



✚ Neonatal
Intensive Care
Nursing
2nd edition

Edited by Glenys Boxwell

Neonatal Intensive Care Nursing

2nd edition

Thoroughly revised and updated, this new edition of *Neonatal Intensive Care Nursing* is a comprehensive, evidence-based text for nurses and midwives caring for sick newborn babies.

Written by and for nurses, it concentrates on the common problems occurring within the neonatal intensive care unit. This user-friendly text will enable nurses to recognise, rationalise and remedy these problems using both a multi-systems and an evidence-based approach. Individual chapters include:

EVIDENCE-BASED PRACTICE • DEVELOPMENTALLY FOCUSED NURSING CARE • FAMILIES IN NICU • RESUSCITATION OF THE NEWBORN • MANAGEMENT OF THERMAL STABILITY • MANAGEMENT OF RESPIRATORY DISORDERS • MANAGEMENT OF CARDIOVASCULAR DISORDERS • NEONATAL BRAIN INJURY • MANAGEMENT OF HAEMATOLOGICAL DISORDERS • MANAGEMENT OF NEONATAL PAIN • FLUID AND ELECTROLYTE BALANCE • NUTRITIONAL MANAGEMENT IN NICU • NEONATAL INFECTION • DIAGNOSTIC AND THERAPEUTIC PROCEDURES • NEONATAL ANAESTHESIA • NEONATAL SURGERY • NEONATAL TRANSPORT • MEDICATION IN THE NEWBORN • BEREAVEMENT IN THE NICU • ETHICS AND NEONATAL NURSING

Neonatal Intensive Care Nursing will be essential reading for experienced nurses and midwives caring for sick newborn babies within the neonatal intensive care unit, for nurses undertaking qualifications in the specialism of neonatal nursing and for pre-registration students undertaking relevant modules or placements.

Glenys Boxwell (Connolly) is an Advanced Neonatal Nurse Practitioner for Plymouth Hospitals NHS Trust. She was previously a senior lecturer at Homerton College, Cambridge.

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Second Edition

Edited by

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Preface

This is the second edition of *Neonatal Intensive Care Nursing*, first published in 2000. In the intervening years since the publication of the first edition, one would probably think that much has changed in neonatal nursing, but, in reality, little has. Newborn infants in the main (approximately 90 per cent) still survive the arduous and challenging processes around the time of birth and escape the ‘neonatal intensive care experience’. Unfortunately that leaves the 10 per cent of the newborn population who will require our services. The vast majority of those will be infants in the preterm category, with a smaller proportion being term infants who become compromised around the time of birth.

Without doubt, technology and interventions now allow us to manage certain conditions more effectively, for example, the use of inhaled nitric oxide and improved ventilation techniques in persistent pulmonary hypertension of the newborn. Additionally, diverse therapeutic strategies have been introduced into common practice in the thermal management of infants. The technique of delivering preterm infants into polyethylene bags (a simple yet incredibly effective manoeuvre) has been revolutionary in achieving and maintaining thermal stability in the most premature populations, with the opposite end of the spectrum, that of significant cooling of the compromised term infant, being introduced to minimise brain injury. Aspects of care delivery that are unchanged are those of providing support for parents within the NICU and coping with the ethical dilemmas that nurses face constantly within their daily practice.

Is a second edition of this textbook necessary? Many people are of the view ‘by the time a book is published, the information is out of date!’ While there may be a degree of truth in that statement, it also has to be said that most published material, if well researched, has credence and can be used as a starting point for a more up-to-date search for information on a particular topic of interest. To that end, each chapter contains a wealth of referenced material so that if further detail is required, then the reader is directed to the relevant reference for further exploration into the subject matter.

There has been a burgeoning development in internet sources of information since the first edition of this textbook which is incredibly useful. However, many practitioners still rely upon resources that are readily available to them, that can be easily accessed, especially for those awful ‘two o’clock in the morning moments’ just before an exam!

The book could easily have been double in size, at least, if it were to cover all of the conditions and situations that may be encountered within a NICU. That would, I believe, have made it an unwieldy tome and turned it into a less user-friendly book.

As previously, this book has been written by people who care for preterm and sick infants on a daily basis, managing their disease process and their concomitant complications. Hands-on practice is the guide in this volume.

Each chapter author has endeavoured to incorporate the anatomical and physiological basis for the conditions described, along with management strategies based on the most current evidence available. By applying this knowledge to clinical practice, it is hoped that disease processes will be better understood, care will be more effectively delivered and parents more effectively supported.

The philosophy of *Neonatal Intensive Care Nursing* is not only that its content will aid students undertaking courses through the arduous process of finding ‘evidence’ to support comments made in assignments, but also encourage the process of linking evidence-based theories to everyday nursing practice within the NICU.

Glenys Boxwell (Connolly)
Plymouth
November 2009

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Glenys Connolly
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Abbreviations

ABSS	Anderson's state scoring system
A/C	assist control ventilation
ACTH	adrenocorticotrophic hormone
ADH	antidiuretic hormone
ADP	adenosine diphosphate
aEEG	amplitude-integrated electroencephalography
ANNP	Advanced Neonatal Nurse Practitioner
ANNT	aseptic non-touch technique
APIB	Assessment of Preterm Infant Behaviour
ARF	acute renal failure
ASD	atrial septal defect
ATP	adenosine triphosphate
AV	atrioventricular
BAT	brown adipose tissue
BIIP	Behavioural Indicators of Infant Pain
BPD	bronchopulmonary dysplasia
CAF	Contact a Family Directory
cAMP	cyclic adenosine monophosphate
CAVH	continuous arteriovenous haemofiltration
CBF	cerebral blood flow
CDH	congenital diaphragmatic hernia
CFUs	colony-forming units
cGMP	cyclic guanosine monophosphate
CHARGE	Coloboma, Heart, Atresia choanal, Retardation (growth), Genital and Ear anomalies
CHD	congenital heart defects
CHF	congestive heart failure

CLD	chronic lung disease
CMV	cytomegalovirus
CMV	continuous mandatory ventilation
CNEP	continuous negative expanding pressure
CNS	central nervous system
CO	cardiac output
CO	carbon monoxide
CONS	coagulase negative staphylococcus
CPAP	continuous positive airways pressure
CRP	C-reactive protein
CRT	capillary refill time
CSF	cerebrospinal fluid
CVP	central venous pressure
DCT	direct Coomb's test
DDH	developmental dysplasia of the hip
DIC	disseminated intravascular coagulation
DJF	duodeno-jejunal flexure
DSVNI	Distress Scale for Ventilated Newborn Infants
EBF	erythroblastosis fetalis
EBM	expressed breast milk
EBP	evidence-based practice
ECF	extracellular fluid
ECG	electrocardiogram
ECHO	echocardiography
ECMO	extracorporeal membrane oxygenation
EDRF	endothelium-derived relaxing factor
EEG	electroencephalogram
ETT	endotracheal tube
FBM	fetal breathing movements
FFP	fresh frozen plasma
FiO ₂	fractional inspired oxygen concentration
FISH	fluorescence in situ hybridisation
FRC	functional residual capacity
GBS	group B beta-haemolytic streptococcus
GCSF	granulocyte colony stimulating factor
GFR	glomerular filtration rate
GMH	germinal matrix haemorrhage
GO/ERD	gastro-(o)esophageal reflux disease
GOR	gastro-oesophageal reflux
HAS	human albumin solution
HDN	haemorrhagic disease of the newborn; also haemolytic disease of the newborn
HFJV	high frequency jet ventilation
HFOV	high frequency oscillation ventilation
HFPPV	high frequency positive-pressure ventilation
HI	hypoxic ischaemic

HIE	hypoxic-ischaemic encephalopathy
HMD	hyaline membrane disease
HUSS	head ultrasound scan
HWM	heated water-filled mattresses
IADH	inappropriate (secretion) of antidiuretic hormone
IM	intramuscular
IMV	intermittent mandatory ventilation
iNO	inhaled nitric oxide
IPPV	intermittent positive-pressure ventilation
ITR	immature to total neutrophil ratio
IUGR	intrauterine growth restriction
IVC	inferior vena cava
IVH	intraventricular haemorrhage
IVIG	intravenous immunoglobulin
LBW	low birth weight
LCPUFA	long chain polyunsaturated fatty acid
LCT	long chain triglycerides
LMA	laryngeal mask airway
LP	lumbar puncture
MAP	mean airway pressure
MAS	meconium aspiration syndrome
MCT	medium chain triglycerides
MDT	multidisciplinary team
MetHb	methaemoglobin
MHRA	Medicines and Healthcare Products Regulatory Agency
MRI	magnetic resonance imaging
MV	minute volume
NBAS	Neonatal Behavioural Assessment Scale
nCPAP	nasal CPAP
NEC	necrotising enterocolitis
NI	nosocomial infection
NICU	Neonatal Intensive Care Unit
NIDCAP	Neonatal Individualised Developmental Care and Assessment Programme
NIRS	near-infrared spectroscopy
NK	natural killer cells
NMC	Nursing and Midwifery Council
NNS	non-nutritive sucking
NO	nitric oxide
OA	oesophageal atresia
OFC	occipito-frontal circumference
OI	oxygen index
PaCO ₂	partial pressure of carbon dioxide in arterial blood
PaO ₂	partial pressure of oxygen in arterial blood
PBE	practice-based evidence
PCA	postconceptional age

PCV	packed cell volume
PD	peritoneal dialysis
PDA	patent ductus arteriosus
PEEP	positive end-expiratory pressure
PFO	patent foramen ovale
PH	pulmonary haemorrhage
PHH	post-haemorrhagic hydrocephalus
PHVD	post-haemorrhagic ventricular dilatation
PICC	peripherally inserted central catheter
PIE	pulmonary interstitial emphysema
PIP	peak inflation pressure
PPHN	persistent pulmonary hypertension
PROM	premature rupture of membranes
PSV	pressure support ventilation
PTV	patient-triggered ventilation
PVH	periventricular haemorrhage
PVHI	periventricular haemorrhage infarction
PVL	periventricular leukomalacia
PVR	pulmonary vascular resistance
RCT	randomised controlled trial
RDS	respiratory distress syndrome
r-HuEPO	Recombinant Human Erythropoietin Therapy
ROP	retinopathy of prematurity
SaO ₂	saturation of haemoglobin (oxygen)
SBR	serum bilirubin
SCBU	special care baby unit
SG	specific gravity
SGA	small for gestational age
SIDS	sudden infant death syndrome
SIMV	synchronised intermittent mandatory ventilation
SIPPV	synchronised intermittent positive pressure ventilation
SVC	superior vena cava
SVT	supraventricular tachycardia
TA-GVHD	Transfusion Associated Graft versus Host Disease
TAT	transanastomotic tube
TcB	transcutaneous bilirubinometers
TDM	therapeutic drug monitoring
TEWL	transepidermal water loss
TGA	transposition of the great arteries
THAM	Trishydroxyaminomethylmethane
TINA	Transport of Neonates in Ambulances
TOF	tracheo-oesophageal fistula
TORCH	Toxoplasmosis, Rubella, Cytomegalovirus and Herpes
TPN	total parenteral nutrition
TSE	transmissible spongiform encephalopathy
TSH	thyroid-stimulating hormone

TTN	transient tachypnoea of the newborn
UAC	umbilical arterial catheter
UVC	umbilical venous catheter
VACTERL	Vertebral, Anal, Tracheal, (O)Esophageal and Renal anomalies, plus Cardiac and Limb anomalies
VATER	Vertebral, Anal, Tracheal, (O)Esophageal and Renal anomalies
VC	volume control
vCJD	variant CJD
VILI	ventilator induced lung injury
VKDB	vitamin K deficient bleeding
V/Q	ventilation perfusion
VSD	ventricular septal defect
VT	ventricular tachycardia

Glossary

Selected terms are highlighted in **bold** type in the text on their first occurrence or in key contexts.

- abduction** to move (a limb) away from the midline of the body
adduction to draw (a limb) into the mid-line of the body
adenosine triphosphate (ATP) organic molecule in body cells responsible for storage and release of energy
aganglionic without ganglia (innervation)
amniocentesis removal of amniotic fluid via the maternal abdominal wall for fetal diagnostic purposes
anabolism building phase of metabolism
anastomosis a union between two structures
anion ion carrying one or more negative charges
antecubital in front of the elbow
anterior towards the front of the body
anteroposterior an X-ray view taken using a vertical beam with the patient placed in a supine position
antibody protein released by plasma cells in response to an antigen
antigen substance recognised as foreign by the immune system
apoptosis programmed cell death
aspiration fluid entering the lungs
atelectasis alveolar collapse
atresia a blind-ended tube
auscultation the process of listening with a stethoscope
autoregulation the automatic adjustment of blood flow to a particular body area in response to current need
B cells cells responsible for humoral (antibody-mediated) immunity
baroreceptors receptors stimulated by pressure change
bradyarrhythmias slow heart, usually due to extracardiac pathology

- bradycardia** slow heart rate, less than 80bpm (term) and 100bpm (preterm)
- brown adipose tissue (BAT)** specialised, strategically placed tissue (fat) which is capable of generating heat
- calcaneus** heel bone
- cardiac output** amount of blood pumped from ventricles in one minute
- carina** the keel-shaped cartilage at the bifurcation of the trachea into the two main bronchi
- catecholamines** compounds that have the effect of sympathetic nerve stimulation
- cation** a positively charged ion
- caudal** relating to the tail end of the body
- cell-mediated immunity** immunity conferred by activated T cells
- cephalad** towards the head
- cephalhaematoma** collection of blood beneath the periosteum of a skull bone
- cephalocaudally** from the head to the 'tail'
- chemoreceptors** receptors sensitive to chemical change
- choroid plexus** CSF producing a capillary 'knot' within a brain ventricle
- chromatic** related to structures within the cell nucleus which carry hereditary (genetic) factors
- cytochrome** iron containing proteins found on inner mitochondrial layer which function as electron carriers during oxidative phosphorylation
- diaphoresis** sweating
- diastole** relaxation phase of the cardiac cycle
- distal** further from the attached limb or the origin of a structure, e.g. the elbow is distal to the shoulder
- dorsiflexed** backward flexion of the hand or foot
- dorsum** the upper or posterior surface of a part of the body
- dynamic precordium** visible heartbeat due to PDA
- ecchymoses** discoloured patch resulting from escape of blood into the tissues just under the skin
- embolus** (plural **emboli**) obstruction of a blood vessel by particulate matter, e.g. blood clot or air
- epiglottis** leaf-shaped cartilage at back of throat, covers the larynx during swallowing
- erythropoietin** hormone released predominantly by the kidney which stimulates red blood cell production (erythropoiesis)
- eventration** flattening and non-movement of the diaphragm following denervation – may be congenital or acquired
- evidence-based (care)** the integration of best available clinical evidence with an individual's expertise
- extravasation** leakage of fluid from a vessel into the surrounding tissue
- extremely low birth weight** infant of less than or equal to 999g
- facilitated tucking** supported positioning of a baby to contain a limb
- fistula** unnatural connection between two structures or body cavities

- flexed** to curl inwards
- fundoplication** surgical procedure in which the proximal stomach is wrapped around the distal oesophagus to prevent reflux
- gestational age** period of time from the first date of last normal menstrual period to the date of birth. Expressed in number of completed weeks or days
- glomerular filtration rate** rate of filtrate formation by the kidneys
- gluconeogenesis** formation of glucose from a non-carbohydrate source, e.g. muscle
- glycogen** stored carbohydrate predominantly in muscle
- glycogenesis** formation of glycogen from glucose
- glycogenolysis** breakdown of glycogen to glucose
- glycolysis** breakdown of glucose to pyruvate
- haemolysis** rupture of red blood cells
- Heimlich valve** a one-way blow-off valve
- histamine** chemical substance which promotes vasodilatation and capillary permeability
- holistic** encompassing all aspects of care
- homeostasis** a state of equilibrium within the body
- humeral immunity** immunity conferred by antibody production
- hydrocephalus** an abnormal increase in the amount of cerebral spinal fluid within the ventricles of the brain
- hypertonic** fluids containing a high concentration of solutes, e.g. greater than cells
- immunoglobulins** antibodies that bind to specific antigens
- inferior** away from the head or towards the lower body or structures
- interferon** chemical that provides some protection against a virus
- intrathecal** within the subarachnoid space
- isotonic** fluids that have the same osmotic pressure as cells
- kernicterus** yellow staining of brain stem, cerebellum and hypocanthus with toxic degeneration of nerve cells due to hyperbilirubinaemia
- lateral** away from the mid-line of the body
- lateral decubitus** lying on one side
- lipophilic** substance attracted to fatty tissues
- loculated** collected in defined areas or pockets
- low birth weight (LBW)** infant of less than or equal to 2499g
- lymphocytes** white blood cells arising from bone marrow denoted T or B cells
- macrophages** principal phagocytes found at specific sites or within bloodstream
- malrotation** anomaly of fetal intestinal rotation and fixation resulting in intestinal obstruction
- medial** towards the mid-line of the body
- mesenteries** extensions of the peritoneum that support abdominal organs
- mitochondria** organelles found in all cells responsible for production of adenosine triphosphate (ATP)

- myelination** the formation of a fatty insulating sheath surrounding most nerve fibres
- nephrotoxic** damaging to nephrons/kidneys
- nociception** the perception by the nerve centres of painful stimulation. The term used in relation to pain perception in neonates
- non-shivering thermogenesis** ability to produce heat by activation of BAT
- nosocomial** an infection that develops within the hospital environment
- oligohydramnios** reduction in liquor volume
- oliguria** diminished urine output, e.g. < 1ml/kg/hr
- opisthotonus** severe contraction of the back muscles causing the body to arch backwards
- opsonisation** process whereby antigens are made more 'attractive' to phagocytes
- ototoxic** damaging to the eighth cranial nerve/hearing
- petechiae** small haemorrhages in the skin
- phagocytes** white blood cells (leucocytes) that destroy pathogens by engulfment
- pharmacodynamics** how drugs affect the body
- pharmacokinetics** absorption, distribution, metabolism, excretion or what the body does to a drug
- phocomelia** congenital anomaly with absence of limbs
- plantar** relating to the sole of the foot
- pleural effusion** the presence of fluid in the pleural space
- pneumoperitoneum** free air in the peritoneal space
- pneumothorax** free air in the pleural cavity
- polyhydramnios** an excess of amniotic fluid
- postconceptional age** current age calculated from date of conception
- posterior** towards the back of the body
- preterm** less than 37 completed weeks of gestation (259 days). Accounts for 8 per cent of births
- primiparous** pregnant for the first time
- prokinetic** agent that increases gastric motility
- proximal** closer to the body or origin of a structure, e.g. the knee is proximal to the ankle
- recidivity** collapsing
- situs inversus** major organs (e.g. heart and stomach) are reversed from their normal positions (as seen on X-ray)
- situs solitus** normal position of major organs (as seen on X-ray)
- small for gestational age (SGA)** infant with birthweight less than the 10th percentile
- solute** substance dissolved in solution
- stenosis** an abnormal narrowing
- stroke volume** amount of blood pumped from the ventricles with each contraction
- superior** towards the head or upper part of the body or a structure
- supine** lying on back, face upwards

- suprapubic** above the symphysis pubis
- syncope** fainting, loss of consciousness
- systole** contraction phase of the cardiac cycle
- T cells** cells responsible for cell-mediated immunity
- tachycardia** heart rate greater than 160bpm (term) and 180bpm (preterm) at rest
- tension pneumothorax** free air (under pressure) in the chest resulting in a shift in the mediastinum potentially reducing cardiac output
- term** from 37 to 42 completed weeks of gestation (259–93 days); see also **preterm**
- thermogenesis** production of heat
- thoracic vertebrae** the twelve bones of the backbone to which the ribs are attached
- thrombus** a clot that develops and persists within a blood vessel
- torsion** twisting, e.g. of gut
- tracheomalacia** ‘floppy’ trachea
- turbidity** clouded with a suspension of particles
- vallecula** a depression in an organ (beneath the epiglottis)
- very low birth weight (VLBW)** infant of less than or equal to 1499g; see also **small for gestational age**
- xiphisternum** the lower part of the breastbone

Exploring Evidence-based Practice (EBP) in Neonatal Care

Fiona Hutchinson



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Introduction

This chapter will explore the concept of evidence-based neonatal nursing care and encourage reflection on differing forms of evidence used in day-to-day practice. Increasingly neonatal nurses are being asked, by peers as well as parents, to provide a rationale for their clinical actions. During nurse training the majority of theoretical evidence is derived from textbooks, journals and lectures. Clinical skills are gained by observing others and receiving support by mentorship. Once qualified, nurses must be accountable for their actions, and must be able to demonstrate that their practice is based on safe and contemporaneous evidence (NMC 2008). The chapter begins by revisiting the concept of evidence-based practice and will explore differing sources of evidence which may be used in practice. The final section of the chapter will discuss how evidence is used in everyday clinical decision-making and explore some sources of evidence which you previously may not have considered.

Exercise 1.1

Think back to the last baby you cared for. Try to recall all the care you provided for the baby and then answer the following questions:

- 1 What were the sources of knowledge you utilised in order to undertake your actions?
- 2 Did you verify that the source of your knowledge was reliable and valid?
- 3 Were your sources up to date?
- 4 If you feel that your practice was research-based, can you quote which research was utilised and have you critiqued the research yourself?
- 5 Do you think that your practice was evidence-based?

Exercise 1.1 is intended to make you reflect on differing sources of knowledge utilised to underpin neonatal nursing practice and is useful as a starting point when considering the concept of 'evidence-based practice'.

What is evidence-based practice (EBP)?

No chapter on evidence-based practice (EBP) would be complete without first repeating Sackett *et al.*'s well-quoted definition of evidence-based medicine: 'The conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients' (Sackett *et al.* 1997, p. 2). As this definition was linked with evidence-based *medicine*, it was, for a while, a common assumption that the only type of evidence was empirical research

derived from the quantitative tradition. Much of the momentum sustaining evidence-based medicine (EBM) derives from the Cochrane Collaboration which was designed in 1993 by Cochrane, a physician-epidemiologist interested in the need for evidence to support health care decisions. He worked with Iain Chalmers in formulating an evidence hierarchy which designated the randomised controlled trial (RCT) as the 'gold standard' of evidence (Jennings and Loan 2001). Systematic reviews are the core focus of the Cochrane Collaboration which enables the reader to synthesise the differing results of studies. The frequent interchange between EBM and EBP has led to confusion in identifying the underlying philosophies underpinning evidence. Jasper (2006) describes how evidence-based medicine developed in the early 1990s with evidence-based *practice* becoming popular in the late 1990s. The introduction of evidence-based practice was to extend the original ideas of evidence-based medicine to other professional disciplines such as nursing and midwifery. Evidence-based *nursing* was first recognised in the mid-1990s and resulted in a strong professional response to evidence-based practice within nursing as a result of key government documents. Cluett (2005) describes how evidence-based practice was advocated as a key component for quality midwifery practice and was a core element in several government publications including *The NHS Plan* (DoH 2000) and *Changing Childbirth* (DoH 1993). Whichever terminology is utilised, it is important to remember that evidence is not static as it constantly changes in response to new research and practice-based experience. What may be deemed as 'good or safe practice' today may be consigned to the archives as new evidence emerges. This becomes particularly important when writing neonatal unit protocols, guidelines and procedures as it is essential that these are based on contemporaneous evidence.

In 1999, the United Kingdom Central Council (UKCC) argued that evidence-based practice should be integral to the preparation of nurses (Swinkels *et al.* 2002). Rycroft-Malone *et al.* open their discussion on evidence-based practice by stating that "evidence" may well be one of the most fashionable words in health care' (2004, p. 82). They suggest that confusion still exists with defining what 'evidence' is and how it differs from 'scientific' research and provide a useful framework for identifying sources of evidence. Rycroft-Malone *et al.* (2004) and Boogaerts *et al.* (2008) identify varying sources of knowledge utilised in evidence-based policy development and practice. These are discussed in more detail in the following section of this chapter.

Propositional knowledge (scientific knowledge)

The Department of Health views scientific research, e.g. RCTs, as the 'gold standard' of evidence and proposes a hierarchy of 'best' evidence placing personal experience at the bottom of the structure. A randomised controlled trial is a study performed with an homogeneous population, controlled variables and specific interventions using a placebo (Girard 2008). Evans (2003) provides an example of the so-called 'hierarchy' of evidence as follows:

- 1 Systematic reviews, multi-centre studies.
- 2 Randomised controlled trials, observational studies.
- 3 Uncontrolled trials with dramatic results, before and after studies, non-randomised controlled trials.
- 4 Descriptive studies, case studies, expert opinion, studies of poor methodological quality.

The above list is limited in nature as it ignores other forms of evidence which will be discussed later. In this hierarchical structure Evans has given equal status to expert opinion, descriptive studies, case studies and studies of poor methodological quality, whereas other frameworks (e.g. Ellis 2000) distinguish between studies and expert opinions in the hierarchical structure, ranking the former above the latter. Brocklehurst and McGuire (2005), in their review on evidence-based care in perinatal medicine, identify some of the difficulties in undertaking neonatal randomised controlled trials. These are summarised as:

- limited infrastructure to support studies;
- large trials needed to detect modest effect sizes;
- limited funding;
- limited potential for industrial partnership;
- trial recruitment undertaken by busy clinicians or carers;
- informed consent obtained at stressful times;
- public perception of neonatal research;
- need for long-term follow-up.

(*ibid.*, p. 36)

There is no doubt that there is a need to evaluate any potential interventions prior to their use in neonatal care. Large multi-centred trials such as the TOBY trial (to determine whether the use of hypothermia as a treatment would reduce mortality and neurodevelopment impairment at 18 months of age) have proved useful in providing evidence to support practice. In view of the difficulties identified above, however, Brocklehurst and McGuire suggest that there should be more perinatal networks for undertaking multi-centre trials as is the case in North America and Australasia. Such collaboration would ensure that competing trials do not occur simultaneously and that parent groups and researchers can prioritise their most important research questions.

Long-term outcomes for very **preterm** babies have been evaluated in an attempt to appraise the effectiveness of perinatal and neonatal care (e.g. Larroque *et al.* 2004). The findings of this particular study (Epipage) concluded that 42 per cent of those born at between 24–28 weeks were receiving special support at 5 years. Of these children, 50 per cent were also receiving care from psychologists or psychiatrists. Studies like these are essential for long-term planning of resources as they remind us that service needs for these children extend long after discharge from the neonatal unit. As with all forms of evidence, however, it depends on how accurate the data are.

Qualitative research is a broad term used to refer to a variety of research traditions originating in philosophy, anthropology, psychology and sociology. It is an inductive approach to discovering or expanding knowledge and is a useful means of generating knowledge about an area that has been little researched previously. Qualitative studies are the best designs to understand experiences, beliefs and attitudes. Wigert *et al.* (2006) undertook a qualitative study of ten mothers in order to find out their experiences of having a baby in a neonatal intensive care unit. This study provided useful evidence for neonatal nurses as the implications for practice established that the mothers in the study felt excluded from the care of their baby and experienced a sense of not belonging to either the maternity care unit or the neonatal unit. The authors concluded by stating that this has implications for maternal–infant attachment and discuss the importance of neonatal nurses developing strategies which support the women in caring for their baby while in the neonatal unit. A systematic review of research into the effectiveness of bereavement interventions in neonatal intensive care was undertaken by Harvey *et al.* (2008). Their findings concluded that qualitative research may be the key to discovering the most effective way of providing bereavement care due to the sensitivity of the subject area and ethical dilemmas of conducting RCTs. Post-bereavement care is an example of a research topic whereby the findings of an RCT may not be applicable to individual circumstances. The ‘best’ intervention, as elicited from a controlled trial, may not be appropriate for all bereaved parents. Henley and Schott (2008) and Kendall and Guo (2008) provide some good examples of how qualitative research is important in providing evidence of how nursing staff can impact on parents’ experiences of bereavement. They argue that this experience has a huge impact on their ability to cope not only at the time of the bereavement but for years afterwards. These examples demonstrate the usefulness of qualitative research in providing evidence to underpin nursing care within the neonatal unit.

Qualitative research, however, is not without its limitations. Bryman (2008) acknowledges that the main criticism of qualitative research are issues surrounding the subjectivity of the researcher, the difficulty in replication of the study, the lack of transparency in the research process, and problems with the generalisation of findings. It would not be an appropriate method for gathering evidence when testing a new pharmacological intervention, for example. What is interesting in Bryman’s work, however, is that he lists the similarities between the two methods, suggesting that they are both ways of achieving evidence to underpin practice even though they utilise differing philosophies.

Two differing approaches to obtaining propositional knowledge are described above, each with their strengths and weaknesses. Flemming (2007) argues that while nurses have developed diverse ways of obtaining knowledge for practice, they have predominantly adopted a medical model of evidence by focusing on evidence obtained from RCTs and other quantitative studies as listed above. In specialist areas like neonatal intensive care, this is understandable, as medical interventions which are derived from scientific sources of evidence tend to take priority. She suggests that in order to develop nursing

practice in such specialist areas, nurses need to synthesise differing forms of research methods, and provides a very strong case for incorporating mixed research methods in order to inform nursing practice. She argues that the combination of qualitative and quantitative research methods produces findings that can enhance the evidence base for nursing practice. Mulhall (1998) suggests that nurses should primarily focus on designing imaginative research which will improve many aspects of nursing practice. It is important to remember that qualitative studies elicit rich data which can provide valuable insight into parents' experiences of neonatal care (e.g. Wigert *et al.* 2006). This, however, is achieved at the expense of acquiring large sample sizes, thus reducing the ability to generalise the findings. Data such as this are of great importance when considering ways in which to develop an evidence base for (neonatal) nursing practice. It is beyond the scope of this chapter to provide an in-depth discussion on the 'qualitative versus quantitative' debate. A detailed discussion on the differing philosophies underpinning these methodologies can be found in Proctor (1998).

Knowledge gained through practice experience

Mantzoukas (2007) argues that knowledge is inextricably linked with practice and therefore should not be solely derived from the distancing and rigour of scientific research. The most renowned advocate of clinical experience as a source of evidence for practice is Patricia Benner (Benner 1984). Knowledge gained through this way is often tacit (implied without being stated) and intuitive. Estabrooks *et al.* (2005) studied how paediatric and adult intensive care nurses obtained the majority of their practice knowledge. The findings indicate that evidence-based care protocols are often rejected in favour of practices based on their own personal experience. The practitioners felt confident in justifying and defending their actions. Nurses also stated that they gained knowledge for practice from social interactions with peers. The authors conclude the study by stating that social interactions and experience should be given more credence as a source of knowledge than more legitimate sources, for example, research and policies, which reinforces the complexity of differing sources of evidence required for practice.

Personal experience

An example from personal experience provides an illustration of how experience gained through past practice can have a long-lasting impact. As part of my midwifery training I spent several weeks in the neonatal unit. Two babies were being nursed side by side in incubators. One was a male infant born at 28 weeks' gestation weighing 980 grams at birth. The other was a female infant with a birth weight of 1,000 grams at 40 weeks' gestation. I remember how their medical and nursing needs were vastly different even though there was only

20 grams difference in their birth weight. Thirty years later I still use this example when teaching student midwives to illustrate the differences between prematurity and growth restriction. The practical experience gained from observing these two babies and how they were cared for has stayed with me all these years and is an example of how knowledge gained through practice can have long-lasting implications. This experience taught me more about the difference between a premature baby and a growth-restricted baby's medical and nursing needs than any books, lectures or research.

Reflection on and in practice can be considered a process of transforming unconscious types of knowledge and practices into logically articulated ones that can be used in clinical decision-making. If undertaken systematically, utilising an appropriate model, for example, Smyth's double loop model, reflection can evaluate the incident from a theoretical perspective by exploring which nursing theory and social practices have influenced the incident and how these may need to be modified (Greenwood 1998). Much is written about intuitive practice and it is important to remember that intuition can only develop in response to an accumulation of practice knowledge. It has a direct bearing on the analytical processes in patient care as it is often a trigger for reflective practice (King and Appleton 1997).

Knowledge from patients, clients and carers

Knowledge from parents and neonatal nurses can provide an important insight into the lived experience of neonatal care. This may take the form of individual case studies, parents' narratives or empirical research. An example of parents' experiences of neonatal care may be found on the website www.healthtalkonline.org (previously known as DipEx). This is a registered charity established in 2001 by two doctors after they had both experienced health care as patients. One particular interview provides a moving account of a mother whose baby was diagnosed with a congenital heart defect. The narrative provides a detailed account of the effect of the experience on her whole family. Rycroft-Malone *et al.* (2004) describe two types of potential patient evidence. The first is specific to one patient's experience in an episode of care; the second is building up evidence from different patient narratives which could then be utilised to inform policy-making. Lindberg *et al.* (2008) undertook qualitative research in order to obtain information about the experience of adjusting to being the father of a premature infant. The findings provide an invaluable and honest account of how fathers feel, how they attempted to adjust and gain confidence in becoming a father. Likewise, Fegran and Helseth (2008) studied the parent–nurse relationship in a neonatal intensive care unit and concluded their work by stating that distancing is necessary to maintain professional boundaries, but achieving the right balance between closeness and distance can assist with parents developing independence in caring for their baby. Jasper (2006) argues that while practice should be based on propositional knowledge and clinical experience, it also needs to take into account patient preferences (in the case of

neonatal care, parents' wishes). A recently published survey by Bliss (2008) provides a good example of a mixed method research methodology. The survey undertaken in 2008 asked neonatal units about their activity and also included questions for parents relating to their experiences of having a baby in the neonatal unit and their impression of neonatal care. The comments made by parents in the report, in conjunction with the survey data, provide a detailed picture of life in a neonatal unit from the perspectives of both parents and staff. Not surprisingly, one of the major themes identified by both groups was the shortage of nursing staff.

Knowledge from a local context (audit and evaluation)

Audit and evaluation are essential activities for the provision of evidence about current practice (Lindsay 2007). Audits measure practice against a pre-determined standard, while evaluation focuses on measuring current service provision. Current strategies emphasise the importance of involving users (in the case of neonatal care, parents) in the process of audit and evaluation. Lindsay claims that the effectiveness of audit and evaluation as providers of evidence is dependent on factors such as the setting of appropriate standards (for audit), reliable data collection and analysis and clear reporting of findings. Redshaw and Hamilton (2005) surveyed all neonatal units in the UK and received a response rate of 70 per cent (153 neonatal units). Services evaluated included those of neonatal networks, admission and transfer rates, staffing levels and some elements of practice. Data like this are useful in providing an overview of national practices and in highlighting areas for improvement, but, as the authors concur, are solely descriptive in nature.

Three frameworks have been utilised in order to identify differing sources of knowledge used in providing evidence for practice. Two further sources of knowledge not alluded to in the hierarchy previously identified by Evans (2003) are mentioned below as they are utilised by health care professionals, especially when undertaking further study. Some would argue that these are not always contemporaneous or accurate sources of evidence.

- 1 *Websites.* Most people today have access to the internet and when a mother has a preterm baby, the probability is the first thing she will do is undertake an internet search on 'prematurity'. It is for this reason that neonatal nurses should be aware of the evidence that is available on the internet in order to address any queries that arise. Reviewing some of the available websites, it is evident that some are well meaning but misguided. One site recommended that in order to prevent preterm labour, a woman should not climb the stairs more than twice a day. Conversely, the website mentioned in an earlier section provides a wealth of knowledge about what it is like to give birth to a baby with a congenital heart defect and the effect it has on the whole family structure (www.healthonline.org). Several frameworks are avail-

able for evaluating the reliability and validity of the content of a website; however, the most important questions that need to be asked are:

- (a) Does the site cover the topic comprehensively and accurately?
- (b) Is the information predominantly fact or opinion?
- (c) Can you understand what is being said?
- (d) Is it written at the right level for the target audience?
- (e) Is the site referenced?
- (f) Are the web links well chosen and relevant?
- (g) Is the site regularly updated?

(Sing-Ling Tsai and Sin-Kuo Chai 2005)

- 2 *Books*. Books have their place in providing evidence for practice. Rolfe and Fulbrook (1998) categorise books as a source of scientific theoretical knowledge. While acknowledging that textbooks are of limited use in providing contemporaneous evidence, they are invaluable for providing principles for practice and information that does not have a limited life span, for example, anatomy and physiology. They are also useful in providing information about a specialist area of nursing practice and are listed as key texts in several undergraduate and postgraduate courses.

The use of evidence in clinical decision-making

The next part of this chapter will explore how differing sources of evidence may be used in making decisions about neonatal practice. Clinical decision-making may be defined as ‘choosing between alternatives’ (Thompson and Dowding 2002). Knowledge utilised to underpin clinical decision-making has been recognised for many years as falling into one of the following categories forming the ‘evidence-based nursing jigsaw’ as described by Di-Censo *et al.* (1998), and Flemming (2007):

- clinical expertise;
- evidence from research;
- available resources;
- patient (or in the case of neonatal care, ‘family’) preferences.

Thompson (2003) claims that the majority of evidence used in day-to-day clinical decision-making is based on experiential knowledge. Reliance on this form of evidence means that nurses must use cognitive shortcuts or heuristics for handling information when making decisions. One of the disadvantages of this is the potential for subjectivity because of previous experiences.

Historically, there have been three main models to assist with decision-making based on differing sources of evidence:

- 1 *The information processing model* – Rooted in medical decision-making, it uses a hypothetico-deductive (scientific) approach to assist with reasoning.

It is derived from the field of cognitive psychology and involves testing hypotheses and then modifying them on the outcome of the situation being tested (Manias *et al.* 2004). Decision trees can be used to assess potential outcomes, for each decision tree, possible outcomes can be assigned a numerical value and the probability of reaching a specific outcome is assessed. This rule of probability is known as Bayes theorem. This form of analysis is used to calculate the risks of particular problems, for example, the risk of fetal hypoxia following meconium staining of the liquor (Raynor *et al.* 2005).

- 2 *The intuitive-humanist model (pattern recognition)* – The focus of this model is intuition and the relationship between nursing experiences, the knowledge gained from it and how it enriches the clinical decision-making process. In this model, hypothesis testing is not used as a marker of accurate or inaccurate propositions and reasoning. Critics of this model state that it lacks scientific reasoning and focuses on reasoning based on hunches or intuition. Rew defines intuition as ‘the act of synthesizing empirical, ethical, aesthetic and personal knowledge’ (2000, p. 95). One drawback of using this model is that initial hunches or cues may be misleading, resulting in an incorrect decision being made. Pattern recognition is the process whereby a judgement is made on the basis of a few critical pieces of information, i.e. it uses ‘stored knowledge’ from past experiences (heuristics). Decisions are made on representativeness (how it relates to previous experience), availability (how easy it is to recall information) and anchoring adjustment (favouring originally held beliefs, but adjusting them on the basis of new evidence (Cioffi and Markham 1997)). The difference between pattern recognition and intuitive practice is that intuition occurs at an unconscious level whereas pattern recognition occurs at a conscious level (Raynor *et al.* 2005). They are, however, very similar thought processes (Manias *et al.* 2004) and an expert practitioner will have more stored knowledge than a novice practitioner (Benner 1984).
- 3 *Spur-of-the-moment decision-making* – Neonatal emergencies such as resuscitation decisions are usually ‘spur-of-the-moment’ decisions as any delay could be detrimental to the well-being of the baby. Because they are made quickly, it does not, however, mean that no thought has gone into them and they are not based on appropriate evidence. They are usually based on written guidelines as a form of evidence where specific steps are followed (e.g. the ABC of resuscitation). Guidelines are usually based on deductive reasoning, not feelings or emotions (the hypothetico-deductive process) and it is for this reason that other sources of knowledge are utilised in practice. Byrne *et al.* (2008), in their narrative on the ethics of delivery room resuscitation, conclude that, in conjunction with agreed guidelines, parents’ views should always be included when making decisions about resuscitation of the newborn.

From the discussion above, it is apparent that decisions made in clinical practice are based on several forms of evidence. Payot *et al.* (2007) describe in their

qualitative study how parents and neonatologists may work together to engage in decision-making about whether or not to resuscitate extremely preterm infants. The findings conclude that the key to arriving at a consensual decision is based on negotiation and taking into account knowledge in diagnostic information and treatment from neonatologists and knowledge from the families who are experts in their own family history, family roots, philosophy and ways of life.

Practice-based evidence/nursing-based evidence

The above discussion has attempted to reinforce the notion that evidence used to inform clinical decision-making in practice is derived from several sources. Earlier in this chapter the concepts of evidence-based medicine, evidence-based practice and evidence-based nursing were discussed. More recent literature describes two other ways that nurses may gain knowledge to underpin practice.

The first is from Girard (2008) who describes an alternative concept; that of *practice-based evidence* (PBE). This differs from EBM/EBP/EBN in that it recognises the individuality of each patient, stating that not every patient reacts to an intervention or care pathway as anticipated. She argues that while EBP utilises the best evidence to make decisions about care, it does not necessarily include the patient in any care plan. As discussed earlier, the gold standard of EBP is the randomised controlled trial, but Girard warns that it can lead to the conclusion that there is only one best treatment or cure. This is not always the case as, while the intervention may be the most effective in trials, it may not be the most acceptable treatment to the patient because of side effects, etc. Byrne *et al.* (2008) in their study of the ethics of delivery-room resuscitation discuss the problems of decision-making when resuscitating babies, particularly extremely preterm babies on the borderline of viability. They describe the problems with current available evidence and suggest that professionals are not always receptive to taking parents' views into account, tending to rely on statistical data instead even though it is not always accurate and predictive. Shieh (2006) describes turning her day-to-day experiences into evidence by generating ideas directly from practice experience working with women with perinatal drug abuse problems. She demonstrates that by listening to clients' views and narratives of their experiences, practice can be modified and improved health care delivery achieved. She concludes her article by stating that 'research and practice should be intertwined, one complementing the other' (Shieh 2006, p. 378).

The second concept is one offered from the speciality of mental health nursing by Geanellos (2004): *nursing-based evidence*. Geanellos argues that mental health nursing has historically relied on other disciplines to provide knowledge to develop practice. She suggests that nursing needs to establish its legitimacy by articulating a distinct contribution to health care. Comparisons to neonatal nursing can be made here in that there is a tendency to place emphasis on quantitative research derived from medical researchers as a source of evidence to underpin practice. In this paradigm, Geanellos proposes that by using the

bio-medical model as a source of evidence in isolation, patients' health care is perceived as a series of problems to be reduced, objectified, researched and cured. An important aspect of neonatal nursing, however, is communicating with families and attempting to provide meaningful care by understanding the 'lived experience' of having a baby in a neonatal unit. This can only be achieved by obtaining knowledge from the families using qualitative research methodologies and learning from previous experience.

Jenicek (2006) provides an interesting summary of variations on a theme of 'evidence-based medicine':

- faith-based medicine (belief and trust in something);
- experience-based medicine (increase in knowledge and skills over time);
- conviction-based medicine (based on firmly held opinions and beliefs);
- big-heart-based medicine (as dictated by the doctor's own compassion and empathy);
- gut feeling-based medicine (as instinctive and intuition-driven understanding and decision-making);
- authority-based medicine (enforced by rules).

Conclusion

This chapter has explored differing forms of evidence used in day-to-day nursing practice. Hierarchies of evidence have been identified and other less utilised sources of evidence discussed. The aim of this chapter is to encourage reflection on where knowledge is obtained to underpin nursing practice and further explore the concept of evidence-based practice in relation to neonatal care. In summary, evidence for practice may be derived from several sources; the most frequently utilised sources are as follows:

- propositional knowledge (e.g. research);
- knowledge gained through practice experience (incorporating intuitive practice and reflecting on practice);
- knowledge from parents and carers (individual narratives or a composition of differing experiences).

Websites and books may also be used as sources of evidence; it is important, however, that the reader checks the writer's source of evidence and acknowledges their strengths and weaknesses. Guidelines and protocols are also to be found in most neonatal units – these too should be underpinned by appropriate evidence and regularly updated. Whatever the source of evidence used for practice, it is essential to be able to critically analyse the material and not take it at face value.

Other chapters in this book will demonstrate how differing forms of evidence are used to inform day-to-day neonatal practice. Scrutiny of each reference list provided will demonstrate how many differing sources of evidence each author

has used. I conclude this chapter by reiterating what I stated in the first edition of this publication: ‘Neonatal Nurses have a wealth of experiential and personal knowledge which should be utilised and disseminated amongst their peers’ (Allan 2000, p. 10). It is hoped that this chapter has demonstrated that this source of evidence is valuable and, if used in conjunction with propositional knowledge, can truly contribute to the package of ‘evidence-based neonatal nursing practice’.

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6 Chapter 6 Management of Respiratory Disorders

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S I M O N J O L L Y E A N D D A V I D S U M M E R S

7 Chapter 7 Management of Cardiovascular Disorders

R O S A R I E L O M B A R D Case study: cardiovascular management Jane was delivered by spontaneous vaginal delivery at 30 weeks' gestation following premature rupture of membranes. The pregnancy was, otherwise, uneventful. Apgars 8 at 1 minute; 9 at 5 minutes. She was transferred to NNU. A partial septic screen was performed for prolonged rupture of membranes and grunting at 10 minutes of age. She was placed on to nasal continuous positive airway pressure (CPAP) in 28 per cent oxygen and commenced on intravenous (IV) benzylpenicillin and gentamicin. IV maintenance fluids were commenced and on day 1 nasogastric feeding of expressed breast milk was commenced. Jane appeared relatively stable until day 3 when her oxygen requirement increased to 45 per cent and she started having profound desaturations and apnoeas. She had increased work of breathing. On examination, a loud murmur was audible, loudest at the left upper costal margin. Q.1. What is the possible diagnosis? Q.2. What is the differential diagnosis? Jane was intubated and ventilated due to a profound apnoea. Her feeding was stopped and IV fluids were given at 120ml/kg/day. A chest X-ray was done and this showed bilateral hazy lung fields with cardiomegaly. An ECHO was performed and this showed a large patent ductus arteriosus. Q.3. What treatment options are available for treatment of the PDA? A decision was made to treat the PDA with ibuprofen. Q.4. What specific nursing observations are required for caring for Jane during treatment? Q.5. What physiological and/or clinical measures would halt treatment? Jane completed her course of ibuprofen but still continued to have a PDA. An ECHO showed that it was still patent. Q.6. What treatment options would you consider next? Archer, N. (2005) 'Cardiovascular disease', in J.M. Rennie (ed.) *Roberton's Textbook of Neonatology*, 4th edn, Philadelphia, PA: Elsevier Churchill Livingstone. A rlettaz, R., Archer, N. and Wilkinson, A.R. (1998) 'Natural history of innocent heart murmurs in newborn babies: controlled echocardiographic study', *Archives of Disease in Childhood: Fetal and Neonatal Edition* 78: F166-F170. BAPM (1998) Report of the Second Working Group of the British Association of Perinatal Medicine : Guidelines for Good Practice in the Management of Neonatal Respiratory Distress Syndrome , London: British Association of Perinatal Medicine. Barrington, K.J. and Finer, N.N. (2007) 'Inhaled nitric oxide for preterm infants: a systematic review', *Pediatrics* 120: 5, 1008. Bell, S.G. (1998) 'Neonatal cardiovascular pharmacology', *Neonatal Nursing* 17(20): 7-15. Blackburn, S.T. (2007) *Maternal Fetal, and Neonatal*

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9 Chapter 9 Management of Haematological Disorders

J A C K I E D E N T A N D K A T I E M C K E N N A

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K A Y E S P E N C E

11 Chapter 11 Fluid and Electrolyte Balance

DEEBERESFORD AND GLENNYSCONNOLLY

Y Following admission to NICU, he developed persistent seizures which required ventilatory support and anticonvulsant therapy. He is currently prescribed 60ml/kg of IV 10 per cent dextrose. A diagnosis has been made of grade three hypoxic-ischaemic encephalopathy. The following results are obtained: Sodium 122mmol/l Urea 2.0mmol/l Potassium 3.9mmol/l Creatinine 55µmol/l Calcium 2.0mmol/l Plasma osmolality 275mosmol/l Magnesium 0.7mmol/l Urine osmolality 320mosmol/l Phosphate 1.6mmol/l Glucose 2.0mmol/l

Q.1. What are the areas of concern within this result? Q.2. What are the contributing factors to this situation? Q.3. What plan of action is necessary to correct this situation? Q.4. What observations does Edward require?

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12 Chapter 12 Nutritional Management of the Infant in NICU

K A Y E S P E N C E Case study: nutritional requirements of a term infant with a congenital heart defect Maggie was born at term to a 38-year-old woman. At birth Maggie's Apgar scores were 6 and 8 at one and five minutes. During a breastfeed on the postnatal ward Maggie's mother noticed that she became blue. On examination a heart murmur was present. Further investigation revealed Maggie had a congenital heart defect. She was transferred to NICU and was scheduled for surgery later in the day. Maggie tolerated her surgery well and was extubated and nursed in an open care system. One week following surgery Maggie remained nil by mouth, had an oro-gastric tube in place and was having 3ml of aspirate every 4 hours. Her mother asked if she could breastfeed Maggie as she had been expressing regular volumes of milk. Answer the questions below giving a rationale for your choices based on the evidence in the chapter. Q.1. How does Maggie's disease affect her nutritional needs? Q.2. How should Maggie be fed? Q.3. Are there any contributory factors that may complicate Maggie's progression with oral feeds? Q.4. What assistance may her mother find beneficial? Bombell, S. and McGuire, W. (2008) 'Delayed introduction of progressive enteral feeds to prevent necrotising enterocolitis in very low birth weight infants', Cochrane Database of Systematic Reviews, Issue 2, Art. No. CD001970.DOI: 10.1002/14651858.CD001970.pub 2. Braun, M.A. and Palmer, M.M. (1986) 'A pilot study of oral-motor dysfunction in at-risk infants', Physical and Occupational Therapy in Pediatrics 5: 13-25. Byrne, B. and Hull, D. (1996) 'Breast milk for preterm infants', Professional Care of Mother and Child 6(2): 39-45. Collins, C.T., Makrides, M. and McPhee, A.J. (2003) 'Early discharge with home support of gavage feeding for stable preterm infants who have not established full oral feeds', Cochrane Database of Systematic Reviews, Issue 4, Art. No. CD003743.DOI: 10.1002/14651858.CD003743. Collins, C.T., Makrides, M., Gillis, J. and McPhee, A.J. (2008) 'Avoidance of bottles during the establishment of breast feeds in preterm infants', Cochrane Database of Systematic Reviews, Issue 4, Art. No. CD005252.DOI: 10.1002/14651858.CD005252.pub 2. Consensus Recommendations (2005) 'Summary of reasonable nutrient intakes for preterm infants', in R. Tsang, R. Uauy, B. Koletzko and S. Zlotkin (eds) Nutrition of the Preterm Infant: Scientific Basis and Practical Guidelines, Cincinnati, OH: Digital Publishing Inc, pp. 415-16. Cry Tan-Dy and Ohlsson, A. (2005) 'Lactase treated feeds to promote growth and feeding tolerance in preterm infants', Cochrane Database of Systematic Reviews, Issue

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G L E N Y S C O N N O L L Y

14 Chapter 14 Diagnostic and Therapeutic Procedures

E L I Z A B E T H H A R L I N G A N D G L E N Y S C O N
N O L L Y

15 Chapter 15 Neonatal Anaesthesia

BEVERLEY GUARD, LIAMBRENNAN AND
RACHEL HOMER Case study: premature infant with
necrotising enterocolitis Holly is a 9-week-old infant who
was born at 26 weeks' gestation. She required ventilation
for six weeks and is still receiving nasal CPAP. Over the
past 48 hours her condition has deteriorated with abdominal
distension, increasing oxygen requirements and deranged
blood-clotting indices. A presumptive diagnosis of
necrotising enterocolitis has been made and she now
requires a laparotomy at the regional paediatric surgical
centre 40 miles away. Q.1. What additional ventilatory
support is likely to be required for transport of this
infant? Q.2. What blood products will need to be ordered
prior to her going to theatre? Q.3. What are the problems
for the anaesthetist in the intra-operative management of
this case? Q.4. Is any special monitoring required in the
post-operative period? Q.5. What methods may be used to
provide adequate pain relief in the post-operative period?

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16 Chapter 16 Neonatal Surgery

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S T E V I E B O Y D A N D A N N E A S P I N

17 Chapter 17 Neonatal Transport

STEVE BOYD AND ANN MITCHELL

18 Chapter 18 Medication in the Newborn

CATHERINE HALL AND PETER MULHOLL
A N D Day 4 Hyponatraemic dehydration, sodium = 160mmol/l.
Day 5 Abdominal distension, bile-stained aspirates. Further investigations revealed necrotising enterocolitis. Q.1. What factors do you need to consider when prescribing medication for a baby born at 24 weeks' gestation? Q.2. Which of the medicines prescribed warrant special monitoring? Would this present any problems? Q.3. The baby suffered from hyponatraemic dehydration. Would this affect the likelihood of toxicity developing with any of the medication? Q.4. Could any of the antibiotics prescribed be given orally? What are the important points to consider?

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