cylinder segment, they do not represent the base of the cylinder, therefore at least half the segment (i.e. 2 cm) must lie below the mark.
4 Ask the patient to relax the foot. From the starting point, using a ruler, mark the inside of the leg at 4 cm intervals along the length of the leg up to the groin.	Reducing the limb to 4 cm segments improves the accuracy of measurement since these segments resemble a cylinder more closely than does the whole limb. The formula used here assumes that the measurements are 4 cm apart (Sitzia 1995, R5).
5 Place the tape measure around the limb and measure the circumference at each marked point, recording the measurement on the chart. Make sure that the tape lies smoothly around the relaxed limb and that it does not lie at an angle. (Decide at the outset whether the tape is to be placed above, below or on the mark and keep to the same position every time.)	Ensuring that there are no gaps between the limb and the tape and that the procedure is the same each time reduces error (Aslem *et al.* 1996, **R3b**).
6 Repeat the process on the other leg, whether or not it is swollen.	If only one limb is affected the normal limb acts as the patient's own control (Piller 1999, R5).
7 If desired, a circumference measurement may be taken of the foot but this is not included in the calculation of volume.	The foot cannot be considered to be a cylinder and it is therefore inappropriate to include it in the calculation of volume (Taylor *et al.* 2006, R5).
Postprocedure	
8 Ensure that the same number of measurements are made and clearly recorded on the record sheet for each leg.	Accurate documentation will ensure accuracy during limb volume calculation for each limb (Badger 1993, **E**).
9 Remove the marks from the patient's skin using warm water and a mild soap preparation.	Removing the marks maintains patient dignity. Mild soap ensures that the skin is not

irritated

Procedure guideline 9.21 Compression therapy: limb volume calculation: upper limbs

Essential equipment

- Ruler, preferably 30 cm or longer
- Tape measure; avoid those made from fabric which tends to stretch
- Washable skin marker for marking the limb
- Record chart and pen

Preprocedure

Action	**Rationale**
1 Explain and discuss the proposed procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (NMC 2008a, **C**).
2 Sit the patient in a chair with the arms extended in front and resting on the back of a chair. The arms should be as close to an angle of 90° to the body as possible.	To ensure the arms are supported and accessible at a standard height. Changing the angle of the arms to the body will result in changes in the measurements (Boland and Adams 1998, R5).
3 If only one arm is swollen, start with the unaffected arm.	
Procedure	
4 Measure the distance from the tip of the middle finger to the wrist. Mark the wrist, allowing at least 2 cm above the ulnar styloid, and note down the distance.	To establish and clearly record a reproducible fixed starting point for all subsequent measurements (Badger 1993, **E**). Note: The marks represent a point midway through each cylinder segment, they do not represent the base of the cylinder, therefore at least half the segment (i.e. 2 cm) must lie below the mark.
5 From the starting point, using a ruler, mark along the ulnar aspect of the arm at 4 cm intervals up to the axilla.	Reducing the limb to 4 cm segments improves the accuracy of measurement since these segments resemble a cylinder more closely than does the whole limb (Sitzia 1995, R5).
6 Place the tape measure around the limb and measure the circumference at each marked point, recording each measurement on the chart. Make sure that the tape lies smoothly around the relaxed limb and that it does not lie at an angle. Decide at the outset whether the tape is to be placed above, below or on the mark and keep to the same position every time.	Ensuring that there are no gaps between the limb and the tape and that the procedure is the same each time reduces error (Aslem *et al.* 1996, **R3b**).
7 Repeat the process on the other arm.	If only one limb is affected, the normal limb acts as the patient's own control (Piller 1999, R5).
8 If desired, a circumference measurement may be taken of the hand but this is not included in the calculation of volume.	The hand cannot be considered to be a cylinder and it is therefore inappropriate to include it in the calculation (Taylor *et al.* 2006, R5).
9 Ensure that the same number of measurements are made and clearly recorded on the record sheet for each arm.	Accurate documentation will ensure accuracy during limb volume calculation for each limb (Badger 1993, **E**).

Postprocedure

10 Remove the marks from the patient's skin using warm water and a mild soap preparation.	Removing the marks maintains patient dignity. Mild soap ensures that the skin is not irritated.

Problem-solving Table 9.6 Prevention and resolution (Procedure guidelines 9.20 and 9.21)

Problem	Cause	Prevention	Action
The tape measure will not lie evenly on the surface of the skin because of the shape of the limb and development of deepened skinfolds	The effect of the lymphoedema on the tissues and the distribution of swelling	The limb shape can be artificially corrected	Wrap the limb in cling film to create a more cylindrical shape. Mark the cling film and measure at these points
Loose areas of skin, making it difficult to place the tape measure smoothly around the limb	Age-related loss of skin turgor or weight loss causing excess skin	The limb shape can be artificially corrected	Elevation of the limb distributes the excess skin and a more accurate measurement of the limb can be gained
Limited range of movement of upper limb, making limb positioning difficult	Brachial plexopathy	Work within the patient's ability	Position the limb comfortably and seek assistance if necessary to support the limb
Skin lesions, open wounds, pain or tenderness resulting in the omission of some measuring points and inaccurate calculation of limb volume	Measurements cannot be taken where there is a breach of skin integrity or pain	Carefully examine the skin for breaks in skin integrity prior to measuring and check that the patient is comfortable so that action can be taken if necessary	Cover any open wounds with cling film to ensure measurements can be taken in the required place. Avoid pulling the measuring tape tightly to avoid trauma to the area

Postprocedural considerations

Once measurement of both limbs has been completed, a number of formulas may be used to calculate the limb volume of each limb (Badger 1993, Sitzia 1995).

The formula for the volume of a cylinder (Box 9.19) considers the limb as a series of cylinders, each with a height of 4 cm. In order to calculate the volume of the limb, each measurement needs to be converted into a volume for that segment of the cylinder and then totalled. This is illustrated in Table 9.9.

Table 9.9 Calculating the total limb volume of a limb using the formula in Box 9.19

Circumference measurement	C^2/π (3.14)	Volume of each cylinder in mL
18.4	=	107.7
19.1	=	116.1
21	=	140.3
23.2	=	171.3
24.9	=	197.3
25.7	=	210.2
26.6	=	225.2
29.6	=	278.8
30.3	=	292.2
31.7	=	319.8
32.7	=	340.3
33.5	=	357.2
Total volume	=	**2757**

Box 9.19. Procedure for calculating volume from circumferences

The formula for calculating the volume of a cylinder is $\frac{\text{circumference}^2}{\pi}$ The formula must be applied to each circumference measurement ($circ_1$, $circ_2$, …, $circ_n$) in order to calculate the volume of each segment; the volumes are then totalled to give the total limb volume.

So $\left(\frac{circ_1 \times circ_1}{3.1415}\right) + \left(\frac{circ_2 \times circ_2}{3.1415}\right) + \left(\frac{circ_3 \times circ_3}{3.1415}\right) + \ldots etc.$

Use of a programmable calculator will speed up the process of calculation.

The volume difference between the limbs is then usually expressed as a

percentage. The calculation for this is shown in Box 9.20.

Box 9.20. Calculating the volume difference between the limbs as a percentage

Limb volume totals
Swollen limb volume
2757
Unaffected limb volume
2459
Difference between the limbs
298
Divide 100 by the unaffected limb volume (2459) and multiply by the volume difference (298), i.e.: 100/2459 ×
298 = 12.11
The swollen limb is 12% bigger than the normal limb

Compression Bandaging

Definition

Short-stretch, inelastic bandages are used during the intensive or reduction phase of treatment for lymphoedema.

Related theory

The bandages used in compression therapy are termed short-stretch bandages with a high resistance to stretch. When applied to a limb, they provide the limb with a firm external encasement. During joint movement and muscular contraction of the limb, pressure against the firm external encasement leads to a temporary increase in pressure within the tissues, known as working pressure (Osbourne 2007). This produces a massaging effect on the tissues below to stimulate lymph drainage (Hopkins 2008). Conversely, when the muscle is inactive during rest, short-stretch bandages support the tissues and provide a relatively low resting pressure. This ensures that the patient remains comfortable and encourages compliance with the planned course of treatment (Williams 2002).

Long-stretch bandages with a high degree of elasticity are unsuitable in the management of lymphoedema. These bandages exert a high working and high resting pressure on the tissues of the limb and can be uncomfortable when left in place for long periods of time.

The pressure exerted by the short-stretch bandage on the limb is influenced by a number of factors.

- *The circumference of the limb*: the highest pressure is achieved where the limb is narrowest (Clark 2003). When a bandage is applied to a limb of normal proportions, therefore, the highest pressure will be achieved at the ankle or wrist, with graduated, reducing pressure along the length of the limb as the circumference increases (Todd 2000). Limbs that are thin and areas where there are bony prominences will need careful protection to avoid high pressure on these exposed areas which can lead to skin or tissue damage (Hafner *et al.* 2000).
- *The number of layers*: every bandage is applied with a degree of overlap. Several layers applied over each other increase the pressure applied to the limb (Partsch *et al.* 2008).
- *The components of the bandage system*: the use of padding and foam beneath the bandages increases the sub-bandage pressure and stiffness of the assembled bandage (Partsch *et al.* 2008).

Evidence-based approaches

Rationale

Indications

- *Large limbs*: elastic compression garments used on large swollen limbs may be ineffective due to the difficulties of applying sufficient tension to compress the limb (Badger *et al.* 2000, Stillwell 1973).
- *Mis-shapen limbs*: elastic compression garments will promote the development of deep skinfolds if the limb is awkwardly shaped (Todd 2000). Foam or soft padding placed under short-stretch bandages will smooth out the folds and restore normal shape to the limb (see Figures 9.24 and 9.25 for examples of a mis-shapen limb before and after bandaging).

Figure 9.24 Example of a mis-shapen limb before bandaging.

Figure 9.25 Example of a mis-shapen limb after bandaging.

- *Severe lymphoedema*: large limbs with long-standing oedema require high pressures to break down tissue fibrosis. Short-stretch bandages provide a low resting and high working pressure which promotes a softening of hardened tissues (Lymphoedema Framework 2006e).
- *Lymphorrhoea*: the leakage of lymph fluid from the skin responds readily to external pressure provided by short-stretch bandages (Jenns 2000).
- *Damaged or fragile skin*: elastic compression garments can cause damage to fragile skin. Short-stretch bandages should be used until the skin condition improves (Jenns 2000).

Contraindications

Short-stretch bandages should not be used where there is:

- arterial disease; tissue ischaemia can occur
- infection in the swollen limb; pain may occur
- uncontrolled cardiac failure; fluid overload can occur
- deep vein thrombosis; anticoagulation therapy should be commenced prior to the use of bandages
- physical or psychological unsuitability of the patient to comply with treatment (Todd 2000).

Principles to be followed in multilayer bandaging

Short-stretch, inelastic bandages should always be used. These are available in a range of widths and provide a low resting pressure to the swollen limb when the muscle is inactive and a high working pressure during activity when the muscle is pumping against the resistance created by the bandage (Todd 2000).

For bandaging to be effective, the following principles must be considered.

- *An even pressure should be provided around the circumference of the limb*. Where the limb shape is irregular or distorted by swelling, an even profile can be achieved with the use of padding or foam to add bulk to an area where shape requires correcting (Williams and Keller 2005).
- *The pressure from the bandages must be graduated along the length of the limb to ensure that the most pressure is achieved distally and the least proximally*. Graduated pressure will be achieved naturally in a regularly shaped limb where the circumference of the wrist or ankle is smaller than the circumference of the root of the limb. Graduated pressure can also be achieved by selecting the correct bandage width for the size of the limb and controlling the amount of bandage tension and overlap used (Todd 2000). Moderate tension only should be used and the bandages should never be stretched to their maximum length.
- *The pressure applied to the limb should be adequate to counter the limb circumference*. Greater pressure is required when the circumference of the limb is large. This can be achieved by using more than one layer of bandages and selecting the correct width of bandage for the circumference of the limb (Todd 2000).
- *The bandages should be left in place day and night and removed once every*

24 hours. This enables skin hygiene to be attended to and the condition of the skin to be checked. Reapplication of the bandages then ensures that effective compression is maintained on the changing limb shape (Damstra *et al*. 2008).

- *The bandages should be comfortable for the patient and removed at any time if they cause any pain, numbness or discoloration (blueness) in the fingers or toes.* This may indicate a variety of causes, including too great a compression on the limb. A satisfactory outcome of treatment should be achieved within 2–3 weeks. More advanced stages of lymphoedema may require up to 4–6 weeks of treatment. The patient may then begin the maintenance phase of treatment where containment hosiery is fitted.

Palliative care

Compression bandaging can be versatile and extremely useful in the palliative care setting when volume reduction may be unrealistic or not indicated and the emphasis is on optimizing the patient's quality of life.

The burden of treatment should not exceed the benefit to be gained from providing support and comfort to a limb with a low level of pressure using a modified technique of bandaging designed around the patient's needs. The therapist should have expertise to apply the correct degree of pressure to the limb and avoid forcing fluid into adjacent areas (Todd 2009). The bandages can be left in place for 2–3 days and should not prevent the patient from maintaining full movement in their bandaged limb (Woods 2000).

Legal and professional issues

Compression bandaging should only be carried out by a skilled therapist with the necessary skills and experience to apply bandages to the swollen limb (Lymphoedema Framework 2006e), ensuring that pressure is graduated towards the root of the limb and evenly applied. Poor technique can lead to serious consequences with damage to the skin and tissues if the bandages are incorrectly or inappropriately applied (Feben 2003, RCN 1998, Thomas and Nelson 1998). The therapist has a professional responsibility to ensure the safety of the patient and should therefore always ensure that the arterial status of the patient is known and that there are no contraindications to the use of low-stretch compression bandages.

Studies by Taylor *et al.* (2000), Hafner *et al.* (2000) and Feben (2003) emphasize the importance of training for therapists to ensure that safe, effective pressure is applied to the limb during the use of short-stretch bandages. Appropriate courses are available for therapists throughout the UK.

Preprocedural considerations

If there is any concern regarding the patient's arterial blood flow, an ABPI should be measured using a hand-held Doppler before undertaking any compression therapy. An ABPI reading of 0.8 or below should be referred for medical opinion (Lymphoedema Framework 2006d).

Specific patient preparations

The bandaging materials used on a swollen limb can be bulky and patients will therefore require appropriate information and advice concerning suitable loose-fitting, easily applied clothing and, if the leg is being bandaged, appropriate wide-opening footwear, which will accommodate the bulk of the bandages during the course of treatment.

As the bandages are worn for 23 hours a day, the timing of appointments for the bandages to be replaced will need to consider opportunities to attend to personal hygiene, travel arrangements and accommodate family and work commitments. The bandages can be removed at home before the appointment to allow for personal hygiene but it is advisable for the patient to wear a suitable compression garment on the journey to the appointment. It is not recommended that patients drive themselves in a car to or from appointments. The bandages will mean that the affected limb will be bulkier than usual, making reaction times slower. Safety can therefore be compromised. If the patient chooses to drive, they must be advised to check with their motor insurance company before doing so.

Activities of daily living may have to be adapted because of the bulk of the bandages and the therapist should discuss and outline with the patient an appropriate exercise regimen to be followed during the course of treatment, to ensure that maximum effectiveness is gained from the course of bandaging. Verbal information given should be supported by written information and include details of what the patient should do if problems develop with the bandages and whom to contact (Williams and Keller 2005).

Procedure guideline 9.22 Compression bandaging (standard multilayer): bandaging an arm and the fingers

Essential equipment

- Tubular stockinette: this can be purchased in a long roll and a length cut to suit the limb size. Different widths are available
- Light retention bandages: 6 and 10 cm to bandage digits and to hold foam padding in place
- Synthetic orthopaedic padding rolls: 6 cm rolls to pad and reshape the limb
- Sheet of low-density foam to cut to shape and pad out uneven areas
- Low-stretch bandages, 6 and 8 cm. A variety of widths are required to suit the shape of the limb
- Tape

Preprocedure

Action	**Rationale**
1 Explain and discuss the procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (NMC 2008a, **C**).
2 If possible, the patient should be seated in a chair with the limb relaxed and supported on the back of a chair or appropriate limb support. The therapist should be positioned in front of the patient.	To ensure the comfort of both the patient and therapist and that the skin and muscles are positioned correctly to avoid inappropriate areas of pressure. **C**
3 The swollen limb should be clean and well moisturized with a bland cream (e.g. E45) before being bandaged.	To promote skin hygiene and integrity. **C**
Procedure	
4 Cut a length of tubular stockinette long enough to fit the patient's arm. Cut a small hole for the thumb and slip over the patient's arm.	To protect the skin from chafing and from any sensitivity caused by the synthetic materials of the padding and foam (Williams and Keller 2005, **E**).
5 The fingers must be bandaged (see Action Figure 5a). Using a narrow light retention bandage, anchor the bandage loosely at the wrist and bring across the back of the hand to the thumb. Bandage around the thumb from the tip downwards (start at the level of the nail bed). Do not pull the bandage tight but go gently and firmly. Take the bandage under the wrist and back over the back of the hand to the index finger (see Action Figure 5b). Again, bandage from the nail bed down to the webs of the finger. Repeat the same procedure for all fingers. Finish by tucking in the end of the bandage (see Action Figure 5c).	To reduce or prevent swelling (Williams and Keller 2005, **E**).
6 Check the colour and temperature of the tips of the fingers.	To ensure that the blood supply is not compromised (Partsch 2003, **E**).
7 Check that the patient can move the fingers and make a fist.	To check that the bandage is not too tight (Partsch 2003, **E**).
8 Using the roll of padding, cover the hand in a figure of eight, padding out the palm and back of the hand (see Action Figure 8).	Padding out the hand ensures even pressure distribution and protects the bony areas of the hand (Williams and Keller 2005, **E**).

9 Continue the padding up to the axilla, doubling it over at the elbow.	Doubling it over at the elbow crease protects the delicate skin at the elbow (Foldi *et al.* 2003, **E**).
10 Foam can be used to even out any exaggerated contours of the limb. The foam should be cut to fit the length and circumference of the arm from the wrist to axilla. The foam can be cut into two pieces, one for the lower and one for the upper arm, with no gap at elbow.	To protect the elbow joint and provide a smooth, even profile on which to bandage (Williams and Keller 2005, **E**). The foam also ensures a more even distribution of pressure and softens the lymphostatic fibrosis (Foldi *et al.* 2003, **E**). It can also be used as a 'brake' to prevent the bandage from slipping (Foldi *et al.* 2003, **E**).
11 Wrap the foam around the arm, securing with a light retention bandage. Finish by tucking in the end of the bandage (see Action Figure 11).	
12 Take a 6 cm compression bandage and start by anchoring it loosely at the wrist. Advise the patient to hold their fingers apart whilst the hand is bandaged and take the bandage across the dorsum of the hand to wrap it twice around the hand close to the base of the fingers. Continue bandaging the hand firmly in a figure of eight until all of the hand is covered (see Action Figure 12). Continue the rest of the bandage up the forearm in a spiral, covering half of the bandage with each turn. Keep the bandage as smooth as possible.	The bandage width must relate to the circumference of the limb with the narrowest bandage used on the smallest circumference (Thomas 2003, R5).
13 Take an 8 or 10 cm bandage and, starting at the wrist, bandage in a spiral, still covering half of the bandage with each turn, up to the top of the arm (see Action Figure 13).	Two layers are used on the forearm to ensure that pressure is highest distally (Thomas 2003, R5).
14 A top layer of bandages can be applied in a spiral.	Applying a top layer can even out and maintain optimal pressure.
15 Secure the end of the bandage with tape.	Tape is used instead of fastening clips due to risk of injury (Foldi *et al.* 2003, **E**).
Postprocedure	
16 Once again, check the colour and sensations of the finger tips and check that the patient can move all joints.	To check that the blood flow is not compromised (Partsch 2003, **E**).
17 Remind the patient to use the limb as normally as possible, to exercise as advised and to remove the bandages if any pain, tingling or numbness is experienced.	To ensure good lymph flow and to prevent complications developing (Partsch 2003, **E**).
18 Record the details of the procedure followed in the patient's relevant documentation.	To maintain accurate records and provide a point of reference for subsequent treatment (NMC 2005, **C**).

Action Figure 5(a) Bandaging swollen fingers.

(a)

Action Figure 5(b) Bandage is taken under wrist, back over hand, to index finger.

(b)

Action Figure 5(c) Finished bandage.

Action Figure 8 Palm and back of hand are padded out.

Action Figure 12 Hand is bandaged firmly in a figure of eight using a 6 cm compression bandage.

Action Figure 11 Foam is wrapped around arm and secured with a light retention bandage.

Action Figure 13 Starting at wrist, an 8 or 10 cm bandage is used to cover to the top of the arm, in a spiral fashion.

Procedure guideline 9.23 Compression bandaging (standard multilayer): bandaging a leg and the toes

Essential equipment

- Tubular stockinette: this can be purchased in a long roll and a length cut to suit the limb size. Different widths are available
- Light retention bandages: 4 cm width to bandage the toes, 6 cm or 10 cm to hold foam in place
- Synthetic orthopaedic padding rolls: 6 cm, 10 cm and 12 cm width rolls to pad and reshape the limb
- Sheet of low-density foam to cut to shape and pad out uneven areas
- Low-stretch compression bandages, 8, 10 and 12 cm. A variety of widths are required to suit the shape of the limb
- Tape
- Scissors

Preprocedure

Action	**Rationale**
1 Explain and discuss the procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (NMC 2008a, **C**).
2 If possible, the patient should be seated upright on a bed or treatment couch. Raise the bed or couch to a comfortable height.	To ensure the comfort of both the patient and nurse. **C**
3 The swollen limb should be clean and well moisturized with a bland cream (e.g. E45) before being bandaged.	To promote skin hygiene and integrity. **C**
Procedure	
4 Cut a length of tubular stockinette long enough to fit the patient's leg. Slip over the leg.	To protect the skin from chafing (Williams and Keller 2005, **E**).
5 If the toes are swollen or have a tendency to swell, they must be bandaged. The little toe can be omitted. Using a narrow light retention bandage, anchor the bandage around the foot and bring across the top of the foot to the big toe (see Action Figure 5a). Bandage around the toe from the tip downwards (start at the level of the nail bed). Do not pull the bandage tight, but gently and firmly. Take the bandage under the foot and back over the top of the foot to the next toe (see Action Figure 5b). Repeat the same procedure for each toe that needs to be bandaged. Finish by tucking in the end of the bandage (see Action Figure 5c).	To reduce or prevent swelling (Lymphoedema Framework 2006e, Williams and Keller 2005, **E**). To prevent friction to and around the little toe (Williams and Keller 2005, **E**).
6 Cut the foam into pads to fit over the dorsum of the foot, around the ankle and behind the knee (see Action Figures 6a, b).	To protect bony prominences and joint flexures (Williams and Keller 2005, **E**).

7 Secure the pads firmly in place with light retention bandages.	
8 Using foam and padding, even out any exaggerated contours of the limb.	To create a smooth profile on which to apply the bandages (Williams and Keller 2005, **E**).
9 Using a 10 cm roll of padding, apply firmly in a spiral up the leg, starting around the foot. Use the 20 cm padding over the thigh (see Action Figure 9).	To protect the skin and create a smooth profile on which to bandage (Lymphoedema Framework 2006e, Williams and Keller 2005, **E**).
10 Take an 8 cm compression bandage and start by anchoring it loosely at the ankle. Advise the patient to hold their foot at a 90° angle whilst it is bandaged and take the bandage across the dorsum of the foot to wrap it around the foot close to the base of the toes (see Action Figure 10). Continue bandaging the foot firmly, forming a figure of eight to cover the heel and ankle without leaving any gaps. Any surplus bandage should be taken up the leg in a spiral.	To avoid constriction at the ankle. Fluid will accumulate in any unbandaged areas (Williams and Keller 2005, **E**).
11 Using a 10 cm bandage, continue from where the first bandage finished, using a spiral up the leg and covering half of the bandage with each turn. Remember to bandage firmly. Use the widest bandage over the thigh. Secure the end of the last bandage with tape.	The bandage width must relate to the circumference of the limb with the narrowest bandage used on the smallest circumference (Thomas 2003, R5).
12 Apply a second layer of bandage, from ankle to thigh, using a figure of eight. Secure the end with tape (see Action Figure 12).	To keep the bandages in place and provide additional pressure along the length of the leg (Williams and Keller 2005, **E**).
Postprocedure	
13 Check the colour and temperature of the patient's toes. It may be difficult for the patient to flex the knee at first but this should get easier as the bandages loosen slightly.	To check that the blood flow is not compromised (Partsch 2003, **E**).
14 Remind the patient to use the limb as normally as possible, to exercise as advised and to remove the bandages if any pain, tingling or numbness is experienced.	To ensure good lymph flow and to prevent complications developing (Partsch 2003, **E**).
15 Record the details of the procedure in the relevant patient documentation.	To maintain accurate records and provide a point of reference for subsequent treatment (NMC 2005, **C**).

Action Figure 5 (a) A narrow light retention bandage is anchored around the foot and brought across the foot to the big toe. (b) The toes are bandaged in turn from the nail bed along the length of the toe. (c) The bandage is taken under the foot and back over the top of the foot to bandage the next toe.

Action Figure 6 (a) Foam is used to cover the dorsum of the foot and around the ankle. (b) A foam pad is bandaged into position behind the knee.

Action Figure 9 Rolls of padding are applied firmly in a spiral up the leg, starting around the foot.

Action Figure 10 Bandaging the foot using an 8 cm compression bandage and starting close to the toes.

Action Figure 12 Applying a second layer of bandage, from ankle to thigh.

Problem-solving table 9.7 Prevention and resolution (Procedure guidelines 9.22 and 9.23)

Problem	Cause	Prevention	Action
Patient becomes breathless	An unknown cardiac pathology may lead to fluid overload as the lymphatic fluid moves from the swollen limb		Medical attention should be sought immediately if the patient becomes breathless during compression bandaging. Compression bandaging should be stopped until the patient's condition is stabilized
Pain, discomfort, numbness and/or tingling of digits when bandages are in place	Incorrect pressure gradient	Ensure patient gives feedback throughout the procedure Observe the skin each day for signs of inflammation where excess pressure may have been applied	Check the pressure gradient after each bandage application, ensure overlap of bandages is even along the length of the limb. Feel the pressure of the bandages regularly to ensure the consistency of the gradient
Pain and tenderness over bony prominences noted when the bandages are removed, for example wrist and ankle	Inadequate padding over bony prominences	Careful assessment of the limb shape prior to application of bandages	Use foam and padding to protect bony prominences and even out shape of limb
Skin irritation developing in sensitive areas, for example elbow crease and popliteal crease, during the course of bandaging	Areas of excess movement resulting in friction from the bandages	Ensure there are no skin allergies to the materials being used	Use appropriate moisturizer for patient. Protect limb with Tubifast. Use extra padding in areas of sensitivity
Poor compliance with bandaging causing premature removal of bandages each day	Lack of information given to patient Lifestyle commitments	Ensure patient is given appropriate information verbally and in writing prior to commencement of treatment	Explore the problems the patient is experiencing. Explain the procedure thoroughly and its intended benefits
Congestion developing at the root of limb during bandaging	Too much pressure throughout the limb causing an overload of fluid at root of limb		Reduce pressure of bandage throughout limb. Teach SLD. Carry out MLD

Postprocedural considerations

Immediate care

Evaluation of each stage of the bandaging procedure is essential to ensure that the bandage and padding have been used appropriately and correctly. This ensures that the best results are being achieved and that resources are being used to the maximum.

The process of evaluation must be thorough and should include the following.

- *Continuous attention to the colour of the digits*. Too much pressure will result in compromised circulation.
- *Continuous attention to the sensations experienced in the bandaged limb*. The bandages should not cause pain, numbness or tingling.
- *The shape of the limb* **.** A cylindrical contour should be achieved with the use of soft foam and padding.
- *The overlap of the bandages*. This should be even and consistent with no gaps in the bandages.
- *The pressure achieved*. This should feel even to the patient and there should be no creases in the bandages. Layers should be used appropriately (Todd 2000). The therapist should feel the bandages regularly during the procedure to ensure the consistency of the gradient.

Ongoing care

The patient should feel comfortable and be able to move their limb. Information should be given concerning when and how to remove the bandages if necessary. The patient should be made aware that if the bandages do have to be removed, a compression garment must be worn until their next appointment. It is vital that the patient reports any concerns to the therapist at each visit.

Compression Garments

Definition

Elastic compression garments are used in the long-term management of lymphoedema. Patients are required to wear their garments on a daily basis with most patients wearing their garments all day and removing them at night. For some patients, their treatment plan may include the flexibility to wear the garment just for exertive activities or for a few hours each day, depending upon their needs.

Evidence-based approaches

Rationale

Choosing the correct garment for the patient can be a difficult decision which should always follow a detailed assessment of the patient (Eagle 2001) and should only be undertaken by a healthcare professional with knowledge and appropriate skills to ensure patient safety.

The size of the required garment can be determined by following the manufacturer's individual size chart and recording three or four circumferential measurements at set points along the length of the limb. It is important to remember that size charts provide a guide only and the patient's evaluation of the comfort of the fitted garment is essential. An alternative style, larger or smaller size may be required.

Indications

- Mild, uncomplicated, swelling with a normal limb shape (Lymphoedema Framework 2006a).
- The maintenance of limb shape and size following a course of intensive therapy (Lymphoedema Framework 2006a).
- A limb volume less than 20% of the opposite limb if the shape of the limb has been preserved (Badger *et al.* 2000).
- To control swelling and provide support in the palliative treatment of oedema (Woods 2000).

Contraindications

- *Arterial disease*: blood supply may be further compromised (Doherty *et al.* 2006).
- *Acute heart failure*: symptoms may be exacerbated (Doherty *et al.* 2006).
- *Distortion of limb shape*: the garment will not fit (Lymphoedema Framework 2006a).
- *Skinfolds*: the garment will cause ridges and a tourniquet effect to the limb (Lymphoedema Framework 2006a).
- *Open wounds*: the garment will become soiled and pose an infection risk.
- *Fragile skin*: application and removal of the garment may cause further damage to the skin (Doherty *et al.* 2006).
- *Lymphorrhoea*: the garment will become wet and may cause skin excoriation (Doherty *et al.* 2006).
- *An acute infective episode (cellulitis)*: application and removal of the garment may be painful and cause damage to the friable skin (Lymphoedema Framework 2006a).
- *Severe peripheral neuropathy*: the patient will not be able to tell if the garment is causing damage to the skin (Lymphoedema Framework 2006a).

Legal and professional issues

It is important to acknowledge that different classifications of compression exist which are determined by testing methods, yarn specification, compression gradient and garment durability (Clark and Krimmel 2006). In the UK, elastic compression garments are available in the British Standard BS 6612, French Standard ASQUAL and German Standard RAL-GZ 387:2000. Each Standard adopts different testing techniques to determine the degree of pressure measured at the ankle when the garment is in place and the pressure range used to define the compression class of the garment differs between each of these Standards (Clark and Krimmel 2006). The compression levels used are generally higher than those used to treat venous disease and are classified according to the pressure exerted at the ankle by the garment. Table 9.10 outlines the indications for compression garments and the suggested compression classification.

Table 9.10. Compression classes and indications for their use

Indications	Suggested compression level
Mild lymphoedema ■ Excess limb volume <20% ■ No shape distortion ■ Maintenance ■ Palliation	Class I LOW COMPRESSION British Standard: 14–21 mmHg French Standard: 10–15 mmHg German Standard: 18–21 mmHg
Moderate lymphoedema ■ Excess limb volume 20–40% ■ Mild shape distortion ■ Maintenance	Class 2 MEDIUM COMPRESSION British Standard: 18–24 mmHg French Standard: 15–20 mmHg German Standard: 22–32 mmHg
Severe lymphoedema ■ Excess limb volume >40% ■ Moderate shape distortion ■ Fibrosed tissues ■ Skin changes; hyperkeratosis and papillomatosis	Class 3 HIGH COMPRESSION British Standard: 25–35 mmHg French Standard: 22–32 mmHg German Standard: 34–46 mmHg

A wide range of elastic compression garments for the treatment of lymphoedema are now available on the drug tariff, making it easier for patients to establish a long-term supply of their garments.

Preprocedural considerations

A number of factors need to be taken into consideration before deciding to fit a patient with an elastic compression garment. The patient should be motivated and compliant with the use of garments and have the physical skills to apply and remove the garment safely. A full physical assessment of the patient will determine the condition of the skin and tissues and the shape and size of the limb in order to determine the style, size and appropriate compression class of the garment suitable for the patient.

Equipment

Elastic compression garments apply an external force to the limb which pulls in to exert pressure on the tissues below (Eagle 2001). The pressure can be sustained over long periods of time during both activity and inactivity of the limb, providing a high working pressure whilst the muscle is active and a high resting pressure during inactivity of the muscle at rest (Todd 2000).

The use of elastic compression garments:

- increases interstitial tissue pressure and reduces production of lymph
- promotes lymph movement along superficial and deep lymphatics
- increases lymph reabsorption (Lymphoedema Framework 2006a)
- provides an external counterforce during activity which enhances muscle pump action (Todd 2000).

A wide range of garments are available which differ in construction, compression class and style, in addition to size and colour.

- *Construction*: garments are manufactured as either round knit or flat knit. Round-knit garments are produced in one piece from synthetic fibres and are readily available in a variety of sizes 'off the shelf' to accommodate the needs of most patients. Whilst more cosmetically acceptable to patients, these garments have a tendency to roll or gather in areas along the limb, if the limb is mis-shapen (Linnitt and Davies 2007). They are more suitable therefore for patients with mild lymphoedema whose limbs have maintained a regular shape. Some round-knit garments are manufactured with inelastic materials, creating a stiffer garment. The pressure under these garments will be higher whilst the muscle is active. Flat-knit garments are manufactured from one piece of material sewn together with a seam. The shape can be adjusted during manufacture to suit patients' specific needs and the provision of accurate measurements before manufacture ensures a good fit. Flat-knit garments offer the highest working pressure relative to their resting pressure and are more suitable for patients with moderate to severe lymphoedema (Linnitt and Davies 2007).
- *Compression class*: the degree of pressure exerted by the garment on the surface of the skin it surrounds determines its compression class (Asmussen and Strossenreuther 2003). The highest compression provided by a garment when fitted can be found at the wrist or the ankle. The compression is then graduated along the length of the limb to encourage movement of the fluid

out of the limb.

- *Style*: all areas influenced by swelling must be contained within the compression garment or further swelling will develop. The patient should be instructed concerning the application, removal and care of the garment to ensure that maximum effectiveness is achieved through its use. The patient's ability must be taken into account when choosing a garment as a high degree of dexterity and strength may be required during its application and removal and this may be impractical for the patient (Todd 2000).
- *Size*: the correct garment is one that fits well and is comfortable for the patient with no loose pockets of material where swelling can develop and no areas of constriction where a tourniquet effect can occur. The manufacturer's guidance for choosing the correct size is based on simple limb measurements and particular attention should be given to the fit at the ankle or wrist where high levels of compression can occur (Todd 2000).

The application of elastic garments can be greatly eased by the wearing of household rubber gloves during application, which facilitate control of the garment and prevent damage to its fabric. Application aids (see Table 9.11) are also available commercially and may assist some patients who experience difficulties. Any moisturizing cream should be applied at night-time rather than in the morning before putting the garment on. A very fine layer of talcum powder applied to hot sticky skin can ease application. If this is the first time that the patient has worn elastic compression garments, the therapist should explain to the patient that the feeling of pressure may seem strange for the first few hours, but that it should not cause pain in the limb or numbness in the digits or toes.

Table 9.11 Application aids

Aid	Description	Supplier
Acti glide	An application to allow open or closed toe compression stockings to glide onto leg	Activa www.activahealthcare.co.uk
Easy off	Aid for taking off leg stockings which reduces bending	Mediven www.mediuk.co.uk
Easy pad	A rectangular piece of non-slip foam to assist with the application of compression garments	Juzo www.juzo.com
Easyslide	A limb-shaped slide sheet designed to ensure easy application of the garment with the right amount of pressure	Credenhill www.credenhill.co.uk
Foot slide	A shaped piece of silky material to assist with the application of open toe compression garments over the foot	Supplied with most compression stockings.
Medi Butler	A specially designed metal frame which holds the garment in place so that the foot or hand can slide into it. The frame has handles which are	Mediven

	used to pull the garment up the limb	www.mediuk.co.uk
Mediven 2 in 1	A limb-shaped slide sheet that assists with the donning and doffing of garments	Mediven www.mediuk.co.uk
Rubber gloves	Cotton-lined rubber gloves to provide a better grip on garments to assist in donning and doffing	Widely available in retail shops and also through Haddenham Healthcare www.hadhealth.com
Sleeve on	A metal applicator with a suction pad to secure the applicator to a firm surface during the application and removal of garments	Haddenham Healthcare www.hadhealth.com
Slide On Stocking (SOS)	Metal frame designed to hold the garment in place so that the foot can slide into it	Sigvaris www.sigvaris.com

Procedure guideline 9.24 Elastic compression garments: application to the leg

Essential equipment

- Appropriate application aids if required (see Table 9.11)
- A compression garment which is appropriate for the patient's lymphoedema

Preprocedure

Action	**Rationale**
1 Explain and discuss the procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (NMC 2008a, **C**).
2 If possible, position the patient seated upright on a bed or couch and raise the height to a comfortable level.	To ensure the comfort of both the patient and nurse.
Procedure	
3 Turn the stocking inside-out to the heel.	This makes it easier to ease the stocking up. **E**
4 Pull the foot of the stocking over the patient's foot.	
5 Turn the rest of the stocking back over the foot and up the leg.	To prevent a tourniquet effect developing at the ankle and to enable the stocking to be eased up the leg. **E**
6 Ask the patient to keep the leg straight and if possible to push against the nurse.	To ensure that a good grip can be gained on the stocking. E
7 Starting at the foot, gradually ease the stocking into place over the heel and up the leg a bit at a time, until it is in its final position.	Since it is the material of the stocking that provides the pressure, it must be distributed evenly to ensure an even distribution of pressure (Juzo 2006, **C**).
8 Do not pull from the top.	This will cause the stocking top to become overstretched and will lead to an uneven distribution of the stocking material (Juzo 2006, **C**).
9 Once the stocking is in place, check that there are no creases or wrinkles, particularly around the joints.	Wrinkles cause chafing of the skin and constricting bands of pressure. **E**
Postprocedure	
10 Check that the patient finds the stocking comfortable and ask that any feelings of pain, tingling or numbness be reported. Check the toes for any visible signs of altered circulation.	Pain, tingling or numbness indicates that the stocking has been either inappropriately applied or fitted. **E**
11 To remove the stocking, peel it off the limb from the top downwards. Do not roll it down.	Rolling the stocking can result in tight bands of material forming, which are difficult to move. **E**
12 Document the manufacturer, style and size of garment that the patient has been provided with.	To maintain accurate records (NMC 2009).

Procedure guideline 9.25 Elastic compression garments: application to the arm

Essential equipment

- Appropriate application aids if required (see Table 9.11)
- A compression garment which is appropriate for the patient's lymphoedema

Preprocedure

Action	**Rationale**
1 Explain and discuss the procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (NMC 2008a, **C**).
2 The patient may be seated or standing.	
Procedure	
3 Turn the sleeve inside-out to the wrist. Pull over the patient's hand. *Note*: if a glove or separate handpiece is worn, always put the sleeve on *after* the glove or handpiece.	To avoid increasing swelling in the hand. **E**
4 Turn the rest of the sleeve back over the hand and up the arm.	To prevent a tourniquet effect developing at the wrist and to enable the sleeve to be eased up the arm. **E**
5 Ask the patient to grip something stable, such as a towel rail or the back of a chair.	This steadies the arm and gives the patient something to pull against. **E**
6 Working from the hand or wrist, gradually ease the sleeve up the arm.	Since it is the material that provides the pressure, it must be evenly distributed to ensure an even distribution of pressure. **C**
7 Do not pull up from the top.	To prevent the top becoming overstretched which will result in an uneven distribution of pressure. **C**
8 Once the sleeve is in place, check that there are no creases or wrinkles, particularly around the joints.	Wrinkles and creases cause chafing of the skin and constricting bands of pressure. **E**
Postprocedure	
9 Check that the patient finds the sleeve comfortable and ask that any signs of pain, tingling or numbness be reported. Check the fingers for any visible signs of altered circulation.	Pain, tingling or numbness indicate that the sleeve has been either inappropriately applied or fitted. **E**
10 To remove the sleeve, peel it off the limb from the top. Do not roll it down.	Rolling the sleeve down can lead to tight bands of material forming which are difficult to move. **E**
11 Document the manufacturer, style and size of garment that the patient has been provided with.	To maintain accurate records (NMC 2009).

Problem-solving Table 9.8 Prevention and resolution (Procedure guidelines 9.24 and 9.25)

Problem	Cause	Prevention	Action
Wrinkling of the garment along the length of the limb	Poor application and positioning of the garment	Supply written instructions with diagrams/ pictures concerning the application and removal of the garment	Demonstrate application and removal of the garment and observe the patient's technique when the garment is provided. The use of donning aids may be required
Slippage of garment during wear	Poorly fitting garment	Ensure the correct measurements are taken to guide the therapist in the selection of the correctly sized garment	Review size of garment. Consider the use of a grip top or skin glue to minimize slippage at the top of the garment
Change of sensation in the limb during wear of the garment	Garment too tight	Ensure the correct measurements are taken to guide the therapist in the selection of the correctly sized garment	Assess for other possible reasons for a change in sensation, e.g. musculoskeletal or circulatory impairment Review the size of garment and consider alternative garments
Skin sensitivity or reaction when wearing compression garment	Possible allergic reaction to the material of the garment	Check the patient's allergy status prior to fitting a garment	Treat any allergy appropriately. Remove the garment until skin reaction clears. A cotton Tubifast lining can be worn underneath the garment to protect the skin. An alternative garment may be required
Poor compliance with use of the garment	Limited information given to patient with regard to the importance of wearing garment. Lifestyle commitments	Ensure the patient is given sufficient information to become compliant with treatment	Explore the problems the patient is experiencing. Explain the purpose of the garments thoroughly and the intended benefits
Swelling extending beyond the edge of the garment: fingers or toes, upper thigh or upper arm	Inappropriate style of garment for the patient's needs	Thorough assessment to establish the history and extent of swelling	If fingers or toes are swollen use a compression glove or toe caps. If upper thigh or upper arm is swollen, garment must extend into the adjacent truncal quadrant

Postprocedural considerations

Immediate care

Evaluate the overall fit of the garment. There should be an even pressure throughout the garment, with no areas of loose-fitting material. The garment should be comfortable so that the patient can use their limb without restriction.

Ongoing care

The shape and size of the limb may change due to an increase in swelling. This can cause the garment to become ill fitting and cause trauma or damage to the skin. Compression garments should be checked regularly to ensure they remain appropriate in size, style and fit.

Education of patient and relevant others

- Ensure the patient knows for how long the garment needs to be worn each day. As each patient is different, the therapist should advise appropriately. Ideally garments should be worn during waking hours and removed at night (Jenns 2000).
- Advise the patient on the care of the garment. The garment should be washed after every wear at 40°C. Hand washing is also acceptable. A biological detergent can be used but fabric softener should be avoided. The garment should be air dried and not tumble dried.
- Advise the patient about how to acquire replacement or additional garments. These can either be supplied by the clinic or, if available, obtained on drug tariff from the patient's doctor. It is advisable that the garments are replaced every 6 months.

Websites

British Lymphology Society: www.thebls.com

Lymphoedema Support Network: www.lymphoedema.org/lsn

Lymphoedema Association of Australia: www.lymphoedema.org.au

Lymphedema People: www.lymphedemapeople.com

National Lymphoedema Network: www.lymphnet.org

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Tracheostomy: Tube Change

Definition

The most critical event after formation of a tracheostomy is the first tube change, although many other aspects of care of these tubes are critical (e.g. suctioning, hygiene, humidity, emergency preparedness). Tube change is a risk because of a possible loss of the airway. The exact period of time to wait before the first postoperative change varies, because time is needed to allow a tract between the skin and the trachea to develop. Therefore around 5 days is usually accepted (Johnson *et al.* 2010).

Evidence-based approaches

Rationale

Indications

- Minimizing risk of postoperative infection and granulation tissue formation around the tube.
- Verifying the formation of a stable tract to allow nursing staff to perform changes.
- Changing from a non-fenestrated to a fenestrated tracheostomy tube to facilitate weaning and communication with tracheostomy speaking valve.
- Downsizing the tracheostomy tube if the patient is clinically improving (MacIntyre and Branson 2009).

Contraindications

- Changing a tracheostomy tube too soon after formation (generally <5 days); this increases likelihood of entry into a false passage as the tract may not have healed adequately.
- Poor visualization of tracheostomy tract and inadequate lighting, exposure, and lack of emergency equipment.
- Performer inexperience without availability of staff versed in airway management.
- Patients with extremely high ventilator settings, which increase the risk of decannulation.
- Patient non-co-operation without ancillary support (Johnson *et al.* 2010).

The Council of the Intensive Care Society recommends that the first tracheostomy tube change should not be performed within 72 hours for surgical tracheostomies, and not before 3–5 (though ideally 7–10) days following a percutaneous tracheostomy to allow the stoma track to establish (ICS 2008).

Procedure guideline 10.12 Tracheostomy: tube change

Essential equipment

- Sterile dressing pack
- Tracheostomy foam-based dressing or keyhole dressing
- Tracheostomy securing tapes or ties
- Cleaning solution, such as 0.9% sodium chloride
- Barrier cream
- Lubricating gel
- Disposable plastic apron, powder-free gloves and eye protection
- Bactericidal alcohol handrub
- New tracheostomy tube for insertion

Preprocedure

Action	**Rationale**
1 Explain and discuss the procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (NMC 2008b, **C**).
2 Ensure the emergency trolley is readily available. Inform staff what procedure will be taking place in case help is required.	In event of difficulty replacing airway. **E** To ensure that all staff are aware that airway is to be changed so in the event of difficulties, staff are available to assist. **E**
3 Recheck suction and oxygen supply, ensure spare tubes, dilators and all emergency equipment are readily available.	To ensure patient safety in the event of inability to secure airway with new tube. **E**
4 Wash hands using bactericidal soap and water or bactericidal alcohol handrub, and prepare a dressing trolley.	To minimize the risk of infection (Fraise and Bradley 2009, **E**).
5 Screen the patient's bed.	To ensure the patient's privacy. **E**
Procedure	
6 Perform the procedure using clean technique. Always perform the procedure in hospital with a second, appropriately trained, person.	To minimize the risk of contamination. **E** To ensure patient safety at all times. **E**
7 Assist the patient to sit in a semi-recumbent position (Clotworthy 2006d) with the neck extended.	To ensure the patient's comfort and to maintain a patent airway. Extending the neck will make removal and insertion of the tube easier (Clotworthy 2006d, **C**).
8 Remove the dressing pack from its outer wrappings and open the tracheostomy dressing.	To reduce the risk of cross-infection (Fraise and Bradley 2009, **E**).
9 Put on a disposable plastic apron and eye protection, for example goggles.	Some patients may accidentally cough directly ahead at the nurse; standing to one side and wearing a disposable apron and eye protection will minimize transfer of secretions on to the nurse. **E**
10 Clean hands with bactericidal alcohol handrub.	To minimize the risk of infection (Fraise and Bradley 2009, **E**).
11 Put on clean disposable plastic gloves.	Gloves minimize the risk of infection from the sputum to the nurse's hands (Fraise and Bradley 2009, **E**).
12 If the new tracheostomy is cuffed, check the cuff by inflating it with air (according to manufacturer's instructions) then fully deflate the cuff.	To check for air leaks and spontaneous deflation (Clotworthy 2006d, **C**).
13 Insert the introducer or obturator of the new	To become familiar with removing the introducer or

13 Insert the introducer or obturator of the new tube, checking that it can be easily removed.	To become familiar with removing the introducer or obturator prior to insertion (Clotworthy 2006d, **C**).
14 Lubricate the new tube sparingly with a lubricating jelly and place on the sterile dressing surface.	To facilitate insertion and maintain sterility. **E**
15 Thread the new tapes or ties through the slit on one of the flanges by untying one side of the old ties.	To ensure the ties are ready to secure as soon as the tube is inserted. Most ties now are made of Velcro and are comfortable to wear and easy to adjust. **E**
16 If the old tube is cuffed slowly deflate the cuff, suctioning patient if required.	Pooled secretions above the cuff may enter the lungs when the cuff is deflated (Clotworthy 2006d, **C**).
17 Gently remove the soiled tube from the patient's neck while asking the patient to breathe out.	Conscious expiration relaxes the patient and reduces the risk of coughing. Coughing can result in unwanted closure of the tracheostomy. **E**
18 Quickly clean around the stoma with 0.9% sodium chloride and dry gently. Apply barrier cream with topical swabs (an aqueous cream may be used if the patient is having the site irradiated).	Provide care efficiently so as to not prolong the time the patient is without a formal airway and/or oxygen. To remove superficial organisms and crusts. Skin around the stoma is at risk of breakdown due to the constant presence of moisture in this area (Serra 2000, **C**). Meticulous skin care is therefore essential in order to prevent infection. Creams containing metallic compounds must not be used on irradiated skin as metal will worsen any skin reaction (Prior and Russell 2004, **C**).
19 Insert a clean tube with introducer in place, using an 'up and over' action.	Introduction of the tube is less traumatic if directed along the contour of the trachea. **E**
20 Remove the introducer immediately.	The patient cannot breathe while the introducer is in place. **E**
21 Place the inner tube in position.	The inner tube can be changed as necessary when the outer tube is in position, thus minimizing the risk of trauma to trachea and stoma. **E** The quantity of secretions present will determine the frequency with which the inner tube is changed. **E**
22 Secure the second tape on the other side of the tracheostomy flange. Ensure the tapes are secure with a space from skin to tie of 1–2 fingers only.	To secure the tube while at the same time ensuring that it will not cause discomfort to the patient. **E**
23 Remove gloves and ask the patient to breathe out onto the palm of your hand.	Flow of air will be felt if the tube is in the correct position. **E**
24 With new gloves on, put the tracheostomy dressing around the tube.	To prevent abrasion of the patient's skin by the tube. **E**
25 Ensure that the patient is comfortable.	The procedure can be traumatic for some patients, resulting in coughing and even discomfort. It is important for the nurse to stay with the patient until coughing has resolved, provide reassurance and administer analgesia where appropriate. **E**
26 Clear away the trolley and equipment.	To ensure removal of equipment. **E**.
27 Dispose of all single-use tracheostomy tubes immediately in contaminated waste. For long-term reusable tubes, clean the soiled tube with sterile water or in line with the manufacturer's recommendations. If the tube is very soiled then use sodium bicarbonate to remove debris. The tube must be rinsed thoroughly and stored dry at the patient's bedside. Plastic tubes should not be soaked in solutions.	Most new tracheostomy tubes are single use with disposable equipment to prevent infection. To remove debris that may occlude the tube and/or become a source of infection. **E** Soaking tubes could result in the absorption of the solution into the material, causing irritation to the trachea. **E**
Postprocedure	
28 Observe patient's respiratory rate and pattern, oxygen saturations, heart rate and work of	Changing a tube is potentially hazardous (ICS 2008, **C**) and may cause respiratory distress in patients. The insertion of a

breathing closely over the following 15 minutes. Observe for signs of bleeding.	new tube may cause new bleeding of surrounding tissues. **E**
29 Document the new tube size and type.	To ensure all staff are aware of the tube size and type. (NMC 2009, **C**).

Problem-solving table 10.5 Prevention and resolution (Procedure guidelines 10.9, 10.10, 10.11 and 10.12)

Problem	Cause	Prevention	Suggested action
Profuse tracheal secretions	Local reaction to tracheostomy tube	Maintain euvolaemia with adequate and not excessive hydration. Hyoscine can be considered by clinicians to aid in the reduction of excessive secretions following the immediate postoperative phase when excessive secretions are common	Suction frequently, for example every 1–2 hours, or on clinical need
Lumen of tracheostomy tube occluded	Tenacious mucus in tube	Frequent suction as required and regular inner tube changes. Humidify airways. Encourage coughing to clear secretions from within the tube	Change the inner tube. Use 0.9% sodium chloride nebulizers, HMEs and suction. Continue to change the inner tube regularly, for example 1–3-hourly
	Dried blood and mucus in the tube, especially in the postoperative period	As above	Provide humidification (see Procedure guideline 10.2). Humidification, administering air if there is no need for oxygen
Tracheostomy tube dislodged accidentally	Tapes/ties not secured adequately. Tracheostomy tube not secured adequately by staff during moving and handling of patient	Ensure tapes secure at all times with 1–2 finger spaces maximum between skin and tapes/ties. Educate patient and staff about safe mobilization of patients with tracheostomy	Insert spare tube. This should be clean and ready at the bedside (Serra 2000) (emergency box) *Note:* tracheal dilators must be kept at the bedside of patients with tracheostomies (Serra 2000)
Unable to insert clean tracheostomy tube during tube change	Unpredicted shape or angle of stoma	Emergency equipment with spare tubes, lubricant, tracheostomy dilators should always be readily available before tube change. Always perform procedure with a second person when in hospital setting. Only perform if skilled and trained in performing a tube change. Know and understand local policy for emergency management before undertaking the procedure	Remain calm since an outward appearance of distress may cause the patient to panic and lose confidence. Lubricate the tube well and attempt to reinsert at various angles. If unsuccessful, attempt to insert a smaller-size tracheostomy tube. If this is impossible, keep the tracheostomy tract open using tracheal dilators and inform the doctor
	Tracheal stenosis due to patient coughing, patient being very anxious or because the tube has been left out too long		Insert a smaller-size tracheostomy tube. If insertion still proves difficult, do not leave the patient but ask for a tube to be brought to the bed. Keep the tracheostomy patent with tracheal dilators if stenosis is pronounced until the tube is reinserted

Tracheal bleeding following or during change of the tube	Trauma due to suction or to the tube being changed. Presence of tumour Granulation tissue forming in fenestration of tube	Ensure emergency equipment including artery forceps available before procedure	Change the tube as planned if bleeding is minimal. For profuse bleeding, insert a cuffed tube and inflate the cuff (Clotworthy 2006d). Inform the doctor. Perform tracheal suction to remove the blood from the trachea
Infection	Nature of surgery and condition of patient often predispose to infection	Ensure dressings are changed when soiled and universal infection precautions are adhered to	Encourage the patient to cough up secretions and/or suction regularly. Change the tube and clean the stoma area frequently, for example 4-hourly. Protect permanent stomas with a bib or gauze. Following result of sputum specimen, commence appropriate antibiotics as needed

Postprocedural considerations

Documentation

All interventions and care given should be clearly documented in the patient's notes once performed. It is essential that all staff caring for a patient with a tracheostomy know the type of tube in place at any one time, and that this information is readily available and clearly documented in the patient's notes (ICS 2008). As discussed, the use of care plans and bundles may aid in standardizing documentation of patients with a tracheostomy, though this should comply with local policy at all times.

Cardiopulmonary Resuscitation

Definition

The term cardiac arrest implies a sudden interruption of cardiac output. It may be reversible with appropriate treatment (Handley 2004). The patient will collapse, lose consciousness, stop breathing and will be pulseless (Jevon 2001, Paradis 2007).

The four arrhythmias that cause cardiac arrest are:

- asystole
- ventricular fibrillation (VF)
- pulseless ventricular tachycardia (VT)
- pulseless electrical activity (PEA).

For the purposes of resuscitation guidelines, these rhythms are divided into two groups by their treatment:

- VF and pulseless VT, which require defibrillation.
- non-VF/VT, which do not require defibrillation (Resuscitation Council 2005).

Resuscitation is the emergency treatment of any condition in which the brain fails to receive enough oxygen.

Anatomy and physiology

The heart

The heart is made up of four chambers: two upper atria and two lower ventricles (Fig 13.5, Conduction system of the heart). The right atrium receives deoxygenated blood via the venous circulation. From the right atrium, blood flows into the right ventricle which pumps it into the lungs via the pulmonary arteries. Carbon dioxide is released and oxygen is absorbed. This blood is oxygenated and returns to the heart via the pulmonary veins that empty into the left atrium. The blood then passes into the left ventricle which pumps it into the aorta and arterial circulation (Waugh and Grant 2010).

The atrioventricular septum completely separates the right and left sides of the heart. From shortly after birth, the two sides of the heart never directly communicate. Blood travels from right side to left side via the lungs only. However, the chambers themselves work together. The two atria contract simultaneously, and the two ventricles contract simultaneously (Waugh and Grant 2010).

To prevent backflow of blood, the heart has valves. The atrioventricular (AV) valves are between the atria and ventricles. The right AV valve between the right atrium and right ventricle is also called the tricuspid valve because it consists of three cusps. The left AV valve between the left atrium and ventricle is called the bicuspid as it has two cusps. Both arteries that emerge from the heart have a valve to prevent blood from flowing back into the heart – the semi-lunar (SL) valves. The pulmonary SL valve lies where the pulmonary trunk leaves the right ventricle and the aortic SL valve is situated at the opening between the aorta and left ventricle. The valves open and close in response to pressure changes as the heart contracts and relaxes (Moran 2010, Tortora and Derrickson 2009).

Cardiac conduction system

This pathway is made up of the:

- sinoatrial (SA) node
- AV node
- bundle of His
- left and right bundle branches
- Purkinje fibres.

The SA node is the natural pacemaker of the heart. It releases electrical stimuli at a regular rate, which will vary depending on whether the body is at rest or in action. As each stimulus passes through the myocardial cells of the atria, it creates a wave of contraction which spreads rapidly through both atria.

The rapidity of atrial contraction is such that around 100 million myocardial cells contract in less than one-third of a second; this is so fast it appears instantaneous.

When the electrical stimulus from the SA node reaches the AV node, it is delayed briefly so that the contracting atria have enough time to pump all the blood into the ventricles. Once the atria are empty of blood, the valves between the atria and ventricles close. At this point the atria begin to refill and the electrical stimulus passes through the AV node, through the bundle of His, along the left and right bundle branches and the Purkinje fibres. In this way all the cells in the ventricles receive an electrical stimulus causing them to contract (Becker 2007).

Around 400 million myocardial cells that make up the ventricles contract in less than one-third of a second. As the ventricles contract, the right ventricle pumps blood to the lungs where carbon dioxide is released and oxygen is absorbed, whilst the left ventricle pumps blood into the aorta from where it passes into the coronary and arterial circulation.

At this point the ventricles are empty, the atria are full and the valves between them are closed. The SA node is about to release another electrical stimulus and the process is about to repeat itself. However, there is a third section to this process. The SA node and AV node contain only one stimulus. Therefore every time the nodes release a stimulus, they must recharge before they can do it again.

In the heart, the SA node recharges whilst the atria are refilling, and the AV node recharges when the ventricles are refilling. This means there is no need for a pause in heart function. Again, this process takes less than one-third of a

second. (The times given for the three different stages are based on a heart rate of 60 beats per minute, or 1 beat per second.)

The term used for the release of an electrical stimulus is ‘depolarization’, and the term for recharging is ‘repolarization’.

So, the three stages of a single heart beat are:

- atrial depolarization
- ventricular depolarization
- atrial and ventricular repolarization (Moran 2010, Tortora and Derrickson 2009).

Related theory

Potentially reversible causes of a cardiopulmonary arrest

During cardiac arrest, potential causes or aggravating factors for which specific treatment exists should be considered. For ease of memory, there are eight common causes of arrest, four of which begin with the letter H and four with the letter T.

- Hypoxia.
- Hypovolaemia.
- Hypothermia.
- Hypo/hyperkalaemia.
- Thromboembolism.
- Tension pneumothorax.
- Tamponade.
- Toxicity (metabolic or drug induced) (Resuscitation Council 2010b).

Hypoxia

There are many reasons why a patient may become severely hypoxic, the most common being the following.

- Acute respiratory failure.
- Airway difficulties.
- Acute lung injury.
- Severe anaemia.
- Neuromuscular disorders.

For healthy cell metabolism, the body requires a constant supply of oxygen. When this is interrupted for more than 3 minutes in most situations (except when there is severe hypothermia), cell death occurs, followed by lactic acidosis and very rapidly a cardiorespiratory arrest. The risk of hypoxia is minimized by ensuring that the patient's lungs are ventilated adequately with 100% oxygen (Resuscitation Council 2010b).

Hypovolaemia

Hypovolaemia in adults that results in PEA is usually due to severe blood loss. While it is not the nurse's role to make a medical diagnosis, they may be aware of significant factors in the history of a patient that may have led to PEA.

The most common causes of severe blood loss are:

- trauma
- surgical procedure
- gastrointestinal mucosa erosion
- oesophageal varices
- peripheral vessel erosion (by tumour usually)
- clotting abnormality.

Note: blood loss, although usually overt, can be covert such as a gastrointestinal bleed which may only become apparent when the patient collapses.

The treatment for hypovolaemia is identifying and stopping the source of fluid or blood loss, and replacing the circulating volume with the appropriate fluid. Fluid resuscitation is normally started with a crystalloid, for example 0.9% sodium chloride, and/or colloid, for example Gelofusin (depending on local protocols); there is no evidence that colloids are more effective than crystalloids. Blood is likely to be required rapidly if the blood loss exceeds 1500–2000 mL in an adult (Perel *et al.* 2007, Resuscitation Council 2010b).

Hypothermia

Hypothermia should be suspected in any submersion or immersion injury. During a prolonged resuscitation attempt, a patient who was normothermic at the onset of cardiac arrest may become hypothermic (Resuscitation Council 2010b). A low-reading thermometer should be used if available. Resuscitation in the presence of hypothermia may be prolonged.

Hypo/hyperkalaemia and other metabolic disorders

Because potassium is so closely linked with muscle and nerve excitation, any imbalance will affect both the nervous conduction and the muscular working of the heart. Therefore a severe rise or fall in potassium can cause arrest arrhythmias. The causes of hypokalaemia are:

- gastrointestinal fluid losses
- urinary fluid loss
- drugs that affect cellular potassium, for example antifungal agents such as amphotericin.

The immediate treatment for hypokalaemia that has resulted in an arrest is to give concentrated infusions of potassium while carefully monitoring the serial potassium measurements. Most intensive care unit (ICU)/Accident and Emergency (A&E) departments and coronary care units (CCUs) will have an arterial blood gas analyser that enables the potassium to be measured in 1 minute.

The patients who are most at risk of hyperkalaemia are those with renal failure or Addison's disease. The immediate treatment for hyperkalaemia is to give intravenous calcium. This has the effect of protecting the myocardium during the cardiac arrest. If the patient is successfully resuscitated it will be essential to monitor their serum potassium and if it remains high, to commence therapy to lower or remove the potassium (Resuscitation Council 2006).

Thromboembolism

The most common cause of thromboembolic or mechanical circulatory obstruction is a massive pulmonary embolus. Options for definitive treatment include thrombolysis or, if available, cardiopulmonary bypass and operative removal of the clot (Resuscitation Council 2010b).

Tension pneumothorax

A tension pneumothorax is the sudden collapse of a lung, usually under pressure, which results in a severe change in intrathoracic pressure and cessation of the heart as a pump (Bersten *et al*. 2009). The most common causes are:

- trauma
- acute lung injury
- mechanical ventilation of the newborn.

The immediate treatment is the insertion of a large-bore cannula into the second intercostal space at the midclavicular line of the affected side (Resuscitation Council 2010b). Arrangements should be made for the insertion of a formal chest tube and underwater seal drain (see Procedure guideline 10.4).

Tamponade

This is where there is an acute effusion of fluid in the pericardial space and as it enlarges, the heart is splinted and finally cannot beat. The fluid is usually blood but can be malignant or infected fluid (Dolan and Preston 2006). The most common cause for a sudden tamponade is trauma. The immediate treatment is the insertion of a catheter or surgical drainage of the fluid. After drainage, the cause of the tamponade should be sought and corrected where possible, for example with appropriate antibiotic therapy for a bacterial aetiology or surgical repair of a myocardial laceration (Shoemaker 2000).

Toxicity: poisoning and drug intoxication

Poisoning rarely leads to cardiac arrest but it is a leading cause of death in patients less than 40 years old. Self-poisoning with therapeutic or recreational drugs is the main reason for hospital admission (Resuscitation Council 2010b). There are few specific therapeutic measures for poisons that are useful in the immediate situation. The emphasis must be on intensive supportive therapy, with correction of hypoxia, acid/base balance and electrolyte disorders. Specialist help can be obtained by telephoning one of the regional National Poisons Information Service Centres (Resuscitation Council 2010b).

Evidence-based approaches

Sudden death as a result of cardiac arrest is responsible for 60% of ischaemic heart disease deaths across Europe (Resuscitation Council 2010b). Survival to hospital discharge is cited as 10.7% of all types of cardiac arrest with survival being higher (21.2%) in ventricular fibrillation arrests (Resuscitation Council 2010b).

Changes to adult basic life support (BLS) guidelines have been made to reflect the importance highlighted by performing high quality chest compressions. The rescuer should reduce the number and duration of pauses during chest compressions (Resuscitation Council 2010b).

Cardiopulmonary resuscitation guidelines in the UK are researched and implemented by the Resuscitation Council UK, and BLS and ALS guidelines are changed according to their recommendations. Although the Resuscitation Council guidelines of 2000 recommended immediate defibrillation for all shockable rhythms, evidence indicates that a period of CPR before defibrillation

may improve survival after prolonged collapse (>5 min) (Wik *et al.* 2003). The duration of collapse is frequently difficult to estimate accurately, so CPR should be given before attempted defibrillation outside hospital, unless the arrest is witnessed by a healthcare professional or an automated external defibrillator (AED) is being used (Resuscitation Council 2010b).

In contrast, there is no evidence to support or refute the use of CPR before defibrillation for in-hospital cardiac arrest. For this reason, after in-hospital VF/VT cardiac arrest, a shock should be given as soon as possible (Resuscitation Council 2010b). Continuing good-quality CPR may improve the amplitude and frequency of fine VF and improve the chance of successful defibrillation to a perfusing rhythm, as fine VF is difficult to distinguish from asystole and very unlikely to be shocked successfully.

Rationale

The basic technique involves a rapid simple assessment of the patient followed by the basic life support (BLS) resuscitation. The first international consensus evidence-based guidelines on resuscitation were published in 2000 (AHA/ILCOR, 2010, Shuster *et al.* 2010). These guidelines were reviewed in 2004/05 by the International Liaison Committee on Resuscitation and published in 2005 (AHA/ILCOR 2010). These internationally agreed guidelines based on research and audit now form the basis for the European resuscitation guidelines (Baskett *et al.* 2005) as well as the UK resuscitation guidelines (Resuscitation Council 2010b).

Changes to Resuscitation Council UK guidelines suggest that the rescuer should not stop to check the patient or discontinue CPR unless the person starts to show signs of regaining consciousness, such as coughing, opening eyes, speaking or moving purposefully and starts to breathe normally (Resuscitation Council 2010b).

Indications

- The patient is unconscious, has absent or agonal (gasping) respirations and has no pulse (Perkins *et al.* 2005). Other clinical features such as pupil size, cyanosis and pallor are unreliable and so the practitioner should not waste time looking for them (Skinner and Vincent 1997).

Contraindications

- Do not attempt resuscitation orders (DNAR) (Box 10.6).
- If the environment is going to place the rescuer at risk, do not attempt resuscitation until environment secured.

Box 10.6 Decision making: do not attempt resuscitation (DNAR)

In an attempt to reduce the number of futile resuscitation attempts, many hospitals have introduced formal DNAR policies, which can be applied to individual patients in specific circumstances. Healthcare professionals must be able to show that their decisions relating to CPR are compatible with the human rights set out in the Human Rights Act 1998 implemented on 2 October 2000 (e.g. the right to life, the right to be free from inhuman or degrading treatment and freedom of expression) (BMA 2000, BMA *et al.* 2002). The following guidelines are based on those provided in a joint statement by the British Medical Association (BMA), the Royal College of Nursing (RCN) and the Resuscitation Council UK (BMA *et al.* 2002). (*Note*: where no decision has been made and the express wishes of the patient are unknown, CPR should be performed without delay.)

- Sensitive advance discussion between experienced medical/nursing staff and patients regarding attempting CPR should be encouraged but not forced. Where patients lack competence to participate, people close to them can be helpful in reflecting their views. (*Note*: in England, Wales and Northern Ireland, no person is legally entitled to give consent to medical treatment on behalf of another adult.) Information about CPR needs to be realistic. Written information explaining CPR should be available for patients and those close to them to read. The BMA, in liaison with the Resuscitation Council UK, RCN and Age Concern England, has published an information leaflet that may help patients and families to discuss DNAR with medical and nursing staff (BMA *et al.* 2002).
- Patients are entitled to refuse CPR even when there is a reasonable chance of success.
- Some patients may ask that no DNAR order be made. Patients cannot demand treatment which the healthcare team judges to be inappropriate, but all efforts should be made to accommodate their wishes and preferences.
- An advance DNAR order should only be made after consideration of the likely clinical outcome, the patient's wishes and the patient's human rights. It should be considered on an individual patient basis where:
  - attempting CPR will not start the patient's heart and breathing
  - there is no benefit in restarting the patient's heart and breathing
  - the expected benefit is outweighed by the burdens (Resuscitation Council 2010b).
- The overall responsibility for decisions about CPR and DNAR orders rests with the consultant in charge of the patient's care. Issues should, however, be discussed with other members of the healthcare team, the patient and people close to the patient where appropriate.
- There are exceptional cases where resuscitation discussions with a patient may be inappropriate, for example where senior members of the medical and nursing team consider

that CPR would be futile and that such a discussion would cause the patient unnecessary distress and anguish. This could apply to patients in the terminal phase of their illness.

- The most senior members of the medical and nursing team available should clearly document any decisions made about CPR in the patient's medical and nursing notes. The decision should be dated and the reasons for it given. This information must be communicated to all other relevant healthcare professionals. Unless it is against the wishes of the patient, their family should also be informed.
- The DNAR order should be reviewed on each admission or in light of changes in the patient's condition (BMA *et al.* 2002).
- Finally, it should be noted that a DNAR order applies only to CPR and should not reduce the standard of medical or nursing care.

Principles of care

Failure of the circulation for 3–4 minutes will lead to irreversible cerebral damage (Docherty and Hall 2002). BLS acts to slow down the deterioration of the brain and the heart until defibrillation and/or advanced life support (ALS) can be provided (Resuscitation Council 2010b).

Assessment

There are two stages of assessment.

- An immediate assessment by the rescuer to ensure that CPR may safely proceed (i.e. checking there is no immediate danger to the rescuer from any hazard, for example electrical power supply).
- Assessment by the rescuer of the likelihood of injury sustained by the patient, particularly injury to the cervical spine. Although there may be no external evidence of injury, the immediate situation may provide the necessary evidence. For example, trauma to the cervical spine should be suspected in an accelerating/decelerating injury such as a road traffic accident with a motorbike travelling at speed.

Once these two aspects have been assessed, the patient's level of consciousness should be checked by gently shaking his shoulders and asking loudly if he is all right (Figure 10.41). If there is no response, the rescuer should commence the BLS assessment (Figure 10.42) immediately.

Figure 10.41 Initial verbal assessment.

Figure 10.42 Basic life support algorithm.

Courtesy of Resuscitation Council 2010b.

Note: if the arrest is witnessed or monitored, and a defibrillator is not immediately to hand, a single precordial thump should be administered. If delivered within 30 seconds after cardiac arrest, a sharp blow with a closed fist on the patient's sternum may convert VF back to a perfusing rhythm (Resuscitation Council 2010b).

Defibrillation

Defibrillation causes a simultaneous depolarization of the myocardium and aims to restore normal rhythm to the heart. This is the definitive treatment for VF and pulseless VT. It has been suggested that 80–90% of adults who collapse because of non-traumatic cardiac arrest are found to be in VF when first attached to a monitor (Varon *et al.* 1998). In hospital, cardiac arrest is more likely to present as non-VF/VT, in other words asystole or PEA. Early defibrillation is a vital link in the chain of survival and developments in public access defibrillation and first responder defibrillation by ward nurses in hospitals are focusing firmly on this link. Delay in defibrillation decreases the chances of success by 7–10% each minute (Robertson *et al.* 1998). Nurses are often first on the scene at a cardiac arrest, highlighting the obvious need for nurse-led defibrillation at ward level. While not all nurses are trained in defibrillation, they should understand why it is necessary and how it is done and be able to assist in an emergency (Austin and Snow 2000). Resuscitation guidelines suggest asking for an automated external defibrillator (AED), if one is available, as it can be used safely and effectively without previous training (Resuscitation Council 2010b). The aim of an effective defibrillation strategy is to reduce the preshock pause to less than 5 seconds by planning ahead and continuing cardiac compressions during charging, and using a very brief safety check (Resuscitation Council 2010b).

Method of basic life support

Basic life support is sometimes known as the ‘ABC’.

Airway

The rescuer should look in the mouth and remove any visible obstruction (leave well-fitting dentures in place). The most likely obstruction in an unconscious person is the tongue. The head tilt/chin lift manoeuvre (Figure 10.43), which removes the tongue from occluding the oropharynx, is an effective method of opening an airway and relieving obstruction in 80% of patients (Simmons 2002).

Figure 10.43 Head tilt/chin lift manoeuvre.

Note: if there is any suspicion of cervical spine injury, try to avoid head tilt.

Breathing

Keeping the airway open, the rescuer should look, listen and feel for breathing (more than an occasional gasp or weak attempts at breathing) for up to 10 seconds. If the patient is breathing they should be turned into the recovery position (Figure 10.44). If the adult patient is not breathing and there is no suspicion of trauma or drowning, an immediate call for the cardiac arrest team should be made. It should be noted that in 40% of cases a person who has arrested still has agonal (gasping) respirations and these can be mistaken for normal breaths (Hauff *et al.* 2003).

Figure 10.44 The recovery position.

Artificial ventilation must then be commenced and maintained. If there are no aids to ventilation available then direct mouth-to-mouth ventilation should be used. There have been isolated reports of infections such as tuberculosis (TB) and severe acute respiratory distress syndrome (SARS) following mouth-to-mouth ventilation but never transmission of HIV. There is no evidence to quantify the degree of risk to the rescuer by performing mouth-to-mouth ventilation but, as it is widely acknowledged that there is reluctance by some people in spite of the lack of evidence, an allowance has been made for them to only perform chest compressions (Resuscitation Council 2010b). The recommended length for each breath is now 1 second (Resuscitation Council 2010b). When cardiac arrest occurs in hospital, the Resuscitation Council recommends the use of adjuncts such as the pocket mask or the bag mask unit.

These can be used to avoid direct person-to-person contact and some devices may reduce the risk of cross-infection between patient and rescuer (Resuscitation Council 2010b). In 2005, in recognition of the concern about providing mouth-to-mouth resuscitation, the guidelines changed and the BLS algorithm now starts with chest compressions and then proceeds to two breaths (Resuscitation Council 2010b).

One of the most easily learnt aids is the 'mouth-to-facemask' method (Figure 10.45) in which a ventilation mask with a one-way valve and an oxygen attachment port is used. The mask directs the patient's exhaled air and any fluid away from the rescuer and the oxygen port allows attachment of oxygen with enrichment up to 45%.

Figure 10.45 Mask with one-way valve over patient's nose and mouth and rescuer giving breath.

Used with permission from Moule and Albarran (2009).

If the operator is skilled in airway management, an Ambu-bag and mask may be used. When the bag is attached to oxygen, high levels, of up to 85%, can be obtained. However, it should be emphasized that to manipulate the head tilt, and hold on a facemask while squeezing a bag is a procedure that requires practice and is most safely achieved by two people, one holding the mask and one squeezing the bag (Hodgetts and Castle 1999, Resuscitation Council 2010b) (Figure 10.46).

Figure 10.46 Two people using Ambu-bag and mask.

Used with permission from Moule and Albarran 2009.

The most effective method of airway management is to use an endotracheal tube, thus enabling the application of 100% oxygen (Resuscitation Council 2010b, Robertson *et al.* 1998). This method of airway management is included in the advanced life support (ALS) algorithm.

Circulation

Circulation is assessed by looking for any signs of movement, including swallowing or breathing. If trained to do so, a check should also be made for the carotid pulse (Figure 10.47) for up to 10 seconds. If no circulation is detected, it must be maintained by compressions. The correct place to compress is in the centre of the lower half of the sternum (Figure 10.48). The rescuer should position themselves vertically above the patient with arms straight and elbows locked. The sternum should be pressed down to depress it by 5–6 cm. This should be repeated at a rate of about 100–120 times a minute. After 30 compressions two rescue breaths are given, continuing compressions and rescue breaths in a ratio of 30:2 (Resuscitation Council 2010b). There is evidence that chest compressions are often interrupted and that this is associated with a reduction in the chance of survival. New adult advanced life support guidelines (Resuscitation Council 2010b) suggest an increased emphasis on the importance of minimal interuption in high quality chest compressions throughout any ALS intervention, therefore, chest compressions are now continued while a defibrillator is charging, which will minimize the preshock pause. It is therefore imperative that interruptions to chest compressions are minimized by effective co-ordination between rescuers (Eftestol *et al.* 2002, van Alem *et al.* 2003, Resuscitation Council 2010b).

Figure 10.47 Carotid pulse check.

Figure 10.48 Correct positioning of hands for external compressions.

Legal and professional issues

All members of the healthcare professions who attempt resuscitation will be expected to employ the highest professional standard of care, in line with their level of training. In general, there are two means by which the risk of personal liability may be minimized. The first is by good practice and the second is by taking out adequate indemnity insurance (NMC 2008a, Resuscitation Council 2010a). To ensure best practice, make sure that regular updates for BLS and if appropriate ALS training are maintained.

The Resuscitation Council (UK) guidelines state that if rescuers are not able, or are unwilling, to give rescue breaths, they should give chest compressions alone (Resuscitation Council 2010b).

Whenever CPR is carried out (outside the hospital setting), particularly on an unknown victim, there is some risk of cross-infection, associated particularly with giving rescue breaths. Normally, this risk is very small and has to be set against the inevitability that a person in cardiac arrest will die if no assistance is given.

Competencies

Cardiopulmonary resuscitation standards and training

The Resuscitation Council UK (RCUK), formed in 1981, aims to promote the education of lay and professional personnel in the most effective methods of resuscitation appropriate to their needs. In its report *CPR Guidance for Clinical Practice and Training in Hospitals* (Resuscitation Council 2004), the Council made a number of recommendations relating to the provision of a resuscitation service in hospital.

- *Resuscitation committee*. This should comprise medical and nursing staff who advise on the role and composition of the cardiac arrest team, resuscitation equipment and resuscitation training equipment.
- *Resuscitation Training Officer* (RTO), who should be responsible for training in resuscitation, equipment maintenance and the auditing of resuscitation/clinical trials.
- *Resuscitation training*. Hospital staff should receive at least annual resuscitation training appropriate to their level and role. Medical and nursing staff should receive basic resuscitation training and should be encouraged to recognize patients who are at risk of having a cardiac arrest and call for appropriate help early. This is the most effective method of improving outcome (Jevon 2002). All medical staff should have advanced resuscitation training and senior nurses and doctors working in acute specialities (CCU, ITU, A&E) should hold a valid RCUK ALS certificate.
- *Cardiac arrest team*. Each hospital should have a team of approximately five people including a minimum of two doctors (physician and anaesthetist), an ALS-trained nurse, the RTO and a porter when possible. Clear procedures should be available for calling the cardiac arrest team. The Resuscitation Council has recommended the development of a medical emergency team which recognizes patients at risk of having a cardiac arrest and initiates the most appropriate clinical intervention to prevent it (Jevon 2002). The development of Track and Trigger systems and MEWS (modified early warning system) alerts nurses to when a patient is deteriorating so that they can initiate interventions and early referral to critical care outreach teams or medical emergency teams (DH 2000, NICE 2007). Hospital staff are often trained in BLS techniques (see Figure 10.41) that are more appropriate for the single lay rescuer in an out-of-hospital environment. These new guidelines are aimed primarily at healthcare professionals who are first to respond to an in-hospital cardiac arrest (Figure 10.49). Some of the

guidelines are also applicable to healthcare professionals in other clinical settings (Resuscitation Council 2004).

Figure 10.49 In-hospital resuscitation algorithm. CPR, cardiopulmonary resuscitation; IV, intravenous.

Courtesy of Resuscitation Council 2010b.

Preprocedural considerations

Equipment

All hospital wards and appropriate departments, for example theatre, computed tomography (CT) scanning, should have a standardized cardiac arrest trolley or box. Resuscitation equipment should be checked on a daily basis (Resuscitation Council 2010b) by the staff on the wards or clinical areas responsible for it, and a record of this check should be maintained (see Procedure guideline 10.13). Defibrillators should also be standardized. The use of AEDs or shock advisory defibrillators is recommended to reduce mortality from cardiac arrests related to ischaemic heart disease (Jevon 2002). Bossaert 1997 recommends that defibrillation should be a basic skill requirement of all nurses.

Training should be provided in the use of AEDs but if there is no trained individual present when a cardiac arrest occurs, the Resuscitation Council (UK) advises that an untrained individual should attempt AED defibrillation. The administration of a defibrillatory shock should not be delayed by waiting for more highly trained personnel to arrive. The same principle should apply to individuals whose period of qualification has expired (Resuscitation Council 2010b).

Placement of paddles or self-adhesive electrodes

The right paddle or electrode should be placed to the right of the sternum below the clavicle and the left paddle vertically in the midaxillary line approximately level with the position V6 used in electrocardiogram (ECG) monitoring (see Figure 10.50).

Figure 10.50 Placement of defibrillation pads attached to defibrillator on patient’s chest.

QUIK-COMBO
Ecg
QUIK-COMBO

Safe defibrillation practice

Defibrillation in an environment where high flows of oxygen are present could represent a danger to patients and rescuers. It is therefore essential to ensure that oxygen tubing and equipment are moved away from the chest when defibrillation is performed. Using adhesive electrodes to deliver the shock as opposed to paddles may also minimize the danger (Resuscitation Council 2010b).

A *pocket mask with oxygen port* (Figure 10.51) may be used as an adjunct to administer mouth-to-mask ventilation for a patient with respiratory arrest. The patient should be in the supine position with the head in the sniffing position (head tilt, chin lift – see Figure 10.43). Apply the mask to the patient's face using the thumbs of both hands. Lift the jaw into the mask with the remaining fingers by exerting pressure behind the angles of the jaw (jaw thrust). Blow through the inspiratory valve and watch the chest rise. Stop inflation and allow the chest to fall before blowing in the second breath.

Figure 10.51 Pocket mask with oxygen port.

A *self-inflating resuscitation bag* with oxygen reservoir and tubing (Figure 10.52) may be used to administer high inspired oxygen concentrations to a patient and can be connected to a facemask, laryngeal mask or tracheal mask. As the bag is squeezed, the contents are delivered to the patient's lungs and on release, the expired gas is diverted to the atmosphere via a one-way valve and the bag then refills automatically via an inlet at the opposite end. Used alone, the bag-valve apparatus ventilates the patient's lungs with ambient air only (FiO_2: 0.21), which can be increased to around 45% by attaching oxygen tubing and increasing the flow to 5–6 L/min directly to the bag adjacent to the air intake. If a reservoir system is attached and the oxygen flow is increased to 10 L/min, an

inspired oxygen concentration of approximately 85% can be achieved (Resuscitation Council 2010b).

Figure 10.52 Self-inflating resuscitation bag with oxygen reservoir.

An *oropharyngeal or Guedel airway* is a curved plastic tube, flanged and reinforced at the oral end with a flattened shape to ensure that it fits neatly between the tongue and the hard palate. It is used to overcome backward tongue displacement in an unconscious patient. Guedel airways come in sizes 2, 3 and 4, for small, medium and large adults respectively. Choosing the right size is done by measuring the Guedel airway from the corner of the mouth to the angle of the jaw/mandible, as indicated in Figure 10.53.

Figure 10.53 Measure the Guedel airway from the corner of the mouth to the angle of the jaw.

Used with permission from Moule and Albarran 2009.

The technique for insertion of an oropharyngeal airway in the unconscious patient is as follows.

- Open the patient's mouth and ensure, by looking into the mouth, that there is no foreign material that may be pushed into the larynx.
- Insert the airway into the mouth in the 'upside-down' position as far as the junction of the hard and soft palate and then rotate the airway through 180° (Figures 10.54, 10.55, 10.56). Then insert the airway until it lies in the oropharynx. This rotation technique minimizes the chance of pushing the tongue backwards and downwards which would further obstruct the airway (Resuscitation Council 2010b).

Figure 10.54 Insert the Guedel airway in an upside down position to the junction of the hard and soft palate.

Used with permission from Moule and Albarran 2009.

Figure 10.55 Rotate the Guedel airway 180° once you have reached the junction of the hard and soft palate.

Used with permission from Moule and Albarran 2009.

Figure 10.56 Insert the Guedel airway until it lies in the oropharynx.

Used with permission from Moule and Albarran 2009.

Use of the incorrect size oropharyngeal airway may result in trauma, laryngospasm and/or worsening of the airway obstruction.

Suction equipment such as a wide-bore suction end (Yankauer sucker – Figure 10.57) should be used to remove liquid (blood, saliva and gastric contents) from the upper airway. This is done best under direct vision during intubation but should not result in any delay in achieving a definitive airway. If tracheal suction is necessary, it should be as brief as possible and preceded and followed by ventilation with 100% oxygen.

Figure 10.57 Yankauer sucker.

Endotracheal suction catheters (Figure 10.58) are used to clear secretions from endotracheal or tracheostomy tubes or laryngeal airway masks (Hallstrom *et al.* 2000, Resuscitation Council 2010b).

A *laryngeal mask airway* (LMA) (size 4) or Combitube (small) consists of a wide-bore tube with an elliptical inflated cuff designed to seal around the laryngeal opening. It is easier to ventilate a patient using bag-valve-LMA

ventilation than using bag-valve-facemask ventilation, because of difficulty of ensuring no air leak on the facemask, especially if there is only one person available to ventilate the patient. The LMA is a reliable and safe device and has a high success rate, after a short period of training (Figure 10.59) (Hallstrom *et al.* 2000, Resuscitation Council 2010b).

Figure 10.58 Endotracheal/tracheostomy suction catheter.

Figure 10.59 Laryngeal mask airway.

A *Magill forceps* (Figure 10.60) is a curved forceps which can be used by the anaesthetist for a difficult intubation and to help introduce an endotracheal tube during intubation (Figure 10.61). Tracheal intubation is considered to be superior to other advanced techniques of airway management because the airway is reliably isolated from foreign material in the oropharynx (Hallstrom *et al.* 2000). Extensive training and regular practice are required to acquire and maintain the skills of intubation, and endotracheal tubes (oral, cuffed, sizes 6, 7 and 8) are kept on emergency trolleys and should be sized according to the patient's size and gender.

Figure 10.60 Magill forceps.

Figure 10.61 Endotracheal tubes.

An *introducer* such as a gum elastic bougie (Figure 10.62) or a semi-rigid stylet is a useful aid to intubation. Water-soluble lubricating jelly is used prior to intubation or insertion of the LMA or nasopharyngeal airway to aid smooth insertion.

Figure 10.62 Bougie.

A *laryngoscope* (see Figure 10.63) with both curved Macintosh and long blades is used by the anaesthetist to visualize the vocal cords prior to intubation. It consists of a handle with either rechargeable or removable batteries and a light source, which needs to be checked regularly, as well as just before use, and in

case of malfunction spare batteries and light sources need to be available (Resuscitation Council 2010b).

Figure 10.63 Laryngoscope handle and blade.

Assessment and recording tools

Decisions relating to CPR ideally should have been documented prior to a cardiac arrest. Every hospital should have a DNAR policy based on national guidelines (BMA *et al.* 2002, Jevon 2001).

During and after a cardiac arrest, all resuscitation attempts should be documented for auditing purposes, ideally using a nationally recognized template such as the Utstein template (recommended for use by the RCUK). If these recommendations are implemented, standards in resuscitation and resuscitation training should improve (Jevon 2002).

Pharmacological support

Only a few drugs are indicated during the immediate management of a cardiac arrest and there is only limited scientific evidence supporting their use. Drugs should be considered only after a sequence of shocks has been delivered (if indicated) and chest compressions and ventilation started (Resuscitation Council 2010b). Central venous access is optimum as it allows for drugs to be delivered rapidly. However, this is dependent on the skills available. If a peripheral intravenous cannula is already in place, it should be used first (Resuscitation Council 2010b). It is also possible to administer drugs using the intraosseous route, which is used commonly in the resuscitation of children.

The drugs used in the treatment of cardiac arrest are as follows.

- *Adrenaline* 1 mg (10 mL of a 1:10,000 solution) given intravenously. The main purpose of adrenaline is to utilize its inotropic effect to maintain coronary and cerebral perfusion during a prolonged resuscitation attempt. It is the first drug used in cardiac arrest of any aetiology. Adrenaline is included in the ALS universal algorithm (Figure 10.64), 1 mg to be given every 3–5 minutes (Resuscitation Council 2010b).

Figure 10.64 The advanced life support algorithm for the management of cardiac arrest in adults. CPR, cardiopulmonary resuscitation; ECG, electrocardiogram; PEA, pulseless electrical activity; VF, ventricular fibrillation; VT, ventricular tachycardia.

Courtesy of the Resuscitation Council 2010b.

- *Atropine* is no longer recommended routinely in patients with asystole or PEA (Resuscitation Council 2010b).
- *Amiodarone* (300 mg in 20 mL) should be considered in VF or pulseless VT. It increases the duration of the action potential in the atrial and ventricular myocardium; thus the QT interval is prolonged. In refractory VT or VF following recovery from cardiac arrest, a further 300 mg may be given followed by an infusion of 900 mg over 24 hours (Resuscitation Council 2010b). *Note*: lidocaine can still be considered if amiodarone is not available (Resuscitation Council 2010b).
- *Calcium chloride* (10 mL of 10%) is only given during resuscitation when

specifically indicated, that is, for the treatment of PEA caused by hyperkalaemia, hypocalcaemia or overdose of calcium channel-blocking drugs (Resuscitation Council 2010b). Although it plays a vital role in the cellular mechanisms underlying myocardial contraction, there is little data supporting any beneficial action for calcium following most cases of cardiac arrest (Resuscitation Council 2010b).

- *Sodium bicarbonate* 8.4% is only used in prolonged cardiac arrest or according to serial blood gas analyses. Potential adverse effects of excessive sodium bicarbonate administration include hypokalaemia, exacerbation of respiratory acidosis and increased affinity of haemoglobin for oxygen. The high concentration of sodium can also exacerbate cerebral oedema. Other adverse effects are increased cardiac irritability and impaired myocardial performance. Sodium bicarbonate is usually given in 25–50 mmol aliquots and repeated as necessary. It can also be given in the special circumstances of tricyclic overdose or hyperkalaemia (Winser 2001).
- *Magnesium sulphate*. Magnesium (4–8 mmol of 50%) should be given in cardiac arrest where there is a suspicion of hypomagnesaemia as this may precipitate refractory VF/VT (Winser 2001). It is important to recognize torsade de pointes. Many of these patients are hypomagnesaemic and/or hypokalaemic and part of effective treatment (prevention of recurrent episodes) will be giving intravenous magnesium and correction of any other electrolyte abnormality. The normal value for magnesium is 0.8–1.2 mmol/L (Wakeling and Mythen 2000).

Use prefilled syringes (mini-jets) whenever possible for speed and ease of use (Figures 10.65, 10.66, 10.67, 10.68). Drugs should be considered only after chest compressions and ventilation have been started and, where indicated, defibrillation attempted.

Figure 10.65 Mini-jet vial and administration chamber with Luer-Lock connector.

Used with permission from Moule and Albarran 2009.

Figure 10.66 Remove caps from both mini-jet vial and administration chamber.

Used with permission from Moule and Albarran 2009.

Figure 10.67 Screw mini-jet vial into administration chamber.

Used with permission from Moule and Albarran 2009.

Figure 10.68 Push vial gently to ensure that medication can be administered and connect Luer-Lock to intravenous device and inject entire contents, followed by 0.9% sodium chloride flush.

Used with permission from Moule and Albarran 2009.

Specific patient preparations

Education

Hospital staff should receive at least annual resuscitation training appropriate to their level and role. Medical and nursing staff should receive basic resuscitation training and should be encouraged to recognize patients who are at risk of having a cardiac arrest and call for appropriate help early. MEWS is a track and trigger system which alerts nurses to when a patient is deteriorating in order to initiate interventions and early referral to critical care outreach teams (DH 2000, NICE 2007). This is the most effective method of improving outcome (Jevon 2002). All medical staff should have advanced resuscitation training and senior nurses and doctors working in acute specialties (CCU, ITU, A&E) should hold a valid RCUK ALS certificate. The importance of prevention of cardiac arrest cannot be highlighted enough. Using a structured communication tool, such as Situation, Background, Assessment, Recommendation (SBAR), may help to identify patients at risk in a timely manner (Resuscitation Council 2010b).

Procedure guideline 10.13 Cardiopulmonary resuscitation

Essential equipment

Airway management:

- Pocket masks with oxygen port
- Self-inflating resuscitation bag with oxygen reservoir and tubing
- Clear facemasks in sizes 4, 5 and 6
- Oropharyngeal airways in sizes 2, 3 and 4
- Yankauer suckers × 2
- Endotracheal suction catheters × 10
- Laryngeal mask airway (size 4) or Combitube (small)
- Magill forceps
- Endotracheal tubes: oral, cuffed, sizes 6, 7 and 8
- Gum elastic bougie
- Lubricating jelly
- Laryngoscopes × 2: normal and long blades
- Spare laryngoscope bulbs and batteries
- 1 inch ribbon gauze/tape
- Scissors
- Syringe: 20 mL
- Clear oxygen mask with reservoir bag
- Oxygen cylinders × 2 (if no wall oxygen)
- Cylinder key

Circulation equipment:

- Intravenous cannulas: 18 gauge × 3, 14 gauge × 3
- Hypodermic needles: 21 gauge × 10
- Syringes: 2 mL × 6, 5 mL × 6, 10 mL × 6, 20 mL × 6
- Cannula fixing dressings and tapes × 4
- Seldinger wire central venous catheter kits × 2
- 12 gauge non-Seldinger central venous catheter × 2
- Intravenous administration sets × 3
- 0.9% sodium chloride: 1000 mL bags × 2

Optional equipment

- Extra ECG electrodes
- Extra defibrillation gel pads unless using fast patch electrodes
- Clock
- Gloves/goggles/aprons
- A sliding sheet or similar device should be available for safe handling

Medicinal products

Immediately available prefilled syringes of:

- Atropine: 3 mg × 1
- Amiodarone: 300 mg × 1
- Adrenaline: 1 mg (1:10,000) × 4

Other readily available drugs used in CPR:

- Epinephrine (adrenaline): 1 mg (1:10,000) × 4
- Sodium bicarbonate 8.4%: 50 mL × 1
- Calcium chloride 10%: 10 mL × 2
- Lidocaine: 100 mg × 2
- Atropine: 1 mg × 2
- 0.9% sodium chloride: 10 mL ampoules × 10
- Naloxone: 400 g × 2
- Epinephrine/adrenaline 1:1000 × 2
- Amiodarone: 150 mg × 4
- Magnesium sulphate 50% solution: 2 g (4 mL) × 1
- Potassium chloride 40 mmol × 1
- Adenosine: 6 mg × 10
- Hydrocortisone: 200 mg × 1
- Glucose 10%: 500 mL × 1

Preprocedure

Action	**Rationale**
1 Note time of arrest, if witnessed.	Lack of cerebral perfusion for approximately 3–4 minutes can lead to irreversible brain damage. **E**

Procedure

2 Give patient precordial thump only in witnessed collapse and in cardiac monitored arrest if defibrillator not immediately available.	This may restore cardiac rhythm, which will give a cardiac output. **E**. Single precordial thump has low success rate for cardioversion of shockable rhythm (Haman *et al.* 2009, **E**).
3 Summon help. If a second nurse is available, they can call for the cardiac arrest team, bring emergency equipment and screen off the area.	Maintain patient's privacy and dignity. CPR is more effective with two rescuers. One is responsible for inflating the lungs, and the other for chest compressions. Continue until medical help arrives (Resuscitation Council 2010b, **C**).
4 Lie patient flat on a firm surface/bed. If on a chair, lower the patient to the floor, ensuring that the head is supported.	Effective external cardiac massage can be performed only on a hard surface (Resuscitation Council 2010b, **C**).
5 If patient is in bed, remove bed head and ensure adequate space between back of bed and wall.	To allow easy access to patient's head in order to facilitate intubation. **E**
6 Ensure a clear airway. If cervical spine injury is excluded, extend, not hyperextend, the neck (thus lifting the tongue off	

the posterior wall of the pharynx). This is best achieved by	
lifting the chin forwards with the finger and thumb of one hand while pressing the forehead backwards with the heel of the other hand (see Figure 10.42). If this fails to establish an airway, there may be obstruction by a foreign body. Try to remove the obstruction if visible. Insert oropharyngeal Guedel airway if you have appropriate training. See Figures 10.53–10.56.	To establish and maintain airway, thus facilitating ventilation (Resuscitation Council 2010b, **C**).
Do not remove well-fitted dentures.	They help to create a mouth-to-mask seal during ventilation. **E**
7 Place the heel of one hand in the centre of the sternum and place the other on top, ensuring that the hands are located between the middle and the lower half of the sternum. Ensure that only the heel of the dominant hand is touching the sternum.	To ensure accuracy of external cardiac compression and reduced delay in commencing cardiac compressions (Resuscitation Council 2010b, **C**).
Place the other hand on top, straighten the elbows and make sure shoulders are directly over the patient's chest.	
The sternum should be depressed sharply by 5–6 cm. The cardiac compressions should be forceful, and sustained at a rate of 100–120 per minute.	This produces a cardiac output by applying direct downward force and compression (Smith 2000, **R3**).
8 Apply facemask with Ambu-bag over nose and mouth. Compress bag in a rhythmical fashion: the bag should be attached to an oxygen source, 12–15 litres. In order to deliver +85% oxygen, a reservoir may be attached to the Ambu-bag. If, however, oxygen is not immediately available, the Ambu-bag will deliver ambient air.	Room air contains only 21% oxygen. In shock, a low cardiac output, together with ventilation/perfusion mismatch, results in severe hypoxaemia. The importance of providing a high oxygen gradient from mouth to vital cells cannot be exaggerated and so oxygen should be added during CPR as soon as it is available (80–100% is desirable) (Simmons 2002, **R3**).
9 Maintain cardiac compression and ventilation at a ratio of 30:2. This rate can be achieved effectively by counting out loud 'one and two', and so on. There should be a slight pause to ensure that the delivered breath is sufficient to cause the patient's chest to rise. This must continue until cardiac output returns and the patient has a palpable blood pressure.	Counting aloud will ensure co-ordination of ventilation and compression ratio. To maintain circulation and oxygenation, thus reducing risk of damage to vital organs. **E**
10 When the cardiac arrest team arrives, it will assume responsibility for the arrest in liaison with the ward staff.	To ensure an effective expert team co-ordinates the resuscitation (Resuscitation Council 2010b, **C**).
11 Attach patient to ECG monitor using three electrodes or defibrillation patches/paddles.	To obtain adequate ECG signal. Accurate recording of cardiac rhythm will determine the appropriate treatment to be initiated. **E**
Intubation in CPR	
12 Continue to ventilate and oxygenate the patient before intubation.	The risks of cardiac arrhythmias due to hypoxia are decreased (Resuscitation Council 2010b, **C**).
13 Equipment for intubation should be checked before handing to appropriate medical/nursing staff **(a)** Suction equipment is operational. **(b)** The cuff of the endotracheal tube inflates and deflates. **(c)** The endotracheal tube is well lubricated. **(d)** That catheter mount with swivel connector is ready for use.	To ensure all equipment is working prior to use. **E**
14 During intubation, the anaesthetist may request cricoid pressure. This involves compressing the oesophagus between the cricoid ring and the sixth cervical vertebra.	To prevent the risk of regurgitation of gastric contents and the consequent risk of pulmonary aspiration (Resuscitation Council 2010b, **C**).
15 Recommence ventilation and oxygenation once intubation is completed.	Intubation should interrupt resuscitation only for a maximum of 16 seconds to prevent the occurrence of cerebral anoxia (Handley *et al.* 1997, **R3**).

	1997, **R3**).
16 Once the patient's trachea has been intubated, chest compressions, at a rate of 100–120 per minute, should continue uninterrupted (except for defibrillation and pulse check when indicated) and ventilation should continue at approximately 12 breaths per minute. Compression should continue while the defibrillator is charging.	Uninterrupted compression results in a substantially higher mean coronary perfusion pressure. A pause in chest compressions allows the coronary perfusion pressure to fall. On resuming compressions, there is some delay before the original coronary perfusion pressure is restored (Resuscitation Council 2010b, **C**). Reducing preshock pause improves time of compression which has a more favourable outcome for patient.
Intravenous access in CPR	
17 Venous access must be established through a large vein as soon as possible.	To administer emergency cardiac drugs and fluid replacement (Resuscitation Council 2010b, **C**).
18 Asepsis should be maintained throughout.	To prevent local and/or systemic infection (Fraise and Bradley 2009, **E**).
19 The correct rate of infusion is required.	To ensure maximum drug and/or solution effectiveness. **E**
20 Accurate recording of the administration of solutions infused and drugs added is essential.	To maintain accurate records, provide a point of reference in the event of queries and prevent any duplication of treatment (NMC 2009, **C**).
Defibrillation	
21 Apply pads/paddles to chest. It may be necessary to shave the chest.	To ensure the pads/paddles are applied correctly and make adequate contact which enhances electrical contact (van Alem *et al.* 2003, **C**).
22 Remove oxygen source at least 1 metre from patient unless intubated.	To reduce the risk of sparks from igniting the oxygen source (Nolan *et al.* 2005, **C**).
23 The person delivering the shock must ask all members of the resuscitation team to stand clear of the patient.	To ensure that none of the resuscitation team are in contact with the patient or the bed as they may also receive the shock (Perkins and Lockey 2008, **C**).
24 Deliver single shock to treat VF/ pulseless VT.	To terminate pulseless VT, VF and restart the heart by depolarizing its electrical conduction system and delivering brief measured electrical shocks to the chest wall or the heart muscle itself (Eftestol *et al.* 2002, **C**; Wik *et al.* 2003, **R1**).
Postprocedure	
25 Check patient by assessing airway, breathing, circulation, blood pressure and urine output.	To ensure a clear airway, adequate oxygenation and ventilation and aim to maintain normal sinus rhythm and a cardiac output adequate for perfusion of vital organs. To ensure adequacy of ventilation and oxygenation (Perkins and Lockey 2008, **C**).
26 Check arterial blood gases.	To ensure correction of acid/base balance (Resuscitation Council 2010b, **C**).
27 Check full blood count, clotting and biochemistry.	To exclude anaemia as a contributor to myocardial ischaemia. A clotting disorder may have contributed to a major haemorrhage. Replacement stored blood for transfusion has fewer clotting factors and the patient may require replacement of clotting factors usually in the form of fresh frozen plasma. **E**

	To assess renal function and electrolyte balance (K^+, Mg^{2+} and Ca^{2+}). To ensure normoglycaemia. To commence serial cardiac enzyme assay (Nolan *et al.* 2005, **C**; Resuscitation Council 2010b, **C**).
28 Monitor patient's cardiac rhythm and record 12-lead ECG.	Normal sinus rhythm is required for optimum cardiac function (Resuscitation Council 2010b, **C**). An assessment of whether cardiac arrest has been associated with a myocardial infarction should be made, as the patient may be suitable for coronary angioplasty or thrombolytic therapy (Nolan *et al.* 2005, **C**).
29 A chest X-ray should be taken.	To establish correct position of tracheal tube, gastric tube and central venous catheter. To exclude left ventricular failure, pulmonary aspiration and pneumothorax. To establish size and shape of heart (Nolan *et al.* 2006, **C**).
30 Continue respiratory therapy aiming for SaO_2 94–98% for adults.	Hypoxia and hypercarbia both increase the likelihood of a further cardiac arrest (Resuscitation Council 2010b, **C**).
31 Assess patient's level of consciousness. This can be done by use of the Glasgow Coma Scale. Although this is intended primarily for head injury, it is clinically relevant. It contains five levels of consciousness: **(a)** Conscious and alert **(b)** Drowsy but responsive to verbal commands **(c)** Unconscious but responsive to minimal painful stimuli **(d)** Unconscious and responsive to deep painful stimuli **(e)** Unconscious and unresponsive. See Chapter 13.	Once a heart has been resuscitated to a stable rhythm and cardiac output, the organ that influences an individual's survival most significantly is the brain (Resuscitation Council 2010b, **C**). Initial assessment and regular monitoring will alert the nurse to any changes in function.
32 The patient should be stable prior to any transfer and nursed in the appropriate position, that is semi-Fowler or the recovery position. Avoid nursing supine as this physiologically hinders cardiac output and respiration, unless clinically indicated for patients with acute head or spinal cord injury. Careful explanation and reassurance are vital at all times, particularly if the patient is conscious and aware.	Transferring a patient post arrest may pose risks because of changes in their haemodynamic status. This is due to movement of the trolley – inertia, changes in environment and/or changing equipment, which may impact negatively on the patient's physiological status (Shirley and Bion 2004, **E**). Nursing a patient in semi-Fowler's position ensures good air entry, and reduces risks for aspiration for patients not contraindicated for head of bed to be elevated (Tablan *et al.* 2004, **C**).

Problem-solving table 10.6 Prevention and resolution (Procedure guideline 10.13)

Problem	Cause	Prevention	Suggested action
Defibrillator not working	Battery pack not charged	Ensure defibrillator is plugged into the mains so battery can recharge	Check defibrillator when doing emergency trolley checks as per hospital policy
No trace when ECG dots or pads are on patient	ECG dots or pads dry Test plug connected to lead	Change ECG dots/pads as they can dry out Ensure that the test plug is not attached	Check expiratory dates of ECG dots/pads when checking emergency trolley/ equipment After emergency trolley checks, ensure that the test plug is no longer attached
Staff unable to use defibrillator	Not had training	Mandatory yearly BLS training for staff who will be present during CPR, and ALS every 3 years for staff who work in specialized areas for example critical care Standardize equipment throughout the hospital	Find a member of staff who is trained in using defibrillator. AED defibrillators should be available as they can be used by people without previous training
Laryngoscope light not working	Laryngoscope handle not charged	Ensure that the laryngoscope handle is charged using rechargeable batteries or new batteries inserted Change laryngoscope light	Check laryngoscope when doing resuscitation equipment checks as per hospital policy If using rechargeable batteries, ensure laryngoscope handle is docked Have spare batteries if not using rechargeable Have spare light bulbs/spare disposable laryngoscope blades on the emergency trolley
Portable suction not working	Battery pack not charged Incorrectly connected tubing	Ensure that suction unit is plugged in so battery can charge Check that tubing correctly connected	Check portable suction is on charge and tubing correctly connected when checking resuscitation equipment as per hospital policy
Emergency drugs missing/expired	Trolley not checked Equipment removed without having been replaced	Have a checklist of the emergency drugs that need to be on the resuscitation trolley	Check drugs and expiry dates when checking resuscitation equipment and resuscitation trolley as per hospital policy and lock trolley for safekeeping of drugs
Equipment missing off resuscitation trolley	Removal of equipment without replacing or returning it	Have a checklist of all equipment needed on resuscitation trolley	Check resuscitation trolley list as per hospital policy. Replace any missing or expired equipment Seal/lock trolley after checks/use Educate all staff not to remove equipment from trolley other than in a cardiac arrest

Postprocedural considerations

Immediate care

Following stabilization of the patient post cardiac or respiratory arrest, consideration should be given to moving them to an appropriate critical care or high-dependency environment. All established monitoring should continue during transfer and the patient should be transferred by individuals capable of monitoring the patient and responding appropriately to any change in the patient's condition, including a further cardiac arrest. A critical care outreach service or designated transfer team, if available, may contribute to the care of the patient during stabilization and transfer (Nolan *et al.* 2006, Resuscitation Council 2010b, Shirley and Bion 2004).

Ongoing care

The patient's haemodynamic status should be continually monitored post resuscitation, as well as observing the patient's level of consciousness, respiration rate and if possible urine output. Monitor blood glucose levels in adults with sustained return of spontaneous circulation (ROSC) after cardiac arrest. Maintaining blood glucose values >10 mmol/L, they should be treated in an HDU/ICU environment, however hypoglycaemia must be avoided (Resuscitation Council 2010b). Documentation of physiological parameters needs to continue and any change in haemodynamic status needs to be reported to the medical team or senior nursing staff attending to the patient prior to transfer to the CCU or HDU.

The Intensive Care Society (UK) has published guidelines for the transport of the critically ill adult (www.ics.ac.uk). These outline the requirements for equipment and personnel when transferring critically ill patients (Nolan *et al.* 2006, Resuscitation Council 2006, Sandroni *et al.* 2007, Shirley and Bion 2004).

Careful explanation and reassurance must be given to the patient before transfer, particularly if the patient is conscious and aware. The patient's relatives will require considerable support and will need to be kept informed of the transfer of their relative and to where. It is important that if the family were not present during the arrest, the appropriate member of the medical team contacts the next of kin and informs them of the arrest and its outcome. If the patient has survived, the next of kin/family will need to know that the patient has been moved to a more appropriate environment for continued monitoring.

Please note: whether the resuscitation attempt was successful or not, the pastoral needs of all those associated with the arrest should not be forgotten (Resuscitation Council 2010b, Sandroni *et al.* 2007).

Documentation

Good record keeping is an integral part of nursing practice, and is essential to the provision of safe and effective care (NMC 2009). There must be documentary evidence of how decisions relating to the patient were made. Accurate recording of the administration of solutions infused and drugs added is essential. All resuscitation attempts should be audited, ideally using a nationally recognized template such as the Utstein template (recommended for use by the Resuscitation Council 2010b). Hospitals should collect data regarding cardiac arrest for the National Cardiac Arrest Audit (NCAA) (Resuscitation Council 2010b).

Education of patient and relevant others

Prevention of cardiac arrest is the most important factor for survival. Education of the patient and relevant others needs to start at first contact with healthcare professionals regarding lifestyle changes, diet, exercise, smoking cessation, and regular check-ups to treat or control any underlying causes such as hypertension and diabetes.

Complications

Some possible complications may arise from cardiopulmonary resuscitation.

- Gastric distension due to bagging too forcefully and/or too quickly, causing air to enter the stomach. A nasogastric tube should be inserted as soon as the airway is secure, to help prevent and manage gastric distension which may cause vomiting and possible aspiration into the lungs.
- Fractured ribs, sternum, punctured lungs can occur as a result of chest compressions. The correct placement of hands during chest compression is vital in helping to prevent fracturing of ribs and sternum.
- Transmission of disease through mouth-to-mouth ventilation. The use of a pocket resuscitation mask with a one-way valve will prevent the transmission of infection from bodily fluids during ventilation (DH 2007).

Websites

British Lung Foundation: www.lunguk.org/

British Thoracic Society: www.brit-thoracic.org.uk

BTS guideline for emergency oxygen use in adult patients: www.brit-thoracic.org.uk/emergencyoxygen)

Intensive Care Society: www.ics.ac.uk/

NPSA Rapid Response Alert May 2008: www.nrls.npsa.nhs.uk

Resuscitation Council UK: www.resus.org.uk

Smoking Cessation Programme Development Group at NICE: www.publichealth.nice.org.uk/page.aspx?o=SmokingCessationPGMain

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Part three

Supporting the patient through the diagnostic process

11 Interpreting diagnostic tests

12 Haematological procedures

13 Observations

14 Radionuclide investigations and therapy

Specimen Collection: Swab Sampling

Definition

Sterile swabs are commonly used in clinical practice to obtain samples of material from skin and mucous membranes. They are utilized to identify microorganisms in suspected infection or as part of a screening programme to identify patients who may be carrying pathogens without displaying clinical signs or symptoms (Ferguson 2005). The overall aim is to identify the causative organism and determine the most effective therapy.

Related theory

Rationale

Obtaining a swab is one of the easiest and most unequivocal methods of sampling in clinical practice (Lawrence 1999). Swabbing is aimed at quantitative or qualitative collection of bodily fluid or cutaneous material for the purpose of obtaining a specimen for microbiological analysis (Kingsley 2001). Samples of infected material can be obtained from any accessible part of the body by using a sterile swab tipped with cotton wool or synthetic material (Hampson 2006).

Swabs for screening programmes

Meticillin-resistant *Staphylococcus aureus* is one of the most significant problematic organisms within healthcare (Weston 2008). Colonized and infected patients represent the most important reservoir of MRSA strains within hospitals (HPA 2008b) The transmission of MRSA and the risk of MRSA infection can only be effectively addressed if MRSA carriers are identified and treated to reduce this risk of transmission (DH 2006). These screening control measures guide staff in the protection of patients from MRSA colonization and infection. Active screening of patients for MRSA carriage is performed based on a risk assessment approach to the use of isolation and cohorting facilities (Coia *et al.* 2006).

Obtaining swabs is a key component of an effective MRSA prevention programme and certain patient groups are deemed to be at higher risk of contracting serious MRSA infections: critical care, burns, transplantation, cardiothoracic surgery, orthopaedic surgery, trauma, vascular surgery and renal patients (Coia *et al.* 2006).

The normal habitat of *Staphylococcus aureus*, including MRSA, is human skin, particularly the anterior nares (nose), axilla (armpit) and perineum (groin) (DH 2006). The most commonly sampled site for MRSA screening is the nose, which can detect up to 80% of MRSA-positive patients (DH 2006). If samples from other sites, such as the groin, are included in the screening regime, detection of MRSA-positive patients increases to 100% (DH 2006). Other samples can be taken from the following sites: skin lesions and wounds, invasive line sites and other skin breaks, tracheostomies, catheter specimens of urine (CSU) and sputum from patients with a productive cough (Coia *et al.* 2006). The microbiological request form should clearly indicate that the samples are for MRSA screening to ensure that correct laboratory techniques are used and to avoid potential waste of resources.

Evidence-based approaches

Rationale

Indications

Taking a swab is indicated:

- if there are clinical signs of infection which may manifest as symptoms such as pain, redness, inflammation, heat, pus, odour and so on
- if a patient shows signs of systemic infection or has a pyrexia of unknown origin (PUO)
- as part of a screening programme.

Contraindications

- As routine use (unless part of a screening regimen).
- On chronic wounds which will be colonized with skin flora.

Principles of care

Although swabs are relatively simple to use, absorbency of infected material is variable and adequate material collection that is representative of pathogenic changes, for example to wounds, is often dependent upon correct sampling technique (Gould and Brooker 2008). Swab specimens should be collected using an aseptic technique using sterile swabs, with the principal aim of gathering as much material as possible from the site of infection/inflammation. Care should be taken to avoid contamination with anything other than sample material such as surrounding tissue, which will be contaminated with other pathogens such as skin flora (Weston 2008).

If an infected area is producing copious amounts of pus or exudate, a specimen should be aspirated using a sterile syringe because swabs tend to absorb excess overlying exudate, resulting in an inadequate specimen (Gilchrist 2000). If the area to be swabbed is relatively dry, for example nasal or skin swabs, the tip of the swab can be moistened with sterile 0.9% sodium chloride which makes it more absorbent and increases the survival of pathogens (Weston 2008).

Obtaining a swab should be considered in conjunction with a comprehensive nursing assessment. This could include observation of localized infection such as inflammation or discharge from a wound during a dressing change.

Practitioners should know what type of pathogenic microorganisms they are testing for, for example whether a bacterial or viral infection is suspected, as this will determine which swab is the most appropriate. Advice should be sought from the microbiology laboratory prior to taking a swab to ensure appropriate and resource-effective sampling or specimen collection. For example, whilst viruses cause the majority of throat infections, group A streptococcus is the main bacterial cause of sore throats and therefore if suspected, a swab with bacterial transport medium would need to be used rather than one containing viral transport medium.

Legal and professional issues

Competencies

Obtaining specimens for microbiological analysis is a key component in the patient's assessment and subsequent nursing care. Therefore, practitioners must be competent and feel confident that they have the knowledge, skill and understanding to obtain and correctly process samples for specimen collection (NMC 2008a).

Preprocedural considerations

Equipment

Commercially produced swabs are aseptically packaged in plastic transport tubes which contain either a bacterial or viral transport medium designed to maintain microorganism viability between sampling and processing (Lawrence and Ameen 1998). If unsure, the practitioner should liaise with the microbiology laboratory to clarify which is the most suitable swab for a particular investigation or type of specimen. See Figure 11.4.

Specific patient preparations

It may be necessary to position the patient in order to obtain the required sample.

**********start*

Procedure guideline 11.14 Swab sampling: ear

Essential equipment

- Gloves
- Apron
- Sterile swab (with transport medium)
- Appropriate documentation/form

Preprocedure

Action	Rationale
1 Explain and discuss the procedure with the patient.	To ensure the patient understands the procedure and gives valid consent (NMC 2008b, **C**).
2 Wash hands with bactericidal soap and water, or decontaminate physically clean hands with alcohol-based handrub. Don apron and gloves.	To reduce the risk of cross-infection and specimen contamination (Fraise and Bradley 2009, **E**).
3 Ensure no antibiotics or other therapeutic drops have been used in the aural region 3 hours before taking the swab.	To prevent collection of such therapeutic agents which may mask pathogenic organisms and invalidate the specimen (Hampson 2006, **E**).

Procedure

4 Remove the swab from outer packaging and place at the entrance of the auditory meatus as shown in Action Figure 4. Rotate gently once.

To avoid trauma to the ear and to collect secretions/ suitable specimen material (Mims *et al*. 2004, **E**).

Postprocedure

5 Remove cap from plastic transport tube.	To avoid contamination of the swab and to maintain the viability of the sampled material during transportation (Ferguson 2005, **E**; HPA 2008a, **C**).
6 Remove gloves and apron and wash/decontaminate hands.	To reduce risk of cross-infection (DH 2006, **C**).
7 Complete microbiology request form (including relevant information such as exact site, nature of specimen and investigation required).	To maintain accurate records and provide accurate information for laboratory analysis (NMC 2009, **C**; Weston 2008, **E**).
8 Arrange prompt delivery to the microbiology laboratory or refrigerate at 4–8°C.	To increase the chance of accurate organism identification and to ensure the best possible conditions for laboratory analysis (Higgins 2007, **C**; HPA 2008c, **C**).

Action Figure 4 Area to be swabbed when sampling the outer ear.

Procedure guideline 11.15 Swab sampling: eye

Essential equipment

- Gloves
- Apron
- Sterile bacterial or viral swab (with transport medium)
- Appropriate documentation/form

Preprocedure

Action	Rationale
1 Explain and discuss the procedure with the patient.	To ensure the patient understands the procedure and gives valid consent (NMC 2008b, **C**).
2 Wash hands with bactericidal soap and water, or decontaminate physically clean hands with alcohol-based handrub. Don apron and gloves.	To reduce the risk of cross-infection and specimen contamination (Fraise and Bradley 2009, **E**).
3 Seek advice from the microbiology laboratory as to the correct culture medium and swab required.	Different culture media and swabs are required for bacteria, viruses and chlamydia (Higgins 2007, **C**).

Procedure

4 Ask patient to look upwards.	To prevent corneal damage (Stollery *et al.* 2005, **E**).
5 Hold the swab parallel to the cornea and gently rub the conjunctiva in the lower eyelids from nasal side outwards.	To ensure that a swab of the correct site is taken and to avoid contamination by touching the eyelid (Stollery *et al.* 2005, **E**).
6 *If for chlamydia specimen:* apply slightly more pressure when swabbing	To obtain as many organisms as possible from the follicles and to sweep organisms away from the lower punctum (Stollery *et al.* 2005, **E**).
7 If both eyes are to be swabbed, label swabs ‘right’ and ‘left’ accordingly.	To prevent the wrong swab being placed in the wrong culture medium. **E**

Postprocedure

8 Remove cap from plastic transport tube.	To avoid contamination of the swab (HPA 2008a, **C**).
9 Carefully place swab into plastic transport tube, ensuring it is fully immersed in the transport medium. Ensure cap is firmly secured.	To avoid contamination of the swab and to maintain the viability of the sampled material during transportation (Ferguson 2005, **E**).
10 Remove gloves and apron and wash/decontaminate hands.	To reduce risk of cross-infection (DH 2006, **C**).
11 Complete microbiology request form (including relevant information such as exact site, nature of specimen and investigation required).	To maintain accurate records and provide accurate information for laboratory analysis (NMC 2009, **C**; Weston 2008, **E**).
12 Arrange prompt delivery to the microbiology laboratory.	To increase the chance of accurate organism identification and to ensure the best possible conditions for laboratory analysis (Higgins 2007, **C**).

Procedure guideline 11.16 Swab sampling: nose

Essential equipment

- Gloves
- Apron
- Sterile bacterial or viral swab (with transport medium)
- Appropriate documentation/form

Optional equipment

- 0.9% sodium chloride

Preprocedure

Action	Rationale
1 Explain and discuss the procedure with the patient.	To ensure the patient understands the procedure and gives valid consent (NMC 2008b, **C**).
2 Wash hands with bactericidal soap and water, or decontaminate physically clean hands with alcohol-based handrub. Don apron and gloves.	To reduce the risk of cross-infection and specimen contamination (Fraise and Bradley 2009, **E**).

Procedure

3 Ask patient to tilt head backwards.	To optimize visualization of area to be swabbed (Gould and Brooker 2008, **E**).
4 Moisten swab with sterile saline.	To prevent discomfort to the patient as the nasal mucosa is normally dry and organisms will adhere more easily to a moist swab (Hampson 2006, **C**).
5 Insert swab inside the anterior nares with the tip directed upwards and gently rotate (see Action Figure 5).	To ensure that an adequate specimen from the correct site is obtained and to avoid damage to the delicate epithelium (Gould and Brooker 2008, **E**).
6 Repeat the procedure with the same swab in the other nostril.	To optimize organism collection. **E**

Postprocedure

7 Remove cap from plastic transport tube.	To avoid contamination of the swab (HPA 2008a, **C**).
8 Carefully place swab into plastic transport tube, ensuring it is fully immersed in the transport medium. Ensure cap is firmly secured.	To avoid contamination of the swab and to maintain the viability of the sampled material during transportation (Ferguson 2005, **E**).
9 Provide the patient with a tissue if required.	For patient comfort (Higgins 2001, **E**).
10 Remove gloves and apron and wash/decontaminate hands.	To reduce risk of cross-infection (DH 2006, **C**).
11 Complete microbiology request form (including relevant information such as exact site, nature of specimen and investigation required).	To maintain accurate records and provide accurate information for laboratory analysis (NMC 2009, **C**; Weston 2008, **E**).
12 *If sample taken for screening:* state clearly on the microbiology request form, for example for MRSA screening.	To ensure only these organisms are being analysed, so the result will only indicate their presence or absence, and sensitivities (HPA 2008d, **C**).
13 Arrange prompt delivery to the microbiology laboratory.	To increase the chance of accurate organism identification and to ensure the best possible conditions for laboratory analysis (Higgins 2007, **C**).

Action Figure 5 Area to be swabbed when sampling the nose.

Procedure guideline 11.17 Swab sampling: penis

Essential equipment

- Gloves
- Apron
- Sterile bacterial or viral swab (with transport medium)
- Appropriate documentation/form

Preprocedure

Action	Rationale
1 Explain and discuss the procedure with the patient.	To ensure the patient understands the procedure and gives valid consent (NMC 2008b, **C**).
2 Wash hands with bactericidal soap and water, or decontaminate physically clean hands with alcohol-based handrub. Don apron and gloves.	To reduce the risk of cross-infection and specimen contamination (Fraise and Bradley 2009, **E**).

Procedure

3 The patient should not have passed urine for at least 1 hour.	To ensure a representative sample from the area being swabbed (HPA 2004, **C**).
4 Retract prepuce.	To obtain maximum visibility of area to be swabbed. **E**
5 Pass the swab gently through the urethral meatus and rotate gently.	To collect a specimen of discharge or secretions. **E**

Postprocedure

6 Remove cap from plastic transport tube.	To avoid contamination of the swab (HPA 2008a, **C**).
7 Carefully place swab into plastic transport tube, ensuring it is fully immersed in the transport medium. Ensure cap is firmly secured.	To avoid contamination of the swab and to maintain viability of the sampled material during transportation (Ferguson 2005, **E**).
8 Remove gloves and apron and wash/decontaminate hands.	To reduce risk of cross-infection (DH 2006, **C**).
9 Complete microbiology request form (including relevant information such as exact site, nature of specimen and investigation required).	To maintain accurate records and provide accurate information for laboratory analysis (NMC 2009, **C**; Weston 2008, **E**).
10 Arrange prompt delivery to the microbiology laboratory (within 4 hours).	To increase the chance of accurate organism identification and to ensure the best possible conditions for laboratory analysis (Higgins 2007, **C**).

Procedure guideline 11.18 Swab sampling: rectum

Essential equipment

- Gloves
- Apron
- Sterile bacterial or viral swab (with transport medium)
- Appropriate documentation/form

Preprocedure

Action	Rationale
1 Explain and discuss the procedure with the patient.	To ensure the patient understands the procedure and gives valid consent (NMC 2008b, **C**).
2 Ensure a suitable location in which to carry out the procedure.	To maintain patient privacy and dignity (Gilbert 2006, **E**).
3 Wash hands with bactericidal soap and water, or decontaminate physically clean hands with alcohol-based handrub. Don apron and gloves.	To reduce the risk of cross-infection and specimen contamination (Fraise and Bradley 2009, **E**).

Procedure

4 Pass the swab, with care, through the anus into the rectum and rotate gently.	To avoid trauma and to ensure that a rectal, not an anal, sample is obtained. **E**
5 *If specimen is for suspected threadworm:* take swab from the perianal area.	Threadworms lay their ova on the perianal skin (Mims *et al.* 2004, **E**).

Postprocedure

6 Remove cap from plastic transport tube.	To avoid contamination of the swab (HPA 2008a, **C**).
7 Carefully place swab into plastic transport tube, ensuring it is fully immersed in the transport medium. Ensure cap is firmly secured.	To avoid contamination of the swab and to maintain viability of the sampled material during transportation (Ferguson 2005, **E**).
8 Remove gloves and apron and wash/decontaminate hands.	To reduce risk of cross-infection (DH 2006, **C**).
9 Complete microbiology request form (including relevant information such as exact site, nature of specimen and investigation required).	To maintain accurate records and provide accurate information for laboratory analysis (NMC 2009, **C**; Weston 2008, **E**).
10 Arrange prompt delivery to the microbiology laboratory.	To increase the chance of accurate organism identification and to ensure the best possible conditions for laboratory analysis (Higgins 2007, **C**).

Procedure guideline 11.19 Swab sampling: skin

Essential equipment

- Gloves
- Apron
- Sterile bacterial or viral swab (with transport medium)
- Appropriate documentation/form

Optional equipment

- Scalpel blade/U blade (for trained practitioners only)

Preprocedure

Action	Rationale
1 Explain and discuss the procedure with the patient.	To ensure the patient understands the procedure and gives valid consent (NMC 2008b, **C**).
2 Wash hands with bactericidal soap and water, or decontaminate physically clean hands with alcohol-based handrub. Don apron and gloves.	To reduce the risk of cross-infection and specimen contamination (Fraise and Bradley 2009, **E**).

Procedure

3 *For cutaneous sampling (for screening, for example groin)*: moisten swab with sterile saline and roll one swab along the area of skin along the inside of the thighs closest to the genitalia.	Organisms adhere more easily to a moist swab (Hampson 2006, **C**).
4 *For suspected fungal infection:* skin scrapings should be obtained. Take a scalpel blade and, with the affected area of skin stretched taut between two fingers, gently scrape the skin with a piece of dark paper underneath. Do not cause bleeding.	To identify superficial fungi that inhabit the outer layer of the skin (Mackie 2003, **E**). To visualize amount of sample and to allow easier transfer. **E**

Postprocedure

5 Either: *For swab specimen:* **(a)** Remove cap from plastic transport tube. **(b)** Carefully place swab into plastic transport tube, ensuring it is fully immersed in the transport medium. Ensure cap is firmly secured.	To avoid contamination of the swab (HPA 2008a, **C**). To avoid contamination of the swab and to maintain the viability of the sampled material during transportation (Ferguson 2005, **E**).
Or: *For skin scrapings*: **(a)** transfer scrapings into sterile container	To allow samples to be processed appropriately in the laboratory. **E**
6 Remove gloves and apron and wash/decontaminate hands.	To reduce risk of cross-infection (DH 2006, **C**).
7 Complete microbiology request form (including relevant information such as exact site, nature of specimen and investigation required).	To maintain accurate records and provide accurate information for laboratory analysis (NMC 2009, **C**; Weston 2008, **E**).
8 Arrange prompt delivery to the microbiology laboratory (keep at room temperature).	To increase the chance of accurate organism identification and to ensure the best possible conditions for laboratory analysis (Higgins 2007, **C**).

Procedure guideline 11.20 Swab sampling: throat

Essential equipment

- Gloves
- Apron
- Sterile bacterial or viral swab (with transport medium)
- Appropriate documentation/form
- Tongue spatula
- Light source

Preprocedure

Action	Rationale
1 Explain and discuss the procedure with the patient.	To ensure the patient understands the procedure and gives valid consent (NMC 2008b, **C**).
2 Wash hands with bactericidal soap and water, or decontaminate physically clean hands with alcohol-based handrub. Don apron and gloves.	To reduce the risk of cross-infection and specimen contamination (Fraise and Bradley 2009, **E**).

Procedure

3 Ask patient to sit upright facing a strong light, tilt head backwards, open mouth and stick out tongue.	To ensure maximum visibility of the area to be swabbed and avoid contact with the oral mucosa (Gould and Brooker 2008, **E**).
4 Depress tongue with a spatula.	The procedure may cause the patient to gag. The spatula prevents the tongue moving to the roof of the mouth, which would contaminate the specimen (Rushing 2006, **E**).
5 Ask patient to say 'Ah'.	To relax the throat muscles and help minimize the gag reflex (Rushing 2006, **E**).
6 Quickly but gently roll the swab over any area of exudate or inflammation or over the tonsils and posterior pharynx (see Action Figure 6).	To obtain the required sample (Weston 2006, **E**).
7 Carefully withdraw the swab, avoiding touching any other area of the mouth or tongue.	To prevent contamination of the specimen with the resident flora of the oropharynx (Weston 2008, **E**).

Postprocedure

8 Remove cap from plastic transport tube.	To avoid contamination of the swab (HPA 2008a, **C**).
9 Carefully place swab into plastic transport tube, ensuring it is fully immersed in the transport medium. Ensure cap is firmly secured.	To avoid contamination of the swab and maintain the viability of the sampled material during transportation (Ferguson 2005, **E**).
10 Remove gloves and apron and wash/decontaminate hands.	To reduce risk of cross-infection (DH 2006, **C**).
11 Complete microbiology request form (including relevant information such as exact site, nature of specimen and investigation required).	To maintain accurate records and provide accurate information for laboratory analysis (NMC 2009, **C**; Weston 2008, **E**).
12 Arrange prompt delivery to the microbiology laboratory.	To increase the chance of accurate organism identification and to ensure the best possible conditions for laboratory analysis (Higgins 2007, **C**).

Action Figure 6 Area to be swabbed when sampling the throat.

Procedure guideline 11.21 Swab sampling: vagina

Essential equipment

- Gloves
- Apron
- Sterile bacterial or viral swab (with transport medium)
- Appropriate documentation/form
- Sterile speculum
- Light source

Preprocedure

Action	Rationale
1 Explain and discuss the procedure with the patient.	To ensure the patient understands the procedure and gives valid consent (NMC 2008b, **C**).
2 Ensure a suitable location in which to carry out the procedure.	To maintain patient privacy and dignity (Gilbert 2006, **E**).
3 Wash hands with bactericidal soap and water, or decontaminate physically clean hands with alcohol-based handrub. Don apron and gloves.	To reduce the risk of cross-infection and specimen contamination (Fraise and Bradley 2009, **E**).
4 Place the patient in a dorsal position supported by a pillow and ask her to bring her heels together, bend her legs and draw her heels towards her bottom.	To ensure patient assumes correct position for the procedure. **E**

Procedure

5 Either: *For low vaginal swab:* **(a)** Insert the swab into the lower part of the vagina and rotate gently but firmly	To obtain appropriate sample. **E**
Or: *For high vaginal swab:* **(b)** Moisten the speculum with warm water and insert into the vagina to separate the vaginal walls. Wipe away any excess cervical mucus with a cotton swab. Using a sterile swab, sample as high as possible in the vaginal vault. Remove speculum and wipe vagina/vulval area with a tissue.	To ensure maximum visibility of the area to be swabbed and to obtain the appropriate sample (Hampson 2006, **E**).
6 Allow patient to resume a comfortable position.	To aid patient comfort. **E**

Postprocedure

7 Remove cap from plastic transport tube.	To avoid contamination of the swab (HPA 2008a, **C**).
8 Carefully place swab into plastic transport tube, ensuring it is fully immersed in the transport medium. Ensure cap is firmly secured.	To avoid contamination of the swab and to maintain the viability of the sampled material during transportation (HPA 2004, **C**; Ferguson 2005, **E**).
9 Remove gloves and apron and wash/decontaminate hands.	To reduce risk of cross-infection (DH 2006, **C**).
10 Complete microbiology request form (including relevant information such as exact site, nature of specimen and investigation required).	To maintain accurate records and provide accurate information for laboratory analysis (NMC 2009, **C**; Weston 2008, **E**).
11 Arrange prompt delivery to the microbiology laboratory (within 4 hours).	To increase the chance of accurate organism identification and to ensure the best possible conditions for laboratory analysis (Higgins 2007, **C**).

Procedure guideline 11.22 Swab sampling: wound

Essential equipment

- Gloves
- Apron
- Sterile bacterial or viral swab (with transport medium)
- Appropriate documentation/form
- Dressing pack, cleansing solution and dressing (post sampling procedure)

Optional equipment

- 0.9% sodium chloride

Preprocedure

Action	Rationale
1 Explain and discuss the procedure with the patient.	To ensure the patient understands the procedure and gives valid consent (NMC 2008b, **C**).
2 Wash hands with bactericidal soap and water, or decontaminate physically clean hands with alcohol-based handrub. Don apron and gloves.	To reduce the risk of cross-infection and specimen contamination (Fraise and Bradley 2009, **E**).
3 Remove current dressing, if applicable.	To expose wound in preparation for swabbing. **E**
4 Rewash and decontaminate hands. Open sterile dressing pack, decant sterile swab and don sterile gloves.	To reduce the risk of cross-infection (Fraise and Bradley 2008, **E**) and prepare equipment for sampling.

Procedure

5 Roll swab in a ‘zig-zag’ motion to cover the entire wound surface whilst simultaneously rotating the swab between the thumb and forefinger.	To maximize collection of microorganisms within the wound bed (Rushing 2006, **C**).
6 Use enough pressure to express fluid from within the wound tissue but avoid taking a specimen from exudates or touching the wound margin at the skin.	To gather as much exudate as possible without contaminating the sterile swab with resident skin flora (Kingsley 2001, **E**).
7 If the wound is dry, the tip of the swab should be moistened with 0.9% sodium chloride.	To make the swab more absorbent and to increase survival of pathogens present prior to culture (Weston 2008, **E**).
8 If pus is present, it should be aspirated using a sterile syringe and decanted into a sterile specimen pot.	To yield the optimum number of microorganisms present within the wound (Weston 2008, **E**).

Postprocedure

9 Remove cap from plastic transport tube.	To avoid contamination of the swab (HPA 2008a, **C**).
10 Carefully place swab into plastic transport tube, ensuring it is fully immersed in the transport medium. Ensure cap is firmly secured.	To avoid contamination of the swab and to maintain the viability of the sampled material during transportation (Ferguson 2005, **E**).
11 Redress the wound, if applicable, as per patient care plan.	To redress the wound. **E**.
12 Remove gloves and apron, discard all clinical waste and wash/decontaminate hands.	To reduce risk of cross-infection (DH 2006, **C**).
13 Complete microbiology request form (including relevant information such as exact site, nature of specimen and investigation required).	To maintain accurate records and provide accurate information for laboratory analysis (NMC 2009, **C**; Weston 2008, **E**).
14 Arrange prompt delivery to the microbiology laboratory (keep at room temperature).	To increase the chance of accurate organism identification and to ensure the best possible conditions for laboratory analysis (Higgins 2007, **C**).

Postprocedural considerations

Immediate care

Specimens may be compromised by incorrect storage and transportation. If not processed immediately, swabs need to be refrigerated or kept at an ambient temperature, depending on where the swab was obtained from, to prevent deterioration of pathogenic microorganisms (see specific procedure guidelines for exact storage requirements). Advice should be sought from the microbiology laboratory if practitioners are unsure of the storage requirements of the sample.

Documentation

Relevant and detailed information such as clinical presentation, signs and symptoms of infection, and the site and nature of the swab should be indicated on the sample and microbiology request form. This allows the microbiology laboratory to select the most appropriate processing technique and assist in differentiating organisms which would normally be expected at a particular site from those causing infection (Weston 2008).

In accordance with the principles of good record keeping, the date and time of when a swab is sent to the laboratory should be documented clearly and promptly in the patient's notes and care plan (NMC 2009). This should be done alongside documentation of the clinical nursing assessment, particularly in relation to significant findings that have prompted the collection of the sample such as observation of inflammation or discharge at the site. This assists in communication and the dissemination of information between members of the interprofessional healthcare team.

Specimen Collection: Urine Sampling

Definition

Urine samples are intended to identify any organisms causing infection within the urinary tract (Hampson 2006). Urinary tract infections (UTIs) result from the presence and multiplication of bacteria in one or more structures of the urinary tract with associated tissue invasion (HPA 2008g).

Related theory

Protection against infection is normally given by the constant flow of urine and regular bladder emptying, which prevent the colonization of microorganisms (HPA 2008g). The urethra is colonized with naturally occurring flora but urine proximal to the distal urethra is normally sterile. As urine passes through the urethra some of these microorganisms are flushed through and normal urine will naturally contain a small number of bacteria. Therefore, the presence of bacteriuria is insignificant in the absence of clinical symptoms of an infection (Weston 2008).

Urinary tract infections account for 19.7% of all overall hospital-acquired infections (DH 2007a). UTIs in adults are common, particularly in women due to the short female urethra and its close proximity to the perineum (HPA 2008g).

Evidence-based approaches

Rationale

Urine sample requests for Microscopy, Culture and Sensitivity (MC&S) constitute the largest single category of specimens examined in microbiological laboratories. The main value of urine culture is to identify bacteria and their sensitivity to antibiotics (Higgins 2007).

Urine sampling should be considered in combination with clinical assessment and urinalysis to avoid unnecessary sample processing which has time and cost implications for the microbiology laboratory (Simerville *et al.* 2005). A clinical assessment would involve examination of the odour, turbidity and colour, whether there are obvious signs of haematuria and pain particularly around the suprapubic area (Dulczak and Kirk 2005). Urinalysis may reveal a high pH, the presence of blood or positivity to leucocyte esterase (an enzyme released by white blood cells) or nitrite, all of which indicate a high probability of bacteriuria (Higgins 2007).

Indications

Obtaining a urine specimen is indicated:

- when there are clinical signs and symptoms to indicate an UTI
- if there are signs of a systemic infection or in patients with a PUO
- on development of new patient confusion as toxicity from infection can cause alterations in mental status or impairments in cognitive ability (Pellowe 2009).

Principles of care

Urine may be collected using a midstream clean-catch technique or from a catheter using a sterile syringe to access the sample port (Pellatt 2007ba). To minimize the contamination of a specimen by bacteria, which may be present on the skin, the perianal region or the external genital tract, good hand and genital hygiene should be encouraged. Therefore, patients should be encouraged to wash their hands prior to collecting a clean-catch midstream urine specimen and to clean around the urethral meatus prior to sample collection (Higgins 2008). The principle for obtaining a midstream collection of urine is that any bacteria present in the urethra are washed away in the first portion of urine voided and therefore the specimen collected more accurately represents the urine in the bladder (Dawson and Whitfield 1996).

Catheter-associated urinary tract infections (CAUTI)

The presence of a urinary catheter, and the duration of its insertion, are contributory factors in the development of a UTI. Some 60% of healthcare-associated UTIs are related to catheter insertion (DH 2007a). For every day the catheter remains *in situ*, the risk of bacteriuria is 5% so that 50% of patients catheterized for longer than 7–10 days will have bacteriuria (Pellowe 2008). Although often asymptomatic, 20–30% of patients with bacteriuria will develop a CAUTI and 1–4% will develop a bacteraemia, which has significant implications for patient morbidity, increased hospital stay and increased cost (Pellowe 2008).

Preprocedural considerations

Equipment

Specimen jars for urine collection must be sterile to ensure no contamination occurs which may lead to an incorrect diagnosis and treatment. The jars must close securely to prevent leakage of the sample. See Figure 11.3.

Specific patient preparations

When collecting a midstream specimen of urine (MSU), the patient must pass a small amount of urine before collecting the specimen. This reduces the risk of contamination of the specimen with naturally occurring microorganisms/flora within the urethra (Rigby and Gray 2005).

Procedure guideline 11.23 Urine sampling: midstream specimen of urine: male

Essential equipment

- Cleaning solution (e.g. soap and water, 0.9% sodium chloride or disinfectant-free solution)
- Sterile specimen container (with wide opening)
- Gloves
- Apron
- Appropriate documentation/forms

Preprocedure

Action	Rationale
1 Discuss need and indication for procedure with patient.	To obtain valid consent (NMC 2008b, **C**).
2 Fully explain the steps of the procedure.	The procedure requires the patient to fully understand the procedure in order to avoid inadvertent contamination of specimen and optimize the quality of the sample (Higgins 2008, **C**).
3 Ensure a suitable, private location.	To maintain patient privacy and dignity (Gilbert 2006, **E**).

Procedure

4 Ask patient to wash hands with soap and water.	To reduce risk of cross-infection (Fraise and Bradley 2009, **E**).
5 *If practitioner's assistance required:* wash hands with bactericidal soap or decontaminate physically clean hands with alcohol rub and don apron.	To prevent cross-contamination (Fraise and Bradley 2009, **E**).
6 Ask patient to retract the foreskin and clean the skin surrounding the urethral meatus with soap and water, 0.9% sodium chloride or a disinfectant-free solution.	To optimize general cleansing and minimize contamination of specimen with other organisms. **E** Disinfectant solutions may irritate the urethral mucous membrane (Higgins 2008, **E**).
7 Ask patient to begin voiding first stream of urine (approx. 15–30 mL) into a urinal, toilet or bedpan.	To commence the flow of urine and avoid contamination of specimen with naturally occurring microorganisms/flora within the urethra (Rigby and Gray 2008, **E**).
8 Place the wide-necked sterile container into the urine stream without interrupting the flow.	To prevent contamination of specimen and ensure the collection of the midstream of urine which most accurately represents the urine in the bladder (Gilbert 2005, **E**.)
9 Ask the patient to void his remaining urine into the urinal, toilet or bedpan.	For patient to comfortably continue passing urine. **E**
10 Transfer specimen into sterile universal container.	For despatch to the laboratory. **E**
11 Allow patient to wash hands.	To maintain personal hygiene. **E**

Postprocedure

12 Label sample and complete microbiological request form including relevant clinical information, such as signs and symptoms of infection, antibiotic therapy.	To maintain accurate records and provide accurate information for laboratory analysis (NMC 2009, **C**; Weston 2008, **E**).
13 Dispatch sample to laboratory immediately (within 2 hours) or refrigerate at 4°C.	To ensure the best possible conditions for microbiological analysis and to prevent microorganism proliferation (Higgins 2007, **C**).

Procedure guideline 11.24 Urine sampling: midstream specimen of urine: female

Essential equipment

- Cleaning solution (e.g. soap and water, 0.9% sodium chloride or disinfectant-free solution)
- Sterile specimen container (with wide opening)
- Gloves
- Apron
- Appropriate documentation/forms

Preprocedure

Action	Rationale
1 Discuss need and indication for procedure with patient.	To obtain valid consent (NMC 2008b, **C**).
2 Fully explain the steps of the procedure.	The procedure requires the patient to fully understand the procedure in order to avoid inadvertent contamination of specimen and optimize the quality of the sample (Higgins 2008, **C**).
3 Ensure a suitable, private location.	To maintain patient privacy and dignity (Gilbert 2006, **E**).

Procedure

4 Ask patient to wash hands with soap and water.	To reduce risk of cross-infection (Fraise and Bradley 2009, **E**).
5 *If practitioner's assistance required:* wash hands with bactericidal soap or decontaminate physically clean hands with alcohol rub and don apron.	To prevent cross-contamination (Fraise and Bradley 2009, **E**).
6 Ask patient to part the labia and clean the urethral meatus with soap and water, 0.9% sodium chloride or a disinfectant-free solution.	To optimize general cleansing and to minimize other organisms contaminating the specimen. **E** Disinfectant solutions may irritate the urethral mucous membrane (Higgins 2007, **C**).
7 Use a separate swab for each wipe and wipe downwards from front to back.	To prevent cross-infection and perianal contamination (Weston 2008, **E**).
8 Ask patient to begin voiding first stream of urine (approx. 15–30 mL) into a toilet or bedpan whilst separating the labia.	To commence the flow of urine and avoid contamination of specimen with naturally occurring microorganisms/flora within the urethra (Rigby and Gray 2005, **E**).
9 Place the wide-necked sterile container into the urine stream without interrupting the flow.	To prevent contamination of specimen and to ensure the collection of the midstream of urine which most accurately represents the urine in the bladder (Gilbert 2006, **E**).
10 Ask the patient to void her remaining urine into the toilet or bedpan.	For patient to comfortably continue passing urine. **E**
11 Transfer specimen into sterile universal container.	For dispatch to the laboratory. **E**
12 Allow patient to wash hands.	To maintain personal hygiene. **E**

Postprocedure

13 Label sample and complete microbiological request form including relevant clinical information, such as signs and symptoms of infection, antibiotic therapy.	To maintain accurate records and provide accurate information for laboratory analysis (NMC 2009, **C**; Weston 2008, **E**).
14 Dispatch sample to laboratory immediately (within 2 hours) or refrigerate at 4°C.	To ensure the best possible conditions for microbiological analysis and to prevent microorganism proliferation (Higgins 2007, **C**).

Procedure guideline 11.25 Urine sampling: catheter specimen of urine (CSU)

Essential equipment

- Sterile gloves
- Apron
- Syringe (and needle if not a needle-free system)
- Non-traumatic clamps
- Alcohol-based swab
- Universal specimen container
- Appropriate documentation/forms

Optional equipment

- Non-sterile gloves

Preprocedure

Action	Rationale
1 Explain and discuss the procedure with the patient.	To ensure the patient understands the procedure and gives valid consent (NMC 2008b, **C**).
2 Ensure a suitable, private location.	To maintain patient privacy and dignity (Gilbert 2006, **E**).
3 Prepare equipment and place on sterile trolley.	To prepare equipment for use. **E**

Procedure

4 *If no urine visible in catheter tubing*: wash/decontaminate physically clean hands with alcohol rub, don apron and apply non-sterile gloves prior to manipulating the catheter tubing.	To minimize the risk of cross-infection (Pellowe 2009, **C**).
5 Apply non-traumatic clamp a few centimetres distal to the sampling port.	To ensure sufficient sample has collected to allow for accurate sampling (Higgins 2008, **C**).
6 Wash hands with bactericidal soap and water, or decontaminate physically clean hands with alcohol rub and don sterile gloves.	To prevent cross-contamination (Fraise and Bradley 2009, **C**).
7 Wipe sampling port with 2% chlorhexidine in 70% isopropyl alcohol and allow drying for 30 seconds.	To decontaminate sampling port and prevent false-positive results (DH 2007a, **C**).
8 *If using needle and syringe:* using a sterile syringe and needle, insert needle into port at an angle of 45° and aspirate the required amount of urine, then withdraw needle.	To enable safe inoculation of urine specimen and to minimize the risk of penetration of the wall of the catheter tubing (Hampson 2006, **C**)
Or in a needle-less system: insert syringe firmly into centre sampling port (according to manufacturer's guidelines), aspirate the required amount of urine and remove syringe.	Reduces the risk of sharps injury (DH 2006, **C**).
9 Transfer an adequate volume of the urine specimen (approx. 10 mL) into a sterile container immediately.	To avoid contamination and to allow for accurate microbiological processing (Gilbert 2006, **E**).
10 Discard needle and syringe into sharps container.	To prevent the risk of needlestick injury. **E**
11 Wipe the sampling port with an alcohol wipe and allow to dry.	To reduce contamination of access port and to reduce risk of cross-infection (DH 2007a, **C**).

Postprocedure

12 Unclamp catheter tubing.	To allow drainage to continue. **E**
13 Dispose of waste, remove apron and gloves and wash hands.	To ensure correct clinical waste management and reduce risk of cross-infection (DH 2006, **C**).
14 Label sample and complete microbiological request form including relevant clinical information, such as signs and symptoms of infection, antibiotic therapy.	To maintain accurate records and provide accurate information for laboratory analysis (NMC 2009, **C**; Weston 2008, **E**).
15 Dispatch sample to laboratory immediately (within 2 hours) or refrigerate at 4°C.	To ensure the best possible conditions for microbiological analysis and to prevent microorganism proliferation (Higgins 2007, **C**).

Procedure guideline 11.26 Urine sampling: sampling from an ileal conduit

Essential equipment

- Sterile trolley
- Sterile dressing pack (with gloves)
- Urinary catheter (not larger than 14 Fr)
- Apron
- Universal specimen container
- Clean stoma appliance
- Appropriate documentation/forms

Preprocedure

Action	Rationale
1 Explain and discuss the procedure with the patient.	To ensure the patient understands the procedure and gives valid consent (NMC 2008b, **C**).
2 Ensure a suitable, private location.	To maintain patient privacy and dignity (Gilbert 2006, **E**).
3 Ensure patient is in a comfortable position (sitting up, supported by pillows) and that stoma is easily accessible.	For patient comfort and to allow access to the stoma. **E**
4 Prepare equipment and place on sterile trolley.	To prepare equipment for use. **E**

Procedure

5 Wash hands with bactericidal soap and water and dry or decontaminate physically clean hands with alcohol rub. Don non-sterile gloves.	To prevent cross-contamination (Fraise and Bradley 2009, **E**).
6 Remove the appliance from stoma. Decontaminate hands, apply sterile gloves and place sterile towel/pad under stoma.	To absorb any spillage from the stoma. **E**
7 Clean around the stoma with sterile water or saline, from the centre outwards.	Cleaning of the area reduces the risk of introducing surface pathogens into the ileal conduit. **E**
8 Apply gentle skin traction to allow the stoma opening to be more visible.	To avoid catheter coming into contact with external surface of the stoma. **E**
9 Insert catheter tip gently into the stoma to a depth of 2.5–5 cm only.	Gentle handling reduces the risk of ileal perforation and is more comfortable for the patient. **E**
10 Allow approximately 10 mL of drain through into a sterile specimen container.	To avoid contamination and to allow for accurate microbiological processing (Gilbert 2006, **E**).
11 Remove the catheter.	As catheter is no longer required. **E**
12 Change gloves, attend to stoma and apply new stoma appliance.	To ensure patient comfort. **E**

Postprocedure

13 Dispose of waste, remove apron and gloves and wash decontaminate hands.	To ensure correct clinical waste management and reduce risk of cross-infection (DH 2006, **C**).
14 Label sample and complete microbiological request form including relevant clinical information, such as signs and symptoms of infection, antibiotic therapy.	To maintain accurate records and provide accurate information for laboratory analysis (NMC 2009, **C**; Weston 2008, **E**).
15 Dispatch sample to laboratory immediately (within 2 hours) or refrigerate at 4°C.	To ensure the best possible conditions for microbiological analysis and to prevent microorganism proliferation (Higgins 2007, **C**).

Procedure guideline 11.27 Urine sampling: 24-hour urine collection

Essential equipment

- Clean urine collection containers (e.g. wide-necked pot)
- Large urine containers (with label attached for patient details)
- Appropriate documentation/forms

Optional equipment

- Written patient instruction sheet

Preprocedure

Action	Rationale
1 Discuss need and indication for procedure with patient.	To obtain valid consent (NMC 2008b, **C**).
2 Fully explain the steps of the procedure, emphasizing the importance of not discarding any urine within the 24-hour period (provide written information if needed).	The procedure requires the patient to fully understand the procedure in order to avoid inadvertent contamination of specimen and optimize the quality of the sample. **E**

Procedure

3 Ask patient to void urine and discard this specimen.	To establish the exact start time of the 24-hour period. **E**
4 All urine passed in the next 24 hours from this appointed time should be collected in a clean urine collection container.	To ensure the specimen is representative of the variables of altering body chemistry within the 24 hours (Thomson 2002, **E**).
5 *If catheter in situ:* completely empty catheter bag and hourly chamber (if applicable) or attach new catheter bag. Attach label indicating start time of 24-hour urine collection.	To clearly indicate to all practitioners the 24-hour collection period. **E**
6 If applicable, transfer urine from collection container into large specimen container.	To ensure specimen is collected in a suitable container for safe transportation to the laboratory. **E**

Postprocedure

7 Label sample and complete request form.	To maintain accurate records and provide accurate information for laboratory analysis (NMC 2009, **C**; Weston 2008, **E**).
8 Dispatch sample to laboratory as soon as possible after completion of the 24-hour period.	To allow accurate laboratory processing and analysis (Higgins 2007, **C**).

Postprocedural considerations

Immediate care

Urine is a very good culture medium so any bacteria present at the time of collection will continue to multiply in the specimen container. Rapid transport or special measures to ensure preservation of the sample are essential for laboratory diagnosis (Garibaldi 1992). Therefore, specimens should be processed immediately as delays of more than 2 hours at room temperature between collection and examination will yield unreliable results, suggesting falsely raised bacteriuria (Higgins 2007).

Where delays in processing are unavoidable, specimens should be refrigerated at 4°C or a boric acid preservative, which holds the bacterial population steady for 48–96 hours, should be utilized (HPA 2008g).

Specimen Collection: Faecal Sampling

Definition

Faecal specimens are primarily obtained for microbiological analysis to isolate and identify pathogenic bacterial, viral or parasitic organisms suspected of causing gastrointestinal infections or in patients with diarrhoea of potentially infectious aetiology (Higgins 2008). Faecal specimens may also be obtained for other non-microbiological testing to detect the presence of other substances, such as occult blood or as part of the national screening programme for colorectal cancer.

Related theory

There are a number of enteric pathogens normally present within the gastrointestinal (GI) tract, along with resident flora, that play an important role in digestion, and in forming a protective, structural and metabolic barrier against the growth of potentially pathogenic bacteria (Kelly *et al.* 2005). Pathogenic agents that disrupt the balance within the GI tract manifest in symptoms such as prolonged diarrhoea, bloody diarrhoea, nausea, vomiting, abdominal pain and/or fever. Bacteria in faeces are representative of the bacteria present in the GI tract, so the culture of a faecal sample is necessary for identification of GI tract colonization (Lautenbach *et al.* 2005).

Laboratory investigations are requested for bacterial infections such as *Salmonella*, *Campylobacter*, *Shigella* and *Clostridium difficile*, viral infections such as norovirus and rotavirus, and parasitic pathogens such as protozoa, tapeworms and amoebiasis (Weston 2008).

Diarrhoea can be defined as an unusual frequency of bowel actions (>3 times in 24 hours) with the passage of loose, unformed faeces (HPA 2008d). It may be attributable to a variety of bacterial, viral or parasitic pathogens and may be associated with antibiotic use, food or travel-related agents (King 2002). Prompt collection of a faecal sample for microbiological investigation is essential in determining the presence and identification of such agents.

Clostridium difficile

Clostridium difficile (C. diff) is recognized as a major healthcare-acquired infection causing diarrhoea associated with antibiotic use and environmental contamination (DH 2006). It is an anaerobic, Gram-positive bacterium that produces spores that are resistant to many disinfectants and can survive in harsh environmental conditions for prolonged periods (Soyfoo and Shaw 2005). It is recognized as having a significant impact upon patient morbidity and mortality and the signs and symptoms range from mild, self-limiting diarrhoea to severe, life-threatening conditions (DH 2010). Those most at risk are older patients, immunocompromised patients, and those who have had a recent course of antibiotics.

Antimicrobials, particularly broad-spectrum antibiotics, alter the normal gut flora, allowing *C. diff* to proliferate and become pathogenic in the absence of other organisms (Carney *et al.* 2002). This leads to the production of toxins that irritate and cause mucosal damage of the intestinal tract.

The diagnosis of *C. diff* is through faecal sampling for culture and toxin analysis on patients who develop diarrhoea or who are admitted to healthcare institutions with unexplained diarrhoea.

Evidence-based approaches

Rationale

Timely and accurate identification of patients with infective diarrhoea is crucial in individual management of colonization and within the context of effective infection control management. Obtaining the specimen provides important diagnostic information that can be used to decide how to manage the patient's condition and the mode of treatment (Kyle 2007). Prompt diagnosis can influence aspects of care such as isolation and cohort nursing of infected patients, infection control procedures, environmental decontamination and antibiotic prescribing (DH 2007b).

Indications

Collection of a faecal specimen is indicated:

- to identify an infective agent in the presence of chronic, persistent or extended periods of diarrhoea
- if patients are systemically unwell with symptoms of diarrhoea, nausea and vomiting, pain, abdominal cramps, weight loss and/or fever
- to investigate diarrhoea occurring after foreign travel
- to identify parasites, such as tapeworms (Pellatt 2007b)
- to identify occult (hidden) blood if rectal bleeding is suspected (Pellatt 2007bb)
- in the presence of diarrhoea associated with prolonged antibiotic administration
- for symptomatic contacts of individuals with certain organisms (e.g. *E. coli* 0157) where an infection can have serious clinical sequelae (HPA 2008d).

Contraindications

- As routine testing.
- In the absence of diarrhoea in suspected infective colonization.

Principles of care

A sample should be obtained as soon as possible after the onset of symptoms, ideally within the first 48 hours of illness, as the chance of successfully identifying a pathogen diminishes once the acute stage of the illness passes (Weston 2008). The specimen should be obtained using a clean technique in order to avoid inadvertent contamination of the specimen (HPA 2008d).

Preprocedural considerations

Assessment and recording tools

Collecting a faecal sample should be considered in conjunction with a comprehensive nursing assessment. This includes the observation of faeces for colour, presence of blood, consistency and odour (Pellatt 2007b). The most widely used assessment tool is the Bristol Stool Chart (Lewis and Heaton 1997), which categorizes faeces into seven classifications (types) based upon the appearance and consistency. Samples sent to the microbiology laboratory for analysis of suspected *C. difficile* should be classified as Type 6/7 on the Bristol Stool Chart (HPA 2008d).

In addition to other associated symptomology such as vomiting, fever, myalgia or abdominal pain, an accurate history should also include the onset, frequency and duration of diarrhoea, and other information such as history of foreign travel or potential food poisoning.

Procedure guideline 11.28 Faecal sampling

Essential equipment

- A clinically clean bedpan or disposable receiver
- Sterile specimen container (with integrated spoon) (see Figure 11.2)
- Gloves
- Apron
- Appropriate documentation/forms

Preprocedure

Action	Rationale
1 Discuss need and indication for procedure with patient.	To ensure the patient understands the procedure and gives valid consent (NMC 2008b, **C**).
2 Wash hands with bactericidal soap and water, or decontaminate physically clean hands with alcohol-based handrub. Don apron and gloves.	To reduce the risk of cross-infection and specimen contamination (Fraise and Bradley 2009, **E**).

Procedure

3 Ask patient to defaecate into a clinically clean bedpan or receiver.	To avoid unnecessary contamination from other organisms (Kyle 2007, **E**).
4 *If the patient has been incontinent:* a sample may be obtained from bedlinen or pads: try to avoid contamination with urine.	Urine would cause contamination of the sample (Higgins 2008, **E**).
5 Using the integrated ‘spoon’, scoop enough faecal material to fill a third of the specimen container (or 10–15 mL of liquid stool).	To obtain a suitable amount of specimen for laboratory analysis. **E**
6 Apply specimen container lid securely.	To prevent risk of spillage. **E**

Postprocedure

7 Dispose of waste, remove apron and gloves, and wash hands with soap and water.	To reduce risk of cross-infection (DH 2006, **C**). Soap and water must be used as alcohol-based handrubs are ineffective for *C. diff* (DH 2007b, R).
8 Examine the specimen for features such as colour, consistency and odour. Record observations in nursing notes/care plans.	To complete as comprehensive nursing assessment (Pellatt 2007a, **C**).
9 *In cases of suspected tapeworms:* segments of tapeworm are easily seen in faeces and should be sent to the laboratory for identification.	Unless the head is dislodged, the tapeworm will continue to grow. Laboratory confirmation of the presence of the head is essential (Gould and Brooker 2008, **E**).
10 Label sample and complete microbiology request form (including relevant information such as onset and duration of diarrhoea, fever or recent foreign travel).	To maintain accurate records and provide accurate information for laboratory analysis (NMC 2008, **C**; Weston 2008, **E**).
11 Dispatch sample to the laboratory as soon as possible or refrigerate at 4–8°C and dispatch within 12 hours.	To increase the chance of accurate organism identification and to ensure the best possible conditions for laboratory analysis (Higgins 2007, **E**).
12 *In cases of suspected amoebic dysentery:* dispatch the sample to the laboratory immediately.	The parasite causing amoebiasis must be identified when mobile and survives for a short period only. Therefore, faeces should remain fresh and warm (Kyle 2007, **E**).
13 *In cases of prolonged diarrhoea, especially in the presence of a fever:* dispatch the sample to the laboratory immediately.	Due to the risk of *C. diff* and to ensure prompt diagnosis and initiation of appropriate infection control measures (DH 2007b, **C**).

Postprocedural considerations

Immediate care

A faecal sample should be transported to the laboratory and processed as soon as possible because a number of important pathogens, such as *Shigella*, may not survive changes in pH and temperature once outside the body (HPA 2008d). If there is an anticipated delay in despatching the sample to the laboratory, it should be refrigerated at 4–8°C and processed within 12 hours (HPA 2008d).

Ongoing care

The result of specimen analysis will determine the patient's ongoing care. The involvement of the microbiology and infection control teams is essential to ensure prudent and safe treatment and nursing care. This should include:

- effective handwashing techniques to minimize the transmission of organisms
- implementation of Standard Precautions (gloves and aprons)
- nursing patients with unexpected or unexplained diarrhoea in isolation *or* cohorted with other infected patients (DH 2007b)
- thorough environmental decontamination (DH 2007b)
- prudent antibiotic prescribing (DH 2007a).

Education of patient and others

Patients should be provided with information and involved in their care as much as they choose to be (NMC 2008a). Confirmation of an infection diagnosis should be relayed to patients and their families alongside information on management strategies (such as antibiotic therapy, the use of PPE, reasons for isolation and visiting restrictions). The provision of written information, such as leaflets, may also prove useful.

Specimen Collection: Respiratory Tract Secretion Sampling

Definition

Obtaining a specimen from the respiratory tract is important in diagnosing illness, infections and conditions such as tuberculosis and lung cancer (Guest 2008). A sample can be obtained invasively or non-invasively and the correct technique will enable a representative sample to identify respiratory tract pathology and to guide treatment.

Related theory

Excessive respiratory secretions may be due to increased mucus production in cases of infection, impaired mucociliary transport or a weak cough reflex (Hess 2002). Lower airway secretions that are not cleared provide an ideal medium for bacterial growth. Suitable microbiological analysis in diagnosing infection will depend upon (HPA 2008a):

- the adequacy of lower respiratory tract specimens
- avoidance of contamination by upper respiratory tract and oral flora
- use of microscopic techniques and culture methods
- current and recent antimicrobial therapy.

Evidence-based approaches

Rationale

The main aim of sputum/secretion collection is to provide reliable information on the causative agent of bacterial, viral or fungal infection within the respiratory tract and its susceptibility to antibiotics for guiding treatment (Ioanas *et al.* 2001).

Indications

A respiratory tract secretion specimen is indicated:

- when there are clinical signs and symptoms of a chest infection, such as a productive cough, particularly with purulent secretions
- if there are signs of systemic infection or in patients with a PUO.

Methods of non-invasive and semi-invasive sampling

Obtaining a sputum sample

Sputum is a combination of mucus, inflammatory and epithelial cells, and degradation products from the lower respiratory tract (Dulak 2005). It is never free from organisms since material originating from the lower respiratory tract has to pass through the pharynx and the mouth, which have commensal populations of bacteria (Thomson 2002). However, it is important to ensure that material sent to the microbiology laboratory is of sputum rather than a saliva sample, which will contain squamous epithelial cells and be unrepresentative of the underlying pulmonary pathology.

Sputum produced as a result of infection is usually purulent and a good sample can yield a high bacterial load (Weston 2008). For patients who are self-ventilating, co-operative, able to cough and expectorate, and able to follow commands, a sputum sample is a suitable collection method. A sufficient quality of sputum will yield a representative specimen and an early morning specimen is thought to be of the best quality (Weston 2008). In cases of suspected *Mycobacterium tuberculosis*, three sputum specimens need to be collected on consecutive days before the pathogenic organisms can be isolated and appropriate treatment initiated. See Figure 11.1 and **Procedure guideline 11.29**.

Nasopharyngeal samples

Sampling techniques to obtain specimens from the nasopharynx are semi-invasive but can be used on patients who are self-ventilating. They are indicated in suspected viral infections such as respiratory syncytial virus (RSV), influenza and parainfluenza. The main aim is to collect epithelial cells from the posterior nasopharynx and a sample can be obtained using nasal washing or vacuum-assisted aspiration (see **Procedure guideline 11.30**).

Invasive sampling techniques

Intubated patients who are unable to clear secretions independently or who require more accurate specimen collection may need a more invasive technique to obtain a sample. Invasive techniques obtain secretions directly from the lower airway and are designed to avoid contamination by upper airway colonization, which may lead to misinterpretation of cultures (Ioanas *et al.* 2001).

Vacuum-assisted aspirate via endotracheal tube

Endotracheal suctioning is frequently used as a diagnostic method and for obtaining specimens in intubated patients with suspected pulmonary infection. This technique bypasses the upper respiratory airways and provides an accurate microbiological result. Suctioning aids the clearance of secretions by the application of negative pressure through a sterile flexible suction catheter or a closed suction system. A sterile sputum trap is attached to the suction catheter at one end, whilst the other end is attached to the suction tubing to collect the sample (Figure 11.12).

Figure 11.12 Types of vacuum-assisted sputum traps.

Bronchoalveolar lavage (BAL)

Bronchoalveolar lavage is a reliable and accurate technique that provides a good diagnostic yield in cases of pulmonary infection, particularly invasive fungal infections (Ioanas *et al.* 2001). It is used to clear secretions and to obtain washings for the retrieval of cellular and non-cellular components of the epithelial surface of the lower respiratory tract (HPA 2008a). It is performed in ventilated patients who will be sedated and paralysed for the procedure to permit effective ventilation and to prevent mucosal damage.

A flexible bronchoscope is inserted through the endotracheal tube (ETT) and advanced distally into a subsegmental bronchus. The area selected for sampling is based upon a correspondent area of infiltration on a chest X-ray or by visualization of a subsegment containing purulent secretions (Ioanas *et al.* 2001). A volume of sterile 0.9% sodium chloride (normally 20–30 mL) is then instilled through a port on the bronchoscope and suctioned back through another port into a sterile sputum trap. The procedure is repeated 3–5 times and the samples are then dispatched to the laboratory for microscopy and microbiological analysis.

Legal and professional issues

Competencies

Practitioners must be competent and feel confident that they have the knowledge, skill and understanding to undertake respiratory tract secretion sampling for microbiological analysis (NMC 2008a). For more advanced skills of specimen collection such as suctioning, the practitioner should receive training and be assessed on their knowledge and understanding of the technique and potential adverse effects that may occur such as hypoxia, cardiovascular instability and mucosal trauma (Thomson 2000). Bronchoalvolar lavage is normally performed by a member of the medical team who has received specialist training and has been deemed competent in the skill.

Preprocedural considerations

Equipment

The use of vacuum-assisted and invasive suctioning techniques requires a comprehensive assessment of clinical indication and safety considerations. These include the following.

- The use of an appropriately sized, single-use, multi-eyed suction catheter which causes less tracheal mucosal trauma (NHSQIS 2007). If suctioning through an ETT, the suction catheter diameter should be half the diameter or less which prevents occlusion of the airway and avoids generation of large negative intrathoracic pressures (Thomson 2000) (see Table 11.5).
- The use of the lowest effective suction pressure that is high enough to clear secretions whilst avoiding trauma to the bronchial mucosa.
- Ensuring suction duration time of <10 seconds to decrease the risk of adverse side-effects (NHSQIS 2007).

Table 11.5 Catheter sizes and suction pressures

Patient age	Catheter size (French)	Suction pressure (mmHg)
Premature infant	6	80–100
Infant	8	80–100
Toddler/preschooler	10	100–120
School age	12	100–120
Adolescent/adult	14	120–150

Procedures that involve suctioning present a risk of suction-induced hypoxaemia, hypertension, cardiac arrhythmias and other problems that warrant patient monitoring, in particular oxygen saturation and cardiac monitoring (Thomson 2000).

Pharmacological support

Adequate analgesia is a key consideration in ensuring that an effective sputum expectoration technique can be achieved. For example, preprocedural analgesia should be given time to be effective, and wounds need to be supported to maximize inhalation and minimize pain (Guest 2008).

Nebulization of 0.9% sodium chloride and/or mucolytic agents, such as N-acetylcysteine, may need to be administered to help loosen tenacious secretions and to elicit an effective cough (Rajiv 2007).

Non-pharmacological support

Collaboration with the physiotherapy team may assist in obtaining a good-quality sample (Hess 2002). For sputum sampling, physiotherapeutic modalities implemented may include appropriate positioning, active cycle of breathing, deep breathing and effective coughing techniques (HPA 2008a).

Specific patient preparation

Patient position is important in optimizing secretion sampling. Patients should be sat upright or on the edge of the bed, if able, or in a high semi-Fowler position (head elevated to 30–45°) in bed supported by pillows (Dulak 2005).

The quality and quantity of secretion production and mucociliary clearance depend on systemic hydration. Patient hydration can boost sputum production to enable a good sample (Dulak 2005). This can be further enhanced with sufficient airway humidity and nebulization.

Procedure guideline 11.29 Sputum sampling

Essential equipment

- Universal container
- Apron
- Non-sterile gloves
- Eye protection (e.g. goggles/visor)
- Appropriate documentation/form

Optional equipment

- Nebulizer

Preprocedure

Action	Rationale
1 Explain and discuss the procedure with the patient.	To ensure the patient understands the procedure and gives valid consent (NMC 2008b, **C**).
2 Fully explain the steps of the procedure.	The procedure requires the patient to fully understand and co-operate in order to optimize the quality of the sample (Dulak 2005, **E**).
3 Position patient upright in a chair or in a semi-or high-Fowler position, supported as necessary with pillows.	For comfort and to facilitate optimum chest/lung expansion. **E**
4 *If secretions thick/tenacious or having difficulty clearing secretions:* administer nebulization therapy and/or enlist help of the physiotherapist.	To loosen secretions and to assist in techniques that will optimize sputum sample collection (Hess 2002, **C**).
5 Wash hands with bactericidal soap/decontaminate physically clean hands with alcohol rub. Don apron, gloves and eye protection.	To reduce the risk of cross-infection or splash injury to practitioner and specimen collection (Fraise and Bradley 2009, **E**).

Procedure

6 Ask patient to take three deep breaths in through their nose, exhale through pursed lips and then force a deep cough.	Deep breathing helps loosen secretions and a deep cough will ensure a lower respiratory tract sample is obtained (Dulack 2005, **C**).
7 Ask patient to expectorate into a clean container and secure lid.	To prevent contamination. **E**

Postprocedure

8 Dispose of waste, remove apron, gloves and eye protection and wash/decontaminate hands.	To ensure correct clinical waste management and to reduce the risk of cross-infection (DH 2006, D).
9 Label sample and complete microbiology request form (including relevant information such as indication for sample and current/recent antimicrobial therapy).	To maintain accurate records and provide accurate information for laboratory analysis (NMC 2009, **C**; Weston 2008, **E**).
10 Dispatch to the laboratory as soon as possible within 2 hours.	To increase the chance of accurate organism identification (Higgins 2007, **C**).

Procedure guideline 11.30 Nasopharyngeal wash: syringe method

Essential equipment

- Universal container
- 5 mL syringe or wide-bore bladder syringe
- Sterile tubing cut to approximately 2–3″ (e.g. size 8 Fr NG tube or cut off tip from a suction catheter if using a 5 mL syringe)
- 3–5 mL 0.9% sodium chloride
- Viral transport medium (VTM) (if required by laboratory)
- Apron
- Non-sterile gloves
- Eye protection (e.g. goggles/visor)
- Appropriate documentation/form

Preprocedure

Action	Rationale
1 Explain and discuss the procedure with the patient.	To ensure the patient understands the procedure and gives valid consent (NMC 2008b, **C**).
2 Position patient upright in a chair or in a semi-or high-Fowler position, supported as necessary with pillows.	For comfort and to facilitate optimum specimen collection. **E**
3 Wash hands with bactericidal soap/decontaminate physically clean hands with alcohol rub. Don apron, gloves and eye protection.	To reduce the risk of cross-infection, splash injury to practitioner and specimen collection (Fraise and Bradley 2009, **E**).

Procedure

4 Fill syringe with 3–5 mL of 0.9% sodium chloride and attach tubing to syringe tip.	To facilitate instillation of 0.9% sodium chloride high into the patient's nostril. **E**
5 Ask patient to tilt their head backwards slightly whilst sitting upright.	To promote the flow of 0.9% sodium chloride into the nostril. **E**
6 Insert tubing into nostril and quickly instil 0.9% sodium chloride into one nostril while holding the second nostril closed.	To facilitate optimal recovery of epithelial cells. **E**
7 Aspirate fluid while withdrawing and rotating the tube to dislodge cells and secretions. NB: recovery must occur rapidly or instilled fluid will drain down the throat.	To obtain desired nasopharyngeal specimen. **E**
8 Either: Where appropriate, patient may tilt head forward and gently push the fluid out of the nostril into a sterile container.	Patients may find this method more comfortable. **E**
Or: *If aspirated*: inject aspirated specimen from syringe into suitable dry, sterile container or one containing viral transport medium, according to virology laboratory requirements.	To ensure a good-quality specimen and to prevent cross-contamination. **E**
9 Repeat procedure with other nostril and inject specimen into the same container (see Action Figure 9).	A combined specimen will promote optimal yield of microorganisms. **E**

Postprocedure

10 Remove apron, gloves and eye protection. Dispose of waste, and wash/decontaminate hands.	To ensure correct clinical waste management and to reduce the risk of cross-infection (DH 2006, **C**).
11 Label sample and complete microbiology request form (including relevant information such as: indication for sample and current/recent antimicrobial therapy).	To maintain accurate records and provide accurate information for laboratory analysis (NMC 2009, **C**; Weston 2008, **E**).
12 Dispatch to the laboratory as soon as possible within 2 hours.	To increase the chance of accurate organism identification (Higgins 2007, **C**).

Action Figure 9 Nasopharyngeal wash: syringe method.

Procedure guideline 11.31 Nasopharyngeal wash: vacuum-assisted aspirate method

Essential equipment

- Suction pump (wall or portable)
- Sterile suction catheter (see Table 11.5 for appropriate size)
- Sterile sputum trap
- Viral transport medium (if required by laboratory)
- Apron
- Sterile gloves
- Eye protection (e.g. goggles/visor)
- Appropriate documentation/form

Preprocedure

Action	Rationale
1 Explain and discuss the procedure with the patient.	To ensure the patient understands the procedure and gives valid consent (NMC 2008b, **C**).
2 Position patient upright in a chair or in a semi-or high-Fowler position, supported as necessary with pillows.	For comfort and to facilitate optimum specimen collection. **E**
3 Wash hands with bactericidal soap/decontaminate physically clean hands with alcohol rub. Don apron and eye protection.	To reduce the risk of cross-infection, splash injury to practitioner and specimen collection (Fraise and Bradley 2009, **E**).

Procedure

4 Attach suction tubing to the male adaptor of the specimen trap and attach rubber tubing on the trap to the end of the suction catheter, leaving the packaging on.	To enable correct set-up and to ensure suction catheter remains sterile. **E**
5 Turn suction on and adjust to correct pressure (see Table 11.5).	To ensure suction pressure is high enough to clear secretions whilst avoiding trauma. **E**
6 Don sterile glove and remove suction catheter from packaging aseptically.	To prevent cross-contamination of specimen. **E**
7 Ask patient to tilt their head backwards slightly whilst sitting upright.	To optimize recovery of specimen collection. **E**
8 Without applying suction, insert catheter into the nostril and direct posteriorly towards the external ear (see Action Figure 8). NB: the depth of insertion necessary to reach the posterior pharynx is equivalent to the distance between the anterior naris and the external ear.	To prevent damage to the nasopharynx and to minimize patient discomfort. **E**
9 Apply suction. Using a rotating movement, slowly withdraw the catheter. NB: catheter should remain in the nasopharynx no longer than 10 seconds.	To prevent damage to the nasopharynx and to obtain desired nasopharyngeal specimen. **E**
10 Hold trap upright to prevent secretions being suctioned into suction pump.	To prevent the loss of specimen. **E**
11 Rinse catheter (if necessary) with approximately 20 mL of viral transport medium.	To ensure maximum recovery of epithelial cells and to prevent cross-contamination (Higgins 2007, **C**).
12 Disconnect suction. Depending on sputum trap type, connect tubing to arm of sputum trap to seal or detach and apply sealable lid.	To ensure specimen container is securely sealed and to prevent cross-contamination. **E**

Postprocedure

13 Dispose of waste, remove apron, gloves and eye protection and wash/decontaminate hands.	To ensure correct clinical waste management and to reduce the risk of cross-infection (DH 2006, **C**).
14 Label sample and complete microbiology request form (including relevant information such as: indication for sample and current/recent antimicrobial therapy).	To maintain accurate records and provide accurate information for laboratory analysis (NMC 2009, **C**; Weston 2008, **E**).
15 Dispatch to the laboratory as soon as possible within 2 hours.	To increase the chance of accurate organism identification (Higgins 2007, **C**).

Action Figure 8 Nasopharyngeal wash: vacuum-assisted aspirate method.

Postprocedural considerations

Immediate care

Many organisms responsible for infection of the lower respiratory tract do not survive well outside the host, so specimens should be dispatched to the laboratory immediately and processed within 2 hours (Gould and Brooker 2008). If there is an anticipated delay in despatching the sample to the laboratory, it should be refrigerated at 4–8°C and sent as soon as possible (HPA 2008a).

Documentation

The date and time of when a sputum sample is sent to the laboratory should be documented clearly and promptly in the patient's notes and care plan (NMC 2009). This should be done alongside documentation in relation to significant findings that have prompted the collection of the sample such as a description of the type and colour of sputum/secretions and method used to obtain the sample.

Specimen Collection: Pleural Fluid

Definition

Specimens of pleural fluid for microbiological analysis are obtained by thoracocentesis to assist in the diagnosis of infection in fluid that has accumulated within the inner and outer (visceral and parietal) layers of the pleural cavity such as parapneumonia, emphyema and tuberculosis (Barnes *et al.* 2005). In the context of microbiological analysis, thoracocentesis is the insertion of a needle into the pleural space to obtain a fluid sample for diagnostic testing (Rushing 2006).

Anatomy and physiology

See Chapter 10.

Related theory

Pleural fluid is generated from pleural vessels as a result of negative intrapleural pressure. It exits via the parietal pleural lymphatic system. Pleural effusions occur when there is an accumulation of fluid within the pleural cavity, which implies either an increased production of fluid that exceeds the capacity of lymphatic removal and/or obstruction of drainage of the pleural space (Pendharkar and Tremblay 2007).

Analysis of pleural effusion fluid is obtained via thoracocentesis, which determines the cause of the effusion. Effusion occurs when factors that influence the formation and absorption of fluid are altered either systematically, for example in cirrhosis or congestive heart failure (transudate effusions), or locally, for example in infection or malignancy (exudate effusions). Pleural fluid in a patient with undiagnosed exudative effusions should be cultured for bacteria (aerobic and anaerobic), mycobacteria and fungi (Barnes *et al.* 2005).

Infection of pleural fluid caused by bacteria, viruses or fungi may originate in the pleura or translocate from another site. Microorganisms can infiltrate the pleural space by various routes: directly in cases of empyema, primary tuberculous focus rupturing into the pleural cavity, from an adjacent area of pneumonia, thoracic surgery or drainage, chest trauma or by transdiaphragmatic spread from intra-abdominal infection (HPA 2008e).

Pleural fluid is a clear, straw-coloured fluid that contains a small number of white blood cells (WBC) but no red blood cells (RBC) or micro-organsims (HPA 2008e). In cases of suspected infection, it appears cloudy due to the presence of micro-organsims and/or increased WBC (Barnes *et al.* 2005). Differential WBC counts assist further in the diagnosis of infection because increased numbers of neutrophils indicate bacterial infection, whereas an increased number of lymphocytes is indicative of malignancy or tuberculosis (Conner *et al.* 2003). Other changes include decreased glucose levels, increased protein or albumin levels and disturbances in lactate level.

Evidence-based approaches

Rationale

Detection of micro-organsims in fluids that are normally sterile indicates significant infection (HPA 2008e). Pleural fluid may be sent to the microbiology laboratory for bacterial culture to identify the cause of an effusion, isolate pathogenic microorganisms and establish susceptibility to antimicrobial therapy.

Indications

Obtaining a specimen of pleural fluid is indicated in patients with:

- bacterial pneumonia with radiological suggestion of significant pleural effusions
- systemic infection with pyrexia, severe pleuritic pain and leucocytosis
- suspected tuberculous focus with clinical signs or radiological evidence of significant pleural effusions (HPA 2008e).

Methods of pleural fluid collection

Diagnosis of infection is established by the microbiological analysis of pleural fluid obtained by thoracocentesis using a strict aseptic technique, including meticulous skin antisepsis (Barnes *et al.* 2005).

Following clinical assessment and possible radiological guidance, local anaesthetic is infiltrated into the area of intended thoracocentesis. A needle is advanced superiorly to the ribs to avoid neuromuscular bundle damage and to reduce the risk of causing a pneumothorax (Pendharkar and Tremblay 2002). Fifty to 100 mL of fluid are drawn, transferred into sterile container and sent to the laboratory for analysis.

The samples can initially be observed for characteristics such as colour and turbidity, and Gram stains allow for direct observation of bacteria under a microscope. When bacterial infection of pleural fluid is suspected, a specimen should be drawn and inoculated directly into aerobic and anaerobic blood culture bottles (Pendharkar and Tremblay 2007).

Specimens should be dispatched to the laboratory immediately and liaison with the laboratory is essential to enable efficient processing of the sample. If there are any delays, the sample should be refrigerated at 4°C (HPA 2008e).

Endoscopic Investigations

Definition

Occasionally patients will be required to undergo further invasive diagnostic procedures such as an endoscopy. An endoscopy is the direct visual examination of the gastrointestinal tract (Figure 11.13) which may include gastroscopy or colonoscopy. Endoscopy allows the practitioner to evaluate the appearance of the visualized mucosa for the purpose of diagnosis and therapeutic procedures (Smith and Watson 2005).

Figure 11.13 Endoscopy. © Cancer Help UK, the patient information website of Cancer Research UK: www.cancerhelp.org.uk.

Used with permission.

Gastroscopy

Definition

A gastroscopy or oesophagogastroduodenoscopy (OGD) is a procedure in which a long flexible endoscope is passed through the mouth, allowing the doctor or nurse endoscopist to look directly at the lining of the oesophagus, stomach and proximal duodenum. The endoscope is generally less than 10 mm in diameter but a larger scope may be required for therapeutic procedures where suction channels are required (Smith and Watson 2005) (Figure 11.13).

Anatomy and physiology

See Figure 11.14.

Figure 11.14 Anatomy of the lower gastrointestinal tract.

Oesophagus

The oesophagus is a muscular thin-walled tube approximately 25 cm long and about 2 cm in diameter. It is located behind the trachea and in front of the vertebral column. There are two sphincters within the oesophagus: the upper or hypopharyngeal sphincter and the lower gastro-oesophageal sphincter. Food passing into the stomach is controlled by the lower sphincter. The oesophagus has three layers, the mucosa, submucosa and the muscularis, with the innermost layer consisting of stratified squamous epithelium (Smith and Watson 2005, Waugh *et al.* 2006).

Stomach

The stomach is located between the oesophagus and the small intestine. It is a J-shaped dilated portion of the alimentary tract. It is also located between the epigastric, umbilical and left hypochondriac regions of the abdomen. It is divided into three regions: the fundus, body and antrum. Distally, the pyloric sphincter is located between the stomach and the duodenum. The stomach has three muscle layers to allow for gastric motility to move the contents adequately whereas other parts of the alimentary tract only have two muscle layers (Smith and Watson 2005, Waugh *et al*. 2006).

Duodenum

The duodenum is part of the small intestine. It is approximately 25 cm long and 3.5 cm in diameter. It is generally C-shaped and muscular, beginning at the pyloric sphincter of the stomach and joining the jejunum. Both the pancreas and the gall bladder release secretions into the duodenum (Smith and Watson 2005, Waugh *et al*. 2006).

Evidence-based approaches

Rationale

A gastroscopy is undertaken to investigate symptoms originating from the upper GI tract such as reflux and dysphagia. The doctor or nurse endoscopist is able to use direct vision to diagnose, sample and document changes in the upper GI tract.

Indications

- Dysphagia.
- Odynophagia.
- Achalasia.
- Unresponsive reflux disease.
- Gastric and peptic ulcers.
- Haematemesis and melaena.
- Suspected carcinoma.
- Oesophageal or gastric varices.
- Monitoring Barrett’s oesophagus disease.

Contraindications

- Fractured base of skull.
- Metastatic adenocarcinoma.
- Some head/neck tumours.
- Symptoms that are functional in origin.

Legal and professional issues

Nurse endoscopists

In some centres nurse endoscopists work alongside medical endoscopists undertaking endoscopy. In 1995 the British Society of Gastroenterology supported the development of non-medical endoscopists. The nurse endoscopist must work within their own professional boundaries and complement the medical endoscopist teams (Smith and Watson 2005). It is essential that all practitioners are adequately trained in the administration of conscious sedation, aware of its side-effects and reversal agents. Clinical units must also limit the possibility of overdose, particularly with midazolam, as highlighted by the NPSA (2008).

Consent

It is essential that informed consent is obtained as previously discussed in this chapter prior to any investigation. This is important as conscious sedation may be utilized during this procedure.

Preprocedural considerations

Equipment

To conduct a gastroscopy, a flexible side-or end-viewing endoscope is required. The endoscope allows visualization of the oesophagus, stomach and proximal duodenum (Smith and Watson 2005). Access to resuscitation equipment is also essential if conscious sedation is going to be administered (BSG 2003).

Assessment and recording tools

A medical and nursing history and assessment must be taken to identify any care needs or concerns that may be significant, in particular, the patient's current drug therapy, drug reactions or allergies, any organ dysfunctions such as cardiac and/or respiratory disease and previous or current illnesses. It is also important to be aware of any coagulopathies as samples of tissue or biopsy may need to be taken during the procedure. This can be pre-empted by reviewing blood results prior to the gastroscopy. A set of observations including temperature, pulse, blood pressure, respiration rate and oxygen saturations should also be taken to identify any preprocedural abnormalities and to provide a baseline. If the patient has diabetes, a blood glucose level should also be checked (BSG 2003, Smith and Watson 2005).

Pharmacological support

Prior to the procedure a local anaesthetic spray may be used on the back of the throat. In some cases conscious sedation may be administered. This technique involves the administration of a benzodiazepine such as midazolam in small doses prescribed by a medical practitioner. Doses must be titrated for elderly patients or those with co-morbidities such as cardiac or renal failure. Oxygen therapy should also be administered for patients at risk or those requiring sedation. Generally 2 litres per minute is adequate for most circumstances to maintain oxygen saturation levels and prevent hypoxaemia (BSG 2003).

Specific patient preparations

The patient must fast for at least 4 hours prior to the gastroscopy to ensure that the stomach is relatively empty. This increases the visual field for the endoscopist and also minimizes the risk of aspiration if the patient vomits. The nurse can also assist by getting the patient to lie on their left side on the trolley (Smith and Watson 2005). If a sedative is used it is essential that the patient is monitored with pulse oximetry and observed for any respiratory depression. Nursing staff can observe and record oxygen saturations and respiratory rate. ECG monitoring may only be required if a patient is at risk of cardiac instability during the procedure (BSG 2003).

Postprocedural considerations

Immediate care

Physiological monitoring must continue in the immediate recovery period. Supplemental oxygen and oxygen saturations may be required especially if a sedative has been used. The patient should avoid drinking or eating for an hour after the use of the throat spray to minimize the risk of aspiration. Once stable, awake and reviewed by the team, the patient may be discharged or transferred to another department.

Ongoing care

It is recommended that patients who have been sedated with an intravenous benzodiazepine do not drive a car, operate machinery, sign legal documents or drink alcohol for 24 hours (BSG 2003). This is irrespective of whether their sedation has been reversed with flumazenil.The patient must be accompanied home if they have been given a sedative. The accompanying adult should stay with the patient for 12 hours at home if they live alone. It is important to remember that aspiration pneumonia may develop hours or days later and the patient should be informed to report any symptoms such as temperatures or breathing difficulty (BSG 2003, Smith and Watson 2005).

Documentation

Any samples should be clearly documented with the appropriate forms as previously discussed in this chapter. All drugs administered, complications and/or findings should be documented.

Complications

Respiratory depression

If oversedation occurs, respiratory function will be affected. It is essential that close monitoring occurs during and after the procedure. A reversal agent may be required such as flumezanil for midazolam (BSG 2003, Smith and Watson 2005).

Perforation

Although rare, it is possible that perforation of the oesophagus, stomach or duodenum may occur. Further medical and/or surgical intervention will be required to manage this potential complication (Putcha and Burdick 2003, Smith and Watson 2005).

Haemorrhage

Where biopsy samples have been taken, this may increase the risk of postprocedural bleeding. Further intervention may be required to stop the bleeding. Patients should be advised to seek medical assistance if there are signs of bleeding which include the presence of fresh blood in the sputum and melaena.

This will be dependent on the specific aetiology of the bleed, for example whether it is from varices when variceal band ligation may be required (SIGN 2008, Smith and Watson 2005).

Colonoscopy

Definition

A colonoscopy is conducted by inserting a colonoscope through the anus into the colon. It provides information regarding the lower GI tract and allows a complete examination of the colon. The colonoscope is similar to the endoscope used in gastroscopy. Its length ranges from 1.2 to 1.8 metres long. It is the most effective method of diagnosing rectal polyps and carcinoma (Smith and Watson 2005, Swan 2005, Taylor *et al.* 2009).

Anatomy and physiology

The colon is about 1.5 metres long. It begins at the caecum and ends at the rectum and anal canal (Waugh *et al.* 2006). See Figure 11.14.

Caecum

The caecum is about 8–9 cm long and opens from the ileum and ileocaecal valve (Waugh *et al.* 2006).

Colon

The colon consists of three parts. The ascending colon runs from the caecum and joins the transverse colon and the hepatic flexure. The transverse colon is in front of the duodenum where it joins the descending colon at the splenic flexure. The descending colon travels down toward the middle of the abdomen where it joins the sigmoid colon which is S-shaped and becomes the rectum (Waugh *et al.* 2006).

Rectum and anal canal

The rectum is approximately 13 cm long and is a dilated section of the colon. It joins the anal canal which is approximately 3.8 cm long (Waugh *et al.* 2006).

Evidence-based approaches

Rationale

A colonoscopy is performed to investigate specific symptoms originating from the lower GI tract such as bleeding. The doctor or nurse endoscopist is able to use direct vision to diagnose, sample and document changes in the lower GI tract (Swan 2005, Taylor *et al.* 2009).

Indications

- Screening of patients with family history of colon cancer, a serious but highly curable malignancy.
- Determining the presence of suspected polyps.
- Monitoring ulcerative colitis.
- Monitoring diverticulosis and diverticulitis.
- Active or occult lower gastrointestinal bleeding.
- Unexplained bleeding or faecal occult blood.
- Abdominal symptoms, such as pain or discomfort, particularly if associated with weight loss or anaemia.
- Chronic diarrhoea, constipation or a change in bowel habits.
- Palliative supportive treatments such as stent insertion.

Contraindications

- Upper gastrointestinal bleeding.
- Inflammatory bowel disease follow-up.
- Acute diarrhoea.

Legal and professional issues

Competencies and consent will be the same as those discussed in the Gastroscopy section.

Preprocedural considerations

Equipment

A colonoscope is a flexible endoscope that allows direct visualization of the rectum and colon (Smith and Watson 2005).

Pharmacological support

Bowel preparation agents, such as senna tablets and Citramag, are given to the patient to take 1 day prior to the colonoscopy to clear the bowel. A sedative and possibly an analgesic are usually administered before the procedure. This involves the administration of a benzodiazepine such as midazolam and an opioid such as fentanyl or pethidine which have been prescribed by a medical practitioner. Doses must be titrated for elderly patients or those with co-morbidities such as cardiac or renal failure. An antispasmodic may also be given. Oxygen therapy should also be administered during sedation. Generally 2 litres per minute is adequate for most circumstances to maintain oxygen saturation levels and prevent hypoxaemia (BSG 2003, Riley 2008, Swan 2009).

Specific patient preparations

To complete a successful colonoscopy, the bowel must be clean so that the physician can clearly view the colon. It is very important that the patient follows all the instructions given for bowel preparation well in advance of the procedure. Without proper preparation, the colonoscopy will not be successful and the test may have to be repeated. If the patient feels nauseated or vomits while taking the bowel preparation, they are advised to wait 30 minutes before drinking more fluid and start with small sips of solution. Some activity such as walking or a few cream crackers may help decrease the nausea (Smith and Watson 2005, Swan 2005).

Two days prior to the endoscopy, specific light foods may be eaten, such as steamed white fish, and others avoided, such as high-fibre foods. On the day before the colonoscopy, breakfast from the approved food groups may be eaten while drinking plenty of clear fluids. On the day of the procedure patients can drink tea/coffee with no milk 4 hours before and water up to 2 hours before (Smith and Watson 2005, Swan 2005).

A medical and nursing history and assessment must be undertaken to identify any care needs or concerns that may be significant. In particular, this should cover the patient's current drug therapy, drug reactions or allergies, any organ dysfunctions such as cardiac and/or respiratory disease, and previous or current illnesses. It is also important to be aware of any coagulopathies as samples of tissue or biopsy may need to be taken during the procedure. This can be pre-empted by reviewing blood results prior to the colonoscopy. A set of observations including temperature, pulse, blood pressure, respiration rate and oxygen saturations should also be taken to identify any preprocedural abnormalities and to provide a baseline. If the patient has diabetes, a blood glucose level should also be checked (BSG 2003, Smith and Watson 2005).

Postprocedural considerations

Immediate care

Physiological monitoring and care post sedation should be the same as those for gastroscopy. However, larger doses of sedative and opioids may have been used so further observation is required. The patient may feel some cramping or a sensation of having gas, but this quickly passes on eating and drinking. Bloating and distension typically occur for about an hour after the examination until the air is expelled. Unless otherwise instructed, the patient may immediately resume a normal diet, but it is generally recommended that the patient waits until the day after the procedure to resume normal activities.

Ongoing care

If a biopsy was taken or a polyp was removed, the patient may notice light rectal bleeding for 1–2 days after the procedure; large amounts of bleeding, the passage of clots or abdominal pain should be reported immediately.

Complications

Perforation

During the procedure the greatest risk or possible complication is bowel perforation. This occurs in 1 in 1000 cases. The nurse monitoring the patient after colonoscopy should be familiar with potential signs and symptoms such as unresolved abdominal pain, rigidity and/or bleeding. If a perforation occurs surgical intervention is likely to be required (Smith and Watson 2005, Swan 2002).

Haemorrhage

On average, haemorrhage occurs in 3 in 1000 procedures but the incidence and complication rates may be higher where a procedure involves a polypectomy. The postprocedure monitoring by the nurse again includes observing for signs and symptoms of bleeding (Smith and Watson 2005, Swan 2002). Depending on the severity of the bleed, it may be managed conservatively or in haemodynamically unstable patients angiography may be required (Farrell and Friedman 2005).

Cystoscopy

Definition

Cystoscopy examines the inside of the urethra and bladder using a cystoscope and is one of the most widely used invasive urological investigations. It gives direct visualization of the urethra and bladder for both males and females but it is especially important in males as the urethra is much more complex (Fillingham and Douglas 2004, Rodgers *et al.* 2006).

Anatomy and physiology

Urethra

The urethra extends from the external urethral orifice to the bladder (Waugh *et al*. 2006).

Male urethra

The male urethra is approximately 19–20 cm long and provides a common pathway for urine, semen and reproductive organ secretions. The three parts of the male urethra are the prostatic, membranous and spongiose or penile urethra. Originating at the urethral orifice of the bladder, the prostatic urethra passes through the prostate gland (Figure 11.15). The narrowest and shortest part of the urethra is the membranous urethra, originating from the prostate gland and extending to the bulb of the penis. The penile urethra ends at the urethral orifice (Fillingham and Douglas 2004, Waugh *et al*. 2006).

Figure 11.15 Cystoscopy for a man. © Cancer Help UK, the patient information website of Cancer Research UK: www.cancerhelp.org.uk.

Used with permission.

Female urethra

The female urethra is located behind the symphysis pubis and opens at the external urethral orifice (Figure 11.16). It is approximately 4 cm long (Waugh *et al.* 2006).

Figure 11.16 Cystoscopy for a woman. © Cancer Help UK, the patient information website of Cancer Research UK: www.cancerhelp.org.uk.

Used with permission.

Evidence-based approaches

Rationale

A cystoscopy is undertaken to gain direct visualization of the urethra and the bladder to aid diagnosis of urological complications and diseases such as bladder cancer (Fillingham and Douglas 2004).

Indications

- Bladder dysfunction.
- Unexplained haematuria.
- Diagnosis of bladder cancer.
- Staging of bladder cancer.
- Obstruction or strictures.
- Dysuria.

Contraindications

- Confirmed urinary tract infection

Preprocedural considerations

Equipment

A cystoscope may be flexible or rigid. A rigid cystoscope is utilized in the operating theatre where the patient is anaesthetized. The flexible cystoscope can be used in the outpatient setting with local anaesthesia. The flexible cystoscope is useful for patients who require more regular examinations for follow-up after bladder cancer treatment (Fillingham and Douglas 2004).

Specific patient preparations

It is essential that the patient does not have a urinary tract infection as the organism that is responsible for the infection may be spread into the bloodstream during the procedure. If the patient is having a general anaesthetic, they will have to fast prior to the procedure, dependent on anaesthetic instruction. Patients undergoing a local anaesthetic can usually eat and drink as normal prior to the procedure. The patient should empty their bladder prior to the procedure (Fillingham and Douglas 2004). It may be necessary for some patients to be treated with antibiotics before the procedure to reduce the risk of infection (AUA 2008).

Postprocedural considerations

Immediate care

Dependent on the type of procedure, recovery will vary. After a general anaesthetic, the patient will be recovered by recovery nursing staff. In the outpatient setting, physiological observations may be required. Nursing staff should monitor for signs of haematuria, infection and excessive pain.

Ongoing care

It is common for the patient to experience some burning sensations whilst passing urine for a few days. It is advised that the patient drink plenty of water post procedure to flush the bladder and reduce the risk of infection. Any signs of excessive bleeding should be reported to the medical team (Fillingham and Douglas 2004).

Complications

Infection

There is a risk of urinary infection in approximately 5% of cystoscopies performed. If an infection were to occur, relevant prescribed antimicrobial therapy may be required (Rodgers *et al.* 2007).

Liver Biopsy

Definition

Liver biopsy involves percutaneous puncture using a biopsy needle and removal of a small piece of the liver (Al Knawy and Shiffman 2007).

Anatomy and physiology

The liver is the largest organ in the body. It weighs between 1 and 2.3 kg and is a highly vascular organ. It is incompletely covered by a layer of peritoneum and enclosed in a thin inelastic capsule. There are four lobes in the liver, with the two most obvious ones being the large right lobe and the smaller left lobe which is wedge shaped. The caudate and quadrate lobes are on the posterior surface (Waugh *et al.* 2006).

Functions of the liver

The liver has many functions including:

- carbohydrate metabolism and contributing to maintenance of plasma glucose levels
- fat metabolism
- protein metabolism
- defence against microbes and breakdown of erythrocytes
- detoxification
- inactivation of hormones
- bile secretion
- heat production
- storage of some vitamins, iron, copper and glycogen (Waugh *et al.* 2006).

Evidence-based approaches

Rationale

A liver biopsy is an invaluable tool for diagnosing or monitoring conditions affecting the liver, such as cirrhosis, inflammation or hepatitis of various causes and some metabolic liver disorders (Al Knawy and Shiffman 2007).

Indications

- Diagnosis of cirrhosis.
- Diagnosis of cancer both primary and secondary.
- Miliary tuberculosis.
- Amyloidosis.

Contraindications

- An unco-operative or confused patient.
- Severe purpura.
- Coagulation defects.
- Prolonged clotting time.
- Increased bleeding time.
- Severe jaundice.
- Under 3 years of age.
- Current right lower lobe pneumonia.
- Current pleuritis (Al Knawy and Shiffman 2007).

Methods of liver biopsy

There are a variety of methods for conducting a liver biopsy. A retrospective study by Manolakopoulos *et al.* (2007) found that the ultrasound-assisted approach was as safe as the ultrasound-guided approach and both obtained adequate samples.

Percussion palpation approach

This method is also known as the blind approach where the liver is palpated in order to determine the position required for the liver biopsy.

Image-guided approach

Image guidance may be conducted utilizing ultrasound, computed tomography (CT) or magnetic resonance imaging (MRI) but the preferred method is ultrasound. The ultrasound method utilizes continuous ultrasound or site marking immediately prior to the procedure (Al Knawy and Shiffman 2007).

Ultrasound-assisted approach

The ultrasound is utilized immediately prior to the procedure and a mark is left on the skin indicating the puncture site. It is also known as the 'X' marks the spot technique.

Ultrasound-guided approach

The ultrasound is utilized throughout the procedure where the liver and biopsy needle are viewed in real time (Al Knawy and Shiffman 2007).

Preprocedural considerations

Equipment

Aspiration or suction type needle

There are a few varieties of aspiration or suction type needles such as the Jamshidi, Klatskin and Menghini (Figure 11.17). The Menghini needle has a retaining device to minimize the risk of the sample being aspirated into the syringe and is the most commonly used. It is 6 cm long and approximately 1.4 mm wide.

Figure 11.17 Liver biopsy needles.

Cutting type needles

The Tru-Cut needle utilizes a cutting sheath to obtain the specimen. It is advanced approximately 2–3 cm into the liver and a sample of 12 cm with a diameter of 1 mm is collected.

Pharmacological support

Nursing staff should take a nursing history reviewing social and medical history and determining allergy status. Up to 7 days prior to the procedure, the referring medical team must ensure that a full blood count, clotting screen and biochemistry have been taken. Nursing staff should review bloods as part of their preprocedure assessment. If a patient is currently taking an anticoagulant such as warfarin, a clotting sample must be taken within 24 hours of the procedure. Medications should be reviewed by medical and nursing staff and arrangements made by the medical team for alternative anticoagulant and diabetic medication if necessary. A local anaesthetic such as lidocaine 2% is infiltrated into the area where the biopsy is to be taken. In some cases where the patient is extremely anxious, conscious sedation may be considered; however, management during and after the procedure would include physiological monitoring and recovery as in colonoscopy with conscious sedation (Al Knawy and Shiffman 2007).

Specific patient preparations

A baseline set of physiological observations must be undertaken. If conscious sedation is used the patient must be nil by mouth and they must have patent IV access (Royal College of Radiologists 2010). The patient is usually in the supine position with the right side as close to the edge of the bed as possible. The left side may be supported by a pillow. The patient's right hand is positioned under their head and their head turned to the left. Oxygen therapy may be required if there are pre-existing conditions or when conscious sedation is used.

Postprocedural considerations

Immediate care

Immediately following the procedure the patient must lie on their right side for 3 hours and remain on bed rest for a total of 6 hours. They may be able to go to the toilet after 3 hours. Physiological observations are required every 15 minutes for the first hour, every 30 minutes for the following 2 hours and then the frequency can be reviewed by the registered nurse. Any abnormality must be reported to the medical team immediately. The nurse should also observe the puncture site and abdomen for signs of bleeding and ensure that pain is adequately controlled.

Ongoing care/education

A postprocedure information sheet should be given to the patient identifying possible complications and instructions on what to do if any symptoms occur (Royal College of Radiologists 2006).

Complications

Haemorrhage

An inadvertent puncture of an intrahepatic or extrahepatic blood vessel can lead to haemorrhage manifesting within 4 hours. However, it is normal to lose approximately 5–10 mL of blood from the surface of the liver after the biopsy. Conservative management with blood products may be appropriate but surgical intervention may also be required to treat haemorrhage.

Peritonitis

An inadvertent puncture of the bile duct which consequently results in bile leaking into the peritoneal cavity can lead to peritonitis. Treatment may range from antimicrobial therapy to surgical and/or critical care intervention dependent on the severity.

Pneumothorax

An inadvertent puncture of the pleura can lead to a pneumothorax. If this occurs, urgent medical intervention is required. A formal chest drain may be necessary to relieve the pneumothorax (Denzer *et al*. 2007, Thampanitchawong and Piratvisuth 1999).

Radiological Investigations: X-ray

Definition

An X-ray is a short-wavelength electromagnetic radiation that passes through matter and is used in diagnostic radiology and radiotherapy (Martin 2010). Further information can be found in Chapter 14.

Evidence-based approaches

Rationale

The general X-ray department performs a wide range of examinations many of which require no patient preparation in advance, and can often be performed on the day of the request. In accordance with the Ionizing Radiation Regulations (1999), to ensure radiation safety, there is a requirement for radiographers to justify, optimize and limit radiation dosage to a patient.

Indications

Diagnostic X-rays are performed to diagnose medical conditions such as damage to the skeletal structures and organ dysfunction, for example chest X-rays for respiratory complications.

Contraindications

The Ionizing Radiation (Medical Exposure) Regulations (2000) (Regulations 6 and 7) prohibit any medical exposure from being carried out which has not been justified and authorized, and provides an optimization process to ensure that doses arising from exposures are kept as low as reasonably practicable (ALARP).

In accordance with the *Medical and Dental Guidance Notes* (2002) for women known or likely to be pregnant, where the examination has been justified on the basis of clinical urgency and involves irradiation of the abdomen, operators must optimize the technique to minimize irradiation of the foetus (IPEM 2002). Radiography of areas remote from the foetus, for example chest, skull or hand, may be carried out safely at any time during pregnancy as long as good beam collimation and proper shielding equipment are used.

Legal and professional issues

The Ionizing Radiation (Medical Exposure) Regulations (2000) set out the legal roles and responsibilities of all duty holders related to medical exposures to X-rays. See Chapter 14.

In accordance with the Ionizing Radiation (Medical Exposure) Regulations (IR(ME)R) (2000), the completed request form for a medical exposure must be clear and legible and the following information must be supplied.

(a) Unique patient identification – to include at least three identifiers from name, date of birth, hospital number or NHS number.

(b) Sufficient details of the clinical problem to allow the IR(ME)R practitioner to justify the medical exposure, and indication of examination thought to be appropriate.

(c) If applicable, information on the patient's possible pregnancy status.

(d) Signature uniquely identifying the referrer as it is important that the referrer is qualified to order an X-ray.

Blank request cards, pre-signed by a referrer, are a breach of the regulations and any entries on the request form made by others should be checked and initialled by the referrer prior to signing the form.

Preprocedural considerations

Pharmacological support

For some types of X-ray such as the barium swallow or enema, the patient is usually required to drink the contrast or have it administered via an enema and a series of X-ray pictures taken at various intervals. Afterwards the patient will be advised to drink plenty of fluids to clear their system of the contrast as quickly as possible.

Specific patient preparations

The radiology department will inform the patient of any requirements prior to the booked procedure such as being nil by mouth. For most examinations, the patient will be asked to remove some of their clothing and change into a hospital gown, to ensure that no artefacts (any feature in an image which misrepresents the object in the field of view) (McRobbie 2007) are caused in the area of clinical interest on the X-ray image. It is advisable for the patient not to wear jewellery at the time of the appointment as in most cases this will have to be removed, again to prevent the presence of artefacts on the image. For all X-rays the patient will be required to keep still to prevent any blurring of the images. Some procedures are performed on inspiration/expiration, and the patient will be given the appropriate breathing instruction by the operator performing the procedure.

Magnetic Resonance Imaging (MRI)

Definition

Magnetic resonance imaging provides cross-sectional images of the body. The patient lies inside the bore of a very strong magnet, typically 1.5 tesla. Protons in the body's water molecules spin or 'precess' when exposed to such a strong magnetic field. Radio waves are transmitted into the patient at the same frequency at which the protons are precessing and the patient transmits a signal that is detected by a receiver coil. This signal contains specific information or 'weighting' about the individual tissues that can be mapped to form a two-or three-dimensional image (Weishaupt *et al.* 2006).

Evidence-based approaches

Rationale

Soft tissue structures such as the brain, spinal cord, musculoskeletal system, liver and pelvic structures are particularly well demonstrated using MRI. It is possible to scan the whole body but MRI tends to be a more targeted scan, and they take longer with scan times of 20–60 minutes. MRI does *not* use ionizing radiation and can therefore be used for repeated examinations. The magnetic field is always present so strict safety procedures are necessary to protect staff and patients (Shellock and Spinazzi 2008).

Indications

- Scanning of the brain to assess stroke, tumour, meningeal disease.
- Spinal pathology is particularly well demonstrated, including intervertebral disc pathology, tumour, infarction, spinal dysraphism, infection and degenerative diseases.
- Differentiation and characterization of benign versus malignant pathology in the liver.
- MRI is highly sensitive for imaging of the breast.
- MRI is the gold standard for assessment of pelvic malignancy and pelvic anatomy.

(Royal College of Radiologists 2006, 2007)

Contraindications

Patients with non-MRI compatible implanted devices, such as cardiac pacemakers and cochlear implants, must not be scanned. Other implanted devices, for example stents, must be confirmed as MR safe prior to scanning.

Magnetic resonance imaging tends not to be used for acute trauma or for primary whole-body staging of malignancies, for which CT is the preferred imaging modality.

Preprocedural considerations

Assessment and recording tools

A pre-MRI checklist is undertaken for all patients to identify risks from implanted devices which may be harmful to the patient or may severely degrade the image quality (Shellock and Spinazzi 2008).

Pharmacological support

The patient may require intravenous access for contrast injection, most often of a gadolinium-based contrast agent. This is used to enhance areas of suspected pathology, to define tumour bulk or to improve the efficacy of the scan by delineation or characterization of a pathological process (Runge *et al.* 2009). Claustrophobia can also be an issue and in some cases patients may require an oral sedative to relax them during the procedure. In severe claustrophobia or when scanning young children or individuals with learning difficulties, general anaesthetic may be necessary.

Non-pharmacological support

The scanner is very noisy so it is mandatory that patients are given ear protection during the scan. If the patient feels claustrophobia there are strategies to manage this such as:

- adapting the patient's position
- changing the scanning technique
- using blindfolds or mirrors
- relaxation therapy.

Specific patient preparations

Apart from safety checking, for most scans there is no preparation but for certain body scans the patient may have to abstain from food, but may drink clear (non-caffeine) fluids to ensure their bladder does not fill too quickly, resulting in movement artefacts.

Patients must be able to lie very still, usually lying on their back for significant time periods. Patient comfort is paramount so patients requiring pain relief should continue with pain medication as normal.

Computed Tomography (CT)

Definition

Computed tomography images are created when radiation passes through a patient and is absorbed in varying degrees by the body tissue. Multislice data are acquired as a three-dimensional block in a matter of seconds and digitally displayed in coronal, sagittal or axial planes (Fishman and Jeffrey 2004).

Evidence-based approaches

Rationale

Multislice CT has excellent image resolution and is used for diagnosis, staging and monitoring treatment response in the oncology setting, as well as being a research tool. Soft tissues as well as bone and lung anatomy are all seen well on CT scans. Routinely patients are given intravenous contrast medium which perfuses the body tissues and enhances the blood vessels and lesions (Husband and Reznek 2010).

Computed tomography does use radiation but protocols are optimized to give the best image with the lowest dose. Also, the number of body areas scanned and the intervals between scans are closely monitored in accordance with IR(ME)R regulations.

Indications

Computed tomography can image all parts of the body and is used for:

- pretreatment staging
- interval scans to monitor treatment
- follow-up post treatment
- diagnosis and assessment of complications:
  - — bowel obstructions and perforation
  - — pulmonary embolism
  - — stroke, cerebral bleeds
- perfusion CT.

Contraindications

- Pregnancy: CT is not recommended unless clinical benefit outweighs radiation risk.
- Patients with poor renal function or those having iodine therapy may have CT without intravenous contrast.
- Previous CT within short timeframe unless clinically urgent.
- Patients who are unable to lie down in order to pass through the machine (Royal College of Radiologists 2010).

Preprocedural considerations

Assessment and recording tools

Patients complete a questionnaire prior to CT in order to assess their suitability for CT and intravenous (IV) contrast. Intravenous contrast contains iodine, therefore patients with an iodine allergy or previous history of reaction to IV contrast should have a non-IV contrast CT.

Pharmacological support

The patient is cannulated for the intravenous injection of iodine-based contrast medium to enhance the blood vessels and bodily organs. During the injection it is normal for the patient to transiently feel warm over their whole body and to experience a metallic taste at the back of the throat, and some patients feel nauseous. CT examinations such as CT pulmonary angiograms demand contrast to flow at a fast rate and therefore a large gauge cannula (20 G) is required (Thomsen *et al.* 2009).

Non-pharmacological support

Although CT is a fast imaging technique (5–20 seconds), some patients are very concerned about being claustrophobic during scanning but with kind careful explanation, most patients manage to be scanned.

Specific patient preparations

Patients are prepared for CT by drinking an oral contrast, usually water, which shows the digestive tract. This serves to hydrate the patient which is beneficial post IV contrast and also it acts as a negative contrast agent in the digestive tract. Patients refrain from eating for 2 hours prior to CT in order to allow them to drink easily and to reduce nausea post IV contrast medium (Thomsen *et al.* 2009).

Patients lie on the CT scan couch and pass through the doughnut-shaped machine. The examination is painless and the majority of patients tolerate the examinations well. Small children require general anaesthetic for CT (Thomsen *et al.* 2009).

Websites

Diagnostic tests: www.library.wmuh.nhs.uk/pil/diagnostictests.htm

British Infertility Counselling Association: www.bica.net

Cancer Research UK: www.cancerhelp.org.uk

Infertility Network UK: www.infertilitynetworkuk.com

Human Fertilization and Embryology Authority: www.hfea.gov.uk

Macmillan Cancer Support: www.macmillan.org.uk

NHS Cancer Screening Programme publications related to cervical screening: www.cancerscreening.nhs.uk/cervical

NHS information Centre: www.ic.nhs.uk

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[*] Grade a: Rapid progressive motility (sperm moving swiftly usually in a straight line).

[>] Grade b: Slow or sluggish progressive motility (may be less linear in progression).

[>>*] Currently being reassessed by the WHO.

Blood Glucose

Definition

Blood glucose is the amount of glucose in the blood (Brooker 2010). See Table 13.9 for normal target ranges, which are expressed as millimoles per litre (mmol/L) (NICE 2004).

Table 13.9 Normal target blood glucose ranges

Children ≤ 18 years of age	**Adults > 18 years of age**
Preprandial blood glucose levels 4–8 mmol/L	Preprandial blood glucose levels 4–7 mmol/L
Postprandial blood glucose levels of less than 10 mmol/L	Postprandial blood glucose levels of less than 9 mmol/L

Reproduced with permission from NICE (2004); www.nice.org.uk/guidance/CG15.

Normally blood glucose levels stay within narrow limits throughout the day: 4–8 mmol/L. But they are higher after meals and usually lowest in the morning.

Anatomy and physiology

Blood glucose is regulated by insulin and glucogon. Insulin is synthesized and secreted from the beta cells within the islets of Langerhans found in the pancreas (Wallymahmed 2007). It is produced in response to high blood glucose levels (i.e. after meals) promoting the uptake and storage of sugar by fat and muscle tissue as glycogen (Crosser and McDowell 2007). Glucagon is secreted by the alpha cells in response to low blood glucose levels and results in the release of stored sugar back into the blood (Wallymahmed 2007). These processes maintain the blood glucose stability within the body (homoeostasis) (Crosser and McDowell 2007).

Diabetes mellitus (DM) is a heterogeneous disorder characterized by chronic hyperglycaemia due to lack of insulin or complete insulin deficiency or the body's resistance to it (Blake and Nathan 2004, WHO 2006). There are two main types of DM: type 1 and type 2. Type 1 is believed to be triggered by an autoimmune process causing destruction of the beta cells in the pancreas, which produce insulin, resulting in complete loss of insulin production. Type 2 diabetes is characterized by a resistance to insulin (Thornton 2009).

People with type 1 or type 2 diabetes will have total or partial disruption to this normal metabolic regulatory system. Type 1 diabetes normally occurs in the younger population (Gillibrand *et al.* 2009) and means that they will need replacement injected insulin to compensate (Crosser and McDowell 2007). Type 2 diabetes is strongly linked to obesity, age and family history (Gillibrand *et al.* 2009) but can also be a result of steroid use and pancreatic cancer (Schwab and Porter 2007). Both these can result in hyperglycaemia (high blood glucose) which may cause degenerative changes affecting the kidneys, nerves and eyes (Wallymahmed 2007), resulting in blindness, renal failure and neuropathies. Further complications including coronary artery and peripheral vascular disease, stroke, renal disease, central and peripheral nerve damage, amputations and blindness are also serious consequences of uncontrolled blood glucose (Gillibrand *et al.* 2009, WHO 2006).

A diagnosis of diabetes can primarily be based on a fasting blood glucose of more than or equal to 7 mmol/L or a random plasma glucose of more than or equal to 11.1 mmol/L accompanied by symptoms associated with diabetes such as polydipsia, polyuria and weight loss (Blake and Nathan 2004, WHO 2006). These features of diabetes do not appear until 80% of beta cells are lost and so it

is possible to reverse type 2 diabetes if it is picked up early enough (Schwab and Porter 2007).

Furthermore, during infection, major surgery or critical illness such as sepsis, pancreatitis or respiratory distress, counter-regulatory or stress hormones (adrenaline, noradrenaline, cortisol, growth hormone and glucagon) are released causing significant metabolic alterations. These hormones increase insulin resistance which decreases peripheral intake of glucose and also promotes glucogenesis by stimulating glycogen and fat breakdown, causing hyperglycaemia (Crosser and McDowell 2007). For this reason patients with diabetes may need treatment of insulin or antidiabetic medication during acute illness, in order to replicate this homoeostasis or improve the body's ability to produce insulin or use it.

Hyperglycaemia

Hyperglycaemia is defined as a random blood glucose of more than 11.1 mmol/L (WHO 2006). When insulin is deficient or absent as in type 1 or 2 diabetes, blood glucose levels will remain high after a meal, in times of illness or stress because it is unable to enter most cells (Wallymahmed 2007). Therefore cells are starved of glucose and the body reacts inappropriately by producing stress hormones that cause glycogenolysis (the breakdown of glycogen to release glucose), lipolysis (the breakdown of stored fat into glycerol and fatty acids) and gluconeogenesis (the conversion of glycerol and amino acids into glucose) (D'Hondt 2008, Marieb and Hoehn 2010) (see Figure 13.26).

Figure 13.26 Consequences of insulin deficiency.

Organs/tissue involved	Organ/tissue responses to insulin deficiency	Resulting conditions		Signs and symptoms
		In blood	In urine	
	Decreased glucose uptake and utilization	Hyperglycaemia	Glycosuria	
	Glycogenolysis		Osmotic diuresis	Polydipsia (and fatigue, weight loss)
	Protein catabolism and gluconeogenesis			Polyphagia
	Lipolysis and ketogenesis	Lipidaemia and ketoacidosis	Ketonuria Loss of Na^+, K^+; electrolyte and acid–base imbalances	Acetone breath Hyperpnoea Nausea/vomiting/ abdominal pain Cardiac irregularities Central nervous system depression; coma

= Muscle = Adipose tissue = Liver

This causes the blood glucose to rise further which results in a number of signs and symptoms. Water reabsorption in the kidneys becomes inhibited, resulting in frequent, large volumes of urine (polyuria). This will cause the person to feel excessive thirst (polydipsia) and may also result in extreme hunger (polyphagia). Polyuria and polydipsia will cause dehydration, a fall in blood pressure and electrolyte imbalance (Marini and Wheeler 2010). Moreover, the subsequent loss of sodium (hyponatraemia) and potassium (hypokalaemia) leads to muscle cramps, nausea, vomiting and diarrhoea, confusion, blurred vision, lethargy, cardiac events, coma and death.

Despite the excessive glucose in the body, the body cannot utilize it, so the

body starts to break down its fat and protein stores for energy, which leads to high levels of fatty acids in the blood (lipidaemia) (Marieb and Hoehn 2010). This can also cause sudden and dramatic weight loss. These fatty acids are converted to ketones. They accumulate in the blood more quickly than they can be excreted or used and cause the blood pH to fall, resulting in ketoacidosis. Ketones will also be present in the urine. If ketoacidosis is allowed to continue it can become life threatening, disrupting all physiological processes, including oxygen transportation and heart activity and depression of the nervous system, leading to coma and death (Marieb and Hoehn 2010).

Reasons for hyperglyceamia include:

- inadequate doses of insulin
- stress
- infection/sepsis
- surgery
- medications, for example steroids
- nutritional support, for example parenteral nutrition (PN) or enteral nutrition.

It has been found that enteral and parenteral feeding contributes to hyperglycaemia in both patients with a diagnosis of diabetes and those without (McNight and Carter 2008). This is particularly true of patients receiving PN which bypasses the gut and therefore the incretin hormones that also help to maintain glucose homoeostasis (McNight and Carter 2008). Hyperglycaemia in response to steroids, for example dexamethasone, is another consideration and some researchers believe that their hypermetabolic action decreases glucose uptake, increases hepatic glucose production and may directly inhibit insulin release (Delaunay *et al.* 1997, Ogawa *et al.* 1992, Wallymahmed 2007). For this reason these patients will need blood glucose monitoring and potential changes to their insulin needs or to temporarily commence insulin.

Hypoglycaemia

Hypoglycaemia is described as a blood glucose level that is unable to meet the metabolic needs of the body (Marini and Wheeler 2010), normally lower than 4 mmol/L (Wallymahmed 2007). Often young, healthy individuals can be asymptomatic during this inadequate level of glucose in the blood but early symptoms can be sweating, tremor, weakness, nervousness, tachycardia and hypertension (Wallymahmed 2007), although these depend on not only the absolute blood glucose but also its rate of decline (Tortora and Derrickson 2009). Severe hypoglycaemia can lead to mental disorientation, convulsions, unconsciousness and death but a blood glucose less than 3 mmol can start to affect the brain.

The most common causes of hypoglycaemia are missed or delayed meals, not eating enough, exercise without carbohydrate compensation, too much glucose-lowering medication (e.g. insulin) and excessive alcohol (Wallymahmed 2007). Other causes could be infection, muscle and fat depletion (e.g. anorexia), diarrhoea and vomiting, hepatic failure due to tumour or cirrhosis, salicylate poisoning, insulin-secreting tumours, ventilation, congestive heart failure, cerebral vascular accident, concurrent medications (beta-blockers, adrenaline) and surgery (D'Hondt 2008, Marini and Wheeler 2010).

Treatment should ideally be the administration of glucose. The route will depend on the consciousness level of the patient, their treatment and their ability to take oral substances (Marini and Wheeler 2010). If they can tolerate an oral or enteral intake they should be given a fast-acting carbohydrate such as 3–6 glucose tablets, 150 mL sugary fizzy drink or 50–100 mL Lucozade followed by a longer acting carbohydrate such as a sandwich or biscuits. If unconscious or unable to take food and drink then they can receive intramuscular glucagon or intravenous dextrose (Wallymahmed 2007). Blood glucose needs to be checked 5–10 minutes after treatment and then as necessary. Diabetic treatment should not be omitted because of a single episode of hypoglycaemia, but if it remains a consistent problem treatment should be reviewed (Wallymahmed 2007).

Evidence-based approaches

Rationale

Blood glucose monitoring provides an accurate indication of how the body is controlling glucose metabolism and provides feedback to guide clinicians and patients about their treatment adjustments in order to achieve optimal glucose control. In the short term it can prevent hypo-and hyperglycaemia and in the long term it can significantly reduce the risk of prolonged, life-threatening microvascular complications (Rizvi and Saunders 2006).

Capillary blood glucose monitoring is preferred due to immediacy of results and its ability to inform us whether blood sugar is high or low, whereas urine testing only indicates instances of high blood sugar (Wallymahmed 2007). Capillary blood glucose monitoring is also referred to as point-of-care testing (POCT).

Indications

Conditions in which blood glucose monitoring will need to take place include the following.

- To make a diagnosis of diabetes indicated by signs and symptoms of polyuria, polydipsia, weightloss for type 1 or weight gain, family history for type 2 (WHO 2006).
- To monitor and manage the day-to-day treatment of known type 1 and type 2 diabetes (Wallymahmed 2007).
- In acute management of unstable diabetes, that is, evidence of hyperglycaemia, hypoglycaemia, diabetic ketoacidosis, hyperosmolar non-ketonic coma (once severe dehydration is corrected) (Wallymahmed 2007).
- Hospitalized patients with diabetes according to morbidity and treatment, that is, sliding scales, nutritional intake/support (McNight and Carter 2008, Wallymahmed 2007).
- Initial parenteral and enteral nutritional support of all patients (McNight and Carter 2008).
- Patients taking steroids and other drugs that cause raised blood glucose (Schwab and Porter 2007).

Contraindications

The following conditions can affect the accuracy of blood glucose monitoring and it may be necessary to obtain a venous sample for more accurate results (DH 2005).

- Peripheral circulatory failure and severe dehydration, for example diabetic ketoacidosis, hyperosmolor non-ketotic coma, shock, hypotension. These conditions cause peripheral shutdown, which can cause artificially low capillary readings.
- Haematocrit values above 55% may lead to inaccurate levels if the blood glucose level is more than 11 mmol/L.
- Intravenous infusion of ascorbic acid.
- Pre-eclampsia.
- Some renal dialysis treatments.
- Hyperlipidaemia: cholesterol levels above 13 mmol/L may lead to artificially raised capillary blood glucose readings.

Principles of care

Although capillary blood glucose monitoring is an essential part of diabetic management, it can have severe consequences if not done correctly (Wallymahmed 2007). The Department of Health issued a hazard warning in 1987 and a safety notice in 1996 highlighting the need for formal training and strict quality control (DH 1996).

Blood glucose monitoring needs to be performed regularly enough for patterns to be established on which treatment changes can be based (Walker 2004). 'Regularly' will vary in different circumstances and any unusual situation, for example illness, change of daily routine, hospitalization, will affect diabetes control and therefore require more frequent testing (Walker 2004). Generally people with type 1 diabetes will need to test blood glucose several times a day or more depending on treatment while those with type 2 will require less testing due to a lower risk of such great fluctuations in blood glucose levels (Goldie 2008). The following list provides guidance on frequency and timing of blood glucose monitoring depending on the type of diabetes and its treatment.

- *Type 1 diabetes:* four or more times daily; more often in unusual circumstances, for example impaired hypoglycaemia awareness, illness, terminal care.
- *Type 2 diabetes (intensive insulin treatment)*: as type 1 diabetes.
- *Type 2 diabetes (conventional insulin)*: once per day on once-daily insulin; twice per day on twice-daily insulin.
- *Type 2 diabetes (insulin and oral treatment)*: one test a day if on daily insulin or more if control fluctuates.
- *Type 2 diabetes (diet and exercise; metformin +/− glitazone, glitazone +/− metformin)*: routine testing not required as low risk of hypoglycaemia.
- *Type 2 diabetes (sulphonylurea alone or in combination with other oral hypoglycaemic agents)*: test at least three times a week to detect any unknown hypoglycaemia.

(Owens *et al.* 2004)

In all the above types of diabetes more regular testing will be required in certain circumstances, for example illness, steroid treatment, changes in diet, exercise and routine (Owens *et al.* 2004).

For all patients (irrespective of previous diabetic diagnosis) receiving

nutritional support, that is enteral or parenteral feeding, blood glucose levels should be checked once or twice daily (or more if needed) until stable and then weekly (NICE 2008).

Methods of blood glucose testing

Blood glucose testing involves obtaining a drop of capillary blood and putting it on a testing strip that is read by a blood glucose meter (Goldie 2008). Most meters offer the option of using blood from the finger tips, palm of the hand, upper arm, forearm, calf or thigh (Dale 2006). The most commonly used site is the finger tip as the blood from this area responds rapidly to changes in blood glucose level, as does the blood from the palm of the hand, and therefore delivers the most accurate results (Dale 2006, Goldie 2008). However, the finger tips contain nerve endings which can become sore and less sensitive with frequent testing. The outer parts of the finger are less painful to prick and the thumb and forefinger should be used sparingly due to their continual use in apposition (Goldie 2008). It is important to rotate areas used for blood glucose testing to avoid infection from multiple stabbings, areas becoming toughened and to reduce pain (Roche Diagnostics 2004).

Anticipated patient outcomes

There have been several trials investigating the benefits of tight glycaemic control to near normal levels. D'Hondt (2008) refers to three randomized controlled trials in which intensive insulin treatment was used in hospitalized patients. The trials showed that intensive insulin treatment to achieve tight glycaemic control did result in reductions in length of stay, sepsis, dialysis and hospital mortality and morbidity (Furnary *et al.* 2000, Krinsley 2004, van den Berghe *et al.* 2001). Blood glucose testing is integral to achieving this tight control but there is currently no absolute conclusion for the standardization of this treatment (D'Hondt 2008). It does, however, indicate that keeping blood sugar levels as near normal as possible should be the ultimate aim of blood glucose testing.

Legal and professional issues

The DH report (1996) highlights that there must be standardization in training, reliability and quality control for blood glucose testing. In order to achieve this, the following aspects must be considered when selecting monitoring devices.

1. Equipment is designed for use by non-laboratory staff and is suitable for use in the clinical environment.

2. All equipment is compatible and will give reliable results.

3. The biochemistry laboratory is involved in the purchase and maintenance of the equipment. This may involve the purchase of one type of device from one company for the whole hospital, to reduce costs and provide standardization (Lowe 1995).

4. The equipment should be easy to use and the staff should be involved in the choice of device (Hall 2005).

5. The ongoing cost and maintenance of the device need to be considered, including buying strips, control solutions and replacement devices (Hall 2005).

6. Written standard operating procedures should be available and kept with the device.

7. Training is given to the operators of the equipment and records are kept of this. After training, the following learning outcomes should be demonstrated by the operator (MDA 2002):

– knowledge of the basic principles of measurement and normal ranges

– the proper use of equipment as stated by the operating instructions

– the consequences of incorrect use

– health and safety procedures for the collection of blood samples, that is, to prevent spillage and needlestick injuries

– the importance of complete documentation

– use of appropriate calibration and quality control techniques

– an understanding that blood sugar analysis should only be used as a guide to diagnosis and treatment and decisions should be made formally with laboratory results (DH 1996).

It is a hospital and government directive to keep records of training and quality testing results and the frequency of these quality control tests may vary according to manufacturer or hospital policy (Walker 2004). Independent quality

control should be carried out with the collaboration of the biochemistry laboratory and external auditing of quality control should be undertaken, which may be provided by the company providing the equipment.

Preprocedural considerations

Equipment

All equipment should be checked for expiry dates (according to individual hospital trust policy) and successful calibration, and stored according to manufacturer's guidelines.

- *Blood glucose monitor*: a medical device which measures the concentration of glucose in a human blood sample using a blood glucose test strip (Roche Diagnostics 2004).
- *Testing strip*: strip with a small window used to collect a sample of the patient's blood to be inserted into the blood glucose monitor. The strips must be calibrated with the monitor prior to use (Roche Diagnostics 2004)
- *Lancet*: a device used to draw out a small amount of blood from the patient for testing of glucose level. Single-use lancets are used to minimize the risk of cross-infection and accidental needlestick injury and set to the correct depth according to the skin turgor (Roche Diagnostics 2004). Disposable lancets are advisable following an outbreak of hepatitis B in French and US hospitals (DH 1996, Roche Diagnostics 2004).

Specific patient preparations

Patients should be advised to wash their hands prior to testing or the test area should be cleaned with soap and water and then dried. Use of alcohol gel should be avoided to ensure non-contamination of the result. The patient should be encouraged to warm their hands before sampling to encourage blood flow and to obtain an adequate amount of blood to cover the test strip (Dale 2006, Wallymahmed 2007).

Procedure guideline 13.9 Blood glucose monitoring

Essential equipment

- Blood glucose monitor
- Test strips
- Control solution
- Single-use safety lancets
- Gloves
- Cotton wool/gauze
- Sharps box

Preprocedure

Action	Rationale
1 Before taking the device to the patient, the monitor needs to be checked for the following: ■ Testing trips are in date and have not been left exposed to air ■ The monitor and test strips have been calibrated together ■ If a new pack of strips is required, the monitor is recalibrated ■ Internal quality control carried out in accordance to trust guidelines ■ Result of internal quality control is recorded in equipment log book and signed.	To ensure accuracy of the result and ensure patient safety (Roche Diagnostics 2004, C).
2 Explain procedure to the patient.	The patient should give consent to the procedure. Explanation may allay any fear or anxieties (NMC 2008b, C).
Procedure	
3 Ask patient to sit or lie down.	To ensure the patient's safety and minimize the risks if they feel faint when blood is taken (Roche Diagnostics 2004, C).
4 Wash hands and put on gloves.	To minimize the risk of cross-infection and contamination (Fraise and Bradley 2009, E).
5 Take a single-use lancet and if it has depth settings, ensure the correct setting is used (most commonly middle one).	To minimize the risk of cross-infection and accidental needlestick injury (Fraise and Bradley 2009, E).
6 Take a blood sample from the side of the finger using the lancet, ensuring that the site of piercing is rotated (see Action Figure 6). Avoid frequent use of index finger and thumb. Other areas may be used if finger or palm of hand unusable. The finger tip may need 'milking' from palm of hand towards finger to gain a large enough droplet of blood.	The side of the finger is less painful and easier to obtain a hanging droplet of blood. Sites are rotated to avoid infection from multiple stabbings, area becoming toughened and to reduce pain (Roche Diagnostics 2004, C).
7 Insert testing strip into blood glucose monitor and apply the blood to the testing strip. Some strips are hydrophilic and are dosed/filled from the side instead of dropping blood directly onto the strip. Ensure that the window on the test strip is entirely covered with blood (see Action Figure 7).	The window on the test strip allows verification of a correctly dosed strip which needs to be covered to ensure accurate results (Blake and Nathan 2004, E; Roche Diagnostics 2004, C).
8 Insert testing strip into blood glucose monitor.	To initiate the process of analysis. E

9 Dispose of lancet in a sharps container.	To reduce the risk of needlestick injury (Roche Diagnostics 2004, C).
10 Place gauze over puncture site and monitor for excess bleeding.	To ensure patient safety (Wallymahmed 2007, C).
Postprocedure	
11 Once result is obtained (see Action Figure 11), document and sign.	To ensure accuracy (NMC 2009, C; Roche Diagnostics 2004, C).
12 Report any unexpected results.	To ensure appropriate treatment and obtain optimal blood glucose range (Wallymahmed 2007, E).

Action Figure 6 Blood glucose taking: Step 1. Take a blood sample from the side of the finger using a lancet, ensuring that the site of piercing is rotated.

Action Figure 7 Blood glucose taking: Step 2. Insert the test strip into the blood glucose monitor and apply the blood to the test strip. Ensure that the window on the test strip is entirely covered with blood.

Action Figure 11 Blood glucose taking: Step 3. Read the result.

Problem-solving table 13.8 Prevention and resolution (Procedure guideline 13.9)

Problem	Cause	Prevention	Action
Inaccurate results	User error including: ■ inadequate meter calibration ■ failure to code correctly ■ poor meter maintenance ■ incorrect user technique 50% of errors are due to an inadequate amount of blood on the test strip, which can lead to a falsely low reading (Blake and Nathan 2004). Out of date or incorrectly stored test strips are other common errors leading to lower glucose levels	Staff training and education about diabetes are essential in prevention of these errors (D'Hondt 2008)	Contact colleague to repeat test and if error persists, report glucose meter to technician and use another machine

Postprocedural considerations

Immediate care

If a true abnormal blood glucose result is detected then the appropriate action should be taken according to medical advice and hospital policy.

Education of patient and relevant others

Diabetes mellitus is a long-term, often lifelong condition affecting all aspects of a person's life. Ninety-five percent of diabetes care is self-care and all people with type 1 and type 2 diabetes should have access to self-monitoring. The nurse has a role in educating and promoting self-management of diabetes and advising patients on the type and frequency of monitoring based on individual clinical need so that patients can monitor and adjust their own treatment (Diabetes UK 2008). NICE and the Department of Health also recommend that people are given annual updates to ensure they are still able to perform tests accurately and learn about any new developments (DH 2008, NICE 2004, NICE 2008). Healthcare professionals should advocate a healthy lifestyle for patients with diabetes, including regulating blood pressure, low-sugar diet and exercise (NICE 2008).

Neurological Observations

Definition

Neurological observations relate to the assessment and evaluation of the integrity and function of an individual's nervous system (Rowley and Fielding 1991).

Anatomy and physiology

The nervous system co-ordinates all body functions, enabling a person to adapt to changes in internal and external environments. It has two main types of neurones: the conducting cells and neuroglia, the supportive cells.

The central nervous system

The central nervous system consists of the brain and spinal cord (Bickley and Szilagyi 2009).

The brain

The brain has four regions: the cerebrum, the diencephalon, the brainstem and the cerebellum. The cerebral hemispheres contain the greatest mass of brain tissue. Each hemisphere is subdivided into frontal, parietal, temporal and occipital lobes, as seen in Figure 13.27.

Figure 13.27 The brain.

Reproduced from Tortora and Derrickson (2009).

Each lobe has a particular function.

- The frontal lobe is the primary motor area of the cerebrum which influences personality and abstract reasoning. It also controls the skeletal muscle influencing voluntary movement.
- The parietal lobe is the primary sensory area which integrates the senses of

touch and pain.

- The occipital lobe integrates visual stimuli and is primarily responsible for sight.
- The temporal lobe is responsible for olfactory (smell) and auditory (sound) areas (Clark 2005).

The spinal cord

This is a cylindrical mass of nerve tissue encased within the bony vertebral column, extending from the medulla to the first or second lumbar vertebra. It contains important motor and sensory nerve pathways that exit and enter the cord through anterior and posterior nerve roots and spinal and peripheral nerves. The spinal cord also mediates reflex activity of the deep tendon reflexes from the spinal nerves.

The spinal cord is divided into five segments: cervical, from C1 to C8; thoracic, from T1 to T12; lumbar, from L1 to L5; sacral, from S1 to S5; and coccygeal (Bickley and Szilagyi 2009) (see Figure 13.28).

Figure 13.28 External anatomy of the spinal cord and the spinal nerves (posterior view).

Reproduced from Tortora and Derrickson (2009).

Posterior view of entire spinal cord and portions of spinal nerves

The peripheral nervous system

The peripheral nervous system consists of the 12 pairs of cranial nerves and the spinal and peripheral nerves. Most of the peripheral nerves contain both motor and sensory fibres (Bickley and Szilagyi 2009).

The cranial nerves

Twelve pairs of special nerves called cranial nerves emerge within the skull or cranium. Cranial nerves II–XII arise from the diencephalon and the brainstem (see Table 13.10). Cranial nerves I and II are actually fibre tracts emerging from the brain. Some cranial nerves are limited to general motor or sensory functions, whereas others are specialized, producing smell, vision or hearing (I, II, VIII) (Bickley and Szilagyi 2009).

Table 13.10 The functions of the cranial nerves

Number	Name	Function
I	Olfactory	Sense of smell
II	Optic	Vision
III	Oculomotor	Pupillary constriction, opening the eye, and most extraocular movements
IV	Trochlear	Downward, inward movement of the eye
VI	Abducens	Lateral deviation of the eye
V	Trigeminal	*Motor* – temporal and masseter muscles (jaw clenching), also lateral movement of the jaw
		Sensory – facial. The nerve has three divisions: (1) ophthalmic, (2) maxillary and (3) mandibular
VII	Facial	*Motor* – facial movements, including those of facial expression, closing the eye, and closing the mouth
		Sensory – taste for salty, sweet, sour and bitter substances on the anterior two-thirds of the tongue
VIII	Acoustic	Hearing (cochlear division) and balance (vestibular division)
IX	Glossopharyngeal	*Motor* – pharynx
		Sensory – posterior portions of the eardrum and ear canal, the pharynx, and the posterior tongue, including taste (salty, sweet, sour, bitter)
X	Vagus	*Motor* – palate, pharynx and larynx
		Sensory – pharynx and larynx
XI	Spinal accessory	*Motor* – the sternomastoid and upper portion of the trapezius
XII	Hypoglossal	*Motor* – tongue

Bickley and Szilagyi (2009).

The peripheral nerves

In addition to cranial nerves, the peripheral nervous system also includes spinal and peripheral nerves that carry impulses to and from the cord. Thirty-one pairs of nerves attach to the spinal cord: eight cervical, 12 thoracic, five lumbar, five sacral and one coccygeal. Most peripheral nerves contain both sensory and motor fibres (Bickley and Szilagyi 2009).

Related theory

Changes in neurological status can be rapid and dramatic or subtle, developing over minutes, hours, days, weeks or even months depending on the insult (Aucken and Crawford 1998). Therefore the frequency of neurological observations will depend upon the patient's condition and the rapidity with which changes are occurring or expected to occur.

Neurological function is assessed by observing five critical areas:

- level of consciousness
- pupillary activity
- motor function
- sensory function
- vital signs.

Level of consciousness

Consciousness is a state of awareness of self and the environment and is dependent upon two components:

- arousability
- awareness.

(Carlson 2002a)

Arousability

This depends on the integrity of the reticular activating system (RAS) (Figure 13.29). The core of nuclei which make up the RAS extends from the brainstem to the thalamic nuclei in the cerebral hemispheres. Thus cognitive ability depends on the ability of the cerebral cortex to permit reciprocal stimulation and conscious behaviour. Consciousness therefore depends on the intactness of the cerebral cortex and the RAS and their ability to communicate effectively (Carlson 2002b, Fairley and McLernon 2005).

Figure 13.29 Reticular activating system.

Awareness

This requires an intact cerebral cortex to interpret sensory input and respond accordingly. This is the content of the consciousness (Bateman 2001, Scherer 1986).

Levels of consciousness may vary and are dependent on the location and extent of any neurological damage (Aucken and Crawford 1998). Previous and/or co-existing problems should be heeded when noting levels of consciousness, for example deafness, hemiparesis/hemiplegia.

Alterations in level of consciousness can vary from slight to severe changes, indicating the degree of brain dysfunction (Aucken and Crawford 1998). Consciousness ranges on a continuum from alert wakefulness to deep coma with no apparent responsiveness. Therefore, nurses must ensure that families and friends are involved at initial history taking and throughout care so as to chronicle accurately any change in neurological symptoms.

Terms such as ‘fully conscious’, ‘semi-conscious’, ‘lethargic’ or ‘stuporous’ used to describe levels of consciousness are subjective and open to misinterpretation. Thus, level of consciousness is often measured using the Glasgow Coma Scale (GCS) (see Assessment and recording tools).

Application of painful stimuli

Painful stimuli should be employed only if the patient does not respond to firm and clear commands. It is always important that the least amount of pressure to elicit a response is applied so as to avoid bruising or paining the patient. As such, it should only be undertaken by experienced professionals.

As the ability to localize pain is lost, various responses may be observed when painful stimuli are applied (Carlson 2002a). It is important to note, when applying a painful stimulus, that the brain responds to central stimulation and the spine responds first to peripheral stimulation (Aucken and Crawford 1998).

Central stimulation can be applied in the following ways (Aucken and Crawford 1998, Carlson 2002a, Price 2002).

- *Trapezium squeeze*: using the thumb and two fingers, hold 5 cm of the trapezius muscle where the neck meets the shoulder and twist the muscle.
- *Supraorbital pressure*: running a finger along the supraorbital margin, a notch is felt. Applying pressure to the notch causes an ipsilateral (on that side) sinus headache. This method is not to be used if the facial or cranial bones are unstable, facial fractures are suspected, after facial surgery or if the assessor has sharp fingernails.
- *Sternal rub*: using the knuckles of a clenched fist to grind on the centre of the sternum. When applied adequately, marks are left on the skin as sternal tissue is tender and bruises easily. Please note that because of the danger of bruising, this method should not be used for repeated assessment but may be indicated if a decision as to whether to re-scan or alter management, for example proceed to surgery, is necessary.

Peripheral stimulation can be applied in the following way. Place the patient's finger between the assessor's thumb and a pencil or pen. Pressure is gradually increased over a few seconds until the slightest response is seen. Any finger can be used, although the third and fourth fingers are often most sensitive (Frawley 1990). Please note that because of the risk of bruising, pressure should not be applied to the nailbed. It must be remembered that nailbed pressure is a peripheral stimulus and should only be used to assess limbs that have not moved in response to a central stimulus (Aucken and Crawford 1998).

It cannot be overemphasized that the above methods of patient assessment should only be undertaken by appropriately qualified and trained nurses.

Pupillary activity

Careful examination of the reactions of the pupils to light is an important part of neurological assessment (Table 13.11). The size, shape, equality, reaction to light (both direct and consensual responses, that is, the response from the eye that is not directly exposed to light) and position of the eyes should be noted. Are the eyes deviated upwards or downwards? Are both eyes conjugate (moving together) or dysconjugate (not moving together)? Impaired pupillary accommodation (adjustment of the eye resulting in pupil constriction or dilation) signifies that the midbrain itself may be suffering from pressure exerted by a swelling mass in the brain. Pupillary constriction and dilation are controlled by cranial nerve III (oculomotor) and any changes may indicate pressure on this nerve or brainstem damage (Figure 13.30) (Fuller 2004).

Figure 13.30 Pressure from expanding mass and/or cerebral oedema.

Table 13.11 Examination of pupils

Observation	Pupil size	Pupil reactiveness	Possible indication
Pupils equal	Pinpoint	—	Opiates or pontine lesion
	Small	Reactive	Metabolic encephalopathy
	Mid-sized	Fixed	Midbrain lesion
		Reactive	Metabolic lesion
Pupils unequal	Dilated	Unreactive	3rd nerve palsy
	Small	Reactive	Horner's syndrome

Reproduced with permission from Fuller (2004).

It should be noted that 'normal' visual function depends on a full and conjugate range of eye movements (involving cranial nerves III, IV, VI) in addition to normally functioning optic and oculomotor nerves and an intact visual centre in the occipital cortex (Aucken and Crawford 1998).

Motor function

Damage to any part of the motor nervous system can affect the ability to move. After assessing motor function on one side of the body, the contralateral muscle group should also be evaluated to detect asymmetry. Motor function assessment involves an evaluation of the following.

- Muscle strength.
- Muscle tone.
- Muscle co-ordination.
- Reflexes.
- Abnormal movements.

(Aucken and Crawford 1998, Fuller 2004)

Muscle strength

This involves testing the patient's muscle strength against the pull of gravity and then against one's own resistance. Changes in motor strength, especially between right and left sides, may indicate imminent neurological failure (Carlson 2002a).

Muscle tone

This involves flexing and extending the patient's limbs on both sides and noting how well such movements are resisted. Increased resistance would denote increased muscle tone and vice versa.

Muscle co-ordination

Any disease or injury that involves the cerebellum or basal ganglia will affect co-ordination. Assessment of hand and leg co-ordination can be achieved by testing the rapidity and rhythm of alternating movements and point-to-point movements.

Reflexes

Amongst the most important reflexes are blink, gag and swallow, oculocephalic and plantar.

- *Blink*: this is a protective reflex and can be affected by damage to the Vth cranial nerve (trigeminal) and the VIIth cranial nerve (facial). Absence of the corneal reflex (Vth and VIIth cranial nerves) may result in corneal damage. Facial weakness (VIIth cranial nerve) will affect eye closure.
- *Gag and swallow*: damage to the IXth cranial nerve (glossopharyngeal) and Xth cranial nerve (vagus) may impair protective reflexes. These two cranial nerves are always assessed together as their functions overlap. Muscle innervation of the palate is from the vagus, while sensation is supplied by the glossopharyngeal nerves (Aucken and Crawford 1998, Fuller 2004).
- *Oculocephalic*: this reflex is an eye movement that occurs only in patients with a severely decreased level of consciousness. In conscious patients this reflex is not present. When the reflex is present, the patient's eyes will move in the opposite direction from the side to which the head is turned. However, in patients with absent brainstem reflexes, the eyes will appear to remain stationary in the centre. Assessing this reflex should not be carried out if there is suspected instability of the cervical spine as this reflex can involve head movement which could exacerbate any spinal injury (Aucken and Crawford 1998).
- *Plantar*: abnormalities of plantar reflex will help to locate the anatomical site of the lesion. Upgoing plantar (extension) reflex is termed 'positive Babinski' and indicates an upper motor neurone lesion. It should be noted that in babies under 1 year of age upgoing plantar is normal (Aucken and Crawford 1998).

Abnormal movements

When carrying out neurological observations, any abnormal movements such as seizures, tics and tremors must be noted.

Sensory functions

Constant sensory input enables an individual to alter responses and behaviour to suit the environment. When disease or injury damages the sensory pathways, the sensory responses are always affected. Any assessment of sensory function should include an evaluation of the following.

- Central and peripheral vision.
- Hearing and ability to understand verbal communication.
- Superficial sensations (light touch, pain) and deep sensations (muscle and joint pain, muscle and joint position).

(Carlson 2002a, Fuller 2004)

Visual acuity

The clarity or clearness of vision may be tested with a Snellen chart, which uses decreasing letter size, or newspaper prints, with and without glasses if worn.

Visual fields

Lesions at different points in the visual pathways affect vision (Table 13.12). It should be noted that loss of vision is always described with reference to the visual fields rather than the retinal fields (Weldon 1998).

Table 13.12 Visual pathways

Defect	Implication
Monocular field defects	Lesion anterior to optic chiasm
Bitemporal field defects	Lesion at the optic chiasm
Homonymous field defects	Lesion behind the optic chiasm
Congruous homonymous field defects	Lesion behind lateral geniculate bodies

Reproduced with permission from Fuller (2004).

Vital signs

It is recommended that assessments of vital signs should be made in the following order.

1. Respirations.
2. Temperature.
3. Blood pressure.
4. Pulse.

See relevant sections in this chapter.

Respirations

Of these four vital signs, respiratory patterns give the clearest indication of how the brain is functioning because the complex process of respiration is controlled by more than one area of the brain. Any disease or injury that affects these areas may produce respiratory changes. The rate, character and pattern of a patient's respiration must be noted. Abnormal respiratory patterns are listed in Table 13.13.

Table 13.13 Abnormal respiratory patterns

Type	Pattern	Significance
Cheyne–Stokes	Rhythmic waxing and waning of both rate and depth of respirations, alternating regularly with briefer periods of apnoea. Greater than normal respiration, that is 16–24 breaths per minute	May indicate deep cerebral or cerebellar lesions, usually bilateral; may occur with upper brainstem involvement
Central neurogenic hyperventilation	Sustained, regular, rapid respirations, with forced inspiration and expiration	May indicate a lesion of the low midbrain or upper pons areas of the brainstem
Apneustic	Prolonged inspiration with a pause at full inspiration; there may also be expiratory pauses	May indicate a lesion of the lower pons or upper medulla, hypoglycaemia or drug-induced respiratory depression
Cluster breathing	Clusters of irregular respirations alternating with longer periods of apnoea	May indicate a lesion of lower pons or upper medulla
Ataxic breathing	A completely irregular pattern with random deep and shallow respirations; irregular pauses may also appear	May indicate a lesion of the medulla

Constant re-evaluation of the patient's ability to maintain and protect their airway is a concern when there is evidence of reduced consciousness or coma (GCS score is less than 8). At this stage, muscles often become flaccid and the use of the recovery position may need to be considered. Patients who have deteriorated may require adjuncts to protect the airway and possibly artificial ventilation (Resuscitation Council 2006). Close working liaison with physiotherapists and speech and language therapists is important to minimize the danger of chest infections.

Temperature

Damage to the hypothalamus, the temperature-regulating centre, may result in grossly fluctuating temperatures (Fairley and McLernon 2005).

Blood pressure, pulse and respirations

Observations of blood pressure, pulse and respirations will provide evidence of increased intracranial pressure. When intracranial pressure is greater than 33 mmHg for even a short time, cerebral blood flow is significantly reduced. The resulting ischaemia stimulates the vasomotor centre, causing systemic blood pressure to rise. The patient becomes bradycardic and the respiratory rate falls. Abnormalities of blood pressure and pulse usually occur late, after the patient's level of consciousness has begun to deteriorate. This change in the blood pressure was first described by Cushing and is known as the Cushing reflex (Carlson 2002b).

Evidence-based approaches

Rationale

Indications

An accurate neurological assessment is essential in planning patient care. The information gained from a neurological assessment can be used in the following ways.

- To aid diagnosis (Douglas *et al.* 2005).
- As a baseline for observations (Crouch and Meurier 2005).
- To determine both subtle and rapid changes in an individual's condition (Crouch and Meurier 2005).
- To monitor neurological status following a neurological procedure (Mooney and Comeford 2003).
- To observe for deterioration and establish the extent of a traumatic head injury (Walsh 2006).
- To detect life-threatening situations (Alcock *et al.* 2002).

Frequency of observations

The frequency and type of neurological observation are matters of much debate (Price 2002). It is therefore not possible to be prescriptive, as the frequency will depend on the underlying pathology and possible consequences. For example, in a patient with a head injury and a skull fracture, there may be bruising to the brain (contusion), cerebral oedema and an extradural haemorrhage which may increase in size. The bruising and oedema may develop over a couple of days and gradually give rise to subtle neurological changes, whilst the extradural haemorrhage can develop very quickly and cause profound neurological changes over a matter of a few hours. Therefore such a patient may require frequent 30-minute GCS observations for the first 6 hours followed by 1–2-hourly observations for a further 48 hours. The nurse must be competent and take appropriate action if changes in the patient's neurological status occur, as well as reporting any subtle signs that may indicate deterioration, for example if the patient is incontinent, reluctant to eat, drink or initiate interaction. It should never be assumed that difficulty to rouse a patient is due to night-time sleep as even a deeply asleep patient with no focal deficit should respond to pain. Therefore if the patient requires an increased amount of stimulus to achieve the same GCS score, this may also be a pointer to subtle deterioration (Table 13.14) (Aucken and Crawford 1998, Waterhouse 2005).

Table 13.14 Frequency of observations

Category	Frequency	Rationale
All patients diagnosed as suffering from neurological or neurosurgical conditions. Unconscious patients (including ventilated and anaesthetized)	At least 4-hourly, affected by the patient's condition. Frequency indicated by patient's condition	To monitor the condition of the patient so that any necessary action can be instigated. To monitor the condition closely and to detect trends so that appropriate action may be taken

Preprocedural considerations

Equipment

The following equipment may be used as part of the neurological assessment.

- *Pen torch*: used to assess the reaction of the pupils to light and consensual light reflex (Aucken and Crawford 1998).
- *Tongue depressor*: device used to depress the tongue to allow for examination of mouth and throat (Fuller 2004).
- *Patella hammer*: a tendon hammer used to strike the patella tendon below the knee to assess the deep knee jerk/reflex (Fuller 2004).
- *Neuro tips*: sharp instrument used to apply pressure and test for superficial sensations to pain. Can be replaced by a safety pin or other suitable sharp object (Fuller 2004).
- *Snellen chart*: an eye chart used to measure visual acuity.
- *Ophthalmoscope*: instrument used to examine the eye.

Assessment and recording tools

The initial assessment of a patient should include a history (taken from relatives or friends if appropriate), noting changes in mood, intellect, memory and personality, since these may be indicators of a long-standing problem, for example brain tumour (Belford 2005).

The GCS, first developed by Teasdale and Jennett (1974), is a common way to assess a patient's conscious level. It forms a quick, objective and easily interpreted mode of neurological assessment. The GCS measures arousal, awareness and activity, by assessing three different areas of the patient's behaviour: eye opening, verbal response and motor response (Dawes and Durham 2007).

Each area is allocated a score, enabling objectivity, ease of recording and comparison between recordings. The total sum provides a score out of 15. A score of 15 indicates a fully alert and responsive patient, whereas a score of 3 (the lowest possible score) indicates unconsciousness (Dawes and Durham 2007). When used consistently, the GCS provides a graphical representation that shows improvement or deterioration of the patient's conscious level at a glance (see Figure 13.31 and Table 13.15).

Figure 13.31 The Glasgow Coma Scale.

Table 13.15 Scoring activities of the Glasgow Coma Scale. Scores are added,

with the highest score 15 indicating full consciousness

Category	Score	Response
Eye opening		
Spontaneous	4	Eyes open spontaneously without stimulation
To speech	3	Eyes open to verbal stimulation (normal, raised or repeated)
To pain	2	Eyes open with painful/noxious stimuli
None	1	No eye opening regardless of level of stimulation
Verbal response		
Orientated	5	Able to give accurate information regarding time, person and place
Confused	4	Able to answer in sentences using correct language but cannot answer orientation questions appropriately
Inappropriate words	3	Uses incomprehensible words in a random or disorganized fashion
Incomprehensible sounds	2	Makes unintelligible sounds, for example moans and groans
None	1	No verbal response despite verbal or other stimuli
Best motor response		
Obeys commands	6	Obeys and can repeat simple commands, for example arm raise
Localizes to pain	5	Purposeful movement to remove painful stimuli
Normal flexion	4	Withdraws extremity from source of pain, for example flexes arm at elbow without wrist rotation in response to painful stimuli
Abnormal flexion	3	Decorticate posturing (flexion of arms, hyperextension of legs) spontaneously or in response to noxious stimuli
Extension	2	Decerebrate posturing (limbs extended and internally rotated) spontaneously or in response to noxious stimuli
None	1	No response to noxious stimuli. Flaccid limbs

Aucken and Crawford (1998), Carlson (2002a).

Assessment of level of consciousness

Assessment using the GCS involves three phases (Teasdale and Jennett 1974).

1. Eye opening.
2. Evaluation of verbal response.
3. Evaluation of motor response.

Evaluation of eye opening

Eye opening indicates that the arousal mechanism in the brain is active. Eye opening may be: spontaneous; to speech, for example spoken name; to painful stimulus; or not at all. Arousal (eye opening) is always the first measurement undertaken when performing the GCS, as without arousal, cognition cannot occur (Aucken and Crawford 1998). It must, however, be remembered that swollen or permanently closed eyes (e.g. after tarsorrhaphy surgery in which the upper and lower eyelids are partially or wholly joined to protect the cornea; Martin 2003) will not open and do not necessarily indicate a falling conscious level.

Evaluation of verbal response

- *Orientated*: the patient is aware of self and environment.
- *Confused*: the patient's responses to questions are incorrect and patient is unaware of self or environment.
- *Inappropriate words*: the patient responds using intelligible words which are unsuitable as responses.
- *Incomprehensible*: the patient may moan and groan without recognizable words.
- *Absent*: the patient does not speak or make sounds at all.

The absence of speech may not always indicate a falling level of consciousness. The patient may not speak English (though they can still speak), may have a tracheostomy or may be dysphasic. The patient may have a motor (expressive) dysphasia, and therefore be able to understand but be unable to find the right word, or a sensory (receptive) dysphasia, being unable to comprehend what is being told to them (Aucken and Crawford 1998, Shah 1999). At times patients with expressive dysphasia may also have receptive problems; therefore it is important to make an early referral to a speech and language therapist. The nurse should also bear in mind that some patients may need a lot of stimulation to maintain their concentration to answer questions, even though they can answer them correctly. It is, therefore, important to note the amount of stimulation that the patient required as part of the baseline assessment (Aucken and Crawford 1998). If a patient cannot follow the instruction due to a language barrier or unconsciousness, observe spontaneous movements and note how strong they appear. Then, if necessary, apply painful stimuli.

Evaluation of motor response

To obtain an accurate picture of brain function, motor response is tested by using the upper limbs because responses in the lower limbs reflect spinal function (Aucken and Crawford 1998). The patient should be asked to obey commands; for example, the patient should be asked to squeeze the examiner's hands (both sides) with the best motor response recorded. The nurse should note power in the hands and the patient's ability to release the grip. This is because some patients with cerebral dysfunction, for example those with diffuse brain disease, may show an involuntary grasp reflex where stimulation of the palm of their hand causes them to grip (Aucken and Crawford 1998). If movement is spontaneous, the nurse should note which limbs move, and how, for example whether the movement is purposeful.

Response to painful stimulus may be:

- *localized*: the patient moves the other hand to the site of the stimulus
- *flexor*: the patient's limb flexes away from pain
- *extensor*: the patient's limb extends from pain
- *flaccid*: no motor response at all.

(Aucken and Crawford 1998, Shah 1999)

Procedure guideline 13.10 Neurological observations and assessment

Essential equipment

- Pen torch
- Thermometer
- Sphygmomanometer
- Tongue depressor
- Patella hammer
- Neuro tips
- Alcohol handrub

Optional equipment

- Low-linting swabs
- Snellen chart
- Two test tubes
- Ophthalmoscope

Preprocedure

Action	Rationale
1 Inform the patient of the procedure, whether conscious or not, and explain and discuss the observations.	Sense of hearing is frequently unimpaired even in unconscious patients. It is important, as far as is possible, that the patient understands the procedure and gives their valid consent (NMC 2008b, C).

Procedure

2 Wash and dry hands.	To minimize the risk of cross contamination (Fraise and Bradley 2009, E).
3 Talk to the patient. Note whether they are alert and giving full attention or restless or lethargic and drowsy. Ask the patient who they are, the correct day, month and year, where they are and to give details about family.	To establish whether the patient's level of consciousness is deteriorating. If the patient is becoming disorientated, changes will occur in this order: **(a)** disorientation as to time **(b)** disorientation as to place **(c)** disorientation as to person (Aucken and Crawford 1998, R5).
4 Ask the patient to squeeze and release your fingers (include both sides of the body) and then to stick out their tongue.	To evaluate motor responses and to ensure that the responses are equal and are not reflexive (Carlson 2002a, R5).
5 If the patient does not respond, apply painful stimuli. Suggested methods have been discussed earlier.	Responses grow less purposeful as the patient's level of consciousness deteriorates. As the condition worsens, the patient may no longer localize pain and respond to it in a purposeful way (Aucken and Crawford 1998, R5).
6 Record the findings precisely, recording the patient's best response. Write exactly what stimulus was used, where it was applied, how much pressure was needed to elicit the response, and how the patient responded.	Vague terms can be easily misinterpreted. Accurate recording will enable continuity of assessment and comply with NMC guidelines (NMC 2009, C).
7 Extend both hands and ask the patient to squeeze your fingers as hard as possible. Compare grip and strength.	To test grip and ascertain strength. Record best arm in GCS chart to reflect best outcome (Carlson 2002a, R5).
8 Darken the room, if necessary, or shield the patient's eyes with your hands.	To enable a better view of the eye. E
9 Ask the patient to open their eyes. If the patient cannot do so, hold the eyelids open and note the size, shape and equality of the pupils.	To assess the size, shape and equality of the pupils as an indication of brain damage. Normal pupils are spherical, usually at mid-position and have a diameter ranging from 2 to 5 mm (Shah 1999, R5).
10 Hold each eyelid open in turn. Move torch towards the patient from the side. Shine it directly into the eye. This should cause the pupil to constrict promptly.	To assess the reaction of the pupils to light. A normal reaction indicates no lesions in the area of the brainstem regulating pupil constriction (Aucken and Crawford 1998, R5).
11 Hold both eyelids open but shine the light into one eye	To assess consensual light reflex. Prompt constriction

only. The pupil into which the light is not shone should also constrict.	indicates intact connections between the brainstem areas regulating pupil constriction (Scherer 1986, R5).
12 Record unusual eye movements.	To assess cranial nerve damage (Aucken and Crawford 1998, R5).
13 Note the rate, character and pattern of the patient's respirations.	Respirations are controlled by different areas of the brain. When disease or injury affects these areas, respiratory changes may occur (Carlson 2002a, R5).
14 Take and record the patient's temperature at specified intervals.	Damage to the hypothalamus, the temperature-regulating centre in the brain, will be reflected in grossly abnormal temperatures (Fairley and McLernon 2005, R5).
15 Take and record the patient's blood pressure and pulse at specified intervals.	To monitor signs of increased intracranial pressure. Hypertension and bradycardia usually occur late, after the patient's level of consciousness has begun to deteriorate. Call for medical assistance as soon as it is evident that there is a deterioration in the patient's level of consciousness (Scherer 1986, R5; Tortora and Derrickson 2009, R5).
16 Ask the patient to close the eyes and hold the arms straight out in front, with palms upwards, for 20–30 seconds. The weaker limb will 'fall away'.	To show weakness and difference in limbs (Carlson 2002a, R5).
17 Stand in front of the patient and extend your hands. Ask the patient to push and pull against your hands. Ask the patient to lie on their back in bed. Place the patient's leg with knee flexed and foot resting on the bed. Instruct the patient to keep the foot down as you attempt to extend the leg. Then instruct the patient to straighten the leg while you offer resistance.	To test arm strength. If one arm drifts downwards or turns inwards, it may indicate hemiparesis. To test flexion and extension strength in the patient's extremities by having the patient push and pull against your resistance (Carlson 2002a, R5).
18 Flex and extend all the patient's limbs. Note how well the movements are resisted.	To test muscle tone (Carlson 2002a, R5).
19 Ask the patient to pat the thigh as fast as possible. Note whether the movements seem slow or clumsy. Ask the patient to turn the hand over and back several times in succession. Evaluate co-ordination. Ask the patient to touch the back of the fingers with the thumb in sequence rapidly.	To assess hand and arm co-ordination. The dominant hand should perform better (Carlson 2002a, R5).
20 Extend one of your hands towards the patient. Ask the patient to touch your index finger, then their nose, several times in succession. Repeat the test with the patient's eyes closed.	To assess hand and arm co-ordination/cerebellar function (Carlson 2002a, R5).
21 Ask the patient to place a heel on the opposite knee and slide it down the shin to the foot. Check each leg separately.	To assess leg co-ordination (Fuller 2004, R5).
22 Ask the patient to look up or hold the eyelid open. With your hand, approach the eye unexpectedly or touch the eyelashes.	To test the corneal (blink) reflex (Fuller 2004, R5).
23 Ask the patient to open the mouth, and hold down the tongue with a tongue depressor. Touch the back of the pharynx, on each side, with a low-linting swab.	To test the gag reflex (Fuller 2004, R5).
24 Ask the patient to lie on their back in bed. Place your hand under the knee, raise and flex it. Tap the patellar tendon. Note whether the leg responds.	To assess the deep tendon knee-jerk reflex (Fuller 2004, R5).
25 Stroke the lateral aspect of the sole of the patient's foot. If the response is abnormal (Babinski's response), the big toe will dorsiflex and the remaining toes will fan out.	To assess for upper motor neurone lesion (Fuller 2004, R5).
	To test for visual acuity (Fuller 2004, R5).

26 Ask the patient to read something aloud. Check each eye separately. If vision is so poor that the patient is unable to read, ask the patient to count your upraised fingers or distinguish light from dark.	To test for visual acuity (Fuller 2004, R5).
27 Occlude one ear with a low-linting swab. Stand a short way from the patient. Whisper numbers into the open ear. Ask for feedback. Repeat for the other ear.	To test hearing and comprehension (Fuller 2004, R5).
28 Ask the patient to close the eyes. Using the point of a Neuro tip (sharp instrument for applying pressure), stroke the skin. Use the blunt end occasionally. Ask patient to tell you what is felt. See if the patient can distinguish between sharp and dull sensations.	To test superficial sensations to pain (Fuller 2004, R5).
29 Ask the patient to close the eyes. Fill two test tubes with water: one warm, one cold. Touch the patient's skin with each test tube and ask patient to distinguish between them.	To test superficial sensations to temperature (Fuller 2004, R5).
30 Stroke a low-linting swab lightly over the patient's skin. Ask the patient to say what they feel.	To test superficial sensations to touch (Fuller 2004, R5).
31 Ask the patient to close the eyes. Hold the tip of one of the patient's fingers between your thumb and index finger. Move it up and down and ask the patient to say in which direction it is moving. Repeat with the other hand. For the legs, hold the big toe.	To test proprioception. (Bickley and Szilagyi 2009, E). *Proprioception* is the receipt of information from muscles and tendons in the labyrinth that enables the brain to determine movements and the position of the body (Tortora and Derrickson 2009, E).

Postprocedure

32 Document the observation recordings on the patient's observation chart, record only what you see and do not be influenced by previous observations.	To ensure adequate records and enable continued care of the patient (NMC 2009, C).
33 Report any abnormal findings to medical staff.	To prevent further deterioration. E
34 Clean the equipment after use.	To prevent cross-infection (Fraise and Bradley 2009, E).

Problem-solving table 13.9 Prevention and resolution (Procedure guideline 13.10)

Problem	Cause	Prevention	Action
Language difficulties or dysphasia	Difficulty making accurate assessment of consciousness	Knowledge of language difficulties	Use of interpreter for language barrier Consideration when taking into account overall assessment process
Patient unable to open eye(s)	Result of swelling	Unable to prevent	Does not necessarily indicate a low or falling conscious level

Postprocedural considerations

Documentation

A validated observation chart is the most common method of monitoring and recording neurological observations. Although the layout may differ from chart to chart, in essence all neurological observation charts measure and record the same clinical information, including the level of consciousness, pupil size and response, motor and sensory response and vital signs (Dawes and Durham 2007).

Observation charts ensure a systematic approach to collecting and analysing essential information regarding a patient's condition. Such charts also act as a means of communication between nurses and other healthcare professionals (Dawes and Durham 2007).

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Part four

Supporting the patient through treatment

15 Cytotoxic therapy

16 Medicines management

17 Perioperative care

18 Vascular access devices: insertion and management

19 Wound management

Alopecia

Definition

Chemotherapy-induced alopecia is the temporary loss of all body hair (Dougherty 2005).

Anatomy and physiology

The hair follicle comprises a bulb at the base of the follicle. The actual hair is produced by cells in the hair matrix zone where nutrients and growth factors are provided by the dermal papilla. Keratinocytes in the hair matrix zone begin to rapidly divide and a keratinized hair emerges with a thin outer cuticle and a thin cortex (Janssen 2006). The hair follicle goes through three growth phases. Anagen is a phase of intensive growth and hair shaft production, which may last as long as 7 years. The hair then enters the catagen phase (involution) when the old hair shaft is broken down and a new hair follicle is formed. This lasts 2–3 weeks and is followed by the telogen phase (resting) which lasts 2–3 months and then an intermediate regrowing state starts and new hair follicles are produced.

Chemotherapy affects rapidly growing keratinocytes in the hair matrix zone in anagen hair follicles and a decrease in the diameter of the hair bulb can be seen 4–6 days after administration of a single dose (Olsen 2009). Not all the hair follicles have the same rhythm of cycling and as approximately 90% of hair follicles are in a phase of growth at any given time, the resulting hair loss can be rapid and extensive (Janssen 2006).

Related theory

Alopecia is a common consequence of many chemotherapeutic regimens and is one of the most devastating effects of cancer chemotherapy (Pickard-Holley 1987, Williams *et al.* 1984). In a study of breast cancer survivors who completed a psychophysical scaling method, hair loss was ranked in the top five distressful side-effects of chemotherapy (Mulders *et al.* 2009), while Mols *et al.* (2008) found that the hair loss associated with chemotherapy was a source of distress for patients, and was rated in the three most troublesome side-effects of treatment, along with nausea and vomiting. Chemotherapy-induced alopecia adversely affects psychosocial functioning and quality of life (Hesketh *et al.* 2003, Lemieux *et al.* 1995, Rosman 1987). It has been identified as such a devastating prospect that some patients may refuse to accept treatment or choose regimens with less favourable outcomes (Boehmke and Dickerson 2005, Browall *et al.* 2006, Hesketh *et al.* 2003, Rosenblatt 2003, Williams *et al.* 1984). Hair loss can also result in changes to the patient's body image (Freedman 2009, Gallagher 2008, Williams *et al.* 1984) which may not be reversed by the regrowth of hair (Munstedt *et al.* 2007).

Prevention of chemotherapy-induced alopecia Several techniques have been tested to prevent chemotherapy-induced hair loss, the first being scalp tourniquets. These were used to minimize the contact the drug had with the hair follicles by occluding, using pressure, the superficial blood vessels supplying the scalp (Maxwell 2004). However, while some investigators found scalp tourniquets effective, others reported this method to be time-consuming, uncomfortable or ineffective (Parker 2010). Research findings indicate that scalp hypothermia (cooling) may be simpler, less traumatic and more effective as a means of preventing alopecia when compared with the scalp tourniquet (David and

Speechley 1987).

It has been documented that men and women experience similar concerns about body image when they have experienced chemotherapy-induced hair loss, although women tended to speak about hair loss from the head and face (above eyeline) while men spoke of losing hair from wider body surfaces (Hilton *et al.* 1999). Healthcare professionals must therefore be mindful that scalp cooling should be offered to patients as determined by the chemotherapy regimen and not the gender of the patient (Hilton *et al*. 1999).

In a study in which patients receiving chemotherapy for breast cancer who underwent scalp cooling were given questionnaires to complete before chemotherapy, after 3 weeks of treatment and 6 months after completion, they rated the burden of scalp cooling as low, suggesting that nursing staff must be aware of how distressing the matter of hair loss can be for patients, and scalp cooling should be offered wherever possible (Mols *et al.* 2008). Physicians tend to underestimate the impact of hair loss on patients so it may be up to the nurse to provide information on scalp cooling (Mulders *et al.* 2009, Rosman 1987).

Scalp cooling is a method of preventing chemotherapy-induced alopecia. It works in three ways (Batchelor 2001, Bulow *et al.* 1985).

1. Reducing perfusion of hair follicles by vasoconstriction, thus limiting the amount of exposure of chemotherapy (an intradermal scalp temperature of 30°C decreases scalp blood flow by 25%).

2. Reduced temperature-dependent cellular uptake of chemotherapy.

3. Reduced intrafollicular metabolic rate.

The rationale is based on characteristics of hair growth, the effect of cytotoxic drugs on hair follicles, physiological changes in scalp circulation and pharmacokinetics (Keller and Blausey 2008). Ninety percent of all scalp hair is in an active phase of growth, characterized by significant mitotic activity; this means the hair bulb is especially sensitive to chemotherapeutic agents (Parker 2010). Scalp hypothermia produces changes in the scalp circulation by causing vasoconstriction of superficial vessels. Decreased blood flow to the scalp reduces the amount of the drug reaching the hair follicles and thus minimizes damage to the scalp hair (Kennedy *et al.* 1988, Parker 2010). Its success is also related to the metabolic effects of cooling, that is, slowing the metabolic rate (Bulow *et al.* 1985), and it also appears that the degree of hair loss is temperature dependent.

In order to prevent alopecia, the temperature of the scalp must be reduced to at

least 24°C but preferably 22°C (Gregory *et al.* 2006). Caps have to be kept in a freezer in order to reach temperatures of −18 to −20°C (Anderson *et al.* 1981, Giaccone *et al.* 1997, Kennedy *et al.* 1988). Then when the cap is placed on the head, the scalp temperature will drop from 37°C to 23–24°C within the first 15 minutes (Guy *et al.* 2003, Tollenaar *et al.* 1987). This is why a preinjection scalp cooling time of 20–30 minutes is said to be required (Anderson *et al.* 1981, Giaccone *et al.* 1997, Kennedy *et al.* 1988, Middleton *et al.* 1995, Robinson *et al.* 2005, Satterwhite and Zimm 2009). Janssen (2006) studied the link between heat transfer in the human head and the transport of doxorubicin. This led to the development of a population-based computational model for scalp cooling which included doses of doxorubicin of 60–70 mg, lowering skin temperature to 17–18°C, leaving the cap on for the total infusion time plus 1 hour and having a haircut to reduce thermal resistance between head and cap, all of which provided the most effective scalp cooling.

Scalp cooling has been used in an attempt to reduce hair loss with palliative whole-brain radiotherapy. However, a pilot study (Shah *et al.* 2005) found that all patients still lost their hair and there was evidence that the cold cap application increased the dose of radiotherapy to the scalp.

More recently, biological methods of preventing hair loss have focused on promoting hair growth or protecting the hair follicles (Batchelor 2001). For example:

- minoxidil 2% topical solution applied twice a day (Shapiro and Price 2006)
- topical topitriol (Hidalgo *et al.* 2004)
- application of a steroid 5-alpha reductase inhibitor (Uno and Kurata 1994)
- immunosuppressive immunophilin ligands such as ciclosporin (Maurer *et al.* 2003), immunomodulators, AS101 (Sredni *et al.* 2000), CDK2 inhibitors (Davis *et al.* 2001) and P53 (a mediator of cellular response which is essential for chemotherapy-induced hair loss) (Botchkarev *et al.* 2000).

Evidence-based approaches

Rationale

Indications

All patients with solid tumours receiving doxorubicin, epirubicin or docetaxel as a single agent or in combination should be offered scalp cooling.

Contraindications

Scalp cooling should not be offered to patients:

- with haematological disease unless the consultant feels it is appropriate to offer scalp cooling on the basis of quality of life
- receiving drugs that cause hair loss, for example vincristine, where there is no research or evidence of the effectiveness of scalp cooling
- who have already received a first course of chemotherapy which may induce hair loss but who were not offered or declined scalp cooling.

(Dougherty 2005)

Principles of care

Scalp cooling

The effectiveness of scalp cooling has been demonstrated satisfactorily with doxorubicin, epirubicin, docetaxel and paclitaxel (Dean *et al.* 1979, Katsimbri *et al.* 2007, Lemenager *et al.* 2003, Robinson *et al.* 2005). Patients receiving other cytotoxic drugs which may cause alopecia, such as vindesine and vincristine, have undergone the procedure, although there are insufficient data to evaluate its effectiveness with these drugs.

Doxorubin is commonly used in cancer chemotherapy and has a uniquely short half-life of approximately 30 minutes (compared to other drugs, such as cyclophosphamide which has a plasma half-life of over 6 hours) (Priestman 1995). This factor makes prophylactic scalp cooling feasible because it need only be utilized during peak plasma levels (Cline 1984). This is particularly important since doxorubicin results in a consistently high incidence of alopecia (80–90% of all patients), often leading to total hair loss (Dean *et al.* 1983). The involvement of doxorubicin, whether used alone or in combination, is a feature of most of the reported scalp-cooling studies. In some studies, there was less success in maintaining hair with increasing doses of doxorubicin and/or liver metastases (David and Speechley 1987, Dean *et al.* 1983), but this may be resolved by extending the time the cap remains in place following chemotherapy administration.

Scalp cooling has also been used during the administration of epirubicin, as a single agent, with good results (Robinson *et al.* 2005), although doses may influence outcomes (Adams *et al.* 1992). Subsequent studies have investigated combination regimens containing epirubicin and other drugs such as cyclophosphamide and 5-fluorouracil, with results of mild to moderate hair loss. However, when intravenous cyclophosphamide is added to anthracycline, the success rate is reduced from 80% of patients keeping most of their hair to about 50–60% of patients (David and Speechley 1987, Middleton *et al.* 1995). Some authors have therefore concluded that when combinations of cyclophosphamide and anthracyclines are given, scalp cooling has no place at all (Tollenaar *et al.* 1987). The group of drugs known as the taxanes also have the unfortunate side-effect of total alopecia; however, there is now evidence that using scalp cooling in patients receiving docetaxel and paclitaxel can prevent complete hair loss (Katsimbri *et al.* 2007, Lemenager *et al.* 2003, 1998, Macduff *et al.* 1997).

Scalp cooling requires the consultant’s permission as the procedure may protect micrometastases in the scalp from chemotherapy, especially where there

is the possibility of circulating cancer cells, for example in cases of leukaemia and lymphoma (Witman *et al.* 1994). In spite of this, scalp cooling has been used successfully in patients with relapsed lymphoma (Purohit 2009). Dean *et al.* (1983), drawing on evidence from 7800 women with breast cancer, found that only two experienced recurrence of disease on the scalp, suggesting that the risk of scalp metastases was minimal. They concluded that scalp cooling should not be contraindicated and could be used routinely with a wide variety of solid tumours. Nevertheless, patients with advanced metastatic disease have been found to develop scalp metastases during scalp cooling and Middleton *et al.* (1995) argued strongly against the use of scalp cooling in this group. Other studies have found no scalp metastases at follow-up (Ron *et al.* 2010). Lemieux *et al.* (1995) found the incidence of scalp metastases was low and no case presented as an isolated site of relapse. However, the potential risk of scalp metastases, albeit remote, should be addressed and demands discussion by healthcare professionals and patients (Batchelor 2001, Peck *et al.* 2003).

The issues relating to scalp metastases are controversial. This dilemma, along with the media coverage regarding preventive measures for chemotherapy-induced alopecia (Carr 1998, Kendell 2005), have led some practitioners to question whether scalp cooling should be offered.

Patients have highlighted how they feel about hair loss (Carr 1998) and also the need to provide more comfortable and effective scalp cooling in all cancer units and centres (Wilson 1999). In addition, an extensive review of the literature concluded that scalp cooling was effective and should be offered to all patients for whom it was appropriate (Batchelor 2001, Crowe *et al.* 1998). This was supported by the views of many nurses who felt that the use of scalp cooling with chemotherapy protocols which are associated with hair loss can effectively prevent alopecia and result in improved quality of life for patients (Lemenager 2006). Patients also feel it is worthwhile to undergo scalp cooling regardless of how successful it is (Dougherty 2006b). However, whilst scalp cooling contributes to well-being in successfully scalp-cooled patients, it can cause additional distress when patients lose their hair despite scalp cooling and so additional support may be required for those patients when scalp cooling is not successful (van den Hurk *et al.* 1993).

Limitations of scalp-cooling studies Despite the large number of studies on scalp cooling, they are difficult to compare with one another, owing to the many variables: different types of scalp-

cooling caps, varying methods of applying the caps, different chemotherapy regimens, tools for assessment of hair loss and who performs the assessment. Also sample numbers are often small and few studies are randomized or have a control group (Dougherty 2006b, Grevelman and Breed 1982). This results in difficulties when making decisions related to selection of scalp-cooling systems, discussing the risk of scalp metastases, or even whether to offer scalp cooling at all (Breed 2004, Christodoulou et al. 2002, Grevelman and Breed 1982, Randall and Ream 1989).

Anticipated patient outcomes

The success of all these methods of preventing hair loss varies and the amount of hair loss experienced by the patient is dependent on a number of factors.

- Involvement of the liver with metastatic disease leads to elevated plasma levels of doxorubicin for a longer period. Early studies seemed to indicate that extension of the cooling period did not improve the results (Satterwhite and Zimm 2009) but more recent studies are finding that longer cooling times in general improve success rates (Massey 2007).
- Inadequate cooling because of exceptionally thick hair may lead to partial loss. It has been demonstrated that maximum cooling occurs 20 minutes after the cap has been placed in position.
- The weight of the cap (as well as the temperature) may be a factor, as this ensures that the contact is maintained over the complete scalp (Hunt *et al.* 2003).
- Success does not appear to be dose dependent, as was first thought (David and Speechley 1987, Dougherty 2006b).
- It seems likely that when anthracyclines are used in combination with other drugs that cause alopecia (e.g. etoposide and cyclophosphamide), the success rate is not as high as with anthracyclines alone (Middleton *et al*. 1995). It has also been found that the type of anthracycline used will affect success rates as hair loss is greater with doxorubicin and cyclophosphamide than when using epirubicin and cyclophosphamide (Dougherty 2006b).

Legal and professional issues Consent

Patients must give consent for the procedure but must first be fully informed about the nature and length of the procedure, the chances of success and, where appropriate, the risk of scalp metastases (Peck *et al.* 2003). Scalp cooling can be a long and uncomfortable procedure and should not be offered unless it is beneficial or the patient insists on undergoing the procedure. Patients must also be informed that they may discontinue the procedure at any time if they find it too physically or psychologically traumatic (Tierney 2002) or if they fail to retain hair.

Research shows that scalp cooling can be very distressing (Tierney 1986), although patients still find it a worthwhile procedure to undergo regardless of whether or not it is successful and many would have it again if necessary (Dougherty 1996, 2006b). It has also been shown that the severity and distress associated with hair loss may be less for those who use scalp cooling (Protiere *et al.* 2003).

Preprocedural considerations

Equipment

Most of the studies that used an ice cap method of scalp cooling used a ‘home-made’ or commercial cap (Anderson *et al.* 1981, David and Speechley 1987, Dean *et al.* 1983, Lemenager *et al.* 1998).

Home-made caps

Initially scalp cooling was achieved using crushed ice in plastic bags (Dean *et al.* 1979). A study of the efficacy of using a moulded prefrozen ice cap hand-made from cryogel bags was conducted at the Royal Marsden Hospital (Anderson *et al.* 1981, David and Speechley 1987).

Cryogel caps

The first commercial cap (Kold Kap) was successful in reducing hair loss, particularly with higher doses of doxorubicin (Dean *et al.* 1983). A three-layer cap (inner cotton, middle cryogel, outer lamb's wool) was also reported to prevent total hair loss (Howard and Stenner 1998). However, Wheelock *et al*. found that most patients suffered from severe hair loss even with the use of the Kold Kap (Wheelock *et al.* 2007). The most recent work has involved the use of cryogel caps such as the Chemocap and Penguin caps, which have been used for patients receiving single agents and combinations of anthracyclines (Christodoulou *et al.* 2002, Katsimbri *et al.* 2007, Peck *et al.* 2003) as well as in the use of docetaxel (Lemenager *et al.* 2003, 1998).

A large (170 patients) randomized study comparing Chemocap with the gelpack method found no statistical difference in efficacy between the two caps but Chemocap was shown to be more comfortable and offered a better fit, as well as being easier to use (Dougherty 2006b).

Scalp-cooling machines

Attempts have been made to produce an alternative type of cap that would improve the effectiveness of scalp cooling, in particular to ensure a sufficiently low and constant reduction in scalp temperature that would endure during the entire procedure. Two types of scalp-cooling machine have been designed.

1 The use of refrigerated air passed over the patient's scalp via a hair-drying helmet was reported to be beneficial in over 50% of patients, with most experiencing no hair loss or slight hair loss and six requiring a wig (Symonds *et al.* 2008). However, other authors found that the system was only successful at lower doses of epirubicin (Adams *et al.* 1992).

2 Refrigerated cooling systems where liquid coolant is pumped via a cap and maintains a more reliable temperature. Guy *et al.* (2003) reported encouraging results when the thermocirculator was first introduced, although Tollenaar *et al.* (1987) found that when used with patients receiving fluorouracil, epirubicin and cyclophosphamide (FEC), there was still a 50% chance of total alopecia occurring. The newer scalp-cooling machines appear to provide a more comfortable and effective system, for example Paxman or Dignitana (Henriksen and Jensen 2003, Massey 2007, Ridderheim *et al.* 1992, Spaeth *et al.* 2008) (Figures 15.10, Figure 15.11).

Figure 15.10 Paxman machine.

Figure 15.11 Paxman machine.

Procedure guideline 15.13 Scalp cooling
Essential equipment

- A scalp-cooling cap, for example Chemocap, or machine, for example Paxman scalp-cooling

machine ■Overcap ■Skin protection, for example gauze, cotton wool pads ■Comfortable chair (recliner) or bed ■Extra pillows and blankets as required ■Equipment to wet and condition patient's hair as determined by manufacturer's instructions

Preprocedure

Action	Rationale
1 Before beginning, it is important to explain and discuss the procedure fully with the patient. Explain that the coldest and most uncomfortable time is the first 15 minutes after the cap has been applied. The patient should understand that the scalp cooling can be discontinued at any time and that it will not jeopardize the chemotherapy.	To ensure that the patient understands the procedure and what the success rate is likely to be depending on the type of chemotherapy regimen they are receiving (Dougherty 2006b, R2b). Patients who have undergone scalp cooling highlighted this as important knowledge to share when first undergoing the procedure (Dougherty 2006b, R2b). To ensure that the patient gives their valid consent and knows that if the scalp cooling does not work, they can obtain a wig (NMC 2008a, C).
Procedure	
2 Check the cap has been in the freezer for a minimum of 12 hours (temperature −25 to −32°C), or that the machine has been cooled to the recommended temperature.	To ensure the cap is cold enough to be effective (manufacturer's recommendations, C).
3 If necessary wet hair and then place the cap on the patient's head, making sure it fits closely and covers the whole hairline (see Action Figure 3).	To ensure cooling over the head, including all the hair roots. E
4 Apply the overcap to the patient's head (see Action Figure 4).	To ensure even and close contact of the cap to the scalp (Dougherty 2006b, R2b).
5 Place protection in any areas where the cap touches the skin.	To prevent cold injury and improve the patient's comfort. E, P
6 Place a pillow behind the patient's head if required.	To provide support for the patient's head and neck and to reduce the effect of the heaviness of the cap (P; Dougherty 1996, R2b).
7 Offer the patient the use of a blanket.	To provide the patient with some protection against the feeling of cold (P; Dougherty 1996, R2b).
8 Leave the patient for at least 15 minutes before injection of the drug.	To obtain initial cooling of the scalp (Dougherty 2006b, R2b; Hunt *et al.* 2003, R4; Lemenager *et al*. 1998, R2b).
9 Administer the drug by intravenous injection as per prescription.	To administer treatment as appropriate. E
10 The cap must be changed after 30 minutes regardless of the stage of administration or, if using a machine, the cap must be on continuously for the recommended times.	To maintain adequate cooling (Dougherty 2006b, R2b; Hunt *et al.* 2003, R4; Lemenager *et al*. 1998, R2b).
11 If a drug takes longer than 30 minutes to administer, the cap will need to be changed after 45–60 minutes and then every hour thereafter depending on the type of drug and the temperature of the freezer.	To maintain adequate cooling (Dougherty 2006b, R2b, Janssen 2006, R2b).
12 On completion of the drug (i.e. the one likely to cause alopecia, for example doxorubicin), leave the patient for a further 45 minutes or according to the manufacturer's recommendations.	To maintain cooling until the plasma levels of drug have fallen (Dougherty 2006b, R2b; Hunt *et al.* 2003, R4; Janssen 2006, R2b; Lemenager *et al*. 1998, R2b).
13 When sufficient time has elapsed, remove the cap.	To prevent damage to the scalp and hair. E, P
Postprocedure	
14 Encourage the patient to rest, if desired.	To prevent the patient feeling faint when the cap is lifted off the head. P, E

	E
15 Wash or wipe the cap with detergent wipes, dry and store on cardboard insert or according to manufacturer's instructions.	To minimize cross-infection and to maintain shape (DH 2007, C).
16 Ensure the patient is given a patient information booklet on how to care for hair and manage hair loss.	To reinforce verbal information given during procedure. E, P

Action Figure 3 Place the cap on the patients head, making sure it fits closely and covers the whole hairline.

Action Figure 4 Apply the overcap to the patients head.

Problem-solving table 15.4 Prevention and resolution (Procedure guideline 15.13)

Problem	Cause	Prevention	Action
Inadequate cooling	Poorly fitting cap. Cap not sufficiently cooled	Select correct size cap for each individual patient Ensure that caps are maintained at correct temperature Follow the procedure correctly	Check that the cap fits and is the correct size and that the hair roots are covered. Ensure the cap is changed at correct times. Check the cap has been cooled to the correct temperature
Excess cooling	Thin hair	Use plenty of gauze between the cap and scalp	Apply more gauze. If it is still painful then discontinue the procedure
Complaints of headache	Weight and coldness of cap	Warn patient of weight and cold sensation. Provide physical support to the neck and shoulders and blankets as required	Provide more support and warmth. Reassure patient that it will ease off as cooling continues
Distressed patient	Claustrophobia	Discuss with patient and allow them to try cap on before starting procedure	Support and reassure the patient. If necessary, remove the cap
	Ice phobia	Discuss with patient and allow them to try cap on before starting procedure	Be aware of this possible problem; encourage the patient to discuss their feelings
Hair loss	Scalp cooling was not successful	Use correct size cap and cool for recommended time	Offer the patient the opportunity to discontinue the scalp cooling. Make arrangements for the patient to see the appliance officer and obtain a wig. Discuss care of hair and scalp and give patient information booklet

Postprocedural considerations Immediate care

It is important to ensure that if a patient fails to retain hair or decides not to undergo scalp cooling, adequate time is spent helping the patient to adapt to the hair loss physically, psychologically and socially. It is recommended that nursing interventions be directed towards helping the patient and family to adapt to alopecia by using patient education, available resources and supportive listening (Pickard-Holley 1987). This can be partly achieved by ensuring that the patient sees the surgical appliance officer as soon as possible, in order to obtain a wig that can be matched to the patient's desired hair style and colour.

Ongoing care

Advice can be given on hair care such as the type of shampoo. There is a misconception that a mild shampoo such as baby shampoo is best, but this kind of shampoo is alkaline and it is recommended that a neutral pH shampoo be used (Dougherty 2005, 2006b). Using a wide-toothed comb can prevent pulling on hair but the patient should not be afraid to comb hair daily (Dougherty 2006b). Patients should be advised to avoid anything that can dry out their hair such as using hair dryers, curlers, and so on, or using chemicals such as perming lotions or hair dyes, and should seek advice from a hairdresser. Finally the patient should be given advice about the use of head covering such as hats, turbans and scarves. All verbal information should be reinforced with a hair care information booklet (Batchelor 2001, Pickard-Holley 1987).

Complications

Patients have reported adverse effects during and following treatment such as headaches, claustrophobia, dizziness and ice phobias (Dougherty 2006b, Mols *et al.* 2008, Rosman 1987). Nurses need to understand the meaning that hair loss has for the patient. Alopecia can cause depression, loss of self-confidence and humiliation: it is a very visible sign of cancer. Patients who have relapsed and are undergoing further chemotherapy which causes alopecia may find the loss of hair a second time to be more devastating (Gallagher 2008).

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Intradermal Injection

Definition

The intradermal route provides a local rather than systemic effect and is used primarily for administering small amounts of local anaesthetic and skin testing, for example allergy or tuberculin testing (Snyder 2007). The injection is given into the dermis of the skin just below the epidermis where the blood supply is reduced and drug absorption can occur slowly (Chernecky *et al.* 2002).

Evidence-based approaches

Observation of an inflammatory reaction is a priority, so the best sites are those that are lowly pigmented, thinly keratinized and hairless. Chosen sites are the inner forearms and the scapulae. The injection site most commonly used is the medial forearm area as this allows for easy inspection (Downie *et al.* 2003). Volumes of 0.5 mL or less should be used (Chernecky *et al.* 2002).

Preprocedural considerations

Equipment

The injections are best performed using a 25 or 27 G needle inserted at a 10–15° angle, bevel up, just under the epidermis. Usually a TB (tuberculosis) or 1 mL syringe is used to ensure accuracy of dose.

Procedure guideline 16.17 Medication: intradermal injection

Essential equipment

- Needle 25–27 G
- 1 mL syringe containing medication
- Alcohol swab
- Non-sterile gloves

Preprocedure

Action	Rationale
1 Explain and discuss the procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (Griffith and Jordan 2003, E; NMC 2008b, C; NMC 2008c, C).
2 Consult the patient's prescription chart and ascertain the following: **(a)** Drug **(b)** Dose **(c)** Date and time of administration **(d)** Route and method of administration **(e)** Diluent as appropriate **(f)** Validity of prescription **(g)** Signature of doctor.	To ensure that the patient is given the correct drug in the prescribed dose using the appropriate diluent and by the correct route (NMC 2008a, C; NPSA 2007d, C).

Procedure

3 Close the curtains or door and assist the patient into the required position.	To ensure patient privacy and dignity. E To allow access to the appropriate injection site (Workman 1999, E).
4 Remove appropriate garments to expose the injection site.	To gain access for injection (Workman 1999, E).
5 Assess the injection site for signs of inflammation, oedema, infection and skin lesions.	To promote effectiveness of administration (Workman 1999, E). To reduce the risk of infection (Fraise and Bradley 2009, E; Workman 1999, E). To avoid skin lesions and avoid possible trauma to the patient (Workman 1999, E).
6 Choose the correct needle size and attach the needle.	To minimize the risk of missing the subcutaneous tissue and any ensuing pain (Workman 1999, E).
7 Clean the injection site with a swab saturated with isopropyl alcohol 70% and apply gloves.	To reduce the number of pathogens introduced into the skin by the needle at the time of insertion. (For further information on this action see Skin preparation.)
8 Remove the needle sheath and hold syringe with the dominant hand with the bevel of needle pointing up.	To facilitate needle placement (Perry 2007, E).

9 With the non-dominant hand, stretch skin over the site with forefinger and thumb.	To facilitate the needle piercing the skin more easily (Perry 2007, E).
10 With the needle almost against the patient's skin, insert the needle into the skin at an angle of 10–15° and advance through the epidermis so the needle tip can be seen through the skin.	To ensure the needle tip is in the dermis (Perry 2007, E).
11 Inject medication slowly. It is not necessary to aspirate as the dermis is relatively avascular.	To minimize the discomfort at site (Perry 2007, E).
12 While injecting medication, a bleb (resembling a mosquito bite) will form (see Action Figure 12).	

Action Figure 12 Intradermal bleb. After Springhouse (2005).

Reproduced with permission of Lippincott Williams and Wilkins.

To indicate medication is in dermis (Perry 2007, E).	
13 Withdraw the needle rapidly and apply pressure gently. Do not massage the site.	To prevent dispersing medication into underlying tissue layers and altering test results (Chernecky *et al.* 2002, E, Perry 2007, E).
Postprocedure	
14 Ensure that all sharps and non-sharp waste are disposed of safely and in accordance with locally approved procedures. For example, sharps into sharps bin and syringes into an orange clinical waste bag.	To ensure safe disposal and to avoid laceration or other injury to staff (DH 2005, C; MHRA 2004, C).
15 Record the administration on appropriate sheets.	To maintain accurate records, provide a point of reference in the event of any queries and prevent any duplication of treatment (NMC 2008a, C; NMC 2009, C; NPSA 2007d, C).

Subcutaneous Injection

Definition

These are given beneath the epidermis into the loose fat and connective tissue underlying the dermis and are used for administering small doses of non-irritating water-soluble substances for example insulin, heparin (Downie *et al.* 2003).

Related theory

Subcutaneous tissue is not richly supplied with blood vessels and so medication is absorbed more slowly than when given intramuscularly. The rate of absorption is influenced by factors that affect blood flow to tissues such as physical exercise or local application of hot or cold compresses (Perry 2007). Other conditions can prevent or delay absorption due to an impaired blood flow so in these conditions subcutaeous injections are contraindicated, for example circulatory shock, occlusive vascular disease (Perry 2007).

Evidence-based approaches

Injection sites

Sites recommended are the abdomen in the umbilical region, the lateral or posterior aspect of the lower part of the upper arm, the thighs (under the greater trochanter rather than mid-thigh) and the buttocks (Downie *et al.* 2003) (Figure 16.22). It has been found that the amount of subcutaneous tissue varies more than was previously thought; this is particularly significant for administration of insulin as inadvertent intramuscular administration can result in rapid absorption and hypoglycaemic episodes (King 2003). Rotation of sites can decrease the likelihood of irritation and ensure improved absorption. If using the abdominal area then try to inject each subsequent injection 2.5 cm from the previous one (Chernecky *et al.* 2002). Injection sites should be free of infection, skin lesions, scars, birthmarks, bony prominences and large underlying muscles or nerves (Perry 2007).

Figure 16.22 Sites recommended for subcutaneous injection.

Reproduced from Elkin et al. (2007) with permission.

The skin should be gently pinched into a fold to elevate the subcutaneous tissue which lifts the adipose tissue away from the underlying muscle (Workman 1999). The practice of aspirating to ensure a blood vessel has not been pierced is no longer recommended as it has been shown that this is unlikely to occur (Peragallo-Dittko 1997, Perry 2007). The maximum volume tolerable using this route for injection is 2 mL and drugs should be highly soluble to prevent irritation (Downie *et al.* 2003).

Preprocedural considerations

Equipment

Injections are usually given using a 25 G needle. To ensure medication reaches the subcutaneous tissue, the rule is: if you can grasp 2 inches of tissue, insert the needle at a 90° angle and for 1 inch, insert needle at a 45° angle (Chernecky *et al.* 2002, Perry 2007). With the introduction of shorter needles (13 mm), it is recommended that insulin injections be given at an angle of 90° (King 2003). The length of the needle should be selected by pinching the skin tissue and selecting a needle one-half the width of the skinfold (Chernecky *et al.* 2002). Shorter needles should also be used at a 45° angle in children and underweight adults.

Specific patient preparations

It has been stated that it is not necessary to use an alcohol swab to clean the skin prior to administration of injections providing the skin is socially clean. If unsure or in immunocompromised patients, the skin should be prepared using an antiseptic swab (Dann 1969, Downie *et al.* 2003).

Procedure guideline 16.18 Medication: subcutaneous injection

Essential equipment

- Alcohol swab
- Needle
- Syringe containing prepared medication
- Sharps bin
- Non-sterile gloves

Preprocedure

Action	Rationale
1 Explain and discuss the procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (Griffith and Jordan 2003, E; NMC 2008b, C; NMC 2008c, C).
2 Consult the patient's prescription chart and ascertain the following: **(a)** Drug **(b)** Dose **(c)** Date and time of administration **(d)** Route and method of administration **(e)** Diluent as appropriate **(f)** Validity of prescription **(g)** Signature of doctor.	To ensure that the patient is given the correct drug in the prescribed dose using the appropriate diluent and by the correct route (NMC 2008a, C; NPSA 2007d, C).
3 Wash hands.	To prevent contamination of medication and equipment (DH 2007, C).

Procedure

4 Close the curtains or door and assist the patient into the required position.	To ensure patient's privacy and dignity. E To allow access to the appropriate injection site (Perry 2007, E).
5 Remove appropriate garments to expose the injection site.	To gain access for injection. E
6 Assess the injection site for signs of inflammation, oedema, infection and skin lesions.	To promote effectiveness of administration (Perry 2007, E). To reduce the risk of infection (Fraise and Bradley 2009, E; Workman 1999, E). To avoid skin lesions and possible trauma to the patient (Perry 2007, E).
7 Pinch the skin of the area and select the correct needle size.	To minimize the risk of missing the subcutaneous tissue and any ensuing pain (Perry 2007, E).
8 Clean the injection site with a swab saturated with isopropyl alcohol 70% and apply gloves.	To reduce the number of pathogens introduced into the skin by the needle at the time of insertion. (For further information on this action see Skin preparation.)
9 Gently pinch the skin up into a fold.	To elevate the subcutaneous tissue, and lift the adipose tissue away from the underlying muscle (Perry 2007, E).
10 Remove the needle sheath and hold syringe between thumb and forefinger of dominant hand as if grasping a dart.	To enable a quick smooth injection (Perry 2007, E).

11 Insert the needle into the skin at an angle of 45° and release the grasped skin (unless administering insulin when an angle of 90° should be used). Inject the drug slowly.	Injecting medication into compressed tissue irritates nerve fibres and causes the patient discomfort (Perry 2007, E). The introduction of shorter insulin needles makes 90° the more appropriate angle (Trounce and Gould 2000, E).
12 Withdraw the needle rapidly. Apply gentle pressure. Do not massage area.	To aid absorption. Massage can injure underlying tissue (Perry 2007, E).
Postprocedure	
13 Ensure that all sharps and non-sharp waste are disposed of safely and in accordance with locally approved procedures.	To ensure safe disposal and to avoid laceration or other injury to staff (MHRA, 2004, C; DH, 2005b, C).
14 Record the administration on appropriate sheets.	To maintain accurate records, provide a point of reference in the event of any queries and prevent any duplication of treatment (NMC 2008a, C; NMC 2009, C; NPSA 2007d, C).

Postprocedural considerations

Education of patient and relevant others

Patients often have to administer their own subcutaneous injections, for example insulin for diabetics. The nurse must teach the patient how to prepare and administer self-injection, including aspects such as equipment, storage, handwashing, injection technique and safe disposal of equipment and sharps (Perry 2007).

Complications

Medications collecting within the tissues can cause sterile abscesses, which appear as hardened, painful lumps (Perry 2007). The nurse must monitor and report these.

Subcutaneous Infusion

Definition

Continuous infusion of fluids or medication into the subcutaneous tissues (Perry 2007).

Evidence-based approaches

Methods for subcutaneous infusions of fluids (hypodermoclysis)

Hypodermoclysis is a method of infusing fluid into subcutaneous tissue that is easier than administering intravenous fluids (Sasson and Shvartzman 2001). Subcutaneous fluids can be given to maintain adequate hydration in patients with mild or moderate dehydration (Mei and Auerhahn 2009, Sasson and Shvartzman 2001). The use of this route is generally limited to palliative care or elderly patients. It is not recommended for patients needing rapid administration of fluids, and is also contraindicated in patients with clotting disorders or who have problems with fluid overload (such as those with cardiac failure) (Mei and Auerhahn 2009).

A volume of 1000–2000 mL can be given over 24 hours; this can be given as a continuous infusion, over a number of hours (such as overnight) or as intermittent boluses (Moriarty and Hudson 2001). More than one site can be used if greater volumes are required (Moses 2009). It is recommended that electrolyte-containing fluids such as sodium chloride 0.9% or dextrose saline be used although 5% glucose has also been used (Sasson and Shvartzman 2001). More than one site can be used to allow administration of a greater volume of fluid.

Advantages of this route include the following.

- Side-effects are few and not generally significant.
- It is a relatively easy procedure which can be carried out at home, reducing the need for hospitalization.
- May be set up and administered by nurses in almost any setting.
- Low cost.
- Less likely to cause fluid overload.
- Intravenous access can be problematic in elderly or debilitated patients; avoidance of this can reduce anxiety and distress (Mei and Auerhahn 2009,

Sasson and Shvartzman 2001).

Side-effects of subcutaneous fluid administration include pain, bruising, local oedema, erythema and local inflammation and can be reduced by changing the site of infusion (Mei and Auerhahn 2009).

Hyaluronidase is an enzyme which temporarily increases the permeability of subcutaneous connective tissue by degrading hyaluronic acid and has been shown to increase the dispersion and absorption of co-administered molecules (Thomas *et al.* 2009). It can be given as a subcutaneous injection before commencing fluids or added to infusion bags (Sasson and Shvartzman 2001). A randomized study compared absorption and side-effects of administration of subcutaneous fluids with or without hyaluronidase. No significant differences were found although patients not receiving hyaluronidase showed an increase in the size of the limb in which the fluid had been administered, but no differences in pain or local discomfort were found so no clear benefit to the use of hyaluronidase was demonstrated (Constans *et al.* 1991). Most agree that it is not necessary to use hyaluronidase if the infusion rate is 1 mL/min or less (Mei and Auerhahn 2009, Moses 2009).

Methods for subcutaneous infusions of drugs

This may be the route of choice in patients with problems such as vomiting, diarrhoea or dysphagia and who are unable to tolerate drugs by the oral route; patients with bowel obstruction whose gut absorption may be impaired may also benefit. It is also commonly used for patients who are dying and no longer able to manage medication orally (Dickman *et al.* 2007, Perry 2007). Continuous subcutaneous infusion of insulin is used in a small number of diabetic patients, particularly when adequate control cannot be achieved with multiple daily insulin doses. Such patients need to be under the care of a multidisciplinary team familiar with the use of such infusions (NICE 2003).

Infusions of a single drug, such as an antiemetic or analgesic, do not generally cause problems with stability. The drug should be diluted with a suitable diluent (sodium chloride is recommended for most drugs) and given over 12–24 hours (Dickman *et al.* 2007). The use of a combination of drugs can be problematic; there is anecdotal evidence regarding combinations of drugs but not many pharmaceutical studies confirming compatibility. Combinations of up to four drugs have been reported, but if compatibility is uncertain it may be best to use a second syringe pump. It is also important to ensure that the diluent used is

compatible with all the drugs in the infusion. It is recommended that infusions are not exposed to direct sunlight or to increased temperatures as drug instability may result (Dickman *et al.* 2007). Hyaluronidase may be used to enhance the pharmacokinetics of drugs such as subcutaneous morphine (Thomas *et al.* 2009).

Preprocedural considerations

Equipment

Access devices

Research has shown that the use of peripheral cannulas rather than steel winged infusion devices results in sites remaining viable for longer (Torre 2002). Incidence of needlestick injuries may also be reduced (Dawkins *et al.* 2000). It is now recommended that subcutaneous infusion be given via a plastic cannula. Administration of infusions of drugs or fluids requires the insertion of a 25 G winged infusion set or a 24 G cannula. These should be inserted at an angle of 45° and secured with a transparent dressing to enable inspection of the site. This may also be appropriate for patients not receiving a continuous infusion but requiring frequent subcutaneous injections; this is common practice in palliative care in order to reduce the number of needles inserted into the patient and the subsequent trauma caused.

Syringe driver

A syringe driver is a portable battery-operated infusion device. It is used to deliver drugs at a predetermined rate via the appropriate parenteral route (e.g. subcutaneous) and is suitable for symptom management and palliative care (Dickman *et al.* 2007, Quinn 2008). The syringe driver should be used for patients who are unable to tolerate oral medication, for example, in nausea and vomiting, dysphagia, intestinal obstruction, local disease or sometimes in intractable pain which is unrelieved by oral medications and where rapid dose titration is required. Drugs administered by subcutaneous infusion include opioid analgesics, antiemetics, anxiolytic sedatives, corticosteroids, non-steroidal anti-inflammatory drugs and anticholinergic drugs (Dickman *et al.* 2007).

The Sims (Graseby) Medical MS16A and MS26 syringe drivers are typical examples of drivers in use; however, other types are available and nurses should follow the manufacturer's instruction manual for details of their use. The MS16A allows drug administration at an hourly rate. This driver is clearly marked with a pink '1 h' in the bottom right-hand corner. The MS26 delivers drugs at a 24-hourly rate. This driver is clearly marked with a yellow '24 h' in the bottom right-hand corner (Figure 16.23). It is important that users are aware that the MS16A syringe driver is calibrated in millimetres per hour, and the MS26 is calibrated in millimetres per day. Confusion between the two drivers in relation to rate settings has resulted in fatal errors (Dickman *et al.* 2007, MHRA 2006a). Most sizes and brands of plastic syringes can be used with these drivers; however, it is recommended to use Luer-Lok syringes to avoid leakage or accidental disconnection.

Figure 16.23 Sims (Graseby) Medical MS26 daily rate syringe driver.

The advantages of the syringe driver are as follows.

- It avoids the necessity of intermittent injections.
- Mixtures of drugs may be administered.

- Infusion timing is accurate, which is particularly advantageous in the community where it is not possible to constantly monitor the rate.
- The device is lightweight and compact, allowing mobility and independence.
- Rate can be increased.
- Simple calculations of dosage are required over a 12-or 24-hour period.
- It allows patients to spend more time at home with their symptoms managed effectively.

The disadvantages are as follows.

- The patient may become psychologically dependent on the device.
- Inflammation or infection may occur at the insertion site of the subcutaneous cannula.
- The rate calculation differs between the Sims (Graseby) Medical MS16A and MS26 syringe drivers and this can be confusing for the nurse.
- The alarm system of some syringe drivers, for example the Sims (Graseby), operates only if the plunger is obstructed. It does not alert the nurse if the flow is too rapid or too slow.

(Dickman *et al.* 2007)

Specific patient preparations

Infusion sites

Choice of site should be based on both thickness of subcutaneous tissue and patient convenience. Sites recommended for subcutaneous infusion of drugs or fluids are the lateral aspects of the upper arms and thighs, the abdomen, the chest and the scapula (Mitten 2001). If the patient is ambulant then the chest or abdomen is the preferred site (Dickman *et al.* 2007). The following areas should not be used.

- Lymphoedematous areas, as absorption may be impaired and infection may be introduced.
- Sites over bony prominences, as there may be insufficient subcutaneous tissue.
- Previously irradiated skin areas, as absorption may be impaired.
- Sites near a joint, as movement may cause the cannula to become dislodged.
- Any areas of inflamed, infected or broken skin (Mitten 2001, Perry 2007).

Rotation of the site every 3 days should be routine in order to minimize site reactions although in some patients this may not be feasible so the infusion site must be monitored regularly and the device resited as necessary (Dickman *et al.* 2007).

Procedure guideline 16.19 Medication: subcutaneous infusion of fluids

Essential equipment

- Clinically clean receiver or tray containing the prepared drug to be administered
- Sharps box
- Isopropyl alcohol 70% swab
- Transparent adhesive dressing
- Infusion fluid
- Administration set
- Winged infusion set or 24 G cannula

Preprocedure

Action	Rationale
1 Explain and discuss the procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (Griffith and Jordan 2003, E; NMC 2008b, C; NMC 2008c, C).
2 Before administering any prescribed fluid check that it is due and has not already been given.	To protect the patient from harm (NPSA 2007d, C).
3 Before administering any prescribed fluid, consult the patient's prescription chart and ascertain the following: **(a)** Type of fluid **(b)** Volume **(c)** Date and time of administration **(d)** Route and method of administration **(e)** Diluent as appropriate **(f)** Validity of prescription **(g)** Signature of doctor **(h)** The prescription is legible.	To ensure that the patient is given the correct fluid in the prescribed dose using the appropriate diluent and by the correct route. To protect the patient from harm (NMC 2008a, C; NPSA 2007d, C).
4 Wash hands with bactericidal soap and water or bactericidal alcohol handrub, and assemble the necessary equipment.	To minimize the risk of infection (Fraise and Bradley 2009, E; Pratt *et al.* 2007, C).

Procedure

5 Check the name and volume of infusion fluid against the prescription chart.	To ensure that the correct type and quantity of fluid are administered (NMC 2008a, C; NPSA 2007d, C).
6 Check the expiry date of the infusion bag.	To prevent an ineffective or toxic compound being administered to the patient (NPSA 2007d, C).
7 Check that the packaging is intact and inspect the container and contents in a good light for cracks, punctures, air bubbles.	To check that no contamination of the infusion container has occurred (NPSA 2007d, C).
8 Inspect the fluid for discoloration, haziness and	To prevent any toxic or foreign matter being

crystalline or particulate matter. If this occurs, discard.	To prevent any toxic or foreign matter being infused into the patient (NPSA 2007d, C). To detect any incompatibility or degradation (NPSA 2007d, C).
9 Establish the correct drip rate setting using the correct calculation.	To monitor rate and ensure fluid is infused safely (Pickstone 1999, E).
10 Place the infusion bag and administration set in a clean receptacle. Wash hands and proceed to the patient.	To minimize the risk of contamination (Pratt *et al.* 2007, C).
11 Check the identity of the patient against the prescription chart, and with the patient.	To minimize the risk of error and ensure the correct fluid is administered to the correct patient (NMC 2006a, C; NMC 2008a, C; NPSA 2007d, C).
12 Place the infusion bag on a flat surface, remove the seal and insert the spike of the administration set fully into the infusion bag port.	To prevent puncturing the side of the infusion and to reduce the risk of contamination (DH 2007, C).
13 Hang the infusion bag from a drip stand.	To allow gravity flow. E
14 Open the roller clamp and allow the fluid through the set to prime it. Close clamp.	To remove air from the set. E
15 Assist the patient into a comfortable position.	To ensure patient comfort during the proedure. E
16 Expose the chosen site for infusion.	To expose the area. E
17 Clean the chosen site with a swab saturated with 70% isopropyl alcohol. Wait until the alcohol evaporates.	To reduce the risk of infection and prevent stinging sensation on insertion of needle (Fraise and Bradley 2009, E; Pratt *et al.* 2007, C).
18 Grasp the skin firmly.	To elevate the subcutaneous tissue. E
19 Insert the infusion needle into the skin at an angle of 45°, bevel up, and release the grasped skin. (If using a cannula, remove the stylet.)	To gain access to the subcutaneous tissue (Moses 2009, E; Sasson and Shvartzman 2001, E).
20 Connect the administration set to the device.	To commence the infusion. E
21 Apply transparent dressing to secure infusion device.	To prevent movement and reduce the risk of mechanical phlebitis and infection (Fraise and Bradley 2009, E; Moses 2009, E; Pratt *et al.* 2007, C; Weinstein and Plumer 2007, E).
22 Open the roller clamp and adjust until the flow rate is achieved.The rate is usually 1 mL/min per site by gravity.	To ensure the correct rate is set (Moses 2009, E).
Postprocedure	
23 Complete the patient's prescription chart and other hospital and/or legally required documents. This should include infusion device and site checks.	To comply with local drug administration policies and provide a record in the event of any queries (NMC 2009, C). To prevent any duplication of treatment (NMC 2009, C).
24 Monitor the patient for any infusion-or site-related complications.	To detect complications promptly (Sasson and Shvartzman 2001, E).
25 Ask the patient to report any pain or tenderness at the infusion site.	To ascertain whether there are any problems that may require nursing care and refer to medical staff where appropriate. E.
26 Discard waste, making sure that it is placed in the correct containers, for example sharps into a designated receptacle.	To ensure safe disposal and avoid injury to staff. To prevent reuse of equipment (DH 2005, C; MHRA 2004, C).

Procedure guideline 16.20 Medication:

Procedure guideline 16.20 Medication: subcutaneous administration using a Graseby syringe driver

Essential equipment

- Clinically clean receiver or tray containing the prepared drug to be administered
- Syringe driver/pump
- Battery (PP3 size, 9 volt alkaline)
- Plastic peripheral cannulas (e.g. 24 G) and microbore driver set (100 cm) with needle-free Y connector injection site (or 100 cm winged infusion set)
- Luer-Lok syringe of suitable size (e.g. 10 mL)
- Isopropyl alcohol 70% swab
- Transparent adhesive dressing
- Drugs and diluent
- Needle (to draw up drug)
- Drug additive label
- Patient's prescription chart
- Recording chart or book as required by law or hospital policy
- Sharps box

Preprocedure

Action	Rationale
1 Explain and discuss the procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (Griffith and Jordan 2003, E; NMC 2008b, C; NMC 2008c, C).
2 Before administering any prescribed drug, check that it is due and has not already been given.	To protect the patient from harm (NPSA 2007d, C).
3 Before administering any prescribed drug, consult the patient's prescription chart and ascertain the following: **(a)** Drug **(b)** Dose **(c)** Date and time of administration **(d)** Route and method of administration **(e)** Diluent as appropriate **(f)** Validity of prescription **(g)** Signature of doctor **(h)** The prescription is legible.	To ensure that the patient is given the correct drug in the prescribed dose using the appropriate diluent and by the correct route. To protect the patient from harm (NMC 2008a, C; NPSA 2007d, C).
4 Calculate and check dosage of drugs required over a 24-hour period.	To establish correct dosages of drugs (Pickstone 1999, E).
5 Wash hands with bactericidal soap and water or bactericidal alcohol handrub, and assemble the necessary equipment.	To minimize the risk of infection (Fraise and Bradley 2009, E; Pratt *et al.* 2007, C).
Procedure	
6 Check the name, strength and volume of subcutaneous drug(s) against the prescription chart.	To ensure that the correct type and quantity of fluid are administered (NMC

	2008a, C; NPSA 2007d, C).
7 Check the expiry date of the drug(s).	To prevent an ineffective or toxic compound being administered to the patient (NPSA 2007d, C).
8 Check that the packaging is intact and inspect the container and contents in a good light for cracks, punctures, air bubbles.	To check that no contamination of the infusion container has occurred (NPSA 2007d, C).
9 Check the identity and amount of drug to be prepared. Consider: **(a)** Compatibility of drugs **(b)** Stability of mixture over the prescription time **(c)** Any special directions for dilution, for example pH, optimum concentration **(d)** Sensitivity to external factors such as light **(e)** Any anticipated allergic reaction. If any doubts exist about the listed points, consult the pharmacist or appropriate reference works.	To minimize any risk of error. To ensure safe and effective administration of the drug. To enable anticipation of toxicities and the nursing implications of these (NPSA 2007d, C).
10 Using a Luer-Lok syringe, draw up drugs required with diluent to measure a total volume (this will depend on type of syringe device used).	To ensure accuracy and avoid any infusion errors. To ensure the drug is prepared correctly (NPSA 2007d, C).
11 Inspect the fluid for discoloration, haziness and crystalline or particulate matter. If this occurs, discard and re-evaluate drug compatability. *Note*: This can occur even if the mixture is theoretically compatible, thus making vigilance essential.	To prevent any toxic or foreign matter being infused into the patient (NPSA 2007d, C). To detect any incompatibility or degradation (NPSA 2007d, C).
12 Establish the correct rate setting of the driver using the correct calculation.	To monitor rate and ensure drug is infused safely (Dickman *et al.* 2007, E; Pickstone 1999, E).
13 Measure stroke length in millimetres. The stroke length is the *length* of fluid to be infused, that is, the distance the plunger has to travel (irrespective of the number of millilitres) (see Action Figure 13).	Example: Stroke length = 48 mm Delivery time = 1 day Rate setting = 48 mm

Action Figure 13 Measuring stroke length.

14 Check the delivery time (previously prescribed) in days. Set rate using screwdriver provided (see Action Figure 14). **Action Figure 14** Setting the rate. 	To ensure correct rate setting. E
15 Calculate: $\text{Rate} = \frac{\text{Fluid length}}{\text{Infusion period in days}}$	See instruction booklets provided with individual syringe driver (manufacturer's instructions, C).
16 Complete the drug additive label and fix it on the syringe.	To identify which drug has been added, when and by whom (NPSA 2007d, C).
17 Wash hands with bactericidal soap and water or bactericidal alcohol handrub.	To minimize the risk of infection (Fraise and Bradley 2009, E; Pratt *et al.* 2007, C).
18 Connect prepared syringe to a 100 cm microbore driver set with needle-free Y connector injection site.	This length of tubing allows patient greater freedom of movement. E.
19 Prime the infusion by gently depressing the plunger of the syringe until the fluid is visible at the end of the infusion set. Priming the infusion set after calculation will reduce the delivery time by approximately half an hour for the first infusion. Do not alter previously calculated rate setting despite volume reduction in barrel of syringe.	This removes extraneous air from the system. E Ensures patient receives drugs immediately and accurately. E
20 Place the syringe and infusion set in a clean receptacle. Wash hands and proceed to the patient.	To minimize the risk of contamination (Pratt *et al.* 2007, C).
21 Check the identity of the patient against the prescription chart, syringe drug additive label and with the patient if possible.	To minimize the risk of error and ensure the correct drug is administered to the correct patient (NMC 2006a, C; NMC 2008a, C; NPSA 2007d, C).
22 Assist the patient into a comfortable position.	To aid patient comfort. E
23 Expose the chosen site for infusion.	To ensure access to site. E
24 Clean the chosen site with a swab saturated with 70% isopropyl alcohol. Wait until the alcohol evaporates.	To reduce the risk of infection and prevent stinging sensation on insertion of needle (Fraise and Bradley 2009, E; Pratt *et al.* 2007, C).
25 Grasp the skin firmly.	To elevate the subcutaneous tissue. E
26 Insert the infusion needle into the skin at an angle of 45° and release the grasped skin. (If using a cannula, remove the stylet and connect the extension set.)	Positioning shallower than 45° may shorten the life of the infusion site. E
27 Apply transparent dressing to secure infusion device.	To prevent movement and reduce the risk of mechanical phlebitis and infection (Fraise and Bradley 2009, E; Pratt *et al.* 2007, C; Weinstein and Plumer 2007, E)

	Plumer 2007, E).
28 Check that the infusion set and syringe are securely connected.	To ensure that there is no disconnection so that the drug(s) are administered correctly. E
29 Connect the syringe to the syringe driver/pump.	To ensure the syringe is connected correctly to the syringe driver/pump. E
30 Place the syringe on the syringe driver along the grooved lines, with barrel clamp firmly in position.	To ensure the syringe is in the correct position. C
31 Secure in place with rubber strap.	To ensure the syringe is securely clamped to the barrel. C
32 Slide the actuator assembly along the lead screw by pressing white release button, as shown in Action Figure 32, until it rests against the end of the plunger.	To enable the pump mechanism to operate correctly. C

Action Figure 6 Connecting syringe to syringe driver.

33 Secure plunger with additional safety clamp (see Action Figure 33) and clear Perspex container.	To ensure extra security and minimize the risk of errors in infusional rates. C

Action Figure 33 Securing the plunger.

34 Fit the battery, ensuring contact by flashing light on front of syringe driver.	To ensure device is working. E
35 Press start/test button to commence infusion. The indicator light should flash to indicate functioning syringe pump.	To check the infusion device is operating correctly. C
Postprocedure	
36 Complete the patient's prescription chart and other hospital and/or legally required documents. This should include infusion device serial number and infusion device and site checks.	To comply with local drug administration policies and ensure the safe administration and monitoring of

	the infused drug and accurate records. To provide a record in the event of any queries (NMC 2009, C). To prevent any duplication of treatment (NMC 2009, C).
37 Monitor the patient for any infusion-related complications.	To detect complications promptly (Dickman *et al.* 2007, E; Dougherty 2002, E; MHRA 2010b, C; Pickstone 1999, E; Quinn 2000, E).
38 Ask the patient to report any pain and tenderness at the infusion site and if they experience any change in their symptoms or have new symptoms.	To ascertain whether there are any problems that may require nursing care and refer to medical staff where appropriate. E
39 Discard waste, making sure that it is placed in the correct containers, for example sharps into a designated receptacle.	To ensure safe disposal and avoid injury to staff. To prevent reuse of equipment (DH 2005, C; MHRA 2004, C).

Procedure guideline 16.21 Medication: subcutaneous administration using a McKinley T34

Essential equipment

- Clinically clean receiver or tray containing the prepared drug to be administered
- Syringe driver/pump
- Battery (PP3 size, 9 volt alkaline)
- Plastic peripheral cannulas (e.g. 24 G) and microbore driver set (100 cm) with needle-free Y connector injection site (or 100 cm winged infusion set)
- Luer-Lok syringe of suitable size (e.g. 10 mL)
- Swab saturated with isopropyl alcohol 70%
- Transparent adhesive dressing
- Drugs and diluent
- Needle (to draw up drug)
- Drug additive label
- Patient's prescription chart
- Recording chart or book as required by law or hospital policy
- Sharps box

Preprocedure

Action	Rationale
1 Explain and discuss the procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (Griffith and Jordan 2003, E; NMC 2008b, C; NMC 2008c, C).
2 Before administering any prescribed drug, check that it is due and has not already been given.	To protect the patient from harm (NPSA 2007d, C).
3 Before administering any prescribed drug, consult the patient's prescription chart and ascertain the following: **(a)** Drug **(b)** Dose **(c)** Date and time of administration **(d)** Route and method of administration **(e)** Diluent as appropriate To comply with NMC (2006a, C; 2008a, C). **(f)** Validity of prescription **(g)** Signature of doctor **(h)** The prescription is legible.	To ensure that the patient is given the correct drug in the prescribed dose using the appropriate diluent and by the correct route. To protect the patient from harm (NMC 2008a, C; NPSA 2007d, C).
4 Calculate and check dosage of drugs required over a 24-hour period.	To establish correct dosages of drugs (Pickstone 1999, E).
5 Wash hands with bactericidal soap and water or bactericidal alcohol handrub, and assemble the necessary equipment.	To minimize the risk of infection (Fraise and Bradley 2009, E; Pratt *et al.* 2007, C).

Procedure

6 Check the name, strength and volume of subcutaneous drug(s) against	To ensure that the correct type and

the prescription chart.	quantity of fluid are administered (NMC 2008a, C; NPSA 2007d, C).
7 Check the expiry date of the drug(s).	To prevent an ineffective or toxic compound being administered to the patient (NPSA 2007d, C).
8 Check that the packaging is intact and inspect the container and contents in a good light for cracks, punctures, air bubbles.	To check that no contamination of the infusion container has occurred (NPSA 2007d, C).
9 Check the identity and amount of drug to be prepared. Consider: **(a)** Compatibility of drugs **(b)** Stability of mixture over the prescription time **(c)** Any special directions for dilution, for example pH, optimum concentration **(d)** Sensitivity to external factors such as light **(e)** Any anticipated allergic reaction. If any doubts exist about the listed points, consult the pharmacist or appropriate reference works.	To minimize any risk of error. To ensure safe and effective administration of the drug. To enable anticipation of toxicities and the nursing implications of these (NPSA 2007d, C).
10 Using a Luer-Lok syringe, draw up drugs required with diluent to measure a total volume (this will depend on type of syringe device used). See Box 16.13 for McKinley T34 recommended volumes and Action Figure 10 for a McKinley T34 syringe pump.	To ensure accuracy and avoid any infusion errors. To ensure the drug is prepared correctly (NPSA 2007d, C).

Action Figure 10 McKinley T34 syringe pump.

11 Inspect the fluid for discoloration, haziness and crystalline or particulate matter. If this occurs, discard and re-evaluate drug compatability. *Note*: This can occur even if the mixture is theoretically compatible, thus making vigilance essential.	To prevent any toxic or foreign matter being infused into the patient (NPSA 2007d, C). To detect any incompatibility or degradation (NPSA 2007d, C).
12 Establish the correct rate setting of the driver using the correct calculation.	To monitor rate and ensure drug is infused safely (Dickman *et al.* 2007, E; Pickstone 1999, E).
13 Complete the drug additive label and fix it onto the syringe without obscuring the markings.	To identify which drug has been added, when and by whom and be able to

	visually inspect the amount in the syringe (NPSA 2007d, C).
14 Wash hands with bactericidal soap and water or bactericidal alcohol handrub.	To minimize the risk of infection (Fraise and Bradley 2009, E; Pratt *et al.* 2007, C).
15 Connect prepared syringe to a 100 cm microbore driver set with needle-free Y connector injection site.	This length of tubing allows patient greater freedom of movement. E
16 Prime the infusion by gently depressing the plunger of the syringe until the fluid is visible at the end of the infusion set. Priming the infusion set after calculation will reduce the delivery time by approximately half an hour for the first infusion. Do not alter previously calculated rate setting despite volume reduction in barrel of syringe.	This removes extraneous air from the system. E Ensures patient receives drugs immediately and accurately. E
17 Place the syringe and infusion set in a clean receptacle. Wash hands and proceed to the patient.	To minimize the risk of contamination (Pratt *et al.* 2007, C).
18 Check the identity of the patient against the prescription chart, syringe drug additive label and with the patient if possible.	To minimize the risk of error and ensure the correct drug is administered to the correct patient (NMC 2006a, C; NMC 2008a, C; NPSA 2007d, C).
19 Assist the patient into a comfortable position.	To aid patient comfort. E
20 Expose the chosen site for infusion.	To gain access to the site. E
21 Clean the chosen site with a swab saturated with 70% isopropyl alcohol. Wait until the alcohol evaporates.	To reduce the risk of infection and prevent stinging sensation on insertion of needle (Fraise and Bradley 2009, E; Pratt *et al.* 2007, C).
22 Grasp the skin firmly.	To elevate the subcutaneous tissue. E
23 Insert the infusion needle into the skin at an angle of 45° and release the grasped skin. (If using a cannula, remove the stylet and connect the extension set.)	Positioning shallower than 45° may shorten the life of the infusion site. E
24 Apply transparent dressing to secure infusion device.	To prevent movement and reduce the risk of mechanical phlebitis and infection (Fraise and Bradley 2009, E; Pratt *et al.* 2007, C; Weinstein and Plumer 2007, E).
25 Check that the infusion set and syringe are securely connected.	To ensure that there is no disconnection so that the drug(s) are administered correctly. E
26 Connect the syringe to the syringe driver/pump.	To ensure the syringe is connected correctly to the syringe driver/pump. E
27 Press the <<FF or >>Back key to adjust the actuator to accommodate the syringe. Lift the barrel arm and ensure the syringe is loaded so as to stop all three sensors (barrel, collar and plunger) flashing.	To ensure the syringe is in the correct position. (manufacturer's instructions, C).
28 The pump will detect size and brand of syringe. Check and confirm by pressing YES key.	To enable the pump mechanism to operate correctly (manufacturer's instructions, C).
29 Set a new programme for each syringe.	To clear previous programme and reduce risk of error (manufacturer's instructions, C).
30 Pump measures deliverable volume in syringe. Use down arrow key to select a smaller volume.	May be necessary to allow for KVO volume. E
31 Press Yes to confirm volume to be infused. Press Yes to confirm infusion duration. Pump displays rate calculated on volume and duration set by user. Then press Yes to confirm.	To complete set-up of device (manufacturer's instructions, C).

32 Secure in the clear Perspex lock box.	To ensure extra security and minimize the risk of errors in infusional rates. E
Postprocedure	
33 Complete the patient's prescription chart and other hospital and/or legally required documents. This should include infusion device serial number and infusion device and site checks.	To comply with local drug administration policies and ensure the safe administration and monitoring of the infused drug and accurate records. To provide a record in the event of any queries (NMC 2009, C). To prevent any duplication of treatment (NMC 2009, C).
34 Monitor the patient for any infusion-related complications.	To detect complications promptly (Dickman *et al.* 2007, E; Dougherty 2002, E; MHRA 2010b, C; Pickstone 1999, E; Quinn 2000, E).
35 Ask the patient to report any pain and tenderness at the infusion site and if they experience any change in their symptoms or have new symptoms.	To ascertain whether there are any problems that may require nursing care and refer to medical staff where appropriate. E
36 Discard waste, making sure that it is placed in the correct containers, for example sharps into a designated receptacle.	To ensure safe disposal and avoid injury to staff. To prevent reuse of equipment (DH 2005, C; MHRA 2004, C).

Box 16.13 Volumes for syringe pumps

- 10 mL syringe must be drawn up to 10 mL (approx. rate = 0.42 mL per 24 hours)
- 20 mL syringe must be drawn up to 17 mL (approx. rate = 0.71 mL per 24 hours)
- 30 mL syringe must be drawn up to 22 mL (approx. rate = 0.92 mL per 24 hours)
- 60 mL syringe must be drawn up to 32 mL (approx. rate = 1.33 mL per 24 hours)

Problem-solving table 16.2 Prevention and resolution (Procedure guideline 16.21)

Problem	Cause	Prevention	Action
Precipitation or cloudiness in the syringe	Indicates incompatability	Check compatability prior to mixing. Use www.pallcarematters.co.uk for up-to-date advice	Remove syringe, dispose of contents and prepare a new syringe

Postprocedural considerations

Ongoing care

Accurate documentation of the site, rate, flow, start time and drugs used is imperative in order to avoid confusion and errors amongst staff (Dickman *et al.* 2007, Dougherty 2002, MHRA 2010b, Moses 2009, NMC 2006a, NMC 2008a, NMC 2009, Quinn 2000, Sasson and Shvartzman 2001). Sites and tubing may need to be changed every 1–4 days (Moses 2009).

The frequency of checks should be as follows.

- At start of infusion – record date, time, start volume, infusion rate setting, name of person setting up infusion.
- Based upon the type of infusion and patient's condition; however, at a minimum these should be carried out 15 minutes and 1 hour after the initial set-up and thereafter a minimum of every 4 hours.
- Device must be checked at the start of each shift and/or when setting up an infusion.

Infusion device and infusion checks

- Check and record the date, time, rate and volume remaining and that the battery/syringe driver is working.
- Record any reasons for changing of the drug, dose, rate setting of syringe driver or site.
- Check subcutaneous site for:
  - pain/discomfort
  - swelling/induration
  - erythema
  - leakage of fluid
  - bleeding.

Complications

Skin reactions

Some drugs are particularly likely to cause irritation and may need to be diluted in a greater volume of diluent; cyclizine and levomepromazine are amongst these. This may result in skin sites that break down rapidly or site reactions. The following methods can help to prevent this.

- Check compatibility of drugs and diluents and consider changing the drug combination.
- Dilute the solution as much as possible or change the diluent.
- Rotate the site at least every 72 hours.
- Use of a non-metal cannula.
- Use a different site cleanser.
- Change the dressing used.
- Consider adding dexamethasone 1 mg to the driver; this may be helpful but is not currently recommended for routine use. Care should also be taken as dexamethasone is incompatible with a number of drug combinations (Dickman *et al*. 2007).

Intramuscular Injections

Definition

An intramuscular injection deposits medication into deep muscle tissue under the subcutaneous tissue (Chernecky *et al.* 2002). The vascularity of muscle aids the rapid absorption of medication (Perry 2007).

Evidence-based approaches

Site and volume of injection

Selecting the site requires correct identification of the muscle groups by landmarking correct anatomical features (Hunter 2008). Choice will be influenced by the patient's physical condition and age. Intramuscular injections should be given into the densest part of the muscle (Pope 2002). An active patient will probably have a greater muscle mass than older or emaciated patients (Hunter 2008).

The injectable volume will depend on the muscle bed. In children, injectable volumes should be halved because muscle mass is less (Workman 1999). However, it appears that it is the medicine rather than just the volume that affects how a patient tolerates the injection. Malkin (2008) uses Botox injections as an example where a volume of 1–3 mL can be injected into facial muscle groups, supporting the view that tolerance of the drug is more important than the volume.

Current research evidence suggests that there are five sites that can be utilized for the administration of intramuscular injections (Rodger and King 2000, Tortora and Derrickson 2009).

- The *ventrogluteal site* (Figure 16.24a) is relatively free of major nerves and blood vessels and the muscle is large and well defined, making it easy to locate (Greenway 2004). It is located by placing the palm of the hand on the patient's opposite greater trochanter (right hand on left hip). The index finger is then extended to the anterior superior iliac spine to make a V. Injection in the centre of the V will ensure the injection is given into the gluteus medius muscle (Hunter 2008). This is the site of choice for intramuscular injections (Rodger and King 2000) and used for antibiotics, antiemetics, deep intramuscular and Z-track injections in oil, narcotics and sedatives. Up to 2.5 mL can be safely injected into the ventrogluteal site (Rodger and King 2000).

Figure 16.24 Intramuscular injection sites.

Reproduced from Rodger and King (2000) with permission.

- The *deltoid site* (Figure 16.24b) has the advantage of being easily accessible whether the patient is standing, sitting or lying down. It is found by visualizing a triangle where the horizontal line is located 2.5–5 cm below the acromial process and midpoint of the lateral aspect of the arm, in line with the axilla to form the apex (Hunter 2008). The injection is then given 2.5 cm down from the acromial process, avoiding the radial and brachial nerves. Owing to the small area of this site, the number and volume of injections which can be given into it are limited. Drugs such as narcotics, sedatives and vaccines, which are usually small in volume, tend to be administered into the deltoid site (Workman 1999). Rodger and King (2000) state that the maximum volume that should be administered at this site is 1 mL.
- The *dorsogluteal site* (Figure 16.24c) or upper outer quadrant is the

traditional site of choice and is used for deep intramuscular and Z-track injections. It is located by using imaginary lines to divide the buttocks into four quarters. However, this site carries the danger of the needle hitting the sciatic nerve and the superior gluteal arteries (Workman 1999). The gluteus muscle has the lowest drug absorption rate and this can result in a build-up in the tissues, increasing the risk of overdose (Malkin 2008). The muscle mass is also likely to have atrophied in elderly, non-ambulant and emaciated patients. Finally, it appears that there is a risk that the medication will not reach the muscle due to the amount of subcutaneous tissue in this area (Greenway 2004) and so it is not recommended for routine immunizations due to the poor absorption and risk of nerve injury (DH 2006, WHO 2004). In adults, up to 4 mL can be safely injected into this site (Rodger and King 2000).

- The *rectus femoris site* (Figure 16.24d) is a well-defined muscle found by measuring a hand's breadth from the greater trochanter and the knee joint, which identifies the middle third of the quadriceps muscle (Hunter 2008). It is used for antiemetics, narcotics, sedatives, injections in oil, deep intramuscular and Z-track injections. It is rarely used by nurses, but is easily accessed for self-administration of injections or for infants (Workman 1999). 1–5 mL can be injected (1–3 mL in children).
- The *vastus lateralis site* (Figure 16.24d) is used for deep intramuscular and Z-track injections. One of the advantages of this site is its ease of access but more importantly, there are no major blood vessels or significant nerve structures associated with this site. It is the better option in the obese patient (Nisbet 2006). Up to 5 mL can be safely injected (Rodger and King 2000).

There is debate over which site to use. The two recommended are the vastus lateralis and the ventrogluteal, but most nurses tend to use the dorsogluteal as it is more familiar (Greenway 2004).

Rate of administration

It is recommended that the plunger is depressed at a rate of 10 seconds per millilitre.

Technique

The Z-track method involves pulling the skin downwards or to one side of the injection site and inserting the needle at a right angle to the skin, which moves the cutaneous and subcutaneous tissues by approximately 1–2 cm (Workman 1999). The injection is given and the needle withdrawn, while releasing the retracted skin at the same time. This manoeuvre seals off the puncture track. An angle of 90° is supported by the DH (2006). The syringe should be held like a pen to insert with a dart-like motion. Aspiration is still an accepted part of an IM injection to ensure that the medication does not enter the capillaries or is inadvertently given intravenously (Hunter 2008), but there is no evidence to support this. Some centres have had to adapt as safety devices do not allow the withdrawal of the plunger as the safety system can then be activated.

Preprocedural considerations

Equipment

The most common size of needle is 21 G (23 G may also be used in a thin patient) but it does depend on the viscosity of the medication. The important aspect of the needle is the length. The correct use of needle length will result in fewer adverse events and reduce complications of absecess, pain and bruising (Malkin 2008). Needles should be long enough to penetrate the muscle and still allow a quarter of the needle to remain external to the skin (Workman 1999). Lenz (1983) states that when choosing the correct needle length for intramuscular injections, it is important to assess the muscle mass of the injection site, the amount of subcutaneous fat and the weight of the patient. It may be necessary to calibrate the BMI to calculate body fat (DH 2006). Without such an assessment, most injections intended for gluteal muscle are deposited in the gluteal fat. The following are suggested as ways of determining the most suitable size of needle to use.

Deltoid and vastus lateralis muscles

The muscle to be used should be grasped between the thumb and forefinger to determine the depth of the muscle mass or the amount of subcutaneous fat at the injection site.

Gluteal muscles

The layer of fat and skin above the muscle should be gently lifted with the thumb and forefinger for the same reasons as before. Use the patient's weight to calculate the needle length required.

The following are recommended but remembering that women have more subcutaneous tissue than men.

- Children 16 mm needle
- 31.5–40.0 kg 25 mm needle
- 40.5–90.0 kg 25 mm needle
- 90 kg 38 mm needle

(Pope 2002)

Specific patient preparations

Skin preparation

There are many inconsistencies regarding skin cleaning prior to subcutaneous or intramuscular injections. Previous studies have suggested that cleaning with an alcohol swab is not always necessary, as not cleaning the site does not result in infections and may predispose the skin to hardening (Dann 1969, Koivistov and Felig 1978, Workman 1999).

Dann (1969), in a study over a period of 6 years involving more than 5000 injections, found no single case of local and/or systemic infection. Koivistov and Felig (1978) concluded that whilst skin preparations did reduce skin bacterial count, they are not necessary to prevent infections at the injection site. Some hospitals accept that if the patient is physically clean and the nurse maintains a high standard of hand hygiene and asepsis during the procedure, skin disinfection is not necessary (Workman 1999).

In the immunosuppressed patient, the skin should be cleaned as such patients may become infected by inoculation of a relatively small number of pathogens (Downie *et al.* 2003). The practice at the Royal Marsden Hospital is to clean the skin prior to injection in order to reduce the risk of contamination from the patient's skin flora. The skin should be cleaned using an 'alcohol swab' (containing 70% isopropyl alcohol) for 30 seconds and then allowed to dry. If the skin is not dry before proceeding, skin cleaning is ineffective and the antiseptic may cause irritation by being injected into the tissues (Downie *et al*. 2003).

Procedure guideline 16.22 Medication: intramuscular injection

Essential equipment

- Alcohol swab
- Needle
- Syringe containing prepared IM medication

Preprocedure

Action	**Rationale**
1 Explain and discuss the procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (Griffith and Jordan 2003, E; NMC 2008b, C; NMC 2008c, C).
2 Consult the patient's prescription sheet and ascertain the following:	To ensure that the patient is given the correct drug in the prescribed dose using the appropriate diluent and by the correct route (NMC 2008a, C; NPSA 2007d, C).
(a) Drug	
(b) Dose	
(c) Date and time of administration	
(d) Route and method of administration	
(e) Diluent as appropriate	
(f) Validity of prescription	
(g) Signature of doctor.	

Procedure

3 Close the curtains or door and assist the patient into the required position.	To ensure patient privacy and dignity. E To allow access to the injection site and to ensure the designated muscle group is flexed and therefore relaxed (Workman 1999, E).
4 Remove the appropriate garment to expose the injection site.	To gain access for injection (Workman 1999, E).
5 Assess the injection site for signs of inflammation, oedema, infection and skin lesions.	To promote effectiveness of administration (Workman 1999, E). To reduce the risk of infection (Fraise and Bradley 2009, E; Workman 1999, E). To avoid skin lesions and avoid possible trauma to the patient (Perry 2007, E; Workman 1999, E).
6 Clean the injection site with a swab saturated with isopropyl alcohol 70% for 30 seconds and allow to dry for 30 seconds (Workman 1999).	To reduce the number of pathogens introduced into the skin by the needle at the time of insertion and to prevent stinging sensation if alcohol is taken into the tissues upon needle entry (Hunter 2008, E; Workman 1999, E). (For further information on this action see Skin preparation.)
7 With the non-dominant hand, stretch the skin slightly around the injection site.	To displace the underlying subcutaneous tissues, facilitate the insertion of the needle and reduce the sensitivity of nerve endings (Hunter 2008, E; Workman 1999, E).
8 Holding the syringe in the dominant hand like a dart, inform the patient and quickly plunge the needle at an angle of 90° into the skin until about 1 cm of the needle is left showing.	To ensure that the needle penetrates the muscle (Hunter 2008, E; Workman 1999, E).
9 Pull back the plunger. If no blood is aspirated, depress the plunger at approximately 1 mL every 10 seconds and inject the drug slowly. If blood appears, withdraw the needle completely, replace it and begin	To confirm that the needle is in the correct position and not in a vein (Workman 1999, E). This allows time for the muscle fibres to expand and absorb the solution (Hunter 2008, E; Workman 1999, E). To prevent pain and ensure

again. Explain to the patient what has occurred.	even distribution of the drug (Perry 2007, E).
10 Wait 10 seconds before withdrawing the needle.	To allow the medication to diffuse into the tissue (Perry 2007, E; Workman 1999, E).
11 Withdraw the needle rapidly. Apply gentle pressure to any bleeding point and then apply a small plaster over the puncture site.	To prevent tissue injury and haematoma formation (Perry 2007, E).
Postprocedure	
12 Ensure that all sharps and non-sharp waste are disposed of safely and in accordance with locally approved procedures, for example put sharps into sharps bin and syringes into orange clinical waste bag.	To ensure safe disposal and to avoid laceration or other injury to staff (DH 2005, C; MHRA 2004, C).
13 Record the administration on appropriate charts.	To maintain accurate records, provide a point of reference in the event of any queries and prevent any duplication of treatment (NMC 2008a, C; NMC 2009, C; NPSA 2007d, C).

Intravenous Injections and Infusions

Definition

The introduction of medication or solutions into the circulatory system via a peripheral or central vein (Chernecky *et al.* 2002).

Anatomy and physiology

See Chapter 18 for anatomy and physiology related to the venous system.

Related theory

Intravenous therapy is now an integral part of the majority of nurses' professional practice (RCN 2010). The nurse's role has progressed considerably from being able to add drugs to infusion bags (DHSS 1976) to now assessing patients and inserting the appropriate vascular access device (VAD) prior to drug administration (Gabriel 2005).

Any nurse administering intravenous drugs must be competent in all aspects of intravenous therapy and act in accordance with *The Code* (NMC 2008b), that is, to maintain knowledge and skills (Hyde 2008, RCN 2010). Training and assessment should comprise both theoretical and practical components and include legal and professional issues, fluid balance, pharmacology, drug administration, local and systemic complications, infection control issues, use of equipment and risk management (Hyde 2008, RCN 2010).

The nurse's responsibilities in relation to intravenous drug administration include the following.

- Knowing the therapeutic use of the drug or solution, its normal dosage, side-effects, precautions and contraindications.
- Preparing the drug aseptically and safely, checking the container and drug for faults, using the correct diluent and only preparing it immediately prior to administration.
- Identifying the patient and checking allergy status.
- Checking the prescription chart.
- Checking and maintaining patency of the VAD.
- Inspecting the site of the VAD and managing/reporting complications where appropriate.
- Controlling the flow rate of infusion and/or speed of injection.
- Monitoring the condition of the patient and reporting changes.
- Making clear and immediate records of all drugs administered (Finlay 2008, NMC 2008a, NMC 2008b, RCN 2010).

Evidence-based approaches

Methods of administering intravenous drugs

There are three methods of administering intravenous drugs: continuous infusion, intermittent infusion and direct intermittent injection.

Continuous infusion

Continuous infusion may be defined as the intravenous delivery of a medication or fluid at a constant rate over a prescribed time period, ranging from several hours to several days to achieve a controlled therapeutic response (Turner and Hankins 2010). The greater dilution also helps to reduce venous irritation (Weinstein and Plumer 2007, Whittington 2008).

A continuous infusion may be used when:

- the drugs to be administered must be highly diluted
- a maintenance of steady blood levels of the drug is required (Turner and Hankins 2010).

Pre-prepared infusion fluids with additives such as those containing potassium chloride should be used whenever possible. This reduces the risk of extrinsic contamination, which can occur during the mixing of drugs (Weinstein and Plumer 2007). Only one addition should be made to each bottle or bag of fluid after the compatibility has been ascertained. More additions can increase the risk of incompatibility occurring, for example precipitation (Weinstein and Plumer 2007, Whittington 2008). The additive and fluid must be mixed well to prevent a layering effect which can occur with some drugs (Whittington 2008). The danger is that a bolus injection of the drug may be delivered. To safeguard against this, any additions should be made to the infusion fluid and the container inverted a number of times to ensure mixing of the drug, before the fluid is hung on the infusion stand (NPSA 2007d). The infusion container should be labelled clearly after the addition has been made. Constant monitoring of the infusion fluid mixture (Weinstein and Plumer 2007, Whittington 2008) for cloudiness or presence of particles should occur, as well as checking the patient's condition and intravenous site for patency, extravasation or infiltration (Downie *et al.* 2003).

Intermittent infusion

Intermittent infusion is the administration of a small-volume infusion, that is, 25–250 mL, over a period of between 15 minutes and 2 hours (Turner and Hankins 2010). This may be given as a specific dose at one time or at repeated intervals during 24 hours (Pickstone 1999).

An intermittent infusion may be used when:

- a peak plasma level is required therapeutically
- the pharmacology of the drug dictates this specific dilution
- the drug will not remain stable for the time required to administer a more dilute volume
- the patient is on a restricted intake of fluids (Whittington 2008).

Delivery of the drug by intermittent infusion can be piggy-backed (via a needle-free injection port), if the primary infusion is of a compatible fluid, may utilize a system such as a 'Y' set or or a burette set with a chamber capacity of 100 or 150 mL (Turner and Hankins 2010). This is when the drug can be added to the burette and infused while the primary infusion is switched off. A small-volume infusion may also be connected to a cannula specifically to keep the vein open, and maintain patency.

All the points considered when preparing for a continuous infusion should be taken into account here, for example pre-prepared fluids, single additions of drugs, adequate mixing, labelling and monitoring.

Direct intermittent injection

Direct intermittent injection (also known as intravenous push or bolus) involves the injection of a drug from a syringe into the injection port of the administration set or directly into a VAD (Chernecky *et al.* 2002, Turner and Hankins 2010). Most are administered anywhere from 3 to 10 minutes depending upon the drug (Weinstein and Plumer 2007, Whittington 2008).

A direct injection may be used when:

- a maximum concentration of the drug is required to vital organs. This is a 'bolus' injection which is given rapidly over seconds, as in an emergency, for example adrenaline
- the drug cannot be further diluted for pharmacological or therapeutic reasons or does not require dilution. This is given as a controlled 'push' injection over a few minutes
- a peak blood level is required and cannot be achieved by small-volume infusion (Turner and Hankins 2010).

Rapid administration could result in toxic levels and an anaphylactic-type reaction. Manufacturer's recommendations of rates of administration (i.e. millilitres or milligrams per minute) should be adhered to. In the absence of such recommendations, administration should proceed slowly, over 5–10 minutes (Dougherty 2002).

Delivery of the drug by direct injection may be via the cannula through a resealable needleless injection cap, extension set or via the injection site of an administration set.

- If a peripheral device is *in situ*, the bandage and dressing must be removed to inspect the insertion of the cannula, unless a transparent dressing is in place (Finlay 2008).
- Patency of the vein must be confirmed prior to administration and the vein's ability to accept an extra flow of fluid or irritant chemical must also be checked (Dougherty 2008).

Administration into the injection site of a fast-running drip may be advised if the infusion in progress is compatible in order to dilute the drug further and reduce local chemical irritation (Dougherty 2002). Alternatively, a stop–start procedure may be employed if there is doubt about venous patency. This allows the nurse to constantly check the patency of the vein and detect early signs of extravasation. If the infusion fluid is incompatible with the drug, the

administration set may be switched off and a compatible solution may be used as a flush (NPSA 2007d).

If a number of drugs are being administered, 0.9% sodium chloride must be used to flush in between each drug to prevent interactions. In addition, 0.9% sodium chloride should be used at the end of the administration to ensure that all the drug has been delivered. The device should then be flushed to ensure patency is maintained (see Chapter 18) (Dougherty 2008).

The following principles are to be applied throughout preparation and administration.

Asepsis and reducing the risk of infection

Microbes on the hands of healthcare personnel contribute to healthcare-associated infection (Weinstein and Plumer 2007). Therefore aseptic technique must be adhered to throughout all intravenous procedures (see Chapter 18). The nurse must employ good handwashing and drying techniques using a bactericidal soap or a bactericidal alcohol handrub. If asepsis is not maintained, local infection, septic phlebitis or septicaemia may result (Hart 2008, Pratt *et al.* 2007, RCN 2010).

The insertion site should be inspected at least once a day for complications such as infiltration, phlebitis or any indication of infection, for example redness at the insertion site of the device or pyrexia (RCN 2010). These problems may necessitate the removal of the device and/or further investigation (Finlay 2008).

It is desirable that a closed system of infusion is maintained wherever possible, with as few connections as is necessary for its purpose (Finlay 2008, Hart 2008). This reduces the risk of bacterial contamination. Any extra connections within the administration system increase the risk of infection. Three-way taps have been shown to encourage the growth of micro-organisms. They are difficult to clean due to their design, as micro-organisms can become lodged and are then able to multiply in the warm, moist environment (Finlay 2008, Hart 2008). This reservoir for micro-organisms may then be released into the circulation.

The injection sites on administration sets or injection caps should be cleaned using a 2% chlorhexidine alcohol-based antiseptic, allowing time for it to dry (Pratt *et al.* 2007). Connections should be cleaned before changing administration sets and manipulations kept to a minimum. Administration sets should be changed according to use (intermittent/continuous therapy), type of device and type of solution, and the set must be labelled with the date and time

of change (NPSA 2007d, RCN 2010).

To ensure safe delivery of intravenous fluids and medication:

- replace all tubing when the vascular device is replaced (Pratt *et al.* 2007)
- replace solution administration sets and stopcocks used for continuous infusions every 72 hours unless clinically indicated, for example, if drug stability data indicate otherwise (Pratt *et al.* 2007, RCN 2010). Research has indicated that routine changing of administration sets (used for infusing solutions) every 48–72 hours instead of every 24 hours is not associated with an increase in infection and could result in considerable savings for hospitals (Pratt *et al.* 2007, RCN 2010)
- replace solution administration sets used for lipid emulsions and parenteral nutrition at the end of the infusion or within 24 hours of initiating the infusion (Pratt *et al.* 2007, RCN 2010). Certain intravenous fluids including lipid emulsions, blood and blood products are more likely than other parenteral fluids to support microbial growth if contaminated and therefore replacement of the intravenous tubing is required more frequently than 48–72 hours (Pratt *et al.* 2007)
- replace blood administration sets at least every 12 hours and after every second unit of blood (McClelland 2007, Pratt *et al.* 2007, RCN 2010)
- all solution sets used for intermittent infusions, for example antibiotics, should be discarded immediately after use and not allowed to hang for reuse (RCN 2010)
- if administering more than one infusion via a multi lumen extension set or multipl ports, be aware of the risk of back tracking of medication and consider using sets with one way, non return or anti reflux valves (MHRA 2010aa).

Inspection of fluids, drugs, equipment and their packaging must be undertaken to detect any points where contamination may have occurred during manufacture and/or transport. This intrinsic contamination may be detected as cloudiness, discoloration or the presence of particles (BNF 2005, RCN 2010, Weinstein and Plumer 2007). Infusion bags should not be left hanging for longer than 24 hours. In the case of blood and blood products, this is reduced to 5 hours (McClelland 2007, RCN 2010).

Safety

All details of the prescription and all calculations must be checked carefully in accordance with hospital policy in order to ensure safe preparation and administration of the drug(s).

The nurse must also check the compatibility of the drug with the diluent or infusion fluid. The nurse should be aware of the types of incompatibilities and the factors which could influence them. These include pH, concentration, time, temperature, light and the brand of the drug. If insufficient information is available, a reference book (e.g. *British National Formulary*) or the product data sheet must be consulted (NPSA 2007d, Whittington 2008). If the nurse is unsure about any aspect of the preparation and/or administration of a drug, they should not proceed and should consult with a senior member of staff (NMC 2008a). Constant monitoring of both the mixture and the patient is important. The preferred method and rate of intravenous administration must be determined.

Drugs should never be added to the following: blood; blood products, that is plasma or platelet concentrate (see Chapter 8); mannitol solutions; sodium bicarbonate solution; and so on. Only specially prepared additives should be used with fat emulsions or amino acid preparations (Downie *et al*. 2003).

Accurate labelling of additives and records of administration are essential (NPSA 2007d, RCN 2010).

Any protective clothing which is advised should be worn, and vinyl gloves should be used to reduce the risk of latex allergy (Hart 2008). Healthcare professionals who use gloves frequently or for long periods face a high risk of allergy from latex products. All healthcare facilities should develop policies and procedures that determine measures to protect staff and patients from latex exposure and outline a treatment plan for latex reactions (Dougherty 2002).

Preventing needlestick injuries should be key in any health and safety programme and organizations should introduce safety devices and needle-free systems wherever possible (NHS Employers 2007). Basic rules of safety include not resheathing needles, disposal of needles immediately after use into a recognized sharps bin and convenient location of sharps bins in all areas where needles and sharps are used (Hart 2008, MHRA 2004, RCN 2010).

Comfort

Both the physical and psychological comfort of the patient must be considered. Comprehensive explanation of the practical aspects of the procedure together with information about the effects of treatment will contribute to reducing anxiety and will need to be tailored to each patient's individual needs.

Legal and professional issues

At least one patient will experience a potentially serious intravenous (IV) drug error every day in an 'average' hospital. IV drug errors have been estimated to be a third of all drug errors. 'Fifteen million infusions are performed in the NHS every year and 700 unsafe incidents are reported each year with 19% attributed to user error' (NPSA 2004, p.1). Between 1990 and 2000, there were 1485 incidents reported to the Medical Devices Agency which involved infusion pumps (MHRA 2010b). In 50% of incidents no cause was established. However, of the remaining incidents, 27% were attributed to user error (e.g. misloading of the administration set or syringe, setting the wrong rate, confusing pump type) and 20% to device-related issues (e.g. poor maintenance, cleaning) (MHRA 2010b, Williams and Lefever 2000). Syringe pumps have given rise to the most significant problems in terms of patient mortality and morbidity (Fox 2000, MHRA 2010b, NPSA 2003).

The high frequency of human error has highlighted the need for more formalized, validated, competency-based training and assessment (MHRA 2010b, NPSA 2003, 2003, Pickstone 2000, Quinn 2000). Nurses must be familiar with the device they are using and not attempt to operate any device that they have not been fully trained to use (Murray and Glenister 2001, NPSA 2003). As a minimum, the training should cover the device, drugs and solutions, and the practical procedures related to setting up the device and problem solving (Medical Devices Agency 2000, MHRA 2010b). Staff should also be made aware of the mechanisms for reporting faults with devices and procedures for adverse incident reporting within their trust and to the MHRA and the NPSA (MHRA 2006b).

A useful checklist (Box 16.14) has been produced by the Medical Devices Agency for staff to follow prior to using a medical device to ensure safe practice (Medical Devices Agency 2000, MHRA 2010b).

Box 16.14 Checklist: how safe is your practice?

- Have I been trained in the use of the infusion device?
- Was the training formalized and recorded or did I just pick it up as I went along?
- How was my competency in relation to the infusion device assessed?
- Have I read the user instructions on how to use the infusion device and am I familiar with any warning labels?

- When was the infusion device last serviced?
- Are there any signs of wear, damage or faults?
- Do I know how to set up and use the infusion device?
- Is the infusion device and any additional equipment in good working order?
- Do I know how the infusion device should perform and the monitoring that needs to be done to check its performance?
- Am I using the correct additional equipment, for example the appropriate disposable administration set for the infusion pump?
- Do I know how to recognize whether the infusion device has failed?
- Do I know what to do if the infusion device fails?
- Do I know how and to whom to report an infusion device-related adverse incident?
- Does checking the infusion device indicate it is functioning correctly and to the manufacturer's specification?
- What action should be taken if the infusion device is not functioning properly?
- Is there up-to-date documentation to record regular checking of the infusion device?
- What are the details (name and serial number) of the infusion device being used?
- What is the cleaning and/or decontamination procedure for the infusion device and what are my responsibilities in this process?
- Do I know how to report an adverse incident?
- Do I have access to MHRA device bulletins of relevance to my area of practice and do I read and take note of hazard and safety notices?

(Adapted from Medical Devices Agency 2000, p.10; 2001, pp. 8, 9)

The nurse must have knowledge of the solutions, their effects, rate of administration, factors that affect flow of infusion, as well as the complications which could occur when flow is not controlled (Weinstein and Plumer 2007). The nurse should have an understanding of which groups require accurate flow control in order to prevent complications (Box 16.15) and how to select the most appropriate device for accuracy of delivery to best meet the patient's flow control needs (according to age, condition, setting and prescribed therapy) (Weinstein and Plumer 2007).

Box 16.15 Groups at risk of complications associated with flow control

- Infants and young children.
- The elderly.
- Patients with compromised cardiovascular status.

- Patients with impairment or failure of organs, for example kidneys.
- Patients with major sepsis.
- Patients suffering from shock, whatever the cause.
- Postoperative or post-trauma patients.
- Stressed patients, whose endocrine homoeostatic controls may be affected.
- Patients receiving multiple medications, whose clinical status may change rapidly.

(Adapted from Quinn 2008)

The identification of risks is crucial, for example complex calculations, prescription errors (Dougherty 2002, Weinstein and Plumer 2007) and the risks associated with infusions, such as neonatal risk infusions, high-risk infusions, low-risk infusions and ambulatory infusions (MHRA 2010b, Quinn 2000). The early detection of errors and infusion-related complications, for example over- and underinfusion (Box 16.16), is imperative in order to instigate the appropriate interventions in response to an error or to manage any complications, as serious errors or complications can result in patient death (Dougherty 2002, NPSA 2003, Quinn 2008). Overinfusion accounts for about half of the reported errors involving infusion pumps, with 80% due to user error rather than a fault with the device (Medical Devices Agency 2000). The use of infusion devices, both mechanical and electronic, has increased the level of safety in intravenous therapy. However, it is recommended that a clearly defined structure for management of infusion systems must exist within a hospital (Department of Health, Social Services and Public Safety 2006, MHRA 2010b, NHS Litigation Authority 2007, NPSA 2004) (Box 16.17).

Box 16.16 Complications of inadequate flow control

Complications associated with overinfusion

- Fluid overload with accompanying electrolyte imbalance.
- Metabolic disturbances during parenteral nutrition, mainly related to serum glucose levels.
- Toxic concentrations of medications, which may result in a shock-like syndrome (‘speed shock’).
- Air embolism, due to containers running dry before expected.
- An increase in venous complications, for example chemical phlebitis, caused by reduced dilution of irritant substances (Weinstein and Plumer 2007).

Complications associated with underinfusion

- Dehydration.
- Metabolic disturbances.
- A delayed response to medications or below therapeutic dose.
- Occlusion of a cannula/catheter due to slow flow or cessation of flow.

(Quinn 2008, p.195)

Box 16.17 Criteria for selection of an infusion device

- Rationalization of devices.
- Clinical requirement.
- Education.
- Compatibility with other equipment.
- Disposables.
- Product support.
- Costs.
- Service and maintenance.
- Regulatory issues, for example compliance with European Community Directives.

(Department of Health, Social Services and Public Safety 2006, Health Care Standards Unit, 2007a, 2007b, MHRA 2010b, NHS Litigation Authority 2007, Quinn 2000).

Strategies need to be developed for replacement of old, obsolete or inappropriate devices (Department of Health, Social Services and Public Safety 2006, Health Care Standards Unit 2007a, 2007b, MHRA 2010b, NHS Litigation Authority 2007, Quinn 2000), planned service maintenance programmes and acceptance testing (MHRA 2010b).

Healthcare professionals are personally accountable for their use of infusion devices and they must therefore ensure they have appropriate training before using the pump (MHRA 2008a, Quinn 2008). Records of training should also be maintained.

Improving infusion device safety

A high frequency of human error is reported in the use of infusion device systems, so competence-based training is advocated for users of these systems (MHRA 2010b, NPSA 2004). By rationalizing the range of infusion device types within organizations and the establishment of a centralized equipment library, the number of patient safety incidents will be reduced (MHRA 2010b, NPSA 2004). Smart infusion pumps reduce pump programming errors by the setting of pre-programmed upper and lower dose limits for specific drugs. The pump will alert the nurse when setting the infusion device if the pump has been set outside the preset dose limits (Keohane *et al.* 2005, Weinstein and Plumer 2007, Wilson and Sullivan 2004). Whatever infusion device is used, the need to monitor the patient and the device remains paramount for patient safety (Quinn 2008, RCN 2010).

Preprocedural considerations

Equipment

Vascular access devices

For vascular access devices see Chapter 18.

Administration sets

An administration set is used to administer fluids, blood or medications via an infusion bag into a VAD. The set comprises a number of components (see Figures 16.25, 16.26, 16.27). At the top is a spike which is inserted into the infusion container via an entry port. This is covered by a sterile plastic lid which is removed just prior to insertion into the container (Downie *et al.* 2003). The plastic tubing continues from the spike to a drip chamber which may contain a filter. This is filled by squeezing it when attached to the fluid and waiting for the chamber to fill halfway, thus allowing the practitioner to observe the drops. Along the tubing is a roller clamp which allows the tubing to be incrementally occluded by pinching the tubing as the clamp is tightened; this is used to adjust the rate of flow (Hadaway 2010). It is usually positioned on the upper third of the administration set but should be repositioned along the set at intervals as the tubing can develop a 'memory' and not regain its shape, making it difficult to regulate (Hadaway 2010). It is opened to allow the fluid along the tubing to remove the air and then closed until attached to the patient's VAD. Finally the Luer-Lok end is covered with a plastic cap to maintain sterility until ready to be attached (Downie *et al.* 2003).

Figure 16.25 Blood administration set.

Figure 16.26 Fluid administration set.

Figure 16.27 Labelled administration set.

There is a variety of sets. A solution set is used to administer crystalloid solutions (it can be used as a primary or secondary set and is also available as a Y-set to allow for dual administration of compatible solutions). Parenteral nutrition is also administered via solution sets. Solution sets may have needle-free injection ports which allow for the administration of bolus injections or connection of secondary infusions. Sets may also have back check valves which allow solutions to flow in one direction only and are used especially when a secondary set is used (Hadaway 2010).

Blood and blood products are administered via a blood administration set (Figure 16.25) which has a special filter. Platelets can be administered via blood sets (check with manufacturer) or specialist platelet administration sets. Some medications such as taxanes must be administered via special taxane administration sets as they have a filter.

Extension sets

Extension sets are used to add length (Hadaway 2010). The short extension sets tend to have a needle-free connector (Figure 16.28) and are attached directly to the VAD to provide a closed system and other equipment is then attached via the needle-free connector. The long (50–200 cm) extension sets are used to connect from syringe pumps or drivers to a VAD and usually have a back check or antisyphon valve. They can be single, double or triple and may contain a slide or pinch clamp but do not regulate flow (Hadaway 2010).

Figure 16.28 Extension set with needle-free injection cap.

Needle-free injection caps

These are caps that are attached to the end of a VAD or extension set (Figure 16.28) to provide a closed system and remove the need for needles when administering medications, thus removing the risk of needlestick injury. There are various types available and differences include the type of septum (split septum or mechanical valve) (Hadaway 2010). Some provide positive or neutral displacement (to reduce risk of blood reflux and occlusion) and others are coated with antimicrobial or antibactericidal solutions on external or internal parts to reduce the risk of infection (Hadaway 2010). These require regular changing in accordance with the manufacturer's instructions as well as cleaning before and after each use (MHRA 2007, 2008).

It has been suggested that needle-free systems can increase the risk of

bloodstream infections (Danzig *et al.* 1995). However, most studies have found no difference in microbial contamination when comparing conventional and needle-free systems (Brown *et al.* 1997, Luebke *et al.* 1998, Mendelson *et al.* 1998). It appears that an increased risk is only likely where there is lack of compliance with cleaning protocols or changing of equipment (Pratt *et al.* 2007).

Other equipment

Other IV equipment includes stopcocks (used to direct flow) usually three-or four-way devices. These tend to be used in critical care but are discouraged in the general setting due to misuse and contamination issues. If used, they should be capped off (Hadaway 2010).

Infusion devices

An infusion device is designed to accurately deliver measured amounts of fluid or drug via a number of routes (intravenous, subcutaneous or epidural) over a period of time. The infusion device is set at an appropriate rate to achieve the desired therapeutic response and prevent complications (Dougherty 2002, MHRA 2010b, Quinn 2000).

Gravity infusion devices

Gravity infusion devices depend entirely on gravity to deliver the infusion. The system consists of an administration set containing a drip chamber and a roller clamp to control the flow, which is usually measured by counting drops (Pickstone 1999). The indications for use are:

- delivery of fluids without additives
- administration of drugs or fluids where adverse effects are not anticipated and which do not need to be infused with absolute precision
- where the patient's condition does not give cause for concern and no complication is predicted (Quinn 2008).

The flow rate is calculated using a formula that requires the following information: the volume to be infused; the number of hours the infusion is running over; and the drop rate of the administration set (which will differ depending on type of set). The number of drops per millilitre is dependent on the type of administration set used and the viscosity of the infusion fluid. Increased viscosity causes the size of the drop to increase. For example, crystalloid fluid administered via a solution set is delivered at the rate of 20 drops/mL; the rate of packed red cells given via a blood set will be calculated at 15 drops/mL (Quinn 2008).

The rate of administration of a continuous or intermittent infusion may be calculated from the following equation (Pickstone 1999):

$$\frac{\text{Volume to be infused}}{\text{Time in hours}} \times \frac{\text{Drop rate}}{\text{60 minutes}} = \text{Drops per minute}$$

In this equation, 60 is a factor for the conversion of the number of hours to the number of minutes.

Factors influencing flow rates are as follows.

Type of fluid

The composition, viscosity and concentration of the fluid affect flow (Pickstone 1999, Quinn 2000, Springhouse 2005, Weinstein and Plumer 2007). Irritating solutions may result in venospasm and impede the flow rate, which may be resolved by the use of a warm pack over the cannula site and the limb (Springhouse 2005, Weinstein and Plumer 2007).

Height of the infusion container

Intravenous fluids run by gravity and so any changes in the height of the container will alter the flow rate. The container can be hung up to 1.5 m above the infusion site which will provide a hydrostatic pressure of 110 mmHg (MHRA 2010b, Springhouse 2005). One metre above the infusion site would create 70 mmHg of pressure, which is adequate to overcome venous pressure (normal range in an adult is 25–80 mmHg) (Pickstone 1999). If it is hung too high then it can create too greater pressure within the vein, leading to infiltration of the medication (MHRA 2006a). Therefore any alterations in the patient's position may alter the flow rate and necessitate a change in the speed of the infusion to maintain the appropriate rate of flow (Hadaway 2010, Weinstein and Plumer 2007). Positioning of the patient will affect flow and patients should be instructed to keep the arm lower than the infusion, if the infusion is reliant on gravity (Quinn 2008).

Administration set

The flow rate of the infusion may be affected in several ways.

- Roller clamps (Figure 16.29) or screw clamps, used to adjust and maintain rates of flow on gravity infusions, vary considerably in their efficiency and accuracy which are often dependent on a number of variables such as patient movement and height of infusion container (Hadaway 2010). The roller clamp should be used as the primary means of occluding the tubing even if there is an anti-free flow device (MHRA 2010b).

Figure 16.29 Roller clamp.

- The inner diameter of the lumen and the length of tubing will also affect flow. Microbore sets have a narrow lumen, so flow is restricted to some degree. However, these sets may be used as a safeguard against ‘runaway’ or bolus infusions by either an integrated antisyphon valve or anti-free flow device (Hadaway 2010, Quinn 2000, Weinstein and Plumer 2007).
- Inclusion of other in-line devices, for example filters, may also affect the flow rate (Hadaway 2010, MHRA 2010b).

Vascular access device

The flow rate may be affected by any of the following.

- The condition and size of the vein; for example, phlebitis can reduce the lumen size and decrease flow (Quinn 2008, Weinstein and Plumer 2007).
- The gauge of the cannula/catheter (MHRA 2010b, Springhouse 2005, Weinstein and Plumer 2007).
- The position of the device within the vein; that is, whether it is up against the vein wall (Quinn 2008).
- The site of the vascular access device, for example, the flow may be affected by the change in position of a limb, such as a decrease in flow when a patient bends their arm if a cannula is sited over the elbow joint (Springhouse 2005).
- Kinking, pinching or compression of the cannula/catheter or tubing of the administration set may cause variation in the set rate (MHRA 2010b, Springhouse 2005).
- Restricted venous circulation; for example, a blood pressure cuff or the patient lying on the limb increases the risk of occlusion of the device and may result in clot formation (Quinn 2008).

The patient

Patients occasionally adjust the control clamp or other parts of the delivery system, for example, change the height of the container, thereby making flow unreliable. Some pumps have tamper-proof features to minimize the risk of accidental manipulation of the infusion device (Hadaway 2010) or unauthorized changing of infusion device controls (Amoore and Adamson 2003).

Advantages and disadvantages of gravity infusion devices

A gravity flow system is simple to set up. It is low cost and the infusion of air is less likely than with electronic devices (Pickstone 1999). However, the system does require frequent observation and adjustment due to:

- the tubing changing shape over time
- creep or distortion of tubing made of polyvinyl chloride (PVC)
- fluctuations of venous pressure which can affect the flow of the solution
- the roller clamp can be unreliable, leading to inconsistent flow rates.

There can also be variability of drop size and if the roller clamp is inadvertently left open, free flow will occur. Infusion rates with viscous fluids can be reduced (particularly if administered via small cannulas) and there is a limitation on the type of infusion as it is not suitable for arterial infusions: this is because viscosity and arterial flow offer a high resistance to flow which cannot be overcome by gravity (Pickstone 1999, Quinn 2008). If more than one infusion is infusing and one is slower than the other or there is no flow in the second set then there is a risk of back tracking which leads to underinfusion or bolus delivery of medicines. The MHRA recommends that in these systems, the sets should include antireflux valves (MHRA 2007).

Gravity drip rate controllers

A controller is a mechanical device that operates by gravity. These devices use standard solution sets and although they look much like a pump, they have no pumping mechanism. The desired flow rate is set in drops per minute and controlled by battery-or mains-powered occlusion valves (MHRA 2010b).

Advantages and disadvantages of gravity drip rate controllers

Although they can maintain a drip rate within 1%, volumetric accuracy is not guaranteed and many of the disadvantages associated with gravity flow still remain. The main advantages are that they are relatively inexpensive and can usually use standard gravity sets. They also incorporate some audible and visual alarm systems (MHRA 2010b).

Infusion pumps

These devices use pressure to overcome resistance from many causes along the fluid pathway, for example length and bore of tubing or particulate matter in the tubing (Hadaway 2010). There are a number of general features required in infusion pumps.

Accuracy of delivery

In order to meet requirements for high-risk and neonatal infusions, pumps must be accurate to within ±5% of the set rate when measured over a 60-minute period although some may be as accurate as ±2% (Hadaway 2010, MHRA 2010b). They also have to satisfy short-term, minute-to-minute accuracy requirements, which demand smoothness and consistency of output (MHRA 2010b).

Occlusion response and pressure

Flow will occur if the pressure at the tip of an intravascular device is just fractionally above the pressure in the vein; the pressure does not need to be excessive. In an adult peripheral vein, pressure is approximately 25 mmHg, while in a neonate it measures 5 mmHg (Quinn 2000). Most pumps have a variable pressure setting which allows the user to use their own judgement about the pressure needed to deliver therapy safely. The normal pumping pressure is only slightly lower than the occlusion pressure (Hadaway 2010). Flow is dependent upon pressure divided by resistance. If long extension sets of small internal bore are used, the resistance to flow will increase (Pickstone 1999, Quinn 2000).

If an administration set occludes, the resistance increases and the infusion will not flow into the vein. The longer the occlusion occurs, the greater the pressure and the pump will continue to pump until an occlusion alarm is activated. There are two types of occlusions: upstream, between the pump and the container, and downstream, which is between the pump and the patient. An upstream occlusion alarms when a vacuum is created in the upstream tubing or full reservoir, due to a collapsed or empty plastic fluid container or clamped/kinking tubing. A downstream occlusion is when the pressure required by the pump exceeds a certain pounds per square inch (psi) limit to overcome the pressure created by the occlusion. Downstream occlusion pressures range from 1.5 to 15 psi (Hadaway 2010).

Pumps alarm at ‘occlusion alarm pressure’ and many pumps allow the user to set the pressure within a range (MHRA 2010b). Therefore, the time it takes to alarm depends on the rate of flow: high rates alarm more quickly. When the alarm is activated, a certain amount of stored medication will be present and it is important that what could be a potentially large bolus is not released into the vein. The release of the stored bolus could lead to rupture of the vein or constitute overinfusion, which may be detrimental to the patient, particularly if it is a critical medication (Amoore and Adamson 2003, MHRA 2010b). With a syringe pump, to prevent a bolus being delivered to the patient, the clamp should not be opened as this will release the bolus: the first action is to remove the pressure by opening the syringe plunger clamp and then deal with the occlusion.

While pressure occlusion may not prevent extravasation, it may minimize the risk of resulting complications (Quinn and Upton 2006). Single-unit variable

pressure pump settings which allow an earlier alarm alert are used in neonatal and paediatric units (Quinn 2008).

Air in line

Air-in-line detectors are designed to detect only visible or microscopic ‘champagne’ bubbles. They should not create anxiety over small particles of air but alert the nurse to the integrity of the system. Most air bubbles detected are too small to have a harmful effect but the nurse should clarify the cause of any alarms (MHRA 2010b).

Antisyphonage

Uncontrolled flow from a syringe is called siphonage; this is a result of gravity or leakage of air into the syringe and administration set. Siphonage can occur whether or not the syringe is fixed into an infusion device (Quinn 2008). It has been reported that 'in practice, a 50 mL syringe attached to a length of administration set with an internal diameter of 3 mm has been shown to empty by siphonage in less than 1 minute' (Pickstone 1999, p.57).

To minimize the risk of siphonage, the following safe practice should be undertaken.

- The syringe (plunger and barrel) should be correctly located and secured.
- Intravenous administration extension sets should always be micro/narrow bore in diameter to increase the resistance to flow; wide-bore extension sets should be avoided.
- Position of the syringe pump should always be the same level as the infusion site (MHRA 2010b).
- Extension sets with an integral antisiphonage/antireflux valve should be used (MHRA 2010b, MHRA 2007, Quinn 2008).

Safety software

Smart pumps contain safety software also known as dose error reduction systems (Hertzel and Sousa 2009). There is an internal drug library, meaning that pumps are programmed to contain information on medications with upper and lower dosing limits (Hadaway 2010). A number of studies have evaluated the effectiveness of using smart pumps to prevent medication errors, showing the success of these systems (Dennison 2007, Fields and Peterson 2005, Larson *et al.* 2005, Rothschild *et al.* 2005).

Volumetric pumps

Volumetric pumps (Figure 16.30) pump fluid from an infusion bag or bottle via an administration set and work by calculating the volume delivered (Quinn 2008). This is achieved when the pump measures the volume displaced in a 'reservoir'. The reservoir is an integral component of the administration set (Hadaway 2010). The mechanism of action may be piston or peristaltic (Hadaway 2010). The indications for use are all large-volume infusions, both venous and arterial.

Figure 16.30 Volumetric pump.

All are mains and battery powered, with the rate selected in millilitres per hour. The accuracy of flow is usually within 5% when measured over a period of time, which is more than adequate for most clinical applications (MHRA 2010b, Pickstone 1999).

Advantages and disadvantages of volumetric pumps

These pumps are able to overcome resistance to flow by increased delivery

pressure and do not rely on gravity. This generally makes the performance of pumps predictable and capable of accurate delivery over a wider range of flow rates (MHRA 2010b).

The pumps also incorporate a wide range of features, including air-in-line detectors, variable pressure settings and comprehensive alarms such as end of infusion, keep vein open (KVO, where the pump switches to a low flow rate, for example 5 mL/h, in order to continue flow to prevent occlusion of the device) and low battery. Many have a secondary infusion facility, which allows for intermittent therapy, for example antibiotics. The pump is programmed to switch to a secondary set and, when completed, it reverts back to the primary infusion at the previously set rate. The changing hospital environment has led to an increased demand on volumetric pumps, which in turn has resulted in the development of multichannel and dual-channel infusion pumps. These may consist of two devices with an attached housing or of several infusion channels within a single device (Hadaway 2010).

The disadvantages are that these are usually relatively expensive and often dedicated administration sets are required. The use of the wrong set could result in error even if the pump appears to work. Some are complicated to set up, which can also lead to errors (MHRA 2010b).

Syringe pumps

Syringe pumps (Figure 6.31) are low-volume, high-accuracy devices designed to infuse at low flow rates. The plunger of a syringe containing the substance to be infused is driven forward by the syringe pump at a controlled rate to deliver it to the patient (MHRA 2010b).

Figure 16.31 The Alaris GH syringe pump.

Syringe pumps are useful where small volumes of highly concentrated drugs need to be infused at low flow rates (Quinn 2008). The volume for infusion is limited to the size of the syringe used in the device, which is usually a 60 mL syringe, but most pumps will accept different sizes and brands of syringe.

These devices are calibrated for delivery in millilitres per hour (Weinstein and Plumer 2007).

Advantages and disadvantages of syringe pumps

Syringe pumps are mains and/or battery powered, are usually easy to operate, and tend to cost less than volumetric pumps. The alarm systems are becoming more comprehensive and include low battery, end of infusion and syringe clamp open alarms. Most of the problems associated with the older models, for example free flow, mechanical backlash (slackness which delays the start-up time of the infusion) and incorrect fitting of the syringe, have been eliminated in the newer models (MHRA 2010b, Quinn 2008). The risk of free flow is minimized by the use of an antisiphonage valve which may be integral to the administration set (Pickstone 1999). Despite the use of an antisiphonage valve, the clamp of the administration set must still be used (MHRA 2010b). Where mechanical backlash is an issue and there is a prime or purge option, this should

be used at the start of the infusion to take up the mechanical slack (Amoore *et al*. 2001).

Specialist pumps

Patient-controlled analgesia pumps

Patient-controlled analgesia (PCA) devices are typically syringe pumps (although some are based on volumetric designs) (MHRA 2010b) (Figure 16.32). The syringe pump forces down on the syringe piston, collapsing the syringe at a preset rate, but the distinguishing feature is the ability of the pump to deliver doses on demand, which occurs when the patient pushes a button (Hadaway 2010). Whether or not the dose is delivered is determined by preset parameters in the pump. That is, if the maximum amount of drug over a given period of time has already been delivered, a further dose cannot be delivered.

Figure 16.32 The Alaris PCA pump used generally in acute hospital settings.
Reproduced by permission of Alaris.

Patient-controlled analgesia pumps are useful for patients who require pain control. They are used more in the acute setting, but are also useful in ambulatory situations.

Infusion options of a PCA pump are usually categorized into three types.

- *Basal*: a ‘baseline’ rate can be accompanied by intermittent doses requested by patients. This aims to achieve pain relief with minimal medication, but not necessarily to achieve a pain-free state (Hadaway 2010).
- *Continuous*: designed for the patient who needs maximum pain relief without the option of demand dosing, for example epidural.
- *Demand*: drug delivered by intermittent infusion when button is pushed and can be used alone or supplemented by the basal rate. Doses can be limited by a designated maximum amount (Hadaway 2010).

The PCA pump can dispense a bolus dose, with an initial bolus being called a loading dose. This may benefit patients as the one-time dose is significantly higher than a demand dose in order to achieve immediate pain relief (see Chapter 9).

Advantages and disadvantages of PCA pumps

These devices offer a ‘lock-out’ feature (when a key or a combination of numbers is necessary to gain access to pump controls), which is designed for patient safety. They have an extensive memory capability which can be accessed through the display via a printer or computer (MHRA 2010b). This facility is critical for the pump’s effective use in pain management (Hadaway 2010), as it enables the clinician to determine when and how often demand is made by a patient and what total volume has been infused (Hadaway 2010). It has also been shown that they increase patient satisfaction, patients require less sedation, their anxiety is reduced and so are their nursing needs and time in hospital (Ripamonti and Bruera 1997).

Anaesthesia pumps

These are syringe pumps designed for delivery of anaesthesia or sedation and must only ever be used for that purpose. They should be restricted to operating theatres or critical care units and should be clearly labelled. They are designed to allow rapid changes in flow rate and bolus to be made while the pump is infusing (Quinn 2008). Total intravenous anaesthesia (TIVA) and target-controlled infusion (TCI) pumps are now available, which have been designed to control the induction, maintenance and reversal phases of anaesthesia (Absalom and Struys 2006).

Epidural pumps

Epidural pumps (Figure 16.33) provide analgesia (most commonly a combination of opioids and anaesthetic agents) via a fine catheter inserted directly into the epidural space. As a form of analgesia delivery, the efficacy of the epidural route has been well highlighted (Block *et al.* 2003, Werawatganon and Charuluxanun 2005, Wheatley *et al.* 2001). see also Chapter 9.

Figure 16.33 Epidural pump.

Ambulatory infusion devices

Ambulatory infusion devices were developed to allow patients more freedom and to enable the patient to continue with normal activities or to move unencumbered by a large infusion device (Hadaway 2010). Ambulatory devices range in size and weight and are used for small volumes of drugs and are mainly designed for patients to wear and use when ambulant. The solution containers are often more cumbersome than the actual pump itself. Due to their size, the number of alarms may be more limited. Considerations for selection of an ambulatory device include the following.

- Type of therapy.
- Patient's ability to understand how to manage the infusion device.
- Drug stability.
- Frequency of doses.
- Reservoir volumes required.
- Control of flow/flow rates.
- Type of access.
- Cost-effectiveness.
- Portability.
- Convenience.

Ambulatory pumps fall into two categories: mechanical and battery-operated infusion devices.

Mechanical infusion devices

These are simple and compact but may not necessarily be cost-effective as they are usually disposable. The mechanism for delivery is by balloon or simple spring, or they may be gas powered. They are usually very ‘user friendly’ as they require minimal input from the patient and no battery. They can also be purchased prefilled (Quinn 2008).

Elastomeric balloon devices These are made of a soft rubberized material capable of being inflated to a predetermined volume and the drug is then administered over a very specific infusion time. The balloon is encapsulated inside a rigid transparent container which may be round or cylindrical. The rate of infusion is not controlled by the balloon but by the diameter of the restricting outlet located in the preattached tubing (Quinn 2008). It is designed to supply the patient’s need for a single dose infusion of drugs, for example intermittent small-volume parenteral therapies such as delivery of antibiotics. Its small size causes little disruption to the patient’s daily activities and it tends to be well tolerated (Hadaway 2010). Figure 16.34 shows an elastomeric device.

Figure 16.34 Elastomeric device.

Spring mechanism Spring coil piston syringes have a spring which powers the plunger of a syringe in the absence of manual pressure. The volume is restricted by the size of the syringe, which is usually prefilled. The spring coil container tends to be a multidose, small-volume administration device and is a combination of a spring coil in a collapsible flattened disc. Its shape can accommodate many therapies and volumes (Hadaway 2010).

Battery-operated infusion devices

Battery-operated pumps are small and light enough to be carried around by the patient without interfering with most everyday activities. They are operated using rechargeable or alkaline batteries but, owing to their size, the available battery capacity tends to be low. The length of time the battery lasts is often dependent on the rate at which the pump is set. Most give an output in the form of a small bolus delivered every few minutes. Most devices have an integral case or pouch which allows the pump and the reservoir/syringe to be worn with discretion by the patient. There are two types: ambulatory volumetric infusion pumps and syringe drivers.

Ambulatory volumetric infusion/syringe pumps An ambulatory volumetric infusion/syringe pump is an infusion device which pumps in the same way as a large volumetric pump, but by nature of its size it is portable and useful in the ambulatory setting (hospital or home care).

This pump is suitable for patients who have been prescribed continuous infusional treatment for a period of time, for example from 4 days to 6 months, and enables the patients, where appropriate, to receive treatment at home, because it is small and portable.

The advantages of the ambulatory pump are as follows.

- Able to deliver drugs continuously or intermittently.
- Infusion routes: central, peripheral venous, epidural, intra-arterial, intrathecal and subcutaneous.
- Delivery of drugs accurately over a set period of time.
- Improving potential outcomes of treatment by delivering treatment continuously.
- Heightening the patient’s independence and control by allowing them to be at home and participate in their own care.
- Compact, light and easy to use.
- Has audible alarm systems.

The disadvantages are as follows.

- It may require the insertion of a central venous access device, which has associated complications and problems.
- It could malfunction at home, which could be distressing and dangerous for the patient.
- In spite of its ease of use, some patients may not be able to cope with it at home.
- Patients may have to adapt their lifestyle to cope with living with a pump

continuously.

Syringe drivers

See Subcutaneous infusion.

Specific patient preparations

Selecting the appropriate infusion device for the patient

The nurse has a responsibility to determine when and how to use an infusion device to deliver hydration, drugs, transfusions and nutritional support, and how to select the appropriate device in order to manage the needs of the patient. The following factors should be considered when selecting an appropriate infusion delivery system (Quinn 2008).

- Risk to the patient of:
  (a) overinfusion
  (b) underinfusion
  (c) uneven flow
  (d) inadvertent bolus
  (e) high-pressure delivery
  (f) extravascular infusion.
- Delivery parameters:
  (a) infusion rate and volume required
  (b) accuracy required (over a long or short period of time)
  (c) alarms required
  (d) ability to infuse into site chosen (venous, arterial, subcutaneous)
  (e) suitability of device for infusing drug (e.g. ability to infuse viscous drugs).
- Environmental features:
  (a) ease of operation
  (b) frequency of observation and adjustment
  (c) type of patient (neonate, child, critically ill)
  (d) mobility of patient.

Paediatric considerations

The MHRA classifies infusion devices into categories of infusion risk. Neonatal infusions are the highest risk category; high-risk infusions are typically the infusion of fluids in children where accuracy of the flow rate is essential (Medical Devices Agency 2003). Infusion therapy within the paediatric setting requires very specific skills (Frey and Pettit 2010). Competency in calculation of paediatric dosages, maintaining a stringent fluid balance, use of paediatric-specific devices and management of complications are paramount.

The MHRA has made recommendations on the safety and performance of infusion devices in order to enable users to make the appropriate choice of equipment to suit most applications (MHRA 2010b). The classification system is divided into three major categories according to the potential risks involved. These are shown in Table 16.10. A pump suited to the most risky category of therapy (A) can be safely used for the other categories (B and C). A pump suited to category B can be used for B and C, whereas a pump with the lowest specification (C) is suited only to category C therapies (MHRA 2010b) (Figure 16.35). Hospitals are required to label each infusion pump with its category and it is necessary to know the category of the proposed therapy and match it with a pump of the same or better category. A locally produced list of drugs/fluids by their categories will need to be provided to all device users (MHRA 2010b).

Table 16.10

Therapy category	Therapy description	Patient group	Critical performance parameters
A	Drugs with narrow therapeutic margin	Any	Good long-term accuracy Good short-term accuracy
	Drugs with short half-life	Any	Rapid alarm after occlusion Small occlusion bolus
	Any infusion given to neonates	Neonates	Able to detect very small air embolus (volumetric pumps only) Small flow rate increments Good bolus accuracy Rapid start-up time (syringe pumps only)
B	Drugs other than those with a short half-life	Any except neonates	Good long-term accuracy Alarm after occlusion
	Total parenteral nutrition Fluid maintenance Transfusions	Volume sensitive except neonates	Small occlusion bolus Able to detect small air embolus (volumetric pumps only) Small flow rate increments
C	Diamorphine Total parenteral nutrition Fluid maintenance Transfusions	Any except neonates Any except volume sensitive or neonates	Bolus accuracy Long-term accuracy Alarm after occlusion Small occlusion bolus Able to detect air embolus (volumetric pumps only) Incremental flow rates

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Figure 16.35 Decision tree for selection of infusion device. MHRA (2010b). © Crown copyright.

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Procedure guideline 16.23 Medication: continuous infusion of intravenous drugs

This procedure may be carried out by the infusion of drugs from a bag, bottle or burette.

Essential equipment

- Clinically clean receiver or tray containing the prepared drug to be administered
- Patient's prescription chart
- Recording chart or book as required by law or hospital policy
- Gloves
- Protective clothing as required by hospital policy for specific drugs
- Container of appropriate intravenous infusion fluid
- 2% chlorhexidine swab
- Drug additive label

Preprocedure

Action	**Rationale**
1 Explain and discuss the procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (Griffith and Jordan 2003, E; NMC 2008b, C; NMC 2008c, C).
2 Inspect the infusion in progress.	To check it is the correct infusion being administered at the correct rate and that the contents are due to be delivered on time in order for the next prepared infusion bag to be connected. To check whether the patient is experiencing any discomfort at the site of insertion, which might indicate the peripheral device needs to be resited (NPSA 2007d, C).
3 Before administering any prescribed drug, check that it is due and has not already been given.	To protect the patient from harm (NPSA 2007d, C).
4 Before administering any prescribed drug, consult the patient's prescription chart and ascertain the following:	To ensure that the patient is given the correct drug in the prescribed dose using the appropriate diluent and by the correct route. To protect the patient from harm (NMC 2008a, C; NPSA 2007d, C).
(a) Drug	
(b) Dose	
(c) Date and time of administration	
(d) Route and method of administration	
(e) Diluent as appropriate	To comply with NMC (2008a) *Standards for Medicines Management.*
(f) Validity of prescription	
(g) Signature of doctor	
(h) The prescription is legible.	
5 Wash hands with bactericidal soap and water or bactericidal alcohol handrub, and assemble the necessary equipment.	To minimize the risk of infection (DH 2007, C; Fraise and Bradley 2009, E).
6 Prepare the drug for injection as described in Procedure guideline 16.15.	To ensure the drug is prepared (NPSA 2007d, C).
7 Check the name, strength and volume of intravenous fluid against the prescription chart.	To ensure that the correct type and quantity of fluid are administered (NMC 2008a, C; NPSA 2007d, C).
8 Check the expiry date of the fluid.	To prevent an ineffective or toxic compound being administered to the patient (NPSA 2007d, C).

9 Check that the packaging is intact and inspect the container and contents in a good light for cracks, punctures, air bubbles.	To check that no contamination of the infusion container has occurred (NPSA 2007d, C).
10 Inspect the fluid for discoloration, haziness and crystalline or particulate matter.	To prevent any toxic or foreign matter being infused into the patient (NPSA 2007d, C).
11 Check the identity and amount of drug to be added. Consider: **(a)** Compatibility of fluid and additive **(b)** Stability of mixture over the prescription time **(c)** Any special directions for dilution, for example pH, optimum concentration **(d)** Sensitivity to external factors such as light **(e)** Any anticipated allergic reaction. If any doubts exist about the listed points, consult the pharmacist or appropriate reference works.	To minimize any risk of error. To ensure safe and effective administration of the drug. To enable anticipation of toxicities and the nursing implications of these (NPSA 2007d, C).
12 Any additions must be made immediately before use.	To prevent any possible microbial growth or degradation (NPSA 2007d, C).
13 Wash hands thoroughly using bactericidal soap and water or bactericidal alcohol handrub.	To minimize the risk of cross-infection (DH 2007, C; Fraise and Bradley 2009, E).
14 Place infusion bag on flat surface.	To prevent puncturing the side of the infusion bag when making additions (NPSA 2007d, C).
15 Remove any seal present.	To expose the injection site on the container. E
Procedure	
16 Clean the site with the swab and allow it to dry.	To reduce the risk of contamination (NPSA 2007d, C).
17 Inject the drug using a new sterile needle into the bag, bottle or burette. A 23 or 25 G needle should be used. If the addition is made into a burette at the bedside:	To minimize the risk of contamination. To enable resealing of the latex or rubber injection site (NPSA 2007d, C). To minimize the risk of contamination (NPSA 2007d, C). To ensure the correct dilution (NPSA 2007d, C).
(a) Avoid contamination of the needle and inlet port	To ensure a bolus injection is not given (NPSA 2007d, C).
(b) Check that the correct quantity of fluid is in the	

chamber **(c)** Switch the infusion off briefly **(d)** Add the drug.	
18 Invert the container a number of times, especially if adding to a flexible infusion bag.	To ensure adequate mixing of the drug (NPSA 2007d, C).
19 Check again for haziness, discoloration and particles. This can occur even if the mixture is theoretically compatible, thus making vigilance essential.	To detect any incompatibility or degradation (NPSA 2007d, C).
20 Complete the drug additive label and fix it on the bag, bottle or burette.	To identify which drug has been added, when and by whom (NPSA 2007d, C).
21 Place the container in a clean receptacle. Wash hands and proceed to the patient.	To minimize the risk of contamination (DH 2007, C).
22 Check the identity of the patient against the prescription chart and infusion bag.	To minimize the risk of error and ensure the correct infusion is administered to the correct patient (NPSA 2007d, C).
23 Check that the contents of the previous container have been fully delivered.	To ensure that the preceding prescription has been administered (NPSA 2007d, C).
24 Switch off the infusion. Apply gloves. Place the new infusion bag on a flat surface and then disconnect empty infusion bag.	To ensure that the administration set spike will not puncture the side wall of the infusion bag (Finlay 2008, E; NPSA 2007d, C).
25 Push the spike in fully without touching it and hang the new infusion bag on the infusion stand. Insert tubing into an infusion pump where appropriate.	To reduce the risk of contamination (DH 2007, C). To ensure accuracy of delivery (Quinn 2008, E).
26 For gravity infusion, restart the infusion and adjust the rate of flow as prescribed. If via an infusion pump, start the pump and set rate.	To ensure that the infusion will be delivered at the correct rate over the correct period of time (NPSA 2007d, C).
27 If the addition is made into a burette, the infusion can be restarted immediately following mixing and recording and the infusion rate adjusted accordingly.	To ensure that the infusion will be delivered correctly (NPSA 2007d, C).
28 Ask the patient whether any abnormal sensations, and so on, are experienced.	To ascertain whether there are any problems that may require nursing care and refer to medical staff where appropriate. E.
Postprocedure	
29 Discard waste, making sure that it is placed in the correct containers, for example sharps into a designated receptacle.	To ensure safe disposal and avoid injury to staff. To prevent reuse of equipment (DH 2005, C; MHRA 2004, C).
30 Complete the patient's recording chart and other hospital and/or legally required documents.	To maintain accurate records. To provide a point of reference in the event of any queries. To prevent any duplication of treatment (NMC 2009, C).

Procedure guideline 16.24 Medication: intermittent infusion of intravenous drugs

Essential equipment

- Patient's prescription chart
- Recording chart or book as required by law or hospital policy
- Protective clothing as required by hospital policy for specific drugs
- Container of appropropriate intravenous infusion fluid
- Drug additive label
- Intravenous administration set
- Intravenous infusion stand
- Clean dressing trolley
- Clinically clean receiver or tray containing the prepared drug to be administered
- Sterile needles and syringes
- 10 mL for injection of a compatible flush solution, for example 0.9% sodium chloride or 5% dextrose
- Flushing solution to maintain patency plus sterile injection cap
- 2% chlorhexidine swab
- Gloves
- Alcohol-based hand wash solution or rub
- Sterile dressing pack
- Hypoallergenic tape
- Sharps bin

Preprocedure

Action	**Rationale**
1 Explain and discuss the procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (Griffith and Jordan 2003, E; NMC 2006c, C; NMC 2008b, C).
2 Before administering any prescribed drug, check that it is due and has not been given already. Check that the information contained in the prescription chart is complete, correct and legible.	To protect the patient from harm (NMC 2008a, C; NPSA 2007d, C).
3 Before administering any prescribed drug, consult the patient's prescription chart and ascertain the following:	To ensure that the patient is given the correct drug in the prescribed dose using the appropriate diluent and by the correct route (NMC 2008a, C; NPSA 2007d, C).
(a) Drug	
(b) Dose	To protect the patient from harm.
(c) Date and time of administration	To comply with NMC (2008a) *Standards for Medicines Management.*
(d) Route and method of administration	
(e) Diluent as appropriate	

(f) Validity of prescription	
(g) Signature of prescriber.	
4 Wash hands with bactericidal soap and water or bactericidal alcohol handrub.	To prevent contamination of medication and equipment (DH 2007, C).
5 Prepare the intravenous infusion and additive as described in Procedure guidelines 16.12, 16.13, 16.14 and 16.15.	To ensure the drug is prepared correctly (NPSA 2007d, C).
6 Prime the intravenous administration set with infusion fluid mixture and hang it on the infusion stand.	To ensure removal of air from set and check that tubing is patent. To prepare for administration (NPSA 2007d, C).
7 Draw up 10 mL of compatible flush solution for injection using an aseptic technique.	To ensure sufficient flushing solution is available. E
8 Draw up solution (as per hospital policy) to be used for maintaining patency, for example 0.9% sodium chloride.	To prepare for administration. E
9 Place the syringes in a clinically clean receiver or tray on the bottom shelf of the dressing trolley.	To ensure top shelf is used for sterile dressing pack in order to minimize the risk of contamination. E
10 Collect the other equipment and place it on the bottom shelf of the dressing trolley.	To ensure all equipment is available to commence procedure. E
11 Place a sterile dressing pack on top of the trolley.	To minimize risk of contamination. E
12 Check that all necessary equipment is present.	To prevent delays and interruption of the procedure. E
13 Wash hands thoroughly using bactericidal soap and water or bactericidal alcohol handrub before leaving the clinical room.	To minimize the risk of cross-infection (DH 2007, C; Fraise and Bradley 2009, E).
14 Proceed to the patient. Check patient's identity against prescription chart and prepared drugs.	To minimize the risk of error and ensure the correct drug is given to the correct patient (NMC 2008a, C; NPSA 2007d, C).
Procedure	
15 Open the sterile dressing pack.	To minimize the risk of cross-infection (DH 2007, C; Fraise and Bradley 2009, E).
16 Open the 2% chlorhexidine swab packet and empty it onto the pack.	To ensure the correct cleaning swab is available (DH 2007, E).
17 Wash hands with bactericidal soap and water or with a bactericidal alcohol handrub.	To minimize the risk of cross-infection. (DH 2007, C; Fraise and Bradley 2009, E).
18 If peripheral device is *in situ* remove the patient's bandage and dressing.	To observe the insertion site (Dougherty 2008, E).
19 Inspect the insertion site of the device.	To detect any signs of inflammation, infiltration, and so on. If present, take appropriate action (DH 2003c, C).
20 Wash and dry hands.	To minimize the risk of contamination (DH 2007, C).
21 Put on gloves.	To protect against contamination with hazardous substances, for example cytotoxic drugs (NPSA 2007d, C).

22 Place a sterile towel under the patient's arm.	To create a sterile area on which to work. E
23 Clean the needle-free cap with 2% chlorhexidine swab.	To minimize the risk of contamination and maintain a closed system (Pratt *et al.* 2007, C).
24 Inject gently 10 mL of 0.9% sodium chloride for injection.	To confirm the patency of the device. E
25 Check that no resistance is met, no pain or discomfort is felt by the patient, no swelling is evident, no leakage occurs around the device and there is a good backflow of blood on aspiration.	To ensure the device is patent (Dougherty 2008, E).
26 Connect the infusion to the device.	To commence treatment. E
27 Open the roller clamp or insert the tubing into an infusion pump and start pump.	To check the infusion is flowing freely. E
28 Check the insertion site and ask the patient if they are comfortable.	To confirm that the vein can accommodate the extra fluid flow and that the patient experiences no pain. E
29 Adjust the flow rate as prescribed.	To ensure that the correct speed of administration is established (NPSA 2007d, C).
30 Tape the administration set in a way that places no strain on the device, which could in turn damage the vein.	To reduce the risk of mechanical phlebitis or infiltration (Dougherty 2008, E).
31 If a peripheral device is *in situ*, cover it with a sterile topical swab and tape it in place.	To maintain asepsis (Dougherty 2008, E).
32 Remove gloves.	To ensure disposal. E
33 If the infusion is to be completed within 30 minutes, bandaging is unnecessary and the patient may be instructed to keep the arm resting on the sterile towel. Otherwise reapply bandage.	To reduce the risk of dislodging the device. E
34 The equipment must be cleared away and new equipment only prepared when required at the end of the infusion.	To ensure that the equipment used is sterile prior to use. E
35 Monitor flow rate and device site frequently.	To ensure the flow rate is correct and the patient is comfortable, and to check for signs of infiltration (NPSA 2007d, C).
36 When the infusion is complete, wash hands using bactericidal soap and water or bactericidal alcohol handrub, and recheck that all the equipment required is present.	To maintain asepsis and ensure that the procedure runs smoothly (DH 2007 C; Finlay 2008, E).
37 Stop the infusion when all the fluid has been delivered.	To ensure that all the prescribed mixture has been delivered and prevent air infusing into the patient (NPSA 2007d, C).
38 Put on non-sterile gloves.	To protect against contamination with hazardous substances. E
39 Disconnect the infusion set and flush the device with 10 mL of 0.9% sodium chloride or other compatible solution for injection. (A 'minibag' may be used to flush the drug through the tubing but the cost implications of this as well as the risk to patients on restricted intake should be considered before this is adopted routinely.)	To flush any remaining irritating solution away from the cannula. E
40 Attach a new sterile injection cap if necessary.	To maintain a closed system (Hart 2008, E).
41 Flushing must follow.	To maintain the patency of the

	device (Dougherty 2008, E).
42 Clean the injection site of the cap with 2% chlorhexidine swab.	To minimize the risk of contamination (Hart 2008, E).
43 Administer flushing solution using the push-pause technique and ending with positive pressure.	To maintain the patency of the device and if needle was used, to enable reseal of the injection site (Dougherty 2008, E).
44 If a peripheral device is *in situ*, cover the insertion site and cannula with a new sterile low-linting swab. Tape it in place. Apply a bandage.	To minimize the risk of contamination of the insertion site. To reduce the risk of dislodging the cannula. E
45 Remove gloves.	To ensure disposal. E
46 Assist the patient into a comfortable position.	To ensure the patient is comfortable. E
Postprocedure	
47 Record the administration on appropriate charts.	To maintain accurate records, provide a point of reference in the event of any queries and prevent any duplication of treatment (NMC 2009, C).
48 Discard waste, placing it in the correct containers, for example sharps into a designated container.	To ensure safe disposal and avoid injury to staff (DH 2005, C; MHRA 2004, C; NHS Employers 2007, C).

Procedure guideline 16.25 Medication: injection (bolus or push) of intravenous drugs

Essential equipment

- Clinically clean receiver or tray containing the prepared drug(s) to be administered
- Patient's prescription chart
- Protective clothing as required by hospital policy or specific drugs
- Clean dressing trolley
- Sterile needles and syringes
- 0.9% sodium chloride, 20 mL for injection, or compatible solution
- Flushing solution, in accordance with hospital policy
- 2% chlorhexidine swab
- Sterile dressing pack
- Hypoallergenic tape
- Sharps container

Preprocedure

Action	**Rationale**
1 Explain and discuss the procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (Griffith and Jordan 2003, E; NMC 2006c, C; NMC 2008b, C).
2 Before administering any prescribed drug, check that it is due and has not been given already. Check that the information contained in the prescription chart is complete, correct and legible.	To protect the patient from harm (NMC 2008b, C).
3 Before administering any prescribed drug, consult the patient's prescription sheet and ascertain the following:	To ensure that the patient is given the correct drug in the prescribed dose using the appropriate diluent and by the correct route (NMC 2008a, C; NPSA 2007d, C).
(a) Drug	
(b) Dose	To protect the patient from harm.
(c) Date and time of administration	To comply with NMC (2008a) *Standards for Medicines Management.*
(d) Route and method of administration	
(e) Diluent as appropriate	
(f) Validity of prescription	
(g) Signature of prescriber	
(h) The prescription is legible.	
Procedure	
4 Select the required medication and check the expiry date.	Treatment with medication that is outside the expiry date is dangerous. Drugs deteriorate with storage. The expiry date indicates when a particular drug is no longer pharmacologically efficacious (NPSA 2007d, C).
5 Wash hands with bactericidal soap and water or bactericidal alcohol handrub, and assemble necessary equipment.	To minimize the risk of infection (DH 2007, C; Fraise and Bradley 2009, E).
6 Prepare the drug for injection as Procedure guideline 16.15.	To prepare the drug correctly. E
7 Prepare a 20 mL syringe of 0.9% sodium chloride (or	To use for flushing between each drug (NPSA 2007d

7 Prepare a 20 mL syringe of 0.9% sodium chloride (or compatible solution) for injection, as described, using aseptic technique.	To use for flushing between each drug (NPSA 2007d, C).
8 Draw up the flushing solution, as indicated by local hospital policy.	To prepare for administration. E
9 Place syringes in a clinically clean receptacle on the bottom shelf of the dressing trolley, along with the receptacle containing any drug(s) to be administered.	To ensure top shelf is used for sterile dressing pack in order to minimize the risk of contamination. E
10 Collect the other equipment and place it on the bottom of the trolley.	To ensure all equipment is available to commence procedure. E
11 Place a sterile dressing pack on top of the trolley.	To minimize the risk of contamination. E
12 Check that all necessary equipment is present.	To prevent delays and interruption of the procedure. E
13 Wash hands thoroughly.	To minimize the risk of infection (DH 2007, C; Fraise and Bradley 2009, E).
14 Proceed to the patient and check identity with prescription chart and prepared drug.	To minimize the risk of error and ensure the correct patient (NPSA 2007d, C).
15 Open the sterile dressing pack and 2% chlorhexidine swab and empty onto pack.	To gain access to equipment and to ensure there is a cleaning swab available (DH 2007, C).
16 Wash hands with bactericidal soap and water or with bactericidal alcohol handrub.	To reduce the risk of infection (DH 2007, C; Fraise and Bradley 2009, E).
17 If a peripheral device is *in situ*, remove the bandage and dressing (if appropriate).	To observe the insertion site. E
18 Inspect the insertion site of the device.	To detect any signs of inflammation, infiltration, and so on. If present, take appropriate action (see Problem-solving table 16.3) (DH 2003c, C).
19 Observe the infusion, if in progress.	To confirm that it is infusing as desired (NPSA 2007d, C).
20 Check whether the infusion fluid and the drugs are compatible. If not, change the infusion fluid to 0.9% sodium chloride to flush between the drugs if necesary.	To prevent drug interaction. Some manufacturers may recommend that the drug is given into the injection site of a rapidly running infusion (NPSA 2007d, C). A compatible fluid must be used to remove the medication and prevent precipitation or drug incompatibility if medications mix in the tubing (Whittington 2008, E).
21 Wash hands or clean them with an alcohol handrub.	To minimize the risk of infection (DH 2007, C; Fraise and Bradley 2009, E).
22 Place a sterile towel under the patient's arm.	To create a sterile field. E
23 Clean the injection site with a 2% chlorhexidine swab and allow to dry.	To reduce the number of pathogens introduced by the needle at the time of the insertion. To ensure complete disinfection has occurred (Pratt *et al.* 2007, C).
24 Switch off the infusion.	To prevent excessive pressure within the vein. To prevent contact with an incompatible infusion fluid. To allow the nurse to concentrate on the site of insertion and injection (NPSA 2007d, C).
25 If a peripheral device is *in situ*, gently inject 0.9% sodium chloride. This may not be necessary if the patient has a 0.9% sodium chloride infusion in progress.	To confirm patency of the vein. To prevent contact with an incompatible infusion solution (NPSA 2007d, C).
26 Open the roller clamp of the administration set fully. Inject the drug at a speed sufficient to slow but not stop the infusion and inject the drug smoothly in the direction of flow at the specified rate.	To prevent backflow of drug up the tubing. To prevent excessive pressure within the vein. To prevent speed shock (NPSA 2007d, C).
27 Ensure used needles and syringes are disposed of immediately into appropriate sharps container (or are	To reduce the risk of needlestick injury and to prevent contamination of pack (RCN 2010, C).

immediately into appropriate sharps container (or are returned to tray). Do not leave any sharps on opened sterile pack.	contamination of pack (RCN 2010, C).
28 Observe the insertion site of the device throughout.	To detect any complications at an early stage, for example extravasation or local allergic reaction (Dougherty 2008, E).
29 Blood return and/or 'flashback' must be checked frequently throughout the injection (that is, every 3–5 mL) but other signs and symptoms must be taken into consideration.	To confirm that the device is correctly placed and that the vein remains patent (Weinstein and Plumer 2007, E). Flashback alone is not an indicator that the vein is patent (Dougherty 2008, E).
30 Consult the patient during the injection about any discomfort, and so on.	To detect any complications at an early stage, and ensure patient comfort (Dougherty 2008, E).
31 If more than one drug is to be administered, flush with 0.9% sodium chloride between administrations by restarting the infusion or changing syringes.	To prevent drug interactions (NPSA 2007d, C).
32 At the end of the injection, flush with 0.9% sodium chloride by restarting the infusion or attaching a syringe containing 0.9% sodium chloride.	To flush any remaining irritant solution away from the device site (NPSA 2007d, C).
33 Observe the insertion site of the cannula carefully.	To detect any complications at an early stage. Extra pressure within the vein caused by both fluid flow and injection of the drug may cause rupture of the vessel (Dougherty 2008, E).
34 After the final flush of 0.9% sodium chloride, adjust the infusion rate as prescribed or open the fluid path of the tap/stopcock or administer the flushing solution using pulsatile flush and ending with positive pressure.	To continue delivery of therapy. To maintain the patency of the cannula (Finlay 2008, E).
35 If a peripheral device is *in situ*, cover the insertion site with new sterile low-linting swab and tape it in place.	To minimize the risk of contamination of the insertion site. E
36 Apply a bandage.	To reduce the risk of dislodging the cannula. E
37 Assist the patient into a comfortable position.	To ensure the patient is comfortable. E
Postprocedure	
38 Record the administration on appropriate charts.	To maintain accurate records, provide a point of reference in the event of any queries and prevent any duplication of treatment (NMC 2009, C).
39 Dispose of used syringes with needles, unsheathed, directly into a sharps container during procedure or place back on to plastic tray and then dispose of in a sharps container as soon as possible. *Do not* disconnect needle from syringe prior to disposal. Other waste should be placed into the appropriate plastic bags.	To avoid needlestick injury (MHRA 2004, C; NHS Employers 2007, C).

Problem-solving table 16.3 Prevention and resolution (Procedure guidelines 16.23, 16.24 and 16.25)

Problem	Cause	Prevention	Action
Infusion slows or stops (part 1)	Change in position of the following:		
	(a) Patient	Check the height of the fluid container if the patient is active and receiving an infusion using gravity flow	Adjust the height of the container accordingly. The infusion should not hang higher than 1 m above the patient as the increased height will result in increased pressure and possible rupture of the vessel/device (Quinn 2008)
	(b) Limb	Prevent by avoiding inserting peripheral devices at joints of limbs	Move the arm or hand until infusion starts again. Secure the device, then bandage or splint the limb again carefully in the desired position. Take care not to cause damage to the limb
		Instruct the patient on the amount of movement permitted. Continued movement could result in mechanical phlebitis (Lamb and Dougherty 2008)	
	(c) Administration set	Tape the administration set so that it cannot become kinked or occluded	Check for kinks and/or compression if the patient is active or restless and correct accordingly
	(d) Cannula	Secure the cannula firmly to prevent movement. It may come into contact with the vein wall or a valve. Infusions sited in small veins are prone to this problem	Remove the bandage and dressing and manoeuvre the peripheral device gently, without pulling it out of the vein, until the infusion starts again. Secure adequately
Infusion slows or stops (part 2)	Technical problems:		
	(a) Negative pressure prevents flow of fluid	Ensure that the container is vented using an air inlet	Vent if necessary, using venting needle
	(b) Empty container	Check fluid levels regularly	Replace the fluid container before it runs dry
	(c) Venous spasm due to chemical irritation or cold fluids/drugs	Dilute drugs as recommended. Remove solutions from the refrigerator a short time before use	Apply a warm compress to soothe and dilate the vein, increase the blood flow and dilute the infusion mixture
	(d) Injury to the vein	Detect any injury early as it is likely to progress and cause more serious conditions (see below)	Stop the infusion and resite the cannula
	(e) Occlusion of the device due to fibrin formation	Maintain a continuous, regular fluid flow or ensure that patency is maintained by flushing. Instruct the patient to keep arm below the level of the heart if ambulant and attached to a gravity flow infusion	**If peripheral device**: remove extension set/injection cap and attempt to flush the cannula gently using a 10 mL syringe of 0.9% sodium chloride. If resistance is met, stop and request a resiting of the peripheral device (see Chapter 18)
			If CVAD: remove injection cap and attempt to flush the cannula gently using a 10 mL syringe of 0.9% sodium chloride. If resistance is met, attempt to instil fibrinolytic agent such as urokinase (see Chapter 18)

	(f) The cannula has become displaced either completely or partially, that is, fluid or drug has leaked into the surrounding tissues (infiltration). If the drugs were vesicant in nature this would then be defined as extravasation	Secure the cannula and tape the administration set to prevent pulling and dislodgement. Instruct the patient on the amount of movement permitted with the limb that has the device *in situ* (Fabian 2000)	Confirm that infiltration of drugs has/has not occurred by: (i) inspecting the site for leakage, swelling, and so on (ii) testing the temperature of the skin: it will be cooler if infiltration has occurred (iii) comparing the size of the limb with the opposite limb Once infiltration has been confirmed, stop the infusion and request a resiting of the device. If the infusion is allowed to progress, discomfort and tissue damage will result. Apply cold or warm compresses to provide symptomatic relief, whichever provides the most comfort for the patient. Reassure the patient by explaining what is happening. Document in care plan and monitor site (Lamb and Dougherty 2008) If extravasation, follow hospital policy and procedure (see Chapter 15)
Infusion pump alarming			
(a) Air detected	Air bubbles in administration set	Ensure all air is removed from all equipment prior to use	Remove all air from the administration set and restart the infusion
(b) Tube misload	Administration set has been incorrectly loaded	Ensure set is loaded correctly	Check that the set is loaded correctly and reload if necessary
(c) Upstream occlusion	Closed clamp, obstruction or kink in the administration set is preventing fluid flow	Ensure the container/fluid bag has been adequately pierced by the administration spike	Inspect the administration set and restart the infusion
		Ensure that the tubing is taped to prevent kinking	If tubing is kinked, reposition, tape and restart infusion
		Ensure the regulating (roller) clamp is open	Check the administration set and open the clamp; restart the infusion
(d) Downstream occlusion	Phlebitis/infiltration or extravasation	Observe site regularly for signs of swelling, pain and erythema	Remove peripheral device, provide symptomatic relief where appropriate. Initiate extravasation procedure. Resite as appropriate
	Closed distal clamp	Ensure clamps are open	Locate distal occlusion, restart infusion
(e) KVO alert (keep vein open)	The volume infused is complete and the device is infusing at the KVO rate	Program in a new volume as appropriate	Do not turn the device off. Allow KVO mode to run to maintain patency of device Prepare new infusion or discontinue as appropriate

Infusion devices malfunctioning (electrical/ mechanical)	Not charging at mains	Ensure that the device is kept plugged in where appropriate	Change device and remove device from use until fully charged. Send to works department to check plug
	Low battery	Check lead is pushed in adequately	
	Batteries keep requiring replacement	Do not use small rechargeable batteries in ambulatory devices	
	Technical fault	Ensure all infusion devices are serviced regularly	Remove infusion device from use and contact biomedical engineering department or relevant personnel
	Device soiled inside mechanism	Maintain equipment and keep clean and free from contamination	Remove administration set, wipe pump, reload. Do not use alcohol-based solutions on internal mechanisms
Unstable infusion device	Mounted on old, poorly maintained stands	Ensure that stands are maintained and kept clean. Replace old stands	Remove device from stand. Remove stand and send to works department for repair
	Mounted on incorrect stands	Ensure the correct stands are used	Check the stand and change to appropriate stand
	Equipment not balanced on stand	Ensure that all equipment is balanced around the stand	Remove devices and attach to two stands if necessary. Balance equipment

Postprocedural considerations

Ongoing care

Monitoring of the infusion while in progress includes monitoring of the patient's condition and response to therapy, the VAD site, the rate and volume infused. It may also include the battery life and occlusion pressure. The frequency of monitoring is often based on the type of therapy and patient condition, for example 15 minutes after setting up infusion, at 1 hour and then 4 hourly. This information must be documented on the patient's fluid balance chart or in their notes. The type and make of pump along with the serial number should also be documented (useful if any errors occur) (MHRA 2008a).

Complications

For phlebitis, thrombosis, septicaemia and embolism, see Chapter 18. For infiltration and extravasation, see Chapter 15.

Allergic reaction

This is a complication associated with any medication administration but because it happens more rapidly when IV medication is administered, it is often considered as more of an issue.

An allergic reaction is a response to a medication or solution to which the patient is sensitive and may be immediate or delayed (Lamb and Dougherty 2008, Perucca 2010). Clinical features may start with chills and fever, with or without urticaria, erythema and itching. The patient could then go onto experience shortness of breath with or without wheezing, then angioneurotic oedema and in severe cases anaphylactic shock (Lamb and Dougherty 2008). Prevention is by assessment and recording of patient allergies (drug, food and products) and application of allergy identification wristbands (NPSA 2008a, Perucca 2010). In the event of an allergic reaction, the infusion should be stopped immediately, the tubing and container changed and the vein kept patent. The doctor should be notified and any interventions undertaken (Lamb and Dougherty 2008).

Circulatory overload (isotonic fluid expansion)

A critical and common complication of intravenous therapy is circulatory overload, which is *isotonic fluid expansion*. It is caused by infusion of fluids of the same tonicity as plasma into the vascular circulation, for example sodium chloride 0.9%. As isotonic solutions do not affect osmolarity, water does not flow from the extracellular to the intracellular compartment. The result is that the extracellular compartment expands in proportion to the fluid infused (Weinstein and Plumer 2007). Because of the electrolyte concentration, no extra water is available to enable the kidneys selectively to excrete and restore the balance. It can also occur due to:

- infusing excessive amounts of sodium chloride solutions
- large volume infusions running over multiple days
- rapid fluid infusion into patients with compromised cardiac, liver or renal status (Lamb and Dougherty 2008, Macklin and Chernecky 2004).

Prevention includes thorough assessment of the patient before commencing IV therapy, close monitoring of patient; maintaining infusion rates as prescribed and use of infusion devices where required (Lamb and Dougherty 2008). If circulatory overload is detected early, place the patient in an upright position

(Macklin and Chernecky 2004). Treatment consists of withholding all fluids until excess water and electrolytes have been eliminated by the body and/or administration of diuretics to promote rapid diuresis (Weinstein and Plumer 2007). However, careful monitoring should continue to prevent isotonic contraction occurring (where there is loss of fluid and electrolytes isotonic to the extracellular fluid such as blood and large volumes of fluid from diarrhoea and vomiting; Weinstein and Plumer 2007). If fluid administration is allowed to continue unchecked, it can result in left-sided heart failure, circulatory collapse and cardiac arrest (Dougherty 2002).

Dehydration

Dehydration may be categorized as either hypertonic or hypotonic contraction and may be caused by underinfusion. Hypertonic contraction occurs when water is lost without corresponding loss of salts (Weinstein and Plumer 2007) and occurs in patients unable to take sufficient fluids (elderly, unconscious or incontinent patients) or who have excess insensible water loss via skin and lungs or as a result of certain drugs in excess. Hypotonic contraction occurs when fluids containing more salt than water are lost and this results in a decrease in osmolarity of the extracellular compartment (Weinstein and Plumer 2007).

It is important that the nurse recognizes the symptoms of overinfusion or underinfusion and certain factors should be considered when monitoring patients (Weinstein and Plumer 2007) (see Table 16.11).

Table 16.11 Monitoring overinfusion and underinfusion

Type of fluid/electrolyte imbalance	Patients at risk	Signs and symptoms	Treatment
Circulatory overload (isotonic fluid expansion)	Early postoperative or post-trauma patients, older people, those with impaired renal and cardiac function and children	Weight gain A relative increase in fluid intake compared to output A high bounding pulse pressure, indicating a high cardiac output Raised central venous pressure measurements Peripheral hand vein emptying time longer than normal (peripheral veins will usually empty in 3–5 seconds when the hand is elevated and will fill in the same length of time when the hand is lowered to a dependent position) Peripheral oedema Hoarseness Dyspnoea, cyanosis and coughing due to pulmonary oedema and neck vein engorgement	If detected early: withholding all fluids until excess water and electrolytes have been eliminated by the body and/or administration of diuretics to promote rapid diuresis
Dehydration (hypertonic contraction or hypotonic contraction)	*Hypertonic:* elderly, unconscious or incontinent patients *Hypotonic*: infants are at greatest risk, especially if they have diarrhoea. Loss of salt from various sources: excess diuresis, fistula drainage, burns, vomiting or sweating	*Hyper/hypotonic contraction* Weight loss *Hypercontraction* Thirst (although this may be absent in the elderly) Irritability and restlessness and possible confusion Diminished skin turgor Dry mouth and furred tongue *Hypocontraction* Negative fluid balance Weak, thready, rapid pulse rate Increased 'hand filling time' Increased skin turgor	Replacement of fluids and electrolytes

Speed shock

Speed shock is a systemic reaction that occurs when a substance foreign to the body is rapidly introduced into the circulation (Perucca 2010, Weinstein and Plumer 2007). This complication can manifest following administration of intravenous bolus injections or when large volumes of fluid are given too rapidly (Perucca 2010). This should not be confused with pulmonary oedema, which relates to the volume of fluid infused into the patient. Rapid, uncontrolled administration of drugs will result in toxic concentrations reaching vital organs (Lamb and Dougherty 2008). Toxicity may be manifested by an exaggeration of the usual pharmacological actions of the drug or by signs and symptoms specific for that drug or class of drugs. The most extreme toxic response which can occur if a drug is given at a dose or rate exceeding that recommended is termed the lethal response.

Signs of speed shock may include:

- flushed face
- headache and dizziness
- congestion of the chest
- tachycardia and fall in blood pressure
- syncope
- shock
- cardiovascular collapse (Perucca 2010, Weinstein and Plumer 2007).

Prevention of speed shock involves the nurse having knowledge of the drug and the recommended rate of administration. When commencing an infusion using gravity flow, check that the solution is flowing freely before adjusting the rate and monitored regularly (Perucca 2010). Movement of the patient or the device within the vessel can cause the infusion to flow more or less freely after a few minutes of setting the rate (Weinstein and Plumer 2007). For high-risk medications an electronic flow control device is recommended (RCN 2010). Although most pumps have an anti-free flow mechanism, always close the roller clamp prior to removing the set from the pump (MHRA 2006a, Pickstone 1999). If speed shock occurs, the infusion must be slowed down or discontinued. Medical staff should be notified immediately and the patient’s condition treated as clinically indicated (Perucca 2010).

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Skin-Tunnelled Catheters

Definition

A skin-tunnelled catheter is a long-term catheter that lies in a subcutaneous tunnel before entering a central vein (usually subclavian) (Hadaway 2000). The tunnel commonly exits between the sternum and the nipple. The tip lies at the junction of the SVC and right atrium or within the lower portion of the SVC or the upper right atrium (Dougherty 2006, Galloway and Bodenham 2009) (see Figure 18.26).

Figure 18.26 Tunnelled catheter. (a) Anatomical positioning of tunnelled catheter. (b) Patient with tunnelled catheter *in situ*.

(a)

(b)

Evidence-based approaches

Rationale

Tunnelled silicone catheters were first described by Broviac in Seattle in 1973 and were modified by Hickman and his colleagues, who created a larger lumen of 1.6 mm internal diameter (Bjeletich and Hickman 1980). The special features added included an inert antithrombogenic flexible material and a subcutaneous Dacron cuff attached to the catheter (Ives 1998). The cuff has two functions – to secure the catheter and prevent infection.

Indications

A skin-tunnelled catheter is used when long-term venous access is required or if peripheral vascular access is problematic (Dougherty 2006).

Contraindications

As for other CVADs.

Methods of insertion

The insertion of a skin-tunnelled catheter is a surgical procedure usually carried out in an operating theatre or designated area, under aseptic conditions, using fluoroscopy and monitoring of the patient by pulse oximetry and electrocardiogram (ECG) to detect arrhythmias (Benton and Marsden 2002, Dougherty 2006, Galloway and Bodenham 2009, Weinstein and Plumer 2007). The procedure is now also performed by nurse specialists at the bedside and within radiology departments (Benton and Marsden 2002, Boland *et al.* 2003, Fitzsimmons *et al.* 2000, Hamilton *et al.* 2009). The procedure is usually performed under sedation along with the use of local anaesthesia (Dougherty 2006). In some patients, for example children, this procedure would be carried out under general anaesthesia.

The aim of the insertion is to place the catheter tip in the right atrium via the subclavian vein and SVC (Galloway and Bodenham 2009). When there is an SVC obstruction from thrombosis or compression, the femoral vein can be used to access the inferior vena cava. Selection of vessels is as for non-tunnelled CVC. Access may be gained percutaneously using a needle and guidewire or via an open surgical cutdown procedure.

The catheter can be inserted percutaneously when the venepuncture site is made near the subclavian or internal jugular. The tunnelling rod is then passed under the skin and exits at a predetermined point on the chest. The catheter is then attached to the tunnelling rod and drawn through the subcutaneous tunnel. The catheter is then passed into the vein via a peel-away sheath introducer (Davidson and Al Mufti 1997, Galloway and Bodenham 2009, Hadaway 2000). Position is confirmed by the easy aspiration of blood from each lumen and these are then flushed with heparin until correct tip placement has been confirmed. A chest X-ray should be performed after insertion to check for correct placement and pneumothorax (Davidson and Al Mufti 1997, Stacey *et al.* 1991).

Methods for removal

Removal techniques for skin-tunnelled catheters vary. Removal should only be performed by specially trained nurses or doctors. It is recommended that the patient is placed supine and that aseptic technique is used throughout. There are two methods for removal.

Surgical excision

This method involves locating the cuff and performing a minor surgical excision under local anaesthetic. A small incision is made over the site of the cuff and blunt dissection, that is, using forceps, is carried out to prise the tissues apart (Galloway and Bodenham 2009); this causes less damage to the tissues than using a scalpel. The cuff and the catheter are freed from the surrounding fibrous tissue (Dougherty 2006). The proximal section of the catheter is then removed, cut and then the distal end is removed via the exit site. Once the catheter has been removed, the wound is sutured using interrupted sutures, which can be removed after 7 days (Drewett 1995, Galloway and Bodenham 2009).

Traction method

With the traction method, there is a greater risk of the catheter breaking, which could result in a catheter embolism.

The catheter is gripped firmly and constant traction applied until the cuff is loosened in the tunnel (Hayden and Goodman 1992). It may take a few minutes for the catheter and cuff to become loose before sliding free. Constant steady pressure will remove the complete catheter; however, the catheter should be checked on removal to ensure it is complete as breakage and splitting can occur (Hayden and Goodman 1992, INS 1999). The catheter and cuff may be pulled through, but the cuff may remain attached to tissue. This is thought to be of no significance and may be left in place, although some suggest that if the cuff is not removed it could become infected later (Drewett 2009, Galloway and Bodenham 2009). Difficulty with removal or a break in the catheter will require surgical intervention.

Legal and professional issues

Nurses who wish to undertake this role must receive additional training in theory and practical hands-on instruction at the bedside in the removal technique and suturing (Bullock-Corkhill 2010). Competencies would include knowledge in use of local anaesthetic, making an incision/use of scalpel, suturing, and prevention and management of complications.

Preprocedural considerations

Equipment

Polyurethane or silicone skin-tunnelled catheters are available as single-, double- or triple-lumen with a Dacron cuff. The cuff is used to secure the catheter as fibrous tissue grows around it and obliterates part of the subcutaneous tunnel within 1–2 weeks of insertion. It also impedes the migration of micro-organisms, creating a 'barrier' along the subcutaneous tract and therefore reducing the incidence of catheter-related infection (Dougherty 2006, Springhouse 2002, Weinstein and Plumer 2007, Wilson 2006). The cuff is about 1 cm wide (Hadaway 2000) and is usually located about 3–5 cm from the exit site (Stacey *et al.* 1991, Weinstein and Plumer 2007). Knowledge of the distance of the cuff from the bifurcation may assist the practitioner in locating the cuff during removal of the catheter, although it will vary according to the brand of catheter.

The tip of the catheter may be open-ended or closed with a slit valve (Dougherty 2006, Ives 1998). The disadvantage of an open-ended catheter is the problem of blood reflux, resulting in occlusion. Catheters such as the Groshong catheter have a round closed tip which incorporates a two-way valve that remains closed at normal vena caval pressure. Application of a vacuum in order to withdraw blood enables the valve to open inwards; positive pressure into the catheter forces the valve to open outwards (Figure 18.27) (Dougherty 2006). The advantages of valved catheters are the reduced risk of bleeding or air emboli on insertion and during subsequent care; the elimination of catheter clamping; and the elimination of the need for heparin along with a reduction in the frequency of flushing (Hoffer *et al.* 2001, Inwood 2009, Weinstein and Plumer 2007). However, if a thrombus forms around the tip, it can result in malfunction and loss of valve competence (Dougherty 2006).

Figure 18.27 Groshong two-way valve catheter. (a) Infusion (positive pressure). (b) Aspiration (negative pressure). (c) Closed (neutral pressure). (Groshong is a registered trademark of CR Bard, Inc. or an affiliate.)

Another type of catheter is the pressure-activated safety valve (PASV). The valve opens with minimal positive pressure for infusion but requires four times as much negative pressure for aspiration (Weinstein and Plumer 2007). This feature reduces the risk of air embolism or bleeding resulting from accidental disconnection (Ives 1998). The valve is incorporated within the hub and not the tip and reduces the risk of reflux even during periods of raised CVP (Weinstein and Plumer 2007).

Procedure guideline 18.11 Central venous catheter (skin-tunnelled): surgical removal

Essential equipment

- Plastic apron
- Sterile gloves
- Minor operations set
- 10 mL Luer-Lok syringe
- 25 G needle
- 21 G needle

Optional equipment

- Steristrips (to be used if necessary)
- Specimen container

Medicinal products

- 10 mL plain lidocaine 1%
- Chlorhexidine 2% in 70% alcohol
- 10 × 10 cm low-linting gauze swabs × 5
- 3/0 Mersilk suture on a curved needle
- Transparent dressing

Preprocedure

Action	**Rationale**
1 Check the patient's full blood count and clotting profile for that day.	To ensure that the patient is not at risk of bleeding or infection from this invasive procedure. The platelets should be above 100×10^9/L, the white blood count >2 and the INR <1.3 (Dougherty 2006, E). In haematology patients the platelets should be >50 and the INR <1.5.
2 Explain and discuss the procedure with the patient.	To ensure that the patient understands the procedure and gives their valid consent (NMC 2008b, C).
3 Screen the bed and ask patient to remove clothing down to the waist.	To ensure ease of access to the patient's chest. E
4 Ask patient to lie as flat as possible with their arms by their sides.	To minimize the risk of bleeding from gravitational pressure and to dissuade the patient from touching the sterile field (Dougherty 2006, E).
Procedure	
5 Palpate and identify the position of the cuff in the patient. This can be done by gently pulling on the catheter and observing for skin pucker.	To locate the area for the incision (Drewett 1995, E; Galloway and Bodenham 2009, E).
6 If the cuff cannot easily be felt, measure up from the bifurcation or hub at the end of the catheter distal to the patient, dependent on the type of catheter *in situ*, then palpate again. If it still cannot be felt, ask for assistance from a more experienced colleague.	The cuff will be positioned differently depending on the type of catheter. To locate the probable site of the cuff. To guard against malplaced incisions (Dougherty 2006, E).
7 Open the outer bag of the minor operation pack.	To gain access to contents. E
8 Put on plastic apron and wash hands, then dry hands on sterile towel provided in the pack.	To reduce risk of infection (DH 2010, C; Fraise and Bradley 2001, E).
9 Put on sterile gloves and assemble all necessary equipment on the sterile pack.	To maintain asepsis and to prepare for the procedure and maximize efficiency (DH 2010, C).
10 Advise the patient that you will explain each step of the procedure as you go along if the patient wishes.	This should take into account the patient's individual wish for information. E
11 Clean the area directly over the cuff with 2% chlorhexidine in 70% alcohol, using back and forth strokes, working out from the centre directly over the cuff. Allow the area to dry.	To reduce the risk of infection. To enable disinfection process to be completed. To prevent stinging on insertion of the needle (Dougherty 2006, E).
12 Apply a fenestrated drape.	To create a sterile field to operate within and therefore reduce the risk of infection (Dougherty 2006, E).
13 Inform the patient that you are about to administer the local anaesthetic and that this will cause a stinging sensation.	To prepare the patient. The first injection can be painful and causes a stinging sensation (BNF 2011, C, P).
14 With a 25 G needle, administer the first millilitre of local anaesthetic intradermally directly over the cuff site, causing a raised bleb.	To commence the numbing of the area to be incised. To provide a raised area for the next injection and identification of the site (Macklin and Chernecky 2004

site, causing a raised bleb.	identification of the site (Macklin and Chernecky 2004, E).
15 Give a further 1–2 mL of local anaesthetic subcutaneously, using the bleb as the area for the insertion of the needle, but directing the needle out and around the area of the cuff site.	To reduce pain for the patient with repeated injections. To ensure all the incision area is numb (Macklin and Chernecky 2004, E).
16 Attach the 21 G needle and with the last remaining 4 mL of local anaesthetic, give two deeper injections to either side of the cuff area.	To ensure anaesthesia at a deeper level during the blunt dissection around the cuff (Macklin and Chernecky 2004, E).
17 Test the area above the cuff for numbness and then make the incision over the cuff site (but slightly to the side of the cuff site in very thin patients). The incision should be longitudinal and about 2 cm in length. Ensure that the incision is through the epidermis and dermis.	To ensure that the patient will not experience any pain. To facilitate identification and removal of the cuff. To allow access to the cuff which is situated below the dermis. To reduce the risk of cutting through the cuff before the cuff has been identified (Dougherty 2006, E; Drewett 1995, E).
18 With one pair of the small artery forceps, commence blunt dissection of tissue from around the cuff. At intervals, place your finger into the site and feel the cuff.	To free the cuff from the surrounding fibrous tissue. To assess the mobility of the cuff. To reduce the risk of bleeding and damage of catheter (Dougherty 2006, E; Drewett 1995, E).
19 Continue with blunt dissection around and under the cuff until it feels mobile.	To facilitate the loosening of the cuff (Dougherty 2006, E).
20 With one pair of artery forceps or the dissecting hook, loop under the cuff and lift it up out of the incision.	To identify the catheter to allow removal (Dougherty 2006, E).
21 Once the cuff is free, still maintaining a grip on the cuff, gently and carefully peel away the thin straw-coloured tissue from the catheter with the blade, ensuring the blade is pulled away from the catheter.	To free the catheter from the anchoring fibrous bands to enable removal. To reduce the risk of accidental incision of the catheter (Dougherty 2006, E).
22 As the last strands of fibre are separated, you should feel the catheter becoming free and you should be able to see the white material of the catheter.	To ensure that you have completely freed the catheter for removal (Dougherty 2006, E).
23 Ask the patient to perform the Valsalva as the proximal portion of the catheter is withdrawn from the vein and apply gentle pressure at the vein exit site.	To remove the catheter and prevent bleeding or air entry (Drewett 1995, E).
24 Remove the distal portion and cut through the catheter using a blade or scissors and remove via the skin exit site.	To remove the distal half of the catheter below the cuff (Dougherty 2006, E).
25 If the catheter is removed because of infection, carefully cut off the tip (approximately 5 cm) of the catheter using sterile scissors and place it in a sterile container for microbiological investigation.	To detect any infection related to the catheter and thus provide necessary treatment (DH 2010, C).
26 Close the incision with three sutures. Commence the first suture in the middle of the incision, with the remaining sutures evenly on either side.	To close the incision efficiently. To ensure that the skin edges and insert are brought together in alignment (Dougherty 2006, E).
27 If there continues to be any bleeding, Steristrips can be applied across the incision over the sutures.	To minimize blood loss (Dougherty 2006, E).
28 It is not usually necessary to suture the exit site.	To leave the exit site to granulate without a suture (Drewett 1995, E).
Postprocedure	
29 Apply a small pressure dressing and cover with an airtight dressing.	To absorb any slight bleed and to maintain a clean site (Scales 2008, E).
30 Advise patient that there might be some oozing and to reapply a dry dressing after 24 hours and thereafter	To ensure that the incision has fully closed and healed (Dougherty 2006, E; Drewett 1995, E).

once a day until the sutures are removed. Advise the patient that the sutures should be removed in 7 days.	
31 Dispose of the equipment in the appropriate containers.	To reduce the risk of environmental contamination (DH 2010, C).
32 Ask the patient to rest on the bed for the next 30–60 minutes, or longer if required, especially patients who are prone to bleeding.	To reduce the risk of bleeding and air embolism as the patient sits or gets up (Dougherty 2006, E).
33 Liaise with the nursing team and document the date, time and reason for removal and any problems in the nursing and medical notes.	To ensure there is good communication between all teams and a written record of the procedure (NMC 2009, C).

Problem-solving table 18.5 Prevention and resolution (Procedure guideline 18.11)

Problem	Cause	Prevention	Action
Unable to locate cuff	Cuff too deep Lack of knowledge of cuff location	Knowledge of all types of catheters and where cuff located as measurement	Contact the catheter manufacturer for cuff details
Bleeding at site	Low platelets or raised INR Small vessels cut	Not undertaking procedure unless levels are corrected	Apply pressure to site until bleeding stops. May need vessel to be tied off
Cut through catheter/ catheter breaks	Removing catheter by traction Incision made too deeply directly over cuff	Only remove catheter by using surgical technique Make incision to side of cuff	Attempt to clamp any remaining catheter with artery forceps Contact surgical team for assistance

Postprocedural considerations

Immediate care

Following insertion

The dressing should be left intact and changed 24 hours after insertion.

Following removal

Since the vein closes following removal of the catheter, there is usually no bleeding. However, there may be slight bleeding at the exit site immediately after removal because of the passage of the cuff.

Following either removal method, pressure should be applied to the site until the bleeding stops, and a dressing may be required for up to 24 hours. The patient should be encouraged to rest flat for 30–60 minutes to allow the tissue tract time to seal (Galloway and Bodenham 2009).

Ongoing care

Following insertion

Healing of the skin tunnel takes approximately 7 days, so at this time the sutures at the entry site may be removed (Dougherty 2006). The exit site sutures should be retained until the fibroblastic response to the Dacron cuff is adequate to secure the catheter, usually in 2–3 weeks (Perucca 2010, Stacey *et al.* 1991, Weinstein and Plumer 2007). A transparent dressing should cover the site and be changed weekly until removal of sutures. Thereafter, a dressing is not usually required unless the patient requests one (Dougherty 2006).

Following removal

Sutures at the incision site should be removed after 7 days (Dougherty 2006).

Education of patient and relevant others

See Discharging patients home with a VAD *in situ*.

Complications

Infection and thrombosis are the main complications – see PICC, Complications.

Implanted Ports

Definition

An implanted port is a totally implanted VAD made of two components: a reservoir with a self-sealing septum which is attached to a silicone catheter (Figure 18.28). The port is usually inserted on either the chest or the arm but it can be placed on the lower chest wall/abdomen or thigh, depending on patient needs. It is accessed using a special non-coring needle (Dougherty 2006, Hayden and Goodman 1992, Weinstein and Plumer 2007).

Figure 18.28 Implantable port cross-section, accessed with non-coring needle.

Evidence-based approaches

Rationale

Ports are implanted subcutaneously to provide repeated long-term access (Weinstein and Plumer 2007) to the vascular system (other ports include arterial, epidural and peritoneal ports). Implanted ports require little care of the site because of the intact skin layer over the accessible port, except when accessed. When not in use, the only care required is a monthly flush (Weinstein and Plumer 2007). Other benefits include a reduced risk of infection (Bow *et al.* 1999, Mirro *et al.* 1989, Moureau *et al.* 1999) and less interference with daily activities such as bathing or swimming (Hayden and Goodman 1992), and body image is less threatened than by the presence of an external catheter (Bow *et al.* 1999, Mirro *et al.* 1989). Patients with ports are often very satisfied with their access devices (Chernecky 2001, Johannson *et al.* 2009).

Disadvantages of the port include discomfort when accessing is performed (particularly if placed deeply or in a difficult area to access). This can be overcome with the use of topical local anaesthetic. However, the tissue over the septum becomes calloused or scarred and over time there is loss of sensitivity (Hadaway 2000, Moureau *et al.* 1999). Needle dislodgement with resulting extravasation and needlestick injury are well-documented problems associated with ports (Viale 2003, Nesti and Kovac 2000, Schulmeister and Camp-Sorrell 2000). There are also issues related to occlusion and ‘sludge’ build-up and newer designs are attempting to reduce this (Stevens *et al.* 2000). Finally there are often problems with obtaining blood return (Moureau *et al.* 1999).

Indications

An implanted port can be used for long-term venous access for all types of therapies, both continuous and intermittent, and if patients have problematic venous access (Dougherty 2006, Springhouse 2002).

Contraindications

Contraindications would be related to location of port, for example not on the chest if there has been bilateral mastectomy or radiation burns, or ability to undergo a general anaesthetic for insertion.

Methods of insertion

Implantation is a surgical procedure usually carried out under general anaesthetic. Some catheters are pre-attached to the reservoir whilst others require attachment on insertion (Dougherty 2006, Hayden and Goodman 1992). The most common veins used are the subclavian, internal jugular and femoral. Ports can also be inserted in the veins of the upper arm (Hadaway 2000, Hayden and Goodman 1992, Weinstein and Plumer 2007).

The catheter is introduced into the SVC via the subclavian or jugular vein and fluoroscopy verifies the placement of the tip. The catheter is then tunnelled to the pocket (Dougherty 2006, Springhouse 2002). The pocket is made just under the skin, usually on a bony prominence for stabilization (Springhouse 2002). The port is then sutured into place to the underlying fascia. The suture line can be lateral, medial, superior or inferior to the port septum to remove it from the area where the port will be accessed because repeated access could cause stress to the suture line (Dougherty 2006, Weinstein and Plumer 2007). The area is tender and oedematous for up to a week following implantation and any manipulation/accessing may be painful. When immediate use is indicated, the port should be accessed and dressed in theatre (Hayden and Goodman 1992).

Legal and professional issues

Although some nurses insert ports (Hadaway 2000), many are responsible for accessing and de-accessing the ports. It is vital that the needle is placed in the port as if it is not then there is a risk of the medications extravasating or infiltrating. Therefore any nurse who wishes to access ports must undergo specific training to gain the necessary knowledge and skills to select the correct type and length of needle and access the port successfully with little patient discomfort.

Preprocedural considerations

Equipment

A variety of ports are available and choice is dependent on a number of factors; for example, whether the patient is a child or an adult, the amount of access required and where it is located (Dougherty 2006). Ports are usually single lumen, although double-lumen ports are available (Dougherty 2006). However, double-lumen ports have two septums and therefore require needle access into each septum (Hayden and Goodman 1992). Port reservoirs (Figure 18.29) are about 2.5 cm in height and 0.625 cm in diameter and can weigh from 21 to 28 g; low-profile ports are smaller and often placed in the arm (Ives 1998). Entry can be gained via the side or top but most are accessed by top entry (Hayden and Goodman 1992, Weinstein and Plumer 2007). Catheters are made of silicone and may be open-ended or have a Groshong valve (Biffi*et al.* 2001). The portal body may be made of stainless steel, plastic or titanium, although steel is not often used now as it interferes with electromagnetic imaging procedures and is quite heavy in comparison with other materials (Dougherty 2006). The self-sealing silicone septum can be accessed approximately 2000 times (regular size) (small ports may take only 750), often dependent upon the size of the needle used (Hadaway 2000, Hayden and Goodman 1992).

Figure 18.29 Implanted ports.

Non-coring needles have the penetration of a knife so when the needle is removed, the septum closes behind it (Hadaway 2000) (Figure 18.30). The bevel opens on the side of the needle instead of the end (Gabriel 2002, Weinstein and Plumer 2007). They are available in straight or 90° angle configuration with or

without extension sets. The needle is available with a metal or plastic hub in gauges 19–24 and lengths from 0.65 to 2.5 cm. Needle gauge is selected dependent on type and rate of infusate as well as the location of the port (Dougherty 2006, Weinstein and Plumer 2007). Safety needles are also now available and activate on withdrawal from the port.

Figure 18.30 Non-coring needles have the penetration of a knife so when the needle is removed, the septum closes behind it.

Pharmacological support

Prior to accessing a port, topical local anaesthetic may be used over the site (Gorski *et al.* 2008). Whilst the port is accessed, it is usual to flush it with 0.9% sodium chloride and heparinized saline 50 IU in 5 mL but once the needle is due to be removed, a higher strength of heparin is recommended – 100 IU heparin per mL to a total of 5 mL (500 IU).

Procedure guideline 18.12 Implanted ports: insertion and removal of non-coring needles

Essential equipment

- Plastic apron
- Dressing pack (containing sterile gloves)
- 10 mL syringes containing 0.9% sodium chloride × 2
- Non-coring (Huber point) needle with extension set
- Plaster

Medicinal products

- Heparinized saline in 10 mL syringe
- 2% chlorhexidine in 70% alcohol

Optional equipment

- Transparent dressing if needle remaining *in situ*

Preprocedure

Action	Rationale
1 Explain and discuss the procedure with the patient.	To ensure the patient understands the procedure and gives their valid consent (NMC 2008b, C).
2 If required, apply topical local anaesthetic cream for 30–60 minutes.	To reduce the feeling of pain on insertion of the needle. E
3 Place the patient in a comfortable position.	To aid patient comfort and to gain access to port. E
4 Locate the port and identify the septum; assess the depth of the port and thickness of the skin.	In order to select correct length of needle (Dougherty 2006, E).
5 Check length and type of therapy.	In order to select correct gauge and configuration of needle (Camp-Sorrell *et al*. 2004, C; Dougherty 2006, E).
Procedure	
6 Wash hands using a bactericidal hand soap.	To minimize the risk of contamination (DH 2010, C).
7 Put on sterile gloves.	To minimize the risk of contamination (DH 2010, C).
8 Flush port needle and extension set with 0.9% sodium chloride.	To check patency of needle and set (Dougherty 2006, E).
9 Clean the skin over the port with 2% chlorhexidine in 70% alcohol using back and forth strokes. Allow to dry.	To minimize the risk of contamination and destroy skin flora (DH 2010, C). To ensure disinfection (DH 2010, C).
10 Holding the needle in the dominant hand, stabilize the port between the forefinger and index finger of the non-dominant hand (see Action Figure 10).	To ensure the port is stabilized and will not move on insertion of the needle (Dougherty 2006, E).
11 Inform the patient you are about to insert the needle.	To prepare the patient for a pushing sensation. P, E
12 Using a perpendicular angle, push the needle through the skin until the needle hits the back plate.	To ensure the needle is well inserted into the portal septum. E
13 Draw back on the syringe and check for blood return.	To check the needle is correctly placed and the port is patent (Camp-Sorrell *et al.* 2004, C; Dougherty 2006, E).
14 Flush with 0.9% sodium chloride and observe the site for any swelling or pain.	To check for patency and correct positioning (Camp-Sorrell *et al*. 2004, C; Dougherty 2006, E).
15 Administer the drug as required.	To carry out instructions as per prescription. E
16 Flush with 10 mL 0.9% sodium chloride.	To ensure all of the drug is administered (RCN 2010, C).
17 If the needle is to remain *in situ*, attach a needlefree injection cap and flush with heparinized saline using a pulsatile flush and ending with positive pressure.	To maintain patency (Camp-Sorrell *et al*. 2004, C; Dougherty 2006, E).
18 Secure the needle by placing gauze under the needle (if necessary) and cover with transparent dressing.	To ensure the needle is well supported and will not become dislodged (Camp-Sorrell *et al*. 2004, C; Dougherty 2006, E).
19 If the needle is to be removed, then heparinize using 500 IU heparin in 5 mL 0.9% sodium chloride.	To maintain patency over a longer period of time, for example 1 month (Camp-Sorrell *et al*.

	2004, C; Dougherty 2006, E).
20 Maintain pressure on the plunger as syringe is disconnected from injection cap.	To prevent backflow of blood and possible clot formation (Camp-Sorrell *et al*. 2004, C; Dougherty 2006, E).
21 Press down on either side of the portal of the implanted port with two fingers.	To support the port while removing the needle (P; Camp-Sorrell *et al*. 2004, C; Dougherty 2006, E).
22 Withdraw the needle using steady traction and activate safety device where appropriate. Discard needle in appropriate sharps container.	To prevent trauma to the skin and the risk of needlestick injury (NHS Employers 2007, C).
Postprocedure	
23 No dressing is usually required, but a small plaster may be applied.	To prevent oozing at the site. E
24 Document date of access, size and length of needle and number of attempts in patient's notes or care plan.	To ensure adequate records and to enable continued care of device and patient (NMC 2009, C).

Action Figure 10 Flushing a port.

Problem-solving table 18.6 Prevention and resolution (Procedure guideline 18.12)

Problem	Cause	Prevention	Action
Unable to access port	Incorrect selection of length of needle Port too deep or mobile Unable to locate port	Choice of correct length needle Skilled practitioners should access difficult ports	Ask for assistance from a colleague to locate port and help to stabilize it
Unable to withdraw blood	Needle not in port Fibrin sheath		Realign needle or remove and ask colleague to access port Instil urokinase to remove fibrin

Postprocedural considerations

Immediate care

Once accessed

The needle should be supported with gauze (if necessary) and covered with a transparent dressing to minimize the risk of needle dislodgement.

Ongoing care

Regular assessment of the port when accessed is essential to check for signs of erythema, swelling or discomfort, which could indicate infection, infiltration or extravasation (INS 1999, Springhouse 2002). Most manufacturers recommend that only syringes 10 mL or larger should be used for drug administration or when flushing, to prevent excessive pressure which could result in separation of the catheter from the reservoir or rupture if the catheter is occluded (Conn 1993). When the port is accessed, the needle can remain *in situ* for 7 days (Dougherty 2006, Gorski *et al.* 2008, Springhouse 2002). When not in use, the port only requires flushing once a month with a concentrated solution of heparin (100 IU in 1 mL), usually a total of 5–6 mL (Gorski *et al.* 2008, Springhouse 2002, Weinstein and Plumer 2007).

Removal

Implanted ports may be surgically removed and after removal the site must be assessed for any signs of inflammation (Galloway and Bodenham 2009).

Education of patient and relevant others

Patients can be taught to access their own ports. See Discharging patients home with a VAD *in situ*.

Complications

As for all other CVADS.

Twiddler's syndrome

This term is used to describe patients who nervously touch and potentially dislodge their ports by turning them over so the septum cannot be accessed (Gorski *et al.* 2008). If this occurs then it may need to be turned back surgically. Explain to patients who 'twiddle' their ports why it can result in problems.

Arterial Cannulas

Definition

An arterial cannula is a plastic tube inserted and secured in a peripheral or central artery. When the cannula is electronically transduced, arterial waveforms can be observed in conjunction with continuous blood pressure readings. An arterial cannula is generally inserted into a peripheral artery, most commonly the radial or dorsalis pedis.

Anatomy and physiology

Arteries are elastic and muscular blood vessels which carry oxygenated blood from the left side of the heart. The large pressure generated by the heart and resistance in the arteries ensure that organs and tissues receive highly oxygenated blood (Scales 2008).

The radial artery originates from the brachial artery at the neck of the radius and passes along the lateral aspect of the forearm (Drake *et al.* 2000). The radial artery gives off multiple fasciocutaneous perforators until it reaches the wrist, where it forms the deep palmar arch. The radial artery contributes to the main artery of the thumb and index finger (Wallach 2004). The radial pulse can be felt by gently palpating the radial artery against the underlying muscle and bone (Drake *et al.* 2000).

Related theory

Pulsus paradoxus is a term used when the difference in peak systolic pressure between inspiration and expiration is greater than 10 mmHg. This accentuates the normal pattern and an exaggerated swing in systolic pressure is seen on the monitor. This is caused by:

- pericardial disease, for example cardiac tamponade causing impeded ventricular filling
- exaggerated inspiration by the patient
- changes in intrathoracic pressure, caused by lung pathology, such as asthma
- hypovolaemia, particularly when the patient has concurrent high airway pressures.

If the arterial device is inserted under emergency conditions and asepsis has been compromised, the Communicable Diseases Centre (O'Grady *et al.* 2002) recommends that the cannula should be replaced within 24 hours. Colonization and infection of arterial devices are rare (Minnaganti and Cunha 2000) and are usually related to duration of cannulation.

Data suggest that arterial cannulas may be associated with a substantially lower risk of local cannula-related infection when compared to short-term peripheral venous cannulas which have been left *in situ* for the equivalent length of time (RCN 2010). There is a common risk of catheter colonization but serious soft tissue infection is very rare, which may be related to exposure to high vascular pressures and subsequent local turbulence experienced in arterial cannulas (O'Grady *et al.* 2002). Additionally, if the puncture site is well stabilized and treated with asepsis and all samples are obtained using aseptic technique, this will further minimize the risk of soft tissue infection (Marini and Wheeler 2010). There is also no evidence suggesting any difference in infection rates between femoral or peripheral arterial cannulation (O'Grady *et al.* 2002). However, regular observation of the arterial cannula insertion site is imperative for signs of inflammation which may predispose patients to cannula-related infection. Cannulation for more than 4 days also increases this risk (O'Grady *et al.* 2002).

Evidence-based approaches

Rationale

It is worth noting that morbidity associated with arterial cannulation is less than that associated with five or more arterial punctures (Bersten *et al.* 2009). An arterial puncture describes a one-off insertion of a needle attached to an appropriately heparinized syringe enabling the aspiration of blood from the artery for analysis. Arterial punctures are important and useful in the initial and short-term assessment of acid/base balance and respiratory function. However, multiple puncture attempts will increase the risk of injury, not only due to the direct trauma but also associated with vasospasm (Lipsitz 2004). If the patient requires repetitive blood sampling, it may be more appropriate to admit the patient into a more clinically suitable area where arterial cannulation is possible. This not only minimizes both the distress to the patient and time taken by skilled personnel in obtaining each sample, but reduces the risks associated with multiple punctures.

An arterial cannula provides an invaluable tool in providing continuous monitoring of systemic blood pressure and facilitates frequent arterial blood gas (ABG) and laboratory sampling. Arterial cannulation is most commonly achieved and maintained in the critical care and theatre setting (Mignini *et al.* 2006). Ideally, prior to obtaining any arterial blood gas sample, the patient should be in a respiratory steady state for 15–20 minutes. The oxygen should not be titrated, and if ventilated, suction should not be attempted and ventilation parameters not adjusted (Weinstein and Plumer 2007).

The arterial device is attached to a transducer that enables the mechanical energy of the arterial pressure to be transformed into an electrical signal. This is displayed as a waveform by a haemodynamic monitoring system. An amplifier enhances the signal, which is converted into a digital display and oscilloscope trace (Hazinski 2001). Arterial device tubing should be stiff with low compliance as this prevents the loss of pressure signals through tube expansion, and it must not exceed 120 cm in length because this may alter pressure readings (Daily and Schroeder 1994).

The arterial waveform has three separate components that reflect the cardiac cycle.

1. The upstroke: the positive deflection occurs at the peak of systole.

2. The dicrotic notch occurs with aortic valve closure and reflects the beginning of diastole.

3. The lowest point of the waveform is end-diastole.

Indications

- During and following major anaesthesia.
- Monitoring of acid/base balance and respiratory status in (Adam and Osborne 2005):
  - – acute respiratory failure
  - – mechanical ventilation, especially in response to alteration of support and oxygenation
  - – the period during and after cardiorespiratory arrest
  - – severe sepsis
  - – shock conditions
  - – major trauma
  - – acute poisoning
  - – acute renal failure
  - – severe diabetic ketoacidosis
  - – critically ill patients.

Contraindications

- Previous upper extremity surgery (harvested for pedicled/free flaps).
- Previous axillary clearance.
- Peripheral vascular disease.
- Raynaud’s disease.
- Diabetes.
- Collagen vascular disease.
- Active upper or lower limb infection.

Principles of care

In critical care, continuous arterial monitoring is invaluable in optimizing and evaluating treatments, particularly in patients receiving intravenous nitrates and inotropes where their effects on mean blood pressure (MBP) can be instantaneous, necessitating appropriate titration (Mignini *et al.* 2006). Arterial devices must be cared for, managed and interpreted by skilled personnel who are able to regularly assess areas distal to the cannula, identify accurate waveforms, distinguish artefact, troubleshoot complications and maintain safe practice. The hazard of disconnection, the necessary monitoring systems, the potential consequence of severe haemorrhage and risks associated with accidental intra-arterial drug administration limit their use outside specialized areas.

Routes of cannulation

Radial arterial cannulation

Cannulation of the radial artery is the most common placement of arterial cannulas (Mignini *et al.* 2006) and is performed in most acute care settings (Box 18.8). The hand has a good collateral blood supply, as the radial artery is near the skin surface, it is readily accessible, easily secured, and the patient is disturbed less (Adam and Osborne 2005, Wallach 2004). However, radial cannulation is not without risk (Wallach 2004); there is an estimated 0.2% risk of serious complications associated with the procedure. In response to these risks, cannulation of the non-dominant hand should be attempted whenever possible (Wallach 2004). Ideally, the cannula should not be positioned close to any intravenous cannula as this may compromise blood flow around the adjoining structures.

Box 18.8 Complications of arterial cannulation

- Vascular thrombosis.
- Distal embolization (see Box 18.10).

Dorsalis pedis cannulation

The dorsalis pedis route for arterial cannulation is, according to Durbin (2001), equally as risky as radial cannulation, and more technically difficult, but provides a safe and easily available alternative when radial arteries are not appropriate.

Blood pressure measured from the dorsalis pedis and radial artery typically have a higher systolic and lower diastolic than centrally measured blood pressure, although the mean blood pressure is identical and clinically interchangeable (Mignini *et al.* 2006); this is described as distal pulse amplification (Dorman *et al.* 1998).

Femoral artery cannulation

The femoral artery may be cannulated if it is not possible to cannulate a peripheral artery, particularly if the patient is haemodynamically compromised. The femoral artery is accessible and there is relative ease in palpating even a weak pulse (Adam and Osborne 2005). If a patient has a femoral catheter in place and needs to be positioned at a 45° angle, there is an increased risk of catheter fracture (Ho *et al.* 2003). This is particularly serious as there is no collateral blood supply to the leg and lower limb, and as such fracture may have long-term consequences for the patient.

Brachial cannulation

The brachial artery is the major artery of the arm and divides into the radial and ulnar branches and should be avoided as a site for inserting an arterial cannula. A cannula inserted at the antecubital fossa into the brachial artery may risk cannula fracture in the conscious patient and its placement may inconvenience the patient because they have to minimize arm flexion.

Legal and professional issues

In 2008 the National Patient Safety Agency (NPSA) published a rapid response report which highlighted the many potential errors associated with the use of arterial cannulas. Various recommendations were given and immediate actions had to be in place by January 2009 (www.npsa.nhs.uk/patientsafety/alerts-and-directives/rapidrr/) (Box 18.9).

Box 18.9 Action required by the National Patient Safety Agency when using arterial catheters

- Sampling from arterial devices is risky and should only be undertaken by competent trained staff. Trusts should raise awareness of the risks and review local guidelines. These should include criteria for requests for blood gas analysis, sampling technique, monitoring and interpretation of results (including unexpected findings).
- Arterial infusion sets must be identified clearly. This means labelling or use of safety solutions such as marked sets adopted by some trusts.
- Any infusion (or additive) attached to the arterial catheter must be prescribed before administration. Further checks should be made at regular intervals and key points (such as shift handover).
- Staff should only use sodium chloride 0.9% to keep catheters open.
- Labels should clearly identify the contents of the infusion bags, even when pressure bags are used. Over time, the manufacturers should develop a universal system to address this problem.

(Reproduced with permission from the NPSA website (www.npsa.nhs.uk))

Box 18.10 Treatment of distal embolism

- Remove the cannula.
- Arrange for Doppler imaging.
- After consultation with consultant, heparinize (if no contraindications).
- Consider a peripheral vasodilator.

- Proximal embolization: digital ischaemia.

- Local/systemic infection.
- Vascular spasm.
- Skin necrosis of catheter site due to accidental intra-arterial injection.
- Hypovolaemia secondary to accidental disconnection.
- Cannula fracture/breakage.
- Pseudo-aneurysm formation.
- Median nerve palsy (Bersten *et al.* 2009).
- Damage to nearby structures.

In order to minimize risks associated with arterial cannulation, sampling should only be done by competent trained staff (NPSA 2008b) (Box 18.9).

Preprocedural considerations

Assessment

It is important prior to any cannulation that the circulation of the hand is assessed: temperature, capillary refill and the colour of the hand (RCN 2010). More than 97% of patients have adequate flow through collateral supply, which prevents ischaemia, should either the radial or ulnar artery be interrupted (Durbin 1993). Although not fully reliable, the Allen test should be completed prior to radial arterial cannulation in order to establish whether there is adequate blood supply to the hand (Figure 18.31). The Allen test consists of simultaneously compressing both the radial and ulnar arteries for approximately 1 minute (Tegtmeyer *et al.* 2006). During this time, the conscious patient rapidly opens and closes the hand to promote local exsanguination. Approximately 5 seconds after release of one of the arteries (usually the ulnar), the extended hand should blush owing to capillary refilling. If blanching occurs, palmar arch circulation is inadequate and a radial cannula could lead to ischaemia of the hand (Pierce 1995).

Figure 18.31 The Allen test.

Evaluation by a Doppler probe may be carried out as a more reliable alternative (Adam and Osborne 2005). Shiloh *et al.* (2010) suggest that using ultrasound guidance may improve arterial cannulation.

Procedure guideline 18.13 Arterial cannula insertion: preparation and setting up of monitoring set

Essential equipment

- 500 mL pressure infuser cuff
- Pressure monitoring system equipment
- Designated arterial cannula
- Sterile intravenous pack
- Non-sterile gloves
- Transparent dressing
- Syringes: various sizes
- A label to identify arterial device
- 2% chlorhexidine in alcohol swab
- Transpore tape
- Bactericidal hand cleanser

Medicinal products

- 500 mL bag of 0.9% sodium chloride
- 1% lidocaine injection

Preprocedure

Action	Rationale
1 Explain the procedure with the patient.	To ensure the patient understands the procedure and gives valid consent wherever appropriate (NMC 2008b, C). *Note*: many patients are anaesthetized when arterial devices are inserted.
2 Wash hands using a bactericidal handrub.	To minimize the risk of infection (Fraise and Bradley 2001, E; Pratt *et al.* 2007, C).
3 Prepare infusion and transducer sets using aseptic technique.	To minimize the risk of infeciton (Fraise and Bradley 2001, E; Pratt *et al.* 2007, C).
4 Check that all Luer-Lok connections are secure.	To prevent disconnection, as equipment is often loose when taken straight from package. E

Procedure

5 Connect transducer to bag of 500 mL 0.9% sodium chloride, which must be prescribed (NPSA 2008b, C).	To prepare infusion, saline is more effective than heparinized flush (O'Grady *et al.* 2002, C; Gamby and Bennett 2010, R3; Kulkarni *et al.* 1998, R3). Only sodium chloride 0.9% must be used as flush (NPSA 2008b, C). To prime the administration set and three-way tap ports. E
6 Open roller clamp fully, squeeze the flush device-actuator (see instructions with set).	To reduce the risk of air embolus, although retrograde air embolus is a rare event after routine radial artery cannula flushing. E
7 Check thoroughly for air bubbles in the circuit.	To reduce the risk of inaccurate pressure readings caused by bubbles in the set (Daily and Schroeder 1994, R4).
8 Insert bag into pressure infuser, inflate the pressure bag to 300 mmHg.	To prevent backpressure of blood into the transducer set by ensuring pressure is higher than arterial blood pressure (Morton and Fontaine 2009, R5). An automatic flush mode is activated within the system which delivers 3 mL per hour, which maintains patency of cannula.
9 Wash hands with bactericidal soap and water or bactericidal handrub.	To reduce the risk of cross-infection (DH 2010, C; Fraise and Bradley 2001, E).
10 Prepare trolley near the patient.	To reduce the risk of cross-infection (DH 2010, C; Fraise and Bradley 2001, E).
11 Complete the Allen test if radial artery is to be used.	To assess whether palmar arch circulation is adequate, although this assessment is not entirely reliable (Wallach 2004, R4).
12 Prepare the insertion site with 2% chlorhexidine swab and place a sterile towel under the appropriate area.	To maintain asepsis. To provide a clean working area (DH 2010, C).
13 Administer adequate local anaesthetic.	To minimize pain during the procedure; this may reduce the sudden movement which could result in through puncture (Lipsitz 2004, R5). Local vasodilation effects of the local anaesthetic may reduce vasospasm, making a successful cannulation more likely (Lipsitz 2004, R5).
14 Apply gloves.	To prevent contamination of hands if blood spillage occurs (Pratt *et al.* 2007, C).
15 Another nurse may act as an assistant and holds the patient's foot or arm. If the radial artery is cannulated, the wrist must be	To prevent movement and to flex the hand/foot slightly to facilitate insertion. E Prolonged hyperextension may be associated with changes in median nerve conduction, so promptly return the wrist to the neutral position

hyperextended.	nerve conduction, so promptly return the wrist to the neutral position following cannulation (Chowet *et al.* 2004, R4).
16 Insert the cannula and observe for blood flashback.	To ascertain that the cannula is in the artery. E
17 Attach transducer set and fully open roller clamp.	To commence flush infusion system, and prevent backflow of blood. E
18 Apply transparent dressing over the cannula and tape tubing securely.	To leave the site visible and secure and to allow the observer to recognize immediately any dislodgement, inflammation or disconnection. E
19 Clearly label the device as arterial, on the dressing as well as on the tubing.	To ensure the device is not mistaken for a venous cannula, preventing accidental intra-arterial injection of drugs (E), particularly if the tubing is disconnected and cannula capped off, in the event of a transfer (NPSA 2008b, C), although this practice should be discouraged.
20 Loop the tubing around the thumb, ensuring this is not too tight (see Action Figure 19).	To minimize movement of cannula and damage to the vessel, to prevent ulcer formation. E

Action Figure 19

Positioning, securing and labelling of cannula.

21 Connect transducer to monitoring equipment.	Allows checking of arterial waveform and obtaining continuous blood pressure measurements. E
22 Calibrate the arterial device.	The transducer will read an arterial pressure calibrated to atmospheric air which offsets the extraneous atmospheric and hydrostatic pressures. E
Postprocedure	
23 Dispose of equipment and clinical waste appropriately.	To prevent sharps injury (NHS Employees 2007, C).
24 Document clearly date and placement of arterial cannula inserted.	To maintain accurate records and provide appropriate reference (NMC 2009, C).

Postprocedural considerations

Ongoing care

Arterial cannulas are not replaced routinely so frequent and accurate assessment is essential in order to minimize complications. In the event of a spike in temperature and raised inflammatory markers, removal may be considered.

The arterial cannula site must be assessed at regular intervals to check for appropriate labelling of the device, correct flush fluid, any pain or erythema at the site. There should always be vigilance if the sample taken from the arterial cannula is not within the expected range and staff must be trained in considering and eliminating any risk of contamination which may affect blood results which could in turn determine changes in consequent therapies. The NPSA (2008b) described a number of serious incidents associated with changes in treatment directly associated with arterial blood sampling results. This was because of inappropriate flush agents, predominantly dextrose; for example, patients had insulin sliding scale infusions titrated in response to contaminated samples where blood glucose was abnormally high and not reflective of the patient's actual serum glucose.

The following volumes of blood should be withdrawn and discarded in order to clear 0.9% sodium chloride, old blood and small emboli from the dead space, the cannula and the three-way tap. Generally, when using a peripheral artery cannula, 3–5 mL must be taken and discarded. A femoral artery cannula is longer and commonly 5 mL should be taken and discarded, but always check manufacturer's instructions.

On each shift it is advisable that the site of the cannulated artery is checked and documented, that an appropriate flush agent is prescribed, that labelling is appropriate and there is absence of pain and colour changes distal to the cannula.

Removal of Arterial Cannula

Procedure guideline 18.14 Arterial cannula: removal

Essential equipment

- Sterile dressing pack
- Non-sterile gloves
- Hypoallergenic tape
- 2% chlorhexidine in 70% alcohol

Preprocedure	
Action	**Rationale**
1 Explain and discuss the procedure with the patient.	To ensure the patient understands the procedure and gives their valid consent (NMC 2008b, C).
2 Check platelet and coagulation screen.	To prevent delay in removal whilst coagulation is corrected. E
3 Prepare trolley	To reduce the risk of cross-infection (DH 2010, C; Fraise and Bradley 2001, E).
4 Wash hands with bactericidal soap and water or bactericidal alcohol handrub before leaving the clinical room.	To reduce the risk of cross-infection (DH 2010, C; Fraise and Bradley 2001, E).
Procedure	
5 Turn three-way tap diagonally or turn off flow switch, depending on arterial product.	To prevent backflow of blood into cannula. E
6 Turn off flush set.	To prevent spillage when removing cannula. E
7 Deflate pressure cuff.	Pressure is no longer required. E
8 Loosen transparent dressing and tape from the cannula site.	To facilitate removal of cannula. E
9 Clean hands with bactericidal skin-cleaning solution.	To minimize the risk of infection (DH 2010, C; Fraise and Bradley 2001, E).
10 Apply gloves.	To prevent contamination of hands with blood (Pratt *et al.* 2007, C).
11 Remove dressing and tape. Clean cannula site area with 2% chlorhexidine swab.	To reduce the risk of infection (DH 2010, C; Fraise and Bradley 2001, E).
12 Place sterile piece of gauze over area and gently remove cannula.	To minimize bleeding and blood spillage (Pratt *et al.* 2007, C).
13 Apply pressure for a minimum of 5 minutes.	To prevent haematoma and blood loss (RCN 2010, C).
14 Apply a clean, sterile, low-linting gauze dressing.	To maintain asepsis and minimize blood loss (E)
15 Secure with tape. Do not create a tourniquet type dressing.	To ensure pressure and prevent haematoma or blood loss. E
Postprocedure	
16 Remove gloves and dispose of equipment appropriately.	To prevent sharps injury (NHS Employers 2007, C).
17 Document the date and time of removal in the patient's notes.	To ensure adequate records and enable continued care of device and patient (NMC 2009, C).

Problem-solving table 18.5 Prevention and

resolution (Procedure guideline 18.14)

Problem	Cause	Prevention	Action
Backflow of blood into the cannula	The pressure infusor cuff may not be inflated to the optimal	Ensure that the pressure infusor cuff is inflated to 300 mmHg	Check that the pressure infusor cuff is inflated to 300 mmHg and if not, inflate to correct level
Arterial spasm	Forceful flushing or forceful aspiration when withdrawing blood	This pressure is higher than arterial blood pressure and an automatic flush mode is activated in the system which delivers 3 mL per hour. This maintains patency of circuit, cannula and artery (Allan 1984)	Check that the pressure infusor cuff is inflated to 300 mmHg and if not, inflate to correct level
Cerebral embolism	Prolonged, high-pressure flushing can drive a clot or gas bubbles retrograde to produce cerebral embolism	Avoid forceful flushing or aspiration and maintain a slow even pressure when withdrawing blood	Check that the pressure infusor cuff is inflated to 300 mmHg and if not, inflate to correct level

Postprocedural considerations

Immediate care

Following the procedure, check the patient's hand, assessing and documenting the temperature, colour, swelling and any signs of bleeding. Avoid blood pressure measurement being taken manually on the arm where the arterial cannula was removed for 12–24 hours to minimize bleeding or haematoma formation. Medical staff must be informed immediately if the hand or forearm becomes discoloured or swollen, or if the patient complains of pain in the limb. In the event of any complication, careful documentation is essential; consider a request for medical photography to photograph the affected area.

Education

Ask the patient to apply pressure if they notice any oozing from the dressing and immediately inform a member of staff.

Complications

There are a number of complications that can occur as a result of arterial cannulation: see Box 18.8.

Hypovolaemia

Hypovolaemia can occur as a result of severe haemorrhage, which can be caused by (a) accidental disconnection of tubing from the cannula or from one of the connections within the system or (b) dislodgement of the cannula.

The flow from an 18 G cannula can result in blood loss of 250 mL per minute (Bersten *et al*. 2009). Unconscious or delirious patients and children are at particular risk. The risk can be minimized by clear labelling of the arterial cannula (Zideman and Morgan 1981), arterial tubing and sets should be predominantly red in colour, and alarm settings on the monitor must be turned on and audible (Adam and Osborne 2005). The use of Luer-Lok connections, ensuring visibility of the cannula, appropriate nurse/patient ratios and adequate training and competency of nurses caring for patients with arterial cannulas will also help reduce this complication.

The cannula may become dislodged, particularly if the patient is diaphoretic and dressings tend to lift. Securing the cannula using an appropriate cannula-securing device may be useful. Inform the patient about the danger of dislodging the cannula and the amount of movement that is preferred. Staff must also take care when moving the patient, and avoid putting stress on the arm and connections. Ideally, non-invasive blood pressure should not be measured on the same arm which has an arterial cannula. Marini and Wheeler (2010) recommend attempting a minimum of once-daily sphygmomanometry in order to confirm cannula pressure, especially in patients whose vasopressors are titrated to these pressures, and particularly in those patients who are elderly, are hypertensive or those with underlying vascular disease.

Accidental intra-arterial injection of drugs

Accidental intra-arterial injection of drugs intended for administration through a central or peripheral venous device may cause distal ischaemia and necrosis, sometimes resulting in permanent functional damage (Marieb and Hoehn 2010, Teplitz 1990, Tinker and Zapol 1992). Drugs such as calcium channel blockers and vasopressors are particularly harmful if injected intra-arterially (Marini and Wheeler 2010). Careful and appropriate labelling and appropriate staff training can minimize this risk. In the event of accidental injection of any drug, stop administering the drug and report immediately to medical staff and the senior nurse. The nurse should then attempt to withdraw blood from the three-way tap

in order to aspirate any of the drug. Then assess the limb pulse, colour and temperature hourly, or more frequently if required, and complete an accident form and/or other relevant documentation.

Local damage to the artery

Local damage to the artery is the most common complication of arterial cannulation (Marieb and Hoehn 2010). Regular close inspection and assessment of the limb and areas distal to the cannula must be carried out as there is a risk of thrombosis and embolism. Signs and symptoms include pain, a change in temperature in the distal limb, mottling and blanching of the limb when the cannula is flushed. The medical team should be informed if any of the above are discovered (Adam and Osborne 2005). If a distal embolism is suspected, the cannula may have to be removed and limb warming attempted in order to avoid permanent damage (Box 18.10). The risk of ischaemia distal to the cannula is increased when associated with low cardiac output, shock, sepsis and prolonged cannulation (Bersten *et al.* 2009, Gamby and Bennett 2010).

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Appendix 1

The code

The code
Standards of conduct, performance and ethics for nurses and midwives

The people in your care must be able to trust you with their health and well-being. To justify that trust, you must:

- make the care of people your first concern, treating them as individuals and respecting their dignity
- work with others to protect and promote the health and well-being of those in your care, their families and carers, and the wider community
- provide a high standard of practice and care at all times
- be open and honest, act with integrity and uphold the reputation of your profession.

As a professional, you are personally accountable for actions and omissions in your practice and must always be able to justify your decisions.

You must always act lawfully, whether those laws relate to your professional practice or personal life.

Failure to comply with this Code may bring your fitness to practise into question and endanger your registration.

This Code should be considered together with the Nursing and Midwifery Council's rules, standards, guidance and advice available from www.nmc-uk.org.

Make the care of people your first concern, treating them as individuals and respecting their dignity

Treat people as individuals

- You must treat people as individuals and respect their dignity
- You must not discriminate in any way against those in your care
- You must treat people kindly and considerately
- You must act as an advocate for those in your care, helping them to access relevant health and social care, information and support

Respect people's confidentiality

- You must respect people's right to confidentiality
- You must ensure people are informed about how and why information is shared by those who will be providing their care
- You must disclose information if you believe someone may be at risk of harm, in line with the law of the country in which you are practising

Collaborate with those in your care

- You must listen to the people in your care and respond to their concerns and preferences
- You must support people in caring for themselves to improve and maintain their health
- You must recognize and respect the contribution that people make to their own care and well-being
- You must make arrangements to meet people's language and communication needs
- You must share with people, in a way they can understand, the information they want or need to know about their health

Ensure you gain consent

- You must ensure that you gain consent before you begin any treatment or care
- You must respect and support people's rights to accept or decline treatment and care
- You must uphold people's rights to be fully involved in decisions about their care
- You must be aware of the legislation regarding mental capacity, ensuring that people who lack capacity remain at the centre of decision making and are fully safeguarded
- You must be able to demonstrate that you have acted in someone's best interests if you have provided care in an emergency

Maintain clear professional boundaries

- You must refuse any gifts, favours or hospitality that might be interpreted as an attempt to gain preferential treatment
- You must not ask for or accept loans from anyone in your care or anyone close to them
- You must establish and actively maintain clear sexual boundaries at all times with people in your care, their families and carers

Work with others to protect and promote the health and well-being of those in your care, their families and carers, and the wider community Share information with your colleagues

- You must keep your colleagues informed when you are sharing the care of others
- You must work with colleagues to monitor the quality of your work and maintain the safety of those in your care
- You must facilitate students and others to develop their competence

Work effectively as part of a team

- You must work co-operatively within teams and respect the skills, expertise and contributions of your colleagues
- You must be willing to share your skills and experience for the benefit of your colleagues
- You must consult and take advice from colleagues when appropriate
- You must treat your colleagues fairly and without discrimination
- You must make a referral to another practitioner when it is in the best interests of someone in your care

Delegate effectively

- You must establish that anyone you delegate to is able to carry out your instructions
- You must confirm that the outcome of any delegated task meets required standards
- You must make sure that everyone you are responsible for is supervised and supported

Manage risk

- You must act without delay if you believe that you, a colleague or anyone else may be putting someone at risk
- You must inform someone in authority if you experience problems that prevent you working within this Code or other nationally agreed standards
- You must report your concerns in writing if problems in the environment of care are putting people at risk

Provide a high standard of practice and care at all times

Use the best available evidence

- You must deliver care based on the best available evidence or best practice
- You must ensure any advice you give is evidence based if you are suggesting healthcare products or services
- You must ensure that the use of complementary or alternative therapies is safe and in the best interests of those in your care

Keep your skills and knowledge up to date

- You must have the knowledge and skills for safe and effective practice when working without direct supervision
- You must recognize and work within the limits of your competence
- You must keep your knowledge and skills up to date throughout your working life
- You must take part in appropriate learning and practice activities that maintain and develop your competence and performance

Keep clear and accurate records

- You must keep clear and accurate records of the discussions you have, the assessments you make, the treatment and medicines you give and how effective these have been
- You must complete records as soon as possible after an event has occurred
- You must not tamper with original records in any way
- You must ensure any entries you make in someone's paper records are clearly and legibly signed, dated and timed
- You must ensure any entries you make in someone's electronic records are clearly attributable to you
- You must ensure all records are kept confidentially and securely

Be open and honest, act with integrity and uphold the reputation of your profession

Act with integrity

- You must demonstrate a personal and professional commitment to equality and diversity
- You must adhere to the laws of the country in which you are practising
- You must inform the NMC if you have been cautioned, charged or found guilty of a criminal offence
- You must inform any employers you work for if your fitness to practise is impaired or is called into question

Deal with problems

- You must give a constructive and honest response to anyone who complains about the care they have received
- You must not allow someone's complaint to prejudice the care you provide for them
- You must act immediately to put matters right if someone in your care has suffered harm for any reason
- You must explain fully and promptly to the person affected what has happened and the likely effects
- You must co-operate with internal and external investigations

Be impartial

- You must not abuse your privileged position for your own ends
- You must ensure that your professional judgement is not influenced by any commercial considerations

Uphold the reputation of your profession

- You must not use your professional status to promote causes that are not related to health
- You must co-operate with the media only when you can confidently protect the confidential information and dignity of those in your care
- You must uphold the reputation of your profession at all times

Information about indemnity insurance

The NMC recommends that a registered nurse, midwife or specialist community public health nurse, in advising, treating and caring for patients/clients, has professional indemnity insurance. This is in the interests of clients, patients and registrants in the event of claims of professional negligence.

Whilst employers have vicarious liability for the negligent acts and/or omissions of their employees, such cover does not normally extend to activities undertaken outside the registrant's employment. Independent practice would not be covered by vicarious liability. It is the individual registrant's responsibility to establish their insurance status and take appropriate action.

In situations where an employer does not have vicarious liability, the NMC recommends that registrants obtain adequate professional indemnity insurance. If unable to secure professional indemnity insurance, a registrant will need to demonstrate that all their clients/patients are fully informed of this fact and the implications this might have in the event of a claim for professional negligence.

Appendix 2

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Specialist Sister (Head and Neck) Val Speechley, Patient Information Officer Moira Stephens, Clinical Nurse Specialist (Haemato-oncology) Mavis Stork, formerly Theatre Services Manager Mary Anne Tanay, Research Nurse (Head and Neck) June Toovey, formerly Sister (Intravenous Therapy Team) Anne Topping, formerly Senior Nurse (Gastrointestinal/Genitourinary) Jennie Treleaven, Consultant Haematologist Robert Tunmore, formerly Clinical Nurse Specialist (Psychological Support) Beverley van der Molen, formerly Clinical Nurse Specialist/Unit Manager (General Oncology) Rebecca Verity, formerly Senior Staff Nurse (Bud Flanagan Ward) Chris Viner, Clinical Nurse Specialist (Ambulatory Chemotherapy) Caro Watts, Nurse Consultant (Transitional Care (Cancer)) Clare Webb, Specialist Sister in Psychological Care Richard Wells, formerly Rehabilitation Services Manager Alexandra Westbrook, Programme Leader

Isabel White, Head of Undergraduate Cancer Care Studies Jane Wilson, formerly Group Theatre Manager Miriam Wood, Senior Practice Development Facilitator (supporting role) Karen Wright, formerly Research Assistant Nursing Research Unit Karen Young, formerly Physiological Measurement Technician

pacing, in respiratory compromise
paclitaxel
PACU *see* peri-anaesthesia care unit paediatric patients
  blood glucose ranges
  blood pressure measurement
  bone marrow biopsy
  bone marrow donation
  enteral feeds
  infusion devices
  nutritional assessment
  nutritional requirements
  oral drug administration
  temperature regulation
  tracheal suctioning
  urinary catheters
  venepuncture *see also* neonates pain
  acute *see* acute pain anatomy and physiology
  bladder irrigation
  bone marrow biopsy
  breakthrough
  cancer *see* cancer pain categories
  chronic *see* chronic pain compression therapy-related
  defined
  at end of life
  evoked
  extravasation
  factors affecting sensitivity to
  gastrostomy/jejunostomy tube-related
  incident
  intensity, assessment
  location
  lumbar puncture
  modulation

moving/positioning patients in
neuropathic
nociceptive
perception
peripheral cannulation
phantom limb
postoperative *see* postoperative pain spinal cord compression
spontaneous
stump
total, concept of
transduction
transmission
venepuncture
wound
pain assessment
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epidural/intrathecal analgesia
pre-existing chronic pain
procedure guidelines
surgical patients
tools
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painful stimuli
application of
response to, Glasgow Coma Scale
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acute pain
chest drainage
chronic pain
complications
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methods
need for effective

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opioid-dependent patients
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postoperative
spinal cord compression *see also* analgesia; analgesics palate
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Palladone
palliative care
compression bandaging
defined
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evidence-based approaches
fungating wounds
nutritional assessment
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subcutaneous administration *see also* dying patients; end-of-life care palmar-plantar erythrodysesthesia syndrome palpation, veins
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panic disorder, pharmacological therapy
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dispensers
disposal of used
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paraesthesia
paralysis
paralytic ileus *see* ileus, paralytic paraphimosis, catheterized patients
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paraplegia
parasites

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parasympathetic nervous system
parathyroid scan, radionuclide
parenteral infusions
parenteral nutrition (PN)
administration sets
blood glucose monitoring
bowel obstruction
changing administration sets
choice of regimen
complications
composition of solutions
contraindications
defined
home
indications
infusion devices
methods of administration
monitoring during
postoperative
termination
parenteral route of drug administration
parenteral transmission
paresis
parietal lobe
partially sighted patients, communication with partial pressure (P)
partial withdrawal occlusion (PWO)
PART (patient-at-risk team) score
Passy Muir® speaking valve pastes
pastilles
patella hammer
pathogen
pathogenicity
patient(s)

collaboration with
comfort
expectations
identification *see* identification, patient information provision *see* information provision involvement in decision making
own drugs
positioning *see* moving and positioning problems/needs
self-administration of medicines
self-assessment tools
tampering with infusion devices
patient-at-risk team (PART) score
patient-controlled analgesia (PCA)
patients not suitable for
pumps
wound drain procedures
patient-controlled epidural analgesia (PCEA) patient education
abdominal paracentesis
assisted feeding
cardiac arrest prevention
chest drainage
compression garments
CPAP
diabetes mellitus
enteral tube feeding
fluid balance monitoring
gastrointestinal infections
immunocompromised patients
infection prevention and control
inhalational drug administration
long-term CVADs
moving and positioning
nasogastric tube feeding
neurological impairment
opioids and driving

oral anticancer medicines
oxygen therapy
pain management
peak flow measurement
protective isolation
sealed source brachytherapy
source isolation
stomas
subcutaneous injections
surgical patients
tracheostomy care
unsealed source radionuclide therapy
urinary diversion
VADs *see also* information provision patient-generated subjective global assessment (PG-SGA) patient group directions (PGD)
controlled drugs
defined
flowchart
Patient-Held Pain Chart, Royal Marsden Hospital patient hygiene *see* personal hygiene patient information materials, writing
patient information toolkit, NHS
patient safety
diathermy risks
myths
patient safety incidents
actions following
developing ‘no blame’ culture
impact
scenario *see also* errors; risk management Patients on Intravenous and Nasogastric Nutrition Therapy (PINNT) patient support groups
Paxman scalp-cooling machine
peak flow (peak expiratory flow, PEF)
cautions
factors affecting

indications
normal values
postprocedure actions
problem solving
procedure guideline
timing of readings
peak flow meters
PEEP *see* positive end expiratory pressure peer support groups
PEG tubes *see* percutaneously endoscopically placed gastrostomy tubes pelvic twist
cervical spinal instability
Penguin cap
penicillin
penile sheaths
fixation methods
procedure guideline
sizing and fitting
penis
pain on erection, catheterized patients
swab sampling
Penrose drain
shortening
pen torch
perception
assessing patient's self
assessment
percutaneously endoscopically placed gastrostomy (PEG) tubes blockage
care
problem solving
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failure
peri-anaesthesia care unit (PACU)
checklist prior to transfer to
discharge from

equipment
problem solving
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perianal care/hygiene
perineal care/hygiene
perineal interstitial brachytherapy
periodontitis
perioperative care *see also* intraoperative care; postoperative care; preoperative care peripheral cannulas
absent blood return
care and management *in situ* choice of vein
complications
cytotoxic drug administration
decision-making tool
defined
discharge home with *in situ* documentation
extravasation of vesicants
management
prevention
procedure guidelines
flow rates
improving venous access
indications
insertion (cannulation)
advancement methods
competencies
complications
local anaesthesia
patient preparation
problem solving
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unsuccessful
vein puncture methods

materials
over the needle
parenteral nutrition
ported
removal and dwell times
safety non-ported
sizing
subcutaneous infusions
taping/securing
winged *see* winged infusion devices peripherally inserted central catheters (PICCs) blood sampling
care *in situ*
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consent
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defined
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insertion
    modified Seldinger technique
    problem solving
    procedure guidelines
    using standard introducer
insertion site care
length measurement
parenteral nutrition
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pros and cons
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securing
tip positioning
types

urokinase instillation
peripheral motor/sensory neuropathies
peripheral nerves
injuries *see* nerve injuries peripheral nervous system (PNS)
peripheral neuropathy, compression garments and peripheral resistance
peripheral vascular access devices
damage and repair
skin care
for venepuncture *see also* midline catheters; peripheral cannulas peristalsis
peritoneal catheters
peritoneal cavity
peritoneal port-catheter
peritoneovenous shunts
peritoneum
peritonitis
personal hygiene
assessment
bed bathing *see* bed bathing benchmarks
compression bandaging and
cultural and religious factors
defined
ear care
eye care
hair care
mouth care
nails and feet
nose care
nurse’s role
oxygen therapy and
perineal/perianal care
principles
privacy concerns
radioactive patients
skin care

personal protective equipment (PPE)
cleaning isolation rooms
cytotoxic drug handling
cytotoxic drug spillage
infection prevention and control
intravenous drug administration
last offices
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protective isolation
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specimen collection/handling *see also* aprons, disposable; eye protection; gloves pessaries, vaginal
procedure guideline
PEST factors, influencing nursing care
PGD *see* patient group directions pH
clinical importance
nasogastric aspirates
scale
phantom limb pain
pharmacists
covert drug administration and
responsibility for dispensing
pharmacodynamics
pharmacokinetics
pharmacology
pharmacovigilance
pharmacy-only medicines (P)
phenazopyridine (pyridium)
phlebitis
after peripheral cannulation
cytotoxic drug-related
infusion flow rate and

VIP scale
phosphate enemas
photopheresis
phrenic nerve
physical abilities, assessment
physical activity *see* exercise physical examination, preoperative
physical status classification, American Society of Anesthesiologists (ASA) physiotherapy
immobile patients
soft tissue and joint restrictions
sputum collection
unconscious patients
pia mater
PICCs *see* peripherally inserted central catheters Picker Report (2008)
pili
pinch-off syndrome
pinna
planning
care
discharge *see* discharge planning plantar reflexes
plaque, dental
plasma (and serum)
cryo-depleted
fresh frozen (FFP)
osmolarity
oxygen transport
plasmapheresis, therapeutic (plasma exchange) plasma proteins
plasma volume, determination
Plasmodium falciparum plastic surgery
extravasation injuries
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platelets
administration sets
collection using apheresis

count
depletion using apheresis
for transfusion
wound healing
pledges, NHS Constitution
Plerixafor
pleura
pleural effusions
chest drains
exudative
fluid sampling
malignant
signs and symptoms
transudative
pleural fluid sampling
pleural space (cavity)
PleurX drain
plugholes, hand basin
plugs, colostomy
pneumatic compression devices, intermittent *see* intermittent pneumatic compression devices *Pneumocystis jiroveci* pneumonia
pleural effusion associated with
pleural fluid sampling
ventilator-associated (VAP) *see also* respiratory tract infections
pneumoperitoneum
pneumothorax
after liver biopsy
chest drains
complicating CVC insertion
signs and symptoms
spontaneous
tension
pocket mask with oxygen port, cardiopulmonary resuscitation poikilothermia
point-of-care testing (POCT)

poisoning, cardiopulmonary arrest
political factors, influencing nursing
polydipsia
polymorphonuclear leucocytes (neutrophils) polyphagia
polytetrafluoroethylene (PTFE)-coated catheters polyurethane enteral feeding tubes
polyuria
polyvinyl chloride (PVC)
  enteral feeding tubes
  urinary catheters
pons, respiratory centres
popliteal artery
porridge test
portal hypertension
portal of entry
portal of exit
Portex® tracheostomy tubes cuffed
  Suctionaid
  Tracheotwist®
positioning *see* moving and positioning positive air pressure, protective isolation rooms positive end expiratory pressure (PEEP)
  complications
  CPAP valves
positive pressure ventilators
postanaesthetic care
postanaesthetic recovery
  complications
  defined
  discharge
  epidural analgesia
  local and regional anaesthesia
  problem solving
  procedure guidelines *see also* peri-anaesthesia care unit postanaesthetic recovery room

postdural puncture headache (PDPH)
posterior iliac crest
  bone marrow biopsy
  difficulty locating
postmortem examination
  cultural and religious issues
  preparation of body for
postoperative care
  bowel function
  defined
  discharge planning
  fluid balance
  nutrition
  observations
  pain management
  patient education and information
  prevention of complications
  principles
  pulse monitoring
  rationale
  stoma patients
  surgical drains
  temperature monitoring
  thromboprophylaxis
  urinary diversion
  urinary output and catheters *see also* postanaesthetic recovery; wound management postoperative nausea and vomiting
Postoperative Observation and Pain Assessment Chart, Royal Marsden Hospital
postoperative pain
  assessment
  epidural analgesia
  management
  postanaesthetic recovery *see also* acute pain postural control, in neurological impairment postural hypotension *see* orthostatic hypotension posture

defaecation
in neurological impairment
pulse rate and
sitting
potassium
in bodily fluids
serum
transport across membranes
powders, reconstitution for injection
power of attorney, lasting (LPA)
PPE *see* personal protective equipment preadmission clinics, discharge planning
prealbumin
precordial thump
prednisolone enema
pregnancy
Entonox use
radionuclide investigations
testing, preoperative
X-ray precautions
premature babies, oxygen toxicity
premedication
preoperative assessment (POA)
ASA physical status classification
clinics
defined
further referrals
history taking
investigations
personnel undertaking
physical examination
preoperative autologous donation (PAD)
preoperative care
defined
fasting

latex allergy
marking skin
patient education and pain control
patient identification
pregnancy testing
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stoma creation
tampon users
test results
theatre checklist
thromboprophylaxis
urinary diversion
presbyopia
prescribing
chemotherapy
independent
nurse *see* nurse prescribing supplementary
unlicensed and off-label medicines
verbal orders and
prescription-only medicines (POM)
prescriptions
controlled drugs
dispensing
electronic (e-prescriptions)
verbal orders without
pressure
arterial puncture site
effects on tissues
venepuncture site
pressure-activated safety valve (PASV)
pressure area care
at end of life

moving and positioning *see also* skin care pressure cushions
pressure necrosis, gastrostomy/jejunostomy stoma site pressure redistributing foam mattress
pressure-relieving devices
last offices
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antiembolic stockings and
assessment
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defined
factors contributing to
frequency
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importance of preventing
management
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principles of care
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PR interval
prion diseases
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prions
privacy
probenecid
probiotics
problems
dealing with
patient
procarbazine

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  advanced practice
  suitable for healthcare assistants
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proctitis, radiation
profession, upholding reputation
professional boundaries, clear
proficient nurse
prognosis, discussing, at end of life
prokaryotes
proliferative phase, wound healing
prone lying, amputees
propofol
proprioception, testing
prostate cancer
  iodine-125 seeds
  unsealed source radionuclide therapy
prostatic surgery, bladder irrigation after prostheses
  eye *see* eye(s), artificial preoperative removal
  voice *see* voice prostheses protected mealtimes
protective isolation
  defined
  entering room, **procedure guideline** preparing room, **procedure guideline**
  principles of care
  rationale
  room requirements
protein, dietary
  requirements, calculation
  supplements
proteins, plasma
protozoa
protract
pruritus
pseudomembranous colitis

psychological care department
psychological interventions, pain management psychological support
  assessment of needs
  bereaved family
  bowel obstruction
  chemotherapy-induced alopecia
  communication issues
  environmental aspects
  intracavitary brachytherapy
  for nursing staff
  peripheral cannulation
  principles
  stoma patients
  time available
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  at end of life
  nasogastric intubation
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  acute/postoperative pain
  chemotherapy-induced alopecia
  poor wound healing
pulmonary drug administration
pulmonary embolism (PE)
  cardiopulmonary arrest
  perfusion lung scan
  prophylaxis *see* thromboprophylaxis risk factors
  signs
pulmonary oedema
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  amplitude
  assessing gross irregularity
  defined
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methods of measuring
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pulseless electrical activity (PEA)
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pulse measurement
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Purkinje fibres
pus, specimen collection
P-wave
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  assessments
  Darzi's 7 steps to enhancing
  defined
  information provision
  key components
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radial artery
  blood pressure monitoring
  cannulation
  pulse
  puncture for blood sampling
radiation
  defined
  dose
  dose meters
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radiation controlled area
radiation protection
  diagnostic radioisotope procedures
  equipment
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radiation protection supervisor
radicular (symptoms)
radicular pain, spinal cord compression

radioactive contamination
control in emergency situations
deceased patients
incident procedure
monitors
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waste disposal
radioactive decay
Radioactive Substances Act 1993
radioactivity
radiography
radiological investigations
preoperative *see also* chest X-rays; ultrasound radiologically inserted gastrostomy (RIG) tubes care
procedure guideline
radionuclides (radioactive isotopes)
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sealed source therapy
see also brachytherapy unsealed source therapy
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meergency procedures
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iodine-131 mIBG treatment
oral iodine-131 administration
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induced alopecia
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sealed source *see* brachytherapy skin reactions

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unsealed radionuclides *see under* radionuclides radium-223
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Rastafarianism
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rectal bladder
rectal bleeding, after colonoscopy
rectal drug administration *see also* enemas; suppositories rectal examination *see* digital rectal examination rectal temperature
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manual evacuation
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red blood cells
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washed
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Redivac drainage system
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reference nutrient intake (RNI)
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  abnormal, role of positioning
  testing
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  respect for
regional anaesthesia, postoperative care
registration, healthcare providers
Regulan
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  anxiety
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  blood transfusion and
  death and dying
  personal hygiene
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renal failure
  biochemical tests
  opioid analgesia
renal nuclear medicine studies
renin-angiotensin system
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repatriation, deceased patients
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  assessment
  cytotoxic drug risks
request forms, diagnostic test

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reservoir of infection
residential care homes, discharge to
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  abnormal patterns
  accessory muscles of *see* accessory muscles of respiration control
  defined
  depth
  external
  internal (cellular)
  rhythm *see also* breathing respirators
  fit testing
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respiratory assessment/observations
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  methods
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  postprocedure actions
  practical aspects
  preoperative
  problem solving
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  in respiratory compromise
respiratory care
respiratory centres
respiratory compromise
  causes
  management
  positioning in

maximizing drainage of secretions
maximizing ventilation/perfusion matching minimizing work of breathing
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CPAP
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type 2 (hypercapnic)
respiratory function
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reduced, spinal cord compression
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respiratory muscles
accessory *see* accessory muscles of respiration respiratory observations *see* respiratory assessment/observations respiratory rate
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respiratory secretions
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at end of life
large volume
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profuse, around tracheostomy tube
sampling
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humidification function
respiratory zone
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restraint, physical
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cardiopulmonary *see* cardiopulmonary resuscitation do not attempt (DNAR)
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resuscitation bag, self-inflating *see* self-inflating resuscitation bag resuscitation committee
Resuscitation Council UK (RCUK)
resuscitation training officer (RTO)
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retinol binding protein
retrolental fibroplasia

reverse barrier nursing
rhenium-186
rhesus (Rh) blood group system
rhesus (Rh) incompatibility
rib fractures, during CPR
rifampicin
right atrial pressure (RAP)
right atrium (RA), CVAD tip position
right bundle branch
rights, NHS Constitution
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rigors
RIG tubes *see* radiologically inserted gastrostomy tubes risk
  analysis and evaluation
  defined
  identification
  monitoring and reviewing
  treatment
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  cytotoxic drug handling
  infection prevention and control
  manual handling
  pressure ulcers
  scenario
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  definitions
  developing ‘no blame’ culture
  falls
  key principles
  NMC *Code*
  organizational change and
  pressure ulcers
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self-assessment checklist
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venous thromboembolism *see also* incidents risk register
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RNIB See It Right
RNID
Roberts catheters
Roho air-filled mattress/cushions
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Roman Catholicism, last offices
Rome Criteria, constipation
Roper *et al* model of nursing roundworms
routes of drug administration
Royal College of Nursing (RCN)
blood transfusion guidance
chemotherapy administration
pressure ulcer guidance
VAD insertion/care
Royal College of Psychiatrists
Royal College of Speech and Language Therapists Royal National Institute of the Deaf (RNID) rubber gloves
Rusch® speaking valve R-wave
Ryle’s tube
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insertion *see also* nasogastric tubes
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sacral nerves
sacral plexus
The Safe and Secure Handling of Medicines: A Team Approach (Duthie Report) safeguarding of vulnerable adults
safety *see* health and safety, occupational; patient safety St John's wort, drug interactions
salicylates
saline, normal *see* sodium chloride 0.9% solution saline flush-out technique, extravasation injury saliva
artificial
Salmonella, diarrhoea Saltair No-roma
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Savene *see* dexrazoxane Saving Lives toolkit
SBAR (Situation-Background-Assessment-Recommendation) tool scabies
scales, weighing
scalp cooling
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scalp metastases
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scars
scavenging system, anaesthetic gases
sclera

The Scope of Professional Practice (UKCC 1992) scotoma
seating, in neurological impairment
seating cushion, lower limb amputees
sedation
  aggressive patients
  bone marrow biopsy
  complicating epidural/intrathecal analgesia conscious, for endoscopy
  critically ill patients
  in delirium
segmentation, intestinal
Seldinger technique, modified, PICC insertion selective serotonin reuptake inhibitors (SSRIs) Selectron unit (low dose rate (LDR) brachytherapy) applicator removal
  method of operating
  patient preparation
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  patient assessment form
  procedure guideline
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self-care, postoperative patients
self concept, assessment
self-esteem, assessment
self-inflating resuscitation bag
  postanaesthetic recovery *see also* Ambu bag and mask ventilation semen
  collection
    procedure guideline
  cryopreservation
  normal parameters
semi-circular canals
semi-lunar valves
semi-permeable films, wound management
senna

sensory function, assessment
sensory inattention
sensory loss, patient positioning and
sentinel lymph nodes, localization
sepsis
  contraindicating spinal analgesia
  CVAD-related *see* central venous access device (CVAD)-related infections
  pulse monitoring
  signs and symptoms
  transfusion-associated *see also* infection(s) septicaemia
septic shock
Serious Adverse Blood Reactions and Events (SABRE) reporting system serious adverse event
serious adverse reaction
Serious Hazards of Transfusion (SHOT) scheme serious untoward incidents (SUI)
serological testing
seromas, surgical site
serotonin-norepinephrine reuptake inhibitors (SNRI) serum *see* plasma Sevredol *see also* morphine Sexual Dysfunction Association
sexual (dys)function
  after brachytherapy
  assessment
  stoma patients
shampooing, hair
sharp debridement
sharps containers (bins)
sharps disposal
sharps injuries *see* inoculation injuries shaving
  facial, male patients
  peripheral cannulation site
  surgical site
Shaw® silver laryngectomy tube shearing
Shiley® laryngectomy tube Shiley® tracheostomy tubes cuffed
  cuffless

fenestrated cuffed
fenestrated cuffless
shivering
postoperative
shock
complicating paracentesis
venepuncture in
shoes *see* footwear SHOT (Serious Hazards of Transfusion) scheme showering, ear care after
shroud
side-lying position
lumbar puncture
minimizing work of breathing
neurological patients
patients with artificial airway
procedure guideline
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unconscious patients
in unilateral lung disease
ventilation/perfusion matching
sight
sigma-rectum pouch
Sikh Educational and Cultural Association Sikhism
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silastic laryngectomy tube
silences
silicone catheters
silicone elastomer-coated catheters
silicone enteral feeding tubes
silicone-filled mattress pad/cushion
silver alloy-coated catheters
silver toxicity
simple lymphatic drainage (SLD)

Sims (Graseby) syringe drivers
  procedure guideline
Single Assessment Process
single checking, medicines
sinoatrial (SA) node
sinus arrhythmia
sinus rhythm
sip feeds
siphonage
sitting in bed
  CVP measurement
  procedure guideline
sitting position
  blood pressure measurement
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by primary intention
proliferative phase
by secondary intention
by tertiary intention
tissue factors affecting
wound infections
amputees
preoperative hair removal and
surgical wounds
wound management
bone marrow biopsy site
moisture balance
negative pressure therapy

  pressure ulcers
  problem solving
  procedure guideline
  TIME principles
  useful addresses
Wright peak flow meter
Wright respirometer
wrist bands
  radioactive patients *see also* identification, patient
xerostomia *see* dry mouth X-rays *see also* chest X-rays
Yates drainage system
  shortening
yeasts
Yellow Card Scheme

Zomorph
Zoroastrian Trust Funds of Europe
Z-track technique, intramuscular injections