Neonatal Guidelines 2015–17

The Bedside Clinical Guidelines Partnership
in association with the

Staffordshire, Shropshire & Black Country
Newborn and Maternity Network

Southern West Midlands Maternity and
Newborn Network

NHS

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COMMONLY USED ABBREVIATIONS • 1/2

ACTH	Adrenocorticotrophic hormone
aEEG	Cerebral function monitoring
ALT	Alanine aminotransferase
APTT	Activated partial thromboplastin time
ASD	Atrial septal defect
AST	Aspartate aminotransferase
AVSD	Atrioventricular septal defect
BAPM	British Association of Perinatal Medicine
BCG	Bacille Calmette-Guerin
BiPAP	Biphasic CPAP
BPD	Bronchopulmonary dysplasia
CAMT	Congenital amegakaryocytic thrombocytopenia
CCAM	Congenital cystic adenomatoid malformation
CDH	Congenital dislocation of hips or congenital diaphragmatic hernia
CH	Congenital hypothyroidism
CHD	Congenital heart disease
CLD	Chronic lung disease
CMPI	Cow's milk protein intolerance
CMV	Cytomegalovirus
CNS	Central nervous system
CoNS	Coagulase-negative staphylococcus
CPAP	Continuous positive airway pressure
CRP	C-reaction protein
CVS	Cardiovascular
DCT	Direct Coombs' test
DDH	Developmental dysplasia of the hip
DEBM	Donor expressed breast milk
DHEA	Dihydroepiandrostenedione
dHT	Dihydrotestosterone
DIC	Disseminated intravascular coagulation
DSD	Disorders of sexual development
EBM	Expressed breast milk
ECG	Electrocardiogram
EDD	Expected date of delivery
EFM	Electronic fetal monitoring
ETT	Endotracheal tube
EUT	Extrauterine transfer
FFP	Fresh frozen plasma
GBS	Group B streptococcus
GGT	Gamma-glutamyl transaminase
GLUT 1	Glucose transporter defect
GOR	Gastro-oesophageal reflux
HCG	Human chorionic gonadotropin
Hct	Haematocrit
HCV	Hepatitis C virus
HFNC	High flow nasal cannulae
HFOV	High frequency oscillatory ventilation
HIE	Hypoxic ischaemic encephalopathy
HIV	Human immunodeficiency virus
HLHS	Hypoplastic left heart syndrome
HSV	Herpes simplex virus
HTLV	Human T-cell lymphotropic virus
ICCP	Integrated comfort care pathway
IMD	Inherited metabolic disorders
IUGR	Intrauterine growth retardation
iNO	Inhaled nitric oxide
IPPV	Intermittent positive pressure ventilation
IUT	In-utero blood transfusion or in-utero transfer
IVC	Inferior vena cava
IVH	Intraventricular haemorrhage
IVIG	Intravenous immunoglobin
LHRH	Luteinizing hormone releasing hormone
LV	Left ventricular
LVOT	Left ventricular outflow tract
MAP	Mean airway pressure or mean arterial pressure
MCADD	Medium chain acyl co-A dehydrogenase deficiency
MDT	Multidisciplinary team
MEBM	Mother's expressed breast milk
MSUD	Maple syrup urine disease
NAIT	Neonatal allo-immune thrombocytopenia
NEC	Necrotising enterocolitis
NGT	Nasogastric tube
NHSP	Newborn Hearing Screening Programme
NKHG	Non-ketotic hyperglycinaemia
NICU	Neonatal intensive care unit
NNU	Neonatal unit
NPSA	National Patient Safety Agency

COMMONLY USED ABBREVIATIONS • 2/2

NTS	Neonatal Transport Service
OI	Oxygenation index
OPS	Oropharyngeal secretions
PAT	Pain assessment tool
PCOS	Polycystic ovary syndrome
PCR	Polymerase chain reaction
PDA	Patent ductus arteriosus
PEEP	Positive end expiratory pressure
PFO	Patent foramen ovale
PIH	Pregnancy-induced hypertension
PIP	Peak inspiratory pressure
PIPP	Premature infant pain profile
PKU	Phenylketonuria
PN	Parenteral nutrition
PPHN	Persistent pulmonary hypertension of the newborn
PROM	Pre-labour rupture of membranes
PT	Prothrombin time
PTV	Patient triggered ventilation
PVL	Periventricular Leukomalacia
PVR	Pulmonary venous return
RDS	Respiratory distress syndrome
ROP	Retinopathy of prematurity
RVH	Right ventricular hypertrophy
SANDS	Stillbirth and Neonatal Death Society
SaO_2/SpO_2	Arterial/peripheral oxygen saturation
SGA	Small for gestational age
SIMV	Simultaneous intermittent mandatory ventilation
SPA	Supra-pubic aspiration
SSRI	Selective serotonin reuptake inhibitor
SVC	Superior vena cava
SVT	Supraventricular tachycardia
TAR	Thrombocytopenia Absent Radii
T_e	Expiratory time
TEW	Transepidermal water
TGA	Transposition of the great arteries
THAM	Trometamol
T_i	Inspiratory time
TTV	Targeted tidal volume
TPN	Total parenteral nutrition
UAC	Umbilical artery catheter
UVC	Umbilical vein catheter
VSD	Ventricular septal defect
VLBW	Very low birth weight
V_t	Tidal volume
VZIG	Varicella Zoster immune globulin
VZV	Varicella-zoster virus
WCC	White cell count

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PREFACE • 1/2

This book has been compiled as an aide-memoire for all staff concerned with the management of neonates, to work towards a more uniform standard of care across the Staffordshire, Shropshire and Black Country and Southern West Midlands Newborn and Maternity Networks' hospitals. Further copies of the book are available to purchase from the Staffordshire, Shropshire and Black Country Newborn and Maternity Network at:
http://www.networks.nhs.uk/nhs-networks/staffordshire-shropshire-and-black-country-newborn/neonatal-guidelines

These guidelines have been drafted with reference to published medical literature and amended after extensive consultation. Wherever possible, the recommendations made are evidence based. Where no clear evidence has been identified from published literature the advice given represents a consensus of the expert authors and their peers and is based on their practical experience.

No guideline will apply to every patient, even where the diagnosis is clear-cut; there will always be exceptions. These guidelines are not intended as a substitute for logical thought and must be tempered by clinical judgement in the individual patient and advice from senior colleagues.

The guidelines are advisory, NOT mandatory

Prescribing regimens and nomograms

The administration of certain drugs, especially those given intravenously, requires great care if hazardous errors are to be avoided. These guidelines do not include comprehensive guidance on the indications, contraindications, dosage and administration for all drugs. Please refer to the **Neonatal Unit's preferred formulary; either the Neonatal Formulary: Drug Use in Pregnancy and the First Year of Life, 7th Edition 2014,** or the **BNF for Children September 2015** available at: http://www.medicinescomplete.com/mc/bnfc/current/ Adjust doses as necessary for renal or hepatic impairment.

Practical procedures

DO NOT attempt to carry out any of these procedures unless you have been trained to do so and have demonstrated your competence.

Legal advice

How to keep out of court:

- Write the patient's name and unit number on the top of each side of paper
- Time and date each entry
- Sign and write your name legibly after every entry
- Document acknowledgement of results of all investigations (including radiology)
- Document all interactions including discussions with parents (and who was present)

Supporting information

Where possible the guidelines are based on evidence from published literature. It is intended that evidence relating to statements made in the guidelines and its quality will be made explicit.

Where supporting evidence has been identified it is graded I to V according to standard criteria of validity and methodological quality as detailed in the table below. A summary of the evidence supporting each statement is available, with the original sources referenced (intranet/internet only). The evidence summaries are developed on a rolling programme which will be updated as the guideline is reviewed.

Level of evidence	Strength of evidence
I	Strong evidence from at least one systematic review of multiple well-designed randomised controlled trials
II	Strong evidence from at least one properly designed randomised controlled trial of appropriate size
III	Evidence from well-designed trials without randomisation, single group pre-post, cohort, time series or matched case-control studies
IV	Evidence from well-designed non-experimental studies from more than one centre or research group
V	Opinions of respected authorities, based on clinical evidence, descriptive studies or reports of expert committees

JA Muir-Gray from Evidence Based Healthcare, Churchill Livingstone London 1997

Evaluation of the evidence-base of these guidelines involves review of existing literature then periodical review of anything else that has been published since the last review. The editors encourage you to challenge the evidence provided in this document. If you know of evidence that contradicts, or additional evidence in support of the advice given in these guidelines, please forward it to the Clinical Guidelines Developer/Co-ordinator, bedsideclinicalguidelines@uhns.nhs.uk or Dr Kate Palmer (Kate.palmer@uhns.nhs.uk).

Evidence-based developments for which funding is being sought

As new treatments prove more effective than existing ones, the onus falls upon those practising evidence-based healthcare to adopt best practice. New treatments are usually, but not always, more expensive. Within the finite resources of each Trust and of the NHS as a whole, adoption of these treatments has to be justified in terms of the improvements they will bring to the quality or cost-effectiveness of care. The priorities for funding new areas of treatment and patient care will be determined at Trust level.

Feedback and new guidelines

The Bedside Clinical Guidelines Partnership, the Staffordshire, Shropshire and Black Country and Southern West Midlands Newborn and Maternity Networks have provided the logistical, financial and editorial expertise to produce the guidelines. These guidelines have been developed by clinicians for practice based on best available evidence and opinion. Any deviation in practice should be recorded in the patient's notes with reasons for deviation. The editors acknowledge the time and trouble taken by numerous colleagues in the drafting and amending of the text. The accuracy of the detailed advice given has been subject to exhaustive checks. However, any errors or omissions that become apparent should be drawn to the notice of the editors, via the Clinical Guidelines Developer/Co-ordinator, bedsideclinicalguidelines@uhns.nhs.uk or Dr Kate Palmer (Kate.palmer@uhns.nhs.uk), so that these can be amended in the next review, or, if necessary, be brought to the urgent attention of users. Constructive comments or suggestions would also be welcome.

There are still many areas of neonatal care which are not included: please submit new guidelines as soon as possible for editorial comment.

For brevity, where the word 'parent(s)' is read, this means mothers, fathers, guardians or others with parental care responsibilities for babies.

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RECOGNITION AND ASSESSMENT

Definition

Neonatal withdrawal/abstinence syndrome

- Symptoms evident in babies born to opiate-dependent mothers and mothers on other drugs associated with withdrawal symptoms (generally milder with other drugs)

Timescale of withdrawal

- Signs of withdrawal from opiates (misused drugs, such as heroin) can occur <24 hr after birth
- Signs of withdrawal from opioids (prescribed drugs, such as methadone) can occur 3–4 days after birth, occasionally up to 2 wk after birth
- Multiple drug use can delay, confuse and intensify withdrawal signs in the first weeks of life

Minor signs

- Tremors when disturbed
- Tachypnoea (>60/min)
- Pyrexia
- Sweating
- Yawning
- Sneezing
- Nasal stuffiness
- Poor feeding
- Regurgitation
- Loose stools
- Sleeping <3 hr after feed (NB: usual among breastfed babies)

Major signs

- Convulsions
- Profuse vomiting or diarrhoea
- Inability to co-ordinate sucking, necessitating introduction of tube feeding
- Baby inconsolable after 2 consecutive feeds

AIMS

- To identify withdrawal symptoms following birth
- To give effective medical treatment where necessary
- To promote bonding and facilitate good parenting skills
- To support and keep baby comfortable during withdrawal period
- To optimise feeding and growth
- To identify social issues and refer to appropriate agencies

ANTENATAL ISSUES

- Check maternal hepatitis B, hepatitis C and HIV status and decide on management plan for baby

Check maternal healthcare record for case conference recommendations and discuss care plan for discharge with drug liaison midwife

Management of labour

- Make sure you know:
  - type and amount of drug(s) exposure
  - route of administration
  - when last dose was taken
- Neonatal team are not required to be present at delivery unless clinical situation dictates

IMMEDIATE TREATMENT

Delivery

- **Do not give naloxone** (can exacerbate withdrawal symptoms)

- Care of baby is as for any other baby, including encouragement of skin-to-skin contact and initiation of early breastfeeding, if this is mother's choice – see **Breastfeeding** guideline

After delivery

- Transfer to postnatal ward/transitional care and commence normal care
- Admit to neonatal unit only if there are clinical indications
- Keep babies who are not withdrawing, feeding well and have no child protection issues with their mothers in postnatal ward/transitional care
- Babies who are symptomatic enough to require pharmacological treatment usually require admission to neonatal unit
- Start case notes
- Take a detailed history, including:
- social history, to facilitate discharge planning
- maternal hepatitis B, hepatitis C and HIV status
- Ensure postnatal baby check and daily review by paediatrician

As symptoms of withdrawal can be delayed, keep baby in hospital for at least 4 days

SUBSEQUENT MANAGEMENT

- Aims of managing a baby at risk of neonatal drug withdrawal are to:
- maintain normal temperature
- reduce hyperactivity
- reduce excessive crying
- reduce motor instability
- ensure adequate weight gain and sleep pattern
- identify significant withdrawal requiring pharmacological treatment
- Ensure baby reviewed daily by neonatal staff
- For babies with minor signs, use non-pharmacological management (e.g. swaddling)
- Start pharmacological treatment (after other causes excluded) if there is:
- recurrent vomiting
- profuse watery diarrhoea
- poor feeding requiring tube feeds
- inconsolability after 2 consecutive feeds
- seizures
- The assessment chart (see below) aims to reduce subjectivity associated with scoring systems
- When mother has been using an opiate or opioid, a morphine derivative is the most effective way to relieve symptoms
- When there has been multiple drug usage, phenobarbital may be more effective

Opioids

- If authorised by experienced doctor/ANNP start morphine 40 microgram/kg oral 4-hrly. In rare cases, and after discussion with consultant, it may be necessary to increase dose by 10 microgram/kg increments
- If baby feeding well and settling between feeds, consider doubling dose interval and, after 48 hr, reducing dose by 10 microgram/kg every 48 hr. If major signs continue, discuss with experienced doctor/ANNP
- Consider need for other medication (e.g. phenobarbital)

Phenobarbital

- For treatment of seizures and for babies of mothers who are dependent on other drugs in addition to opiates and are suffering serious withdrawal symptoms, give phenobarbital 20 mg/kg IV loading dose over 20 min, then maintenance 4 mg/kg oral daily

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- Unless ongoing seizures, give a short 4–6 day course
- For treatment of seizures, see **Seizures** guideline

Chlorpromazine

- For babies of mothers who use benzodiazepines, give chlorpromazine 1 mg/kg oral 8-hrly if showing signs of withdrawal
- remember chlorpromazine can reduce seizure threshold

Breastfeeding

- Unless other contraindications co-exist or baby going for adoption, strongly recommend breastfeeding – see **Breastfeeding** guideline
- Support mother in her choice of feeding method
- Give mother all information she needs to make an informed choice about breastfeeding
- Drugs of misuse do not, in general, pass into breast milk in sufficient quantities to have a major effect in newborn baby
- Breastfeeding will certainly support mother in feeling she is positively comforting her baby, should he/she be harder to settle

Infections

- Follow relevant guidelines for specific situations, such as HIV, hepatitis B or hepatitis C positive mothers – see **HIV** guideline and **Hepatitis B and C** guideline
- Give BCG immunisation where indicated – see **BCG immunisation** guideline

ASSESSMENT CHART

- Chart available for download from Staffordshire, Shropshire and Black Country Newborn Network website: http://www.networks.nhs.uk/nhs-networks/staffordshire-shropshire-and-black-country-newborn/documents/Abstinence%20ASSESSMENT_CHART.pdf/view?searchterm=abstinence
- Local severity assessment/score charts may be used
- Aim of treatment is to reduce distress and control potentially dangerous signs
- Minor signs (e.g. jitters, sweating, yawning) do **not** require treatment

Has baby been inconsolable with standard comfort measures (cuddling, swaddling, or non-nutritive sucking) since last feed, had profuse vomiting or loose stools, had an unco-ordinated suck requiring tube feeds or had seizures?

Place a tick in yes or no box (do not indicate any other signs in boxes)

Date						
Time	04:00	08:00	12:00	16:00	20:00	24:00
Yes						
No						

DISCHARGE AND FOLLOW-UP

Babies who required treatment

- Ensure discharge planning involving:
  - social worker (may not be needed if prescribed for pain relief and no other concerns)
  - health visitor
  - community neonatal team if treated at home after discharge
  - drug rehabilitation team for mother
- If seizures occurred or treatment was required, arrange follow-up in named consultant's clinic or as per local protocol

Babies who did not require treatment

- If no signs of withdrawal, discharge at day 5
- Arrange follow-up by GP and health visitor and advise referral to hospital if there are concerns
- Clarify the need for any ongoing social services involvement

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ADMISSION TO NEONATAL UNIT (NNU) • 1/2

- There should be good clinical reasons for admission to NNU
- Avoid unnecessary separation of mother and baby as it affects maternal bonding

Please ensure that all babies born have NIPE (Newborn Infant Physical Examination) between 6–72 hr of birth

CRITERIA FOR ADMISSION FROM LABOUR WARD OR POSTNATAL WARD

Discuss need for admission with senior medical staff

- Clinical condition requiring constant monitoring, <34 weeks' gestation or birth weight <1800 g
- Unwell baby:
  - poor condition at birth requiring prolonged resuscitation for >10 min and/or cord pH<7.0 (a low cord pH may not in itself necessitate an admission to NNU)
  - respiratory distress or cyanosis
  - apnoeic or cyanotic attacks
  - signs of encephalopathy
  - jaundice needing intensive phototherapy or exchange transfusion
  - major congenital abnormality likely to threaten immediate survival
  - seizures
  - inability to tolerate enteral feeds with vomiting and/or abdominal distension and/or hypoglycaemia (blood glucose <2.6 mmol/L)
  - symptomatic hypoglycaemia or hypoglycaemia not responding to treatment – see **Hypoglycaemia** guideline
- Neonatal abstinence syndrome requiring treatment – see **Abstinence syndrome** guideline
- Mother admitted to ITU

Procedure

- Deal with any immediate life-threatening clinical problems (e.g. airway, breathing, circulation and seizures)
- Show baby to parents and explain reason for admission to NNU
- Inform NNU nursing staff that you wish to admit a baby, reason for admission and clinical condition of baby
- Inform middle grade doctor and/or consultant
- Ensure baby name labels present
- Document relevant history and examination
- Complete problem sheets and investigation charts (follow local guidelines)
- Measure and plot birth weight and head circumference on growth chart
- Measure admission temperature
- Measure blood pressure using non-invasive cuff
- Institute appropriate monitoring and treatment in conjunction with nursing and senior medical colleagues

Investigations

For babies admitted to the NNU, obtain 1 bloodspot on newborn bloodspot screening (Guthrie) card

Babies <32 weeks/1500 g weight/unwell/ventilated

- FBC
- Blood glucose
- Blood gases
- Clotting screen if clinically indicated - see **Coagulopathy** guideline
  - routine clotting screens in all babies <30 weeks' gestation is not recommended
- If respiratory symptoms or support, chest X-ray

- If umbilical lines in place, abdominal X-ray
- If suspicion of sepsis, blood culture and CRP before starting antibiotics and consider lumbar puncture (see **Infection in the first 72 hours** guideline)

Other babies

- Decision depends on initial assessment and suspected clinical problem (e.g. infection, jaundice, hypoglycaemia etc.) see relevant guidelines

IMMEDIATE MANAGEMENT

- Evaluation of baby, including full clinical examination
- Define appropriate management plan and procedures in consultation with middle grade doctor and perform as efficiently as possible to ensure baby is not disturbed unnecessarily
- Aim for examination and procedures to be completed within 1 hr of admission
- If no contraindications, unless already administered, give Vitamin K – see **Vitamin K** guideline
- If antibiotics appropriate, give within 1 hr
- Senior clinician to update parents as soon as possible (**certainly within 24 hr**) and document discussion in notes

Respiratory support

- If required, this takes priority over other procedures
- include incubator oxygen, high-flow humidified oxygen, continuous positive airway pressure (CPAP) or mechanical ventilation

Intravenous access

- If required, IV cannulation and/or umbilical venous catheterisation (UVC) – see appropriate guidelines in **Practical procedures** section

MONITORING

Use minimal handling

- Cardiorespiratory monitoring through skin electrodes. **Do not use** in babies <26 weeks' gestation
- Pulse oximetry. Maintain SpO_2 as per gestation target values (see **Oxygen saturation targets** guideline)
- Transcutaneous probe for T_cPO_2/T_cPCO_2, if available
- Temperature
- Blood glucose
- If ventilated, umbilical arterial catheterisation/peripheral arterial line for monitoring arterial blood pressure and arterial blood gas – see appropriate guideline in **Practical procedures** section

CRITERIA FOR ADMISSION TO TRANSITIONAL CARE UNIT

The following are common indications for admitting babies to transitional care unit (if available locally), **refer to local guidelines for local variations**

- Small for gestational age 1.7–2 kg and no other clinical concerns
- Preterm 34–36 weeks' gestation and no other clinical concerns
- Minor congenital abnormalities likely to affect feeding, e.g. cleft lip and palate
- Requiring support with feeding
- Babies of substance abusing mothers (observe for signs of withdrawal)
- Receiving IV antibiotics

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INTRODUCTION

Incidence of anorectal malformation (ARM) is 1 in 5,000 neonates. More common in boys. It can be associated with the other abnormalities including the VACTERL association, chromosomal abnormalities and duodenal atresia

Symptoms and signs

- ARM is present when either:
  - anus is not present (**Figure 1**)
  - bowel opens in the wrong position in the perineum (a fistula) (**Figure 2**)

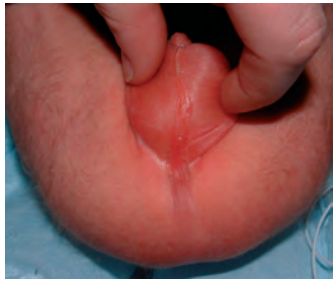

Figure 1: Anus is absent

- One or more of the following features may be present:
  - abnormal looking perineum
  - delayed or no passage of meconium
  - abdominal distension
  - bilious vomiting
  - drooling of saliva (if coexistent oesophageal atresia)

Examination

- Full physical examination. Look for:
  - dysmorphic features
  - cardiac anomalies
  - limb anomalies
  - abdominal distension
  - absence of anus **(Figure 1)**
  - abnormal position of bowel opening **(Figure 2)**. In girls, an abnormal opening may be seen at the vestibule
  - rarely (in girls): cloaca [1 opening in the perineum instead of 3 (urethra, vagina and anus)]

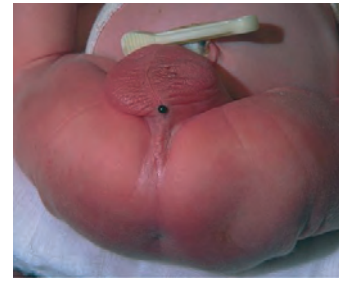

Figure 2: Fistula opening onto scrotal raphe

Caution

- The presence of meconium in the nappy **does not** exclude an ARM, as a neonate may still pass meconium through a fistula
- Always clean the perineum and establish that a normally sited anus is present

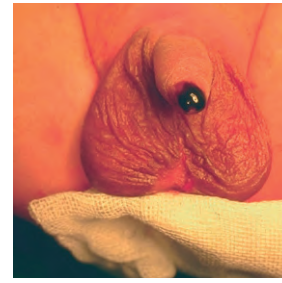

Figure 3: ARM with a fistula to the urinary tract

ANO-RECTAL MALFORMATION IN NNU BEFORE TRANSFER TO SURGICAL CENTRE • 2/2

MANAGEMENT

- Nil-by-mouth
- Insert a size 8 Fr nasogastric tube (NGT) and fix securely (see **Nasogastric tube insertion** guideline). Successful passage of an NGT excludes diagnosis of oesophageal atresia
- Empty stomach by aspirating NGT 4-hrly with a 5 mL syringe. Place NGT on free drainage by connecting to a bile bag
- Insert an IV cannula and obtain blood for FBC, U&E, glucose and blood cultures
- Start maintenance IV fluids (see **IV fluid therapy** guideline)
- Give broad spectrum antibiotics
- Give vitamin K IM (see **Vitamin K** guideline)
- Collect pre-transfusion bloodspot and send with baby to surgical centre
- Replace nasogastric losses mL-for-mL using sodium chloride 0.9% with 10 mmol potassium chloride in 500 mL IV
- Chest X-ray to confirm position of NGT and:
  - vertebral anomalies
  - abnormal cardiac outline
- Supine abdominal X-ray looking for:
  - dilated bowel/associated bowel atresia
  - vertebral anomalies
- A combined chest and abdominal X-ray is suitable as an alternative
- Take photographs for parents

Referral

- Refer to paediatric surgical team
- Obtain a sample of mother's blood for crossmatch. Handwrite form, completing all relevant sections and indicating this is the mother of the baby being transferred. Include baby's name
- Complete nursing and medical documentation for transfer and arrange electronic transfer of any X-rays taken. Ensure you have mother's name and telephone contact details (including ward details if she is still an in-patient). Surgeon will require verbal telephone consent if operation is required and a parent is not able to attend surgical unit at appropriate time
- Inform surgical unit staff when baby is ready for transfer. Have available: name, gestational age, weight, ventilatory and oxygen requirements (if applicable) and mother's name and ward (if admitted)

Useful Information

- http://www.bch.nhs.uk/content/neonatal-surgery
- http://www.bch.nhs.uk/find-us/maps-directions

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ANTENATAL ULTRASOUND ABNORMALITIES • 1/1

DEFINITION

- Any lesion identified antenatally in the fetus (e.g. renal pelvic dilatation, hypoplastic left heart)
- Any maternal factor identified antenatally that could affect the baby after delivery (e.g. anhydramnios from preterm prolonged rupture of membranes)

COUNSELLING BEFORE DELIVERY

- All affected pregnancies will have detailed individualised plans for management of baby by consultant neonatologist, including place of delivery
- As some lesions are progressive (e.g. hypoplastic left heart syndrome, gastroschisis), the situation can change and information from the obstetric team can alter over time. Discuss all affected pregnancies at the combined fetomaternal meeting until delivery
- Offer neonatal counselling to all women whose pregnancy has been affected by major lesions, to discuss the impact of the identified lesion on quality of life, including possible disabilities, investigations and surgery, and post-delivery plan

Cleft lip and/or palate

- Obstetric team to refer to regional multidisciplinary cleft palate team, who will counsel parents, communicate plans for delivery and provide postnatal support for baby

Hypoplastic left heart syndrome or other presumed duct-dependent lesions

- Obstetric team to refer to regional cardiac team, who will counsel parents and, where appropriate, confirm diagnosis and provide a plan of action

Congenital diaphragmatic hernia

- Obstetric team to refer all cases to tertiary fetal medicine team (Birmingham or Liverpool) who will counsel, monitor and arrange delivery

MANAGEMENT AFTER DELIVERY

- For minor lesions, such as renal pelvic dilatation, follow appropriate guideline and inform senior staff and parents
- For other lesions, follow written plan made by senior staff before delivery, including need to contact seniors and specialist staff in regional referral centre before and after delivery
- Communicate any new information obtained after birth to consultant as this may change the plan of care required
- Maintain regular contact with specialist teams as indicated by them
- Arrange postnatal transfer if required when bed available
- Keep parents informed of actions taken, and contact from specialist teams
- Consider syndrome for babies with >1 lesion, discuss with senior staff as soon as possible
- When available and if not issued antenatally, provide written information from 'Contact a family' book or www.cafamily.org.uk/

Specific lesions

See **Urinary tract abnormalities on ultrasound scan, Gastroschisis,** and **Congenital heart disease: duct dependent lesions** guidelines

RECOGNITION AND ASSESSMENT

Apnoea

Pause(s) in breathing for >20 seconds (or less, when associated with bradycardia or cyanosis)

Bradycardia

Heart rate <100/min, associated with desaturation

Types

- **Central**
  - caused by poorly developed neurological control
  - respiratory movements absent
- **Obstructive**
  - caused by upper airway obstruction, usually at pharyngeal level
  - respiratory movements continue initially but then stop
- **Mixed**
  - initially central, followed by obstructive apnoea

Significance

- Most babies born <34 weeks' gestation have primary apnoea of prematurity (PAP). Hence babies born <34 weeks should have SpO_2 monitoring until at least 34 weeks post conceptional age (PCA)
- multiple aetiologic factors can exacerbate apnoea in preterm babies
- sudden increase in frequency warrants immediate action
- Consider causes other than apnoea of prematurity if occurs:
  - in term or near-term baby (>34 weeks' gestation)
  - on first day after birth in preterm baby
  - onset of apnoea after 7 days of age in a preterm baby

Causes

- **Infection**
  - septicaemia
  - necrotising enterocolitis
  - meningitis
- **Respiratory**
  - inadequate respiratory support
  - upper airway obstruction
  - surfactant deficiency
- **CNS**
  - intracranial haemorrhage
  - seizure
  - congenital malformations
- **CVS**
  - patent ductus arteriosus
  - anaemia
- **GI**
  - gastro-oesophageal reflux
- **Other**
  - metabolic abnormalities, especially hypoglycaemia
  - haematological: anaemia
  - inherited metabolic disorders e.g. non-ketotic hyperglycinaemia

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MANAGEMENT

Terminate episode

- If apnoea not self-limiting, perform the following in sequence to try to terminate episode:
  - ensure head in neutral position
  - stimulate baby by tickling feet or stroking abdomen
  - if aspiration or secretions in pharynx suspected, apply brief oropharyngeal suction
  - face mask ventilation
  - emergency intubation
- Once stable, perform thorough clinical examination to confirm/evaluate cause

Screen for sepsis

- If apnoea or bradycardia increasingly frequent or severe, screen for sepsis as apnoea and bradycardia can be sole presenting sign

TREATMENT

- Treat specific cause, if present
- Primary apnoea of prematurity is a diagnosis of exclusion and may not require treatment unless pauses are:
  - frequent (>8 in 12 hr) or
  - severe (>2 episodes/day requiring positive pressure ventilation)

Pharmacological treatment

- Caffeine citrate 20 mg/kg loading dose oral/IV (over 30 min) followed, after 24 hr, by maintenance dose of 5 mg/kg oral/IV (over 10 min) once daily, increasing to 10 mg/kg if required until 34 weeks PCA
  - may continue beyond 34 weeks PCA if desaturations and bradycardias persist. If so review need for treatment regularly
- This dosing regime is recommended by BNF-C. Higher doses have been used with evidence that it reduces risk of failure of extubation in preterm babies

Non-pharmacological treatment

- CPAP, SiPAP/BiPAP – see **CPAP** guideline
- If above fails, intubate and ventilate

PERIPHERAL ARTERIAL LINES

INDICATIONS

- Frequent monitoring of blood gases
- Direct monitoring of arterial blood pressure
- Premature removal (or failure to site) an umbilical artery catheter (UAC)
- Exchange transfusion (peripheral venous and arterial catheters 'continuous' technique) or partial exchange transfusion

CONTRAINDICATIONS

- Bleeding disorder
- Inadequate patency of ulnar artery on transillumination or failed Allen's test (if cannulating radial artery) or vice-versa
- Pre-existing evidence of circulatory insufficiency in limb
- Local skin infection
- Malformation of upper extremity for radial arterial cannulation

Possible sites of arterial entry

- Radial (most commonly used): the only procedure discussed in this guideline
- Posterior tibial
- Dorsalis pedis
- Ulnar (usually only if ipsilateral radial artery cannulation has not been attempted)

EQUIPMENT

- Gloves
- Cleaning solution as per unit policy
- 24-gauge cannula
- T-connector with Luer lock
- Adhesive tape
- Splint
- Sodium chloride 0.9% flush in 2 mL syringe, primed through T-connector
- Transillumination fibre-optic light source
- 3-way tap

PROCEDURE USING RADIAL ARTERY

Preparation

- Wash hands
- Check patency of ipsilateral ulnar artery and proceed only if patent
- Put on gloves
- Extend baby's wrist with palm of hand upwards
- Transilluminate radial artery with fibre-optic light source behind baby's wrist **OR** palpate pulse
- Allen's test – for patency of ulnar artery
- Clean skin with antiseptic cleaning solution

Procedure

- Enter artery with 24-gauge cannula just proximal to wrist crease at 25–30º angle
- Remove stylet from cannula and advance cannula into artery
- Connect cannula to T-connector primed with sodium chloride 0.9%, and flush gently
- Secure cannula with tape, ensuring fingers are visible for frequent inspection, and apply splint
- Connect T-connector to infusion line (sodium chloride 0.9% with heparin 1 unit/mL), with 3-way tap *in situ* for blood sampling

Documentation

- Document clearly in notes all attempts at cannulation, including those that are unsuccessful

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AFTERCARE

Monitor

- Inspect distal digits regularly for circulatory status: if blanching does not recover after 5 min, remove line
- Avoid excessive hyperextension of wrist, as this can result in occlusion of artery
- Ensure a continuous pressure waveform tracing is displayed on monitor screen at all times: if flushing line does not restore lost tracing, change position of limb/dressing

Usage

- Do not administer rapid boluses of fluid as this can lead to retrograde embolisation of clot or air: use minimal volume when flushing after sampling and inject slowly
- Use cannula only for sampling or removal of blood during exchange transfusion, and infuse only sodium chloride 0.9% with heparin 1 unit/mL
- Remove cannula as soon as no longer required

Removal

- Aseptic removal of arterial line: apply pressure for at least 5 min (longer if coagulopathy/low platelets) until no bleeding or bruising
- dressings do not prevent bleeding or bruising
- do not send tip for culture routinely

COMPLICATIONS

- Thromboembolism/vasospasm/ thrombosis
- Blanching and partial loss of digits (radial artery)
- Necrosis
- Skin ulceration
- Reversible occlusion of artery
- Extravasation of sodium chloride infusate
- Infection (rarely associated with line infection)
- Haematoma
- Haemorrhage
- Air embolism

ARTERIAL LINE SAMPLING • 1/2

INDICATIONS

- Blood gas analysis
- Biochemical/and haematological investigations

CONTRAINDICATIONS

- Blood drawn from an arterial line may not be suitable for clotting studies (see **Coagulopathy** guideline and **Bloodspot screening** guideline)

COMPLICATIONS

Haemorrhage

- Ensure all connections are secure, Luer locks tight and 3-way taps appropriately adjusted

Infection

- Maintain sterile technique during sampling to reduce risk of infection

Artery spasm

- Limb appears blanched. Stop procedure and allow time for recovery. Warming of opposite limb can elicit reflex vasodilatation

Thromboembolism

- Flush catheter with 0.5 mL sodium chloride 0.9% each time sample taken. If catheter not sampling, clot formation may be in progress. Request urgent middle grade review of arterial line for a prompt decision about removal

Inaccuracy of blood gas results

- Analyse sample immediately. After blood is withdrawn from an artery, it continues to consume oxygen
- Excess heparin in syringe can result in a falsely low pH and $PaCO_2$. Remove excess heparin from syringe before obtaining sample
- Do not use if air bubbles in sample: take fresh specimen

EQUIPMENT

- Gloves
- Paper towel
- Alcohol swabs x 2
- Syringes
  - 2 mL syringe (A) for clearing line
  - 2 mL syringe (B) for other blood samples as necessary
  - 1 mL syringe (C) pre-heparinised for blood gas analysis
  - 2 mL syringe (D) containing 0.5–1 mL of sodium chloride 0.9%
- Appropriate blood sample bottles and request forms

PREPARATION AND PROCEDURE

Preparation

- Record SpO_2 and $TcCO_2$ at time of taking blood to allow comparison with blood gas if performed
- Wash hands and put on gloves
- Place paper towel beneath 3-way tap collection port (maintain asepsis by non-touch technique rather than sterile gloves and towel)
- Ensure 3-way tap closed to port hole

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Procedure

- Remove Luer lock cap, clean with alcohol swab and allow to dry, or prepare bioconnector
- Connect 2 mL syringe (A)
- Turn 3-way tap so it is closed to infusion and open to syringe and arterial catheter
- Withdraw 2 mL blood slowly. It must clear the dead space
- If bioconnector not being used, turn 3-way tap so it is closed to arterial catheter to prevent blood loss from baby
- if bioconnector used, do not turn 3-way tap until end of procedure
- Attach appropriate syringe (B/C) needed for required blood sample
- If bioconnector not being used, turn 3-way tap to open to syringe and arterial catheter and withdraw required amount of blood for blood samples. Do not withdraw more than required amount
- If bioconnector not being used, turn 3-way tap off to arterial catheter in between syringes B and C if both required, after taking required samples with syringes
- Reattach syringe (A)
- Clear the connection of air
- Slowly return to baby any blood in line not required for samples
- If bioconnector not being used, turn 3-way tap off to arterial catheter
- Attach syringe (D) of heparinised sodium chloride 0.9%
- If bioconnector not being used, turn 3-way tap so it is open to syringe and arterial line, clear line of air and slowly flush line to clear it of blood
- Turn 3-way tap so it is closed to syringe, remove syringe (D), swab port hole with alcohol wipe and cover with Luer lock cap
- Record amount of blood removed and volume of flush on baby's daily fluid record

AFTERCARE

- Ensure all connections tight and 3-way tap turned off to syringe port to prevent haemorrhage
- If sampling from umbilical arterial catheter (UAC), ensure lower limbs are pink and well perfused on completion of procedure
- If sampling from peripheral arterial line, check colour and perfusion of line site and limb housing arterial line
- Ensure line patency by recommencing infusion pump
- Before leaving baby, ensure arterial wave form present and all alarms set

BCG IMMUNISATION • 1/3

See also **Tuberculosis (Investigation and management following exposure in pregnancy)** guideline

INDICATIONS

- Born or living in an area where the notification rate of TB is >40/100,000 (including UK)
- A parent or grandparent born in a country where the notification rate of TB is ≥40/100,000
- Family history of TB in previous 5 yr
- Local policy to give BCG to all neonates in that area

Countries with incidence of TB >40/100,000

Afghanistan
Algeria
Angola
Armenia
Azerbaijan
Bangladesh
Belarus
Belize
Benin
Bhutan
Bolivia
Bosnia & Herzegovina
Botswana
Brazil
Brunei
Burkina Faso
Burundi
Cambodia
Cameroon
Cape Verde
Central African Republic
Chad
China
Congo
Congo DR
Côte d'Ivoire
Djibouti
Dominican Republic
Ecuador
Equatorial Guinea
Eritrea
Ethiopia
Gabon
Gambia
Georgia
Ghana
Greenland
Guam
Guatemala
Guinea
Guinea-Bissau
Guyana
Haiti
Honduras
Hong Kong
India
Indonesia
Iraq
Kazakhstan
Kenya
Kiribati
Korea DPR
Korea (Rep. of)
Kyrgyzstan
Lao PDR
Latvia
Lesotho
Liberia
Libya
Lithuania
Macao
Madagascar
Malawi
Malaysia
Maldives
Mali
Marshall Islands
Mauritania
Micronesia
Moldova
Mongolia
Morocco
Mozambique
Myanmar
Namibia
Nauru
Nepal
Niger
Nigeria
Pakistan
Panama
Papua New Guinea
Paraguay
Peru
Philippines
Qatar
Romania
Russia
Rwanda
Saudi Arabia
Senegal
Sierra Leone
Singapore
Solomon Islands
Somalia
South Africa
Sri Lanka
Sudan
South Sudan
Suriname
Swaziland
Tajikistan
Tanzania
Thailand
Timor-Leste
Togo
Turkmenistan
Tuvalu
Uganda
Ukraine
Uzbekistan
Vanuatu
Vietnam
Yemen
Zambia
Zimbabwe

https://www.gov.uk/government/publications/tuberculosis-tb-by-country-rates-per-100000-people

Parts of UK with incidence of TB >40/100,000

Brent
Ealing
Greenwich
Haringey
Harlow
Hillingdon
Hounslow
Leicester
Luton
Newham
Redbridge
Slough
Tower Hamlets
Waltham Forrest

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/358226/TB_Official_Statistics_230914.pdf

Tuberculin testing not necessary <6 yr old unless baby has been in recent contact with tuberculosis or has resided in high-incidence country for >3 months

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BCG IMMUNISATION • 2/3

See also **Tuberculosis (Investigation and management following exposure in pregnancy)** guideline

CONTRAINDICATIONS

- Temperature >38ºC
- Severe eczema (give at suitable lesion-free site)
- Neonate in household where an active TB case suspected or confirmed, see **Tuberculosis (Investigation and management following exposure in pregnancy)** guideline
- Immunodeficient or on high-dose corticosteroids
  - defer BCG until 3 months after stopping corticosteroids if given prednisolone 1 mg/kg/day for >3 weeks, 2 mg/kg/day for 1 week, (or equivalent doses of another corticosteroid, e.g. dexamethasone 0.2 mg = prednisolone 1 mg)
- HIV positive, living in UK
  - if mother HIV positive and exclusively formula feeding, give vaccine only after baby has had negative test for HIV after 3 months of age
  - if high risk of TB exposure and maternal HIV viral load <50 copies/mL after 36 weeks gestation, BCG can be given at birth
  - encourage maternal HIV testing but do not withhold BCG if mother declines testing unless mother from sub-Saharan Africa in which case refer to HIV team for counselling about testing

SPECIAL CASES

- No need to delay routine vaccinations
- BCG can be given simultaneously with other vaccines [including palivizumab (Synagis)] but not in same arm
- no further immunisation should be given in the arm used for BCG immunisation for at least 3 months due to risk of regional lymphadenitis
- if not given at same time, leave 4 weeks before giving other live vaccines

EQUIPMENT

- Alcohol hand gel
- Injection tray
- 1 mL syringe
- Brown needle (26 FG 0.45 x 10 mm) to administer immunisation
- Green needle 21 FG 1 inch (to draw up diluents and mix with vaccine powder)
- Cotton wool balls
- Foil dish for cotton wool balls
- Non-woven gauze
- Sharps container
- Bags for clinical waste
- BCG vaccine
  - BCG vials are kept in fridge
  - consist of 2 vials
  - make up brown vial with entire contents of clear vial
  - invert vial 1–2 times to mix, do not shake
  - available for use for 4 hr after reconstitution
  - dose: 0.05 mL (**note**: vial contains 20 doses)
- Document that BCG has been given, site, dose and batch number

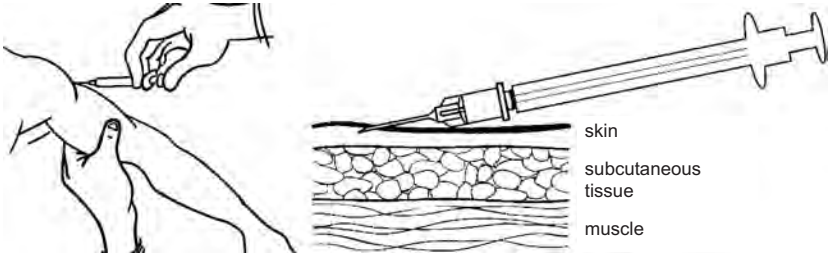
PROCEDURE

Consent

- Midwife to record at booking if risk factor present
- Postnatal check for risk factor
- Ensure baby within inclusion group
- Give mother information on vaccine
- Give appropriate language leaflet **TB, BCG vaccine and your baby**, available from https://www.gov.uk/government/publications/tb-bcg-and-your-baby-leaflet order line: 0300 123 1002 or https://www.orderline.dh.gov.uk/ecom_dh/public/home.jsf
- DH guidelines state written consent is not required but follow local practice

BCG IMMUNISATION • 3/3

See also **Tuberculosis (Investigation and management following exposure in pregnancy)** guideline



Injection

Only staff trained to give intradermal injections to give BCG

- Hold arm at 45º to body
- At insertion of deltoid muscle near middle of left upper arm
- If skin is clean, no further cleaning is necessary
- If skin is visibly dirty, clean with soap and water
- Stretch skin between thumb and forefinger
- Introduce needle bevel upwards about 3 mm into superficial layers of dermis almost parallel to skin
- If considerable resistance not felt, remove needle and reinsert before giving more vaccine
- Correctly given intradermal injection results a tense blanched bleb

DOCUMENTATION

- Complete 'Unscheduled vaccine form' or letter with batch number, vaccine name and site of immunisation
- Send to local TB service/Public Health Department
- Keep a local record
- Enter in Red book on relevant page

SEQUELAE

- Scar
  - within 2–6 wk a small papule will appear
  - sometimes, this ulcerates and can ooze
  - site need not be protected from water
  - do not cover with an impervious dressing
  - can take several months to heal
  - occasionally persists as keloid (particularly if given superior to insertion of deltoid)
- Adenitis:
  - a minor degree of adenitis can occur in the weeks following BCG
  - no treatment indicated
- Rare sequelae:
  - local abscess
  - chronic suppurative lymphadenopathy
  - disseminated disease, if immunocompromised
  - osteitis, refer to infectious diseases specialist

Refer to paediatric TB team if

- Severe local reactions
  - abscesses or drainage at the injection site

or

  - regional suppurative lymphadenitis with draining sinuses

Refer disseminated BCG infection to paediatric TB specialist

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BLOOD GROUP INCOMPATIBILITIES (including Rhesus disease) • 1/2

Aim to avoid kernicterus and severe anaemia

Keep consultant in charge informed

POSTNATAL MONITORING

Babies at risk

- Those with mothers with known blood group antibodies including:
- D (Rhesus), c, C, s, E, e, Duffy
- Kell: causes bone marrow suppression in addition to haemolysis

Management of babies at risk of haemolysis

- **Antenatally:** prepare a plan based on antibody titres, middle cerebral artery Dopplers and evidence of hydrops
- in severely affected cases, order blood in advance for exchange transfusion
- Send cord blood **urgently** for Hb, blood group, direct Coombs' test (DCT) and bilirubin
- in all babies who have had an in-utero blood transfusion (IUT), send cord blood also for a Kleihauer test
- chase results
- If pale with abnormal cardiorespiratory signs (e.g. tachycardia), admit to Neonatal Unit (NNU)
- If baby has positive DCT or had an IUT (regardless of DCT and blood group):
- discuss with middle-grade or consultant
- if cord bloods not available, check baby's blood immediately for bilirubin, Hb and DCT
- monitor serum bilirubin, usually at 6-hrly intervals until the level is both stable/falling **and** 2 consecutive values are >50 umol/L below the treatment threshold
- plot bilirubin values on the NICE gestational age-specific charts: http://www.nice.org.uk/guidance/CG98
- keep parents informed
- discuss progress regularly with middle-grade or consultant
- Decide whether baby needs phototherapy or exchange transfusion as determined by the gestational age-specific charts
- If baby has negative DCT and had no IUT, no further action required; baby is not affected

Management of babies with haemolysis diagnosed or suspected postnatally

- Babies with:
- blood group incompatibility with a positive DCT, manage as above
- red cell enzyme defect, inform on-service consultant

PHOTOTHERAPY

Indications/treatment thresholds

Refer to NICE jaundice guideline table and treatment charts

Prophylactic phototherapy (e.g. from birth) is not beneficial

DO NOT subtract the direct/conjugated bilirubin value from the total

- Inform middle-grade when a baby requires phototherapy

Management

- Plot bilirubin values on the appropriate gestation NICE treatment chart
- Administer phototherapy – see **Jaundice** guideline
- Check bilirubin 6 hr after onset of phototherapy **and** at least 6-hrly until the level is both stable/falling **and** 2 consecutive values of >50 umol/L below the treatment threshold

INTRAVENOUS IMMUNOGLOBULIN (IVIG)

Always discuss indications with consultant

Indications for IVIG use in isoimmune haemolytic anaemia

Indication	Bilirubin levels
IVIG indication for rapidly rising bilirubin level as recommended by NICE 2010	>8.5 micromol/L per hour despite intensive phototherapy (4 light sources used at correct distance – see **Table** in **Jaundice** guideline)
Second dose of IVIG	If bilirubin continues to rise rapidly as above (see **Table** in **Jaundice** guideline), a single repeat dose of IVIG can be given 12 hr+ later

Dose and administration

- Complete immunoglobulin request form (this is a red indication for use; please tick relevant box on the form)
- 500 mg/kg over 4 hr (see **Neonatal Formulary**)

EXCHANGE TRANSFUSION (ET)

Always discuss indications with consultant

See **Exchange transfusion** guideline

BEFORE DISCHARGE

- Check discharge Hb and bilirubin

FOLLOW-UP AND TREATMENT OF LATE ANAEMIA

All babies with haemolytic anaemia

- Arrange Hb check and review at 2 weeks of age
- Discuss results urgently with neonatal consultant
- dependent on rate of fall of Hb from discharge Hb, frequency of Hb checks planned (may need to be as frequent as weekly)
- for babies who had IUT, IVIG or exchange transfusion, follow-up with Hb check every 2 weeks initially, and until 3 months of age; thereafter arrange developmental follow-up (see below)
- for all other babies who had Coombs' tests more than weakly positive, review with Hb check at 2 and 6 weeks; once Hb stable discharge from follow-up and discontinue folic acid if this has been prescribed

Indication for top-up transfusion for late anaemia

- Symptomatic anaemia
- Hb <75 g/dL

Ongoing neuro-developmental follow-up and hearing test

- Arrange for any baby:
- with definite red cell anomalies
- who has undergone an exchange transfusion
- who has had an IUT
- who required IVIG
- with serum bilirubin at or above exchange transfusion threshold

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INTRODUCTION

- Screen babies on day 5 of age (date of birth = day 0) for the following conditions:
  - sickle cell disease
  - phenylketonuria (PKU)
  - congenital hypothyroidism (CHT)
  - cystic fibrosis (phased implementation)
  - medium chain acyl co-A dehydrogenase (MCADD) deficiency
  - maple syrup urine disease (MSUD)
  - isovaleric acidaemia (IVA)
  - glutaric aciduria type 1 (GA1)
  - homocystinuria (HCU)

Obtain pre-transfusion bloodspot samples as previous blood transfusions can falsify results

TIMING

If transfused before day 5

- Collect first bloodspot card before transfusion
  - fill one circle
  - mark card 'pre-transfusion'
- Collect second bloodspot card at 5–8 days of age and at least 72 hr after blood transfusion
  - fill 4 circles
  - record whether plasma or red cells transfused
- Staple pre-transfusion and second bloodspot card together and send to West Midlands screening centre via courier service after validation check

Multiple transfusions between 5 and 8 days of age

- Collect 4 bloodspots within this window. Complete with as much time-lapse as possible from any transfusion
- Depending on circumstances, screening laboratory will request repeat bloodspot

No transfusions before day 5

- Collect routine bloodspot card at day 5
  - fill 4 circles and send to West Midlands screening centre via courier service after validation check, irrespective of milk feeds or gestational age

Preterm babies <32 weeks (≤31 weeks and 6 days) will require repeat sample at 28 days or discharge home, whichever is the sooner for CHT

CONSENT AND INFORMATION

- Person undertaking procedure must:
  - explain pre-transfusion screening procedure to parent(s)
  - provide national pre-screening leaflet
- It is mandatory to include baby's NHS number on the bloodspot card

Further Information

Detailed information available from UK Newborn screening programme centre website:

http://newbornbloodspot.screening.nhs.uk/

BOTTLE FEEDING IN THE NEONATAL UNIT • 1/2

INTRODUCTION

It is rare for babies to be developmentally ready for bottle feeding before 34 weeks

AIM

- Recognition of baby's feeding skills and cues by neonatal staff and parents
- Sensitive and safe bottle feeding
- To prevent long-term aversive behaviour

INDICATIONS

- Breastfeeding is the preferred feeding method for the majority of babies except if:
  - mother unable to breastfeed for medical reasons (maternal HIV, HTLV) or on treatment making breast milk unsafe
  - parental choice – discuss merits of breastfeeding, including bottle feeding expressed breast milk
  - baby's medical condition makes full breastfeeding impractical or unsafe

CONTRAINDICATIONS

- Mother has chosen to breastfeed
- Baby has a medical condition and specialist assessment indicates bottle feeding contraindicated

Special precautions/cautions

- Medical condition indicates oral motor and pharyngeal skills may be compromised/delayed, impacting safety of baby's swallow (e.g. extreme prematurity, chronic lung disease, cleft palate, certain syndromes and neurological dysfunction), take special care in introducing bottle feeds. Refer to speech and language therapist

PROCEDURE

Action	Reason
● Parents/carers to be available for feeds	● Benefits for baby: ○ consistency ○ bonding and attachment
● Plan care activities in relation to feeding	● Care activities before feeds will cause: ○ fatigue ○ depleted energy ○ reduced capacity to feed orally
● Observe baby's behaviour before feeding, looking for signs of: ○ alertness ○ rooting ○ physiologically stable	● Risks of feeding baby or no feeding cues: ○ aspiration ○ long-term feeding aversion
● Ensure quiet environment	● Sensitive babies will show signs of stress and instability
● In preterm babies begin feeds with a **slow-flow** teat	● Consider length, shape and flow of teat in relation to: ○ baby's size ○ oral structures ○ strength ○ texture of liquid

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PROCEDURE (cont.)

Action	Reason
● Warm milk to room or body temperature before feeding	● Benefits: ○ comfort ○ easier to digest
● All premature babies benefit from a swaddled, elevated side-lying feeding position to support bottle feeding skills, especially at the beginning of their bottle feeding journey. This position will require nursing team education and training	● Benefits: ○ comfort ○ safety ○ facilitates postural support ○ supports pacing and co-ordination
● If baby does not tolerate an elevated side-lying feeding position, revert to an upright feeding position: ○ swaddle ○ provide back support ○ ensure baby's hands are free to grasp	● Benefits: ○ supports flexed position and grasp reflex ○ maintains firm muscle tone to suck and swallow safely ○ able to observe stress cues
● If baby is not actively sucking, avoid stimulation to the mouth area	● Stimulation is distracting and indicates baby not able to continue with bottle feed
● Pace baby during bottle feed to help regulate sucking, swallowing and breathing	● To pace: ○ adjust milk flow by lowering angle of teat ○ if baby continues to suck and not breathe, remove teat from mouth
● Bottle feed should take 20–30 min	● Long bottle feeds will: ○ cause fatigue ○ impact on weight gain ○ increase risk of feeding aversion
● Introduce cue-based feeding	● Benefits: ○ baby in control ○ improved milk volumes orally ○ reduced risk of feeding aversion ○ reduced aspiration risk
● Teach parents to mix feeds following infection control guidelines	● Unhygienic and incorrectly constituted feeds can cause poor growth and illness
● Parents to room-in and demand-feed baby before discharge	● To ensure parent and baby confidence

Table adapted from 'A guide to infant development in the newborn nursery 2010' 5th Edition Inga Warren and Cherry Bond, Winnicott Baby Unit, St. Mary's Hospital, Paddington (with permission)

PRETERM BABIES

Rationale

- Breast milk feeding, even partial, reduces risk of necrotising enterocolitis (NEC) and improves cognitive outcomes in preterm babies
- Human milk is important in establishing enteral nutrition
- Any amount of mother's fresh breast milk is better than none
- Physician advocacy has a strong influence on intention to feed

Parent information

- Offer parents the following fact sheets, available from:
- http://www.bliss.org.uk/Shop/the-best-start-a-guide-to-expressing-and-breastfeeding-your-premature-baby
- Small Wonders DVD

IMPLEMENTATION

- In pregnancy at high risk of premature delivery, discuss feeding during antenatal period
- Discuss value/benefits during mother's first visit to neonatal unit
- Document discussion in maternal healthcare record
- Separate decision to provide a few weeks' pumped breast milk from the commitment to long-term, exclusive breastfeeding
- Praise efforts to provide expressed breast milk
- Ensure adequate discussion and provision of written information on hand-expression, and on mode and frequency of pump use
- See **Nutrition and enteral feeding** guideline re: establishing breastfeeding

CONTRAINDICATIONS TO BREASTFEEDING

Babies with galactosaemia should not receive breast milk

HIV in UK

- Always check maternal HIV status before breastfeeding
- breastfeeding absolutely contraindicated in UK
- if you are concerned that mother intends to breastfeed, ensure an HIV specialist explains the risk to baby

HIV in developing countries

- If returning to a developing country where there is no access to clean water, exclusive breastfeeding is safer than mixed

Maternal medications

The risk of the medication to baby is dependent on the gestation, age and clinical condition of baby

- Antimetabolites or cytotoxic drugs
- Radioisotope investigation (until isotope clears)
- See **Neonatal Formulary, BNF or 'Medications and mother's milk' by T W Hale**

A current, reliable reference for drugs and breastfeeding must be available on the neonatal unit

BREASTFEEDING WITH SPECIAL PRECAUTIONS

Tuberculosis

- Maternal sputum-positive TB is not a contraindication to breastfeeding
- If mother on isoniazid, give prophylactic pyridoxine to mother and baby

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- Refer to **Tuberculosis – Investigation and management following exposure in pregnancy** guideline for further advice

Cytomegalovirus (CMV)

- Mothers who have a primary CMV infection or a reactivation may be infective. Take senior microbiological advice on testing and feeding
- Pasteurisation of milk inactivates CMV

Hepatitis B

- Risk of transmission can be almost totally eliminated by a combination of active and passive immunisation
- Breastfeeding is not contraindicated
- See **Hepatitis B and C** guideline

Hepatitis C

- Transmission by breastfeeding theoretically possible but has not been documented
- Breastfeeding not contraindicated but inform mother that risks are unknown – consider avoiding breastfeeding if nipples cracked as increased risk of infection

Varicella-zoster virus (VZV)

- Babies of mothers with active VZV can reduce the risk by avoiding breastfeeding until mother is no longer infectious (5 days from onset of rash)
- Premature babies born <1 kg or <28 weeks are considered high-risk and should be given Varicella-zoster immunoglobulin VZIG (see **Varicella** guideline)

Herpes simplex type 1

- Omit breastfeeding or feeding EBM from affected side in women with herpetic lesions on breast until lesions have healed
- cover active lesions elsewhere
- careful hand hygiene essential
- affected side – cover, pump and discard milk (no breastfeeding) until lesions are clear
- unaffected side – can breastfeed and use EBM

Phenylketonuria (PKU)

- Breastfeeding not contraindicated in babies with PKU
- Screening service will contact paediatric dietitians directly
- Careful dietetic management necessary
- All babies should be under the care of paediatric dietitians and inherited metabolic diseases team

Radioactive diagnostic agents

- Women receiving radioactive diagnostic agents should pump and discard although most agents have very short plasma half-lives, seek advice from hospital nuclear medicine department as to how long to discard milk for

Medications

- For medications that require caution with breastfeeding, see **Maternal medications** above

Social drugs

- **Alcohol**
- discourage more than limited consumption
- **Nicotine**
- nicotine concentration in breast milk increases immediately after smoking
- discourage mothers from smoking directly before breastfeeding or expressing breast milk

- Electric breast pumps used in hospital should have the following characteristics:
  - easy to assemble and disassemble with all parts able to withstand sterilisation methods
  - fully automatic, with a cyclic suction rhythm that mimics baby suckling
  - vacuum strength not exceeding 250 mmHg, and easily regulated
  - separate drive and suction system to ensure no contamination from milk spillage can enter pump
  - collection system enabling milk to be pumped directly into storage container with universal thread, to avoid need to transfer milk to another container for storage or administration

GENERAL

- Advise mothers to:
  - bath or shower daily
  - wash hands thoroughly with soap and running water before expressing
  - gently massage breast and stimulate nipple to trigger milk ejection reflex before milk expression
  - complete expressing log

MILK COLLECTION

- Sterilise milk collection utensils before use
- Commence milk collection as soon as possible following delivery (preferably within 6 hr)
- Frequency of expression should be 8–12 times/24 hr (not leaving a gap of longer than 6 hr overnight)
- Teach all mothers hand expression
- Use hand expression to express colostrum and collect the milk obtained via a syringe
- When milk obtained is sufficient to flow easily into a storage container, teach mothers to use an electric breast pump
- Encourage simultaneous (double) pumping of both breasts
- Ensure mother has a properly fitting breast shield (funnel), size is determined by comfort

TECHNIQUE

- Ensure mother seated in comfortable straight-backed chair and keep clothing away from breast while expressing milk
- Support breast from underneath with fingers flat on ribs and index finger at junction of breast and ribs with nipple positioned centrally in shield (funnel)
- Adjust suction control for comfort
- Use light pressure to obtain patent seal between breast and shield. Firm pressure will inhibit milk flow by compressing ducts
- Empty breasts as thoroughly as possible since fat content increases as breast is drained
- If using a single pump, switch to second breast when milk flow slows
- Use a new bottle for each expression
- Leave a space of 1–2 cm at the top of each bottle to allow for expansion during freezing
- Following expression, wash equipment in hot soapy water with a bottle brush before sterilisation
- Encourage mothers to practice ‘kangaroo care’ also known as skin-to-skin holding (see **Kangaroo care** guideline)
- Encourage mothers to express where they feel most comfortable; either close to baby or with baby picture/memento
- Complete at least 4 formal expressing assessments in the first 2 weeks (optimise milk production and address any issues related to expressing)

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Problems related to milk expression

Sore nipples

- Centre milk expression shield
- Try a variety of shield sizes
- Check pump vacuum
- Stop pump before removing shields
- Do not use plastic-backed breast pads
- Change breast pads frequently

Too little milk

- Increase kangaroo care (skin-to-skin)
- Express close to baby's cot
- Check frequency and duration of pumping
- Check shield (funnel) size
- Encourage breast compression during expression
- Increase frequency of expression sessions
- Consider enhancing prolactin secretion using domperidone
- Praise provision of expressed milk, no matter how small

Parent information

- Offer parents the following fact sheets, available from:
- http://www.bliss.org.uk/Shop/the-best-start-a-guide-to-expressing-and-breastfeeding-your-premature-baby
- Small Wonders DVD

BREAST MILK HANDLING AND STORAGE • 1/2

Improperly collected or stored breast milk can become contaminated and cause sepsis

Staff must adhere to local policies on collection of human milk and hand washing

ADMINISTRATION

- Ensure there is a dedicated fridge and freezer for milk storage on ward
- Add date and time bottles removed from freezer/opened to bottle label

ADVICE TO MOTHERS

- See **Breast milk expression** guideline
- Advise mothers to bath or shower daily
- do not wash breasts with bactericidal detergent or soap
- Before expressing milk, it is essential to wash hands thoroughly with soap and water and dry with a disposable towel
- Wipe breast pump with disinfectant wipe before use
- Give all breastfeeding mothers:
- fact sheet available from http://www.bliss.org.uk
- and 'Small Wonders' DVD
- Emphasise to mothers the importance of washing all breast milk collecting equipment properly before disinfection
- wash equipment with detergent and hot water using bottle brush (not shared) and rinse well before disinfection
- discard bottle brushes on discharge

COLLECTION OF BREAST MILK

- Give mother sterile collection kit
- Provide parents with patient identification stickers to label milk. Before giving a mother the patient identification stickers positive identification must be made at the cotside/bedside
- Clearly label milk from individual mothers in individual patient labelled containers and store separately in fridge (individual containers must not hold bottles from more than one mother)
- Blood and other pigments can discolour milk causing appearance to vary considerably
- unless it appears rancid and smells offensive, the appearance of milk is of no clinical concern and it can be safely fed to baby

STORAGE

Where

- Store in refrigerator at 4ºC. Freshly expressed breast milk can be stored for 48 hr before freezing
- Breast milk can be stored for 3 months in freezer at -18ºC without a defrost cycle (in hospital)
- if freezer has defrost cycle and milk appears frothy but does not smell rancid, it is safe to use
- Monitor fridge and freezer temperature daily using maximum/minimum thermometer that is calibrated every 6 months. This temperature should be recorded – date/time and temperature

How

- Place milk in sterile container with airtight lid
- Ensure bottles labelled appropriately – see **Record keeping**
- Store labelled bottles in separate containers in fridge/freezer (individual containers must not hold bottles from more than one mother)
- Wash containers stored in fridge daily in warm soapy water, rinse well and dry thoroughly
- Clean containers between each use
- Shake milk container to mix milk before use
- refrigerated milk separates with hind milk forming top layer

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DEFROSTING

- Use frozen milk in sequence of storage until enteral feeds are established
- Thaw frozen milk in waterless warmer or in fridge (if warmer is not available)
- If frozen milk needs to be thawed quickly (and warmer is not available), hold bottle under cold or tepid water. Shake frequently and do not allow water to enter bottle via cap
- Discard thawed milk (stored in a refrigerator at 4ºC) after 24 hr

USE

- Once removed from fridge, fresh or defrosted milk must be used within 4 hr
- Fresh milk is preferable to thawed milk (when on full feeds)
- Change continuous tube feeding (tubing between nasogastric tube and pump) every 4 hr
- To minimise fat loss, position syringe delivering feed in semi-upright position
- Bolus, feeds – warm milk before giving using waterless warmer if available (to minimise fat loss)
- Additives should be added to breast milk as close to feed time as possible
- Only warm volume of milk required for feed. Store remainder in refrigerator

TRANSPORTATION OF MILK

Milk is often transported from:

- Mother's home to hospital
- transport in an insulated container that can be easily cleaned
- encourage mothers to use coolant block to maintain stable temperature
- Hospital-to-hospital
- use rigid container for easy cleaning (e.g. cool box) and fill empty space with bubble wrap
- use coolant block to maintain temperature and transfer to fridge as soon as possible on arrival in NNU/ward

PRECAUTIONS

- Wash hands thoroughly
- Cover cuts and abrasions and wear gloves if necessary

RECORD KEEPING

- Label all bottles with baby's printed hospital label containing:
- name and hospital number
- date and time of expression
- If mother is expressing milk at home, provide supply of printed hospital labels
- Before giving breast milk, **2** members of staff must check label and cross-reference with baby's identity bracelet to ensure milk is not given to wrong child
- If freezing MEBM label date and time frozen and date time of defrosting
- See **Breastfeeding** guideline

STORAGE FOLLOWING DISCHARGE

- Ensure parents take home all EBM in the refrigerator or freezer. If mother's EBM remains on unit and is in date, transfer from refrigerator to freezer immediately – inform parents to collect as soon as possible
- Discard milk stored in neonatal unit freezer one month after discharge

BROVIAC LINE INSERTION • 1/3

INDICATIONS

- Long-term central venous access necessary (3–4 weeks) and all sites for peripherally inserted central catheters (PICC) line insertion have been exhausted
- Referring neonatologist must balance the risks of the procedure/transfer against the benefits

CONTRAINDICATIONS

- Pyrexial or septic baby. Remove any other lines e.g. PICC and administer antibiotics until apyrexial for at least 48 hr before insertion of Broviac line

Consent and communication with parents

- Before transferring to surgical centre, explain procedure to parents and discuss risks including:
  - infection
  - bleeding/bruising
  - line dislodgement/break/blockage
  - wound problems (especially vascuports)
  - pneumothorax (uncommon)
  - haemothorax (uncommon)
  - pericardial effusion (uncommon)
  - cardiac arrhythmias (uncommon)
- Inform parents the surgeon inserting the line will meet with them before the procedure to discuss their concerns and complete formal consent form
  - if parents are not able to attend surgical centre on day of procedure, formal 'delegated consent' must be gained by local neonatal team and completed consent form must accompany baby to surgical centre. File a copy in baby's healthcare record. This should be discussed with the surgical team
- Document all discussions with parents in baby's healthcare record

Complications of insertion	Problems in established lines	Causes of line blockage Difficult to aspirate and flush

Pneumothorax	• Infection
	  • line
	  • cuff
	  • skin
	  • endocarditis
		Tip of line in wrong place

Haemothorax	Breakage	• Lumen blocked
		  • blood clot or
		  • PN/drug concretion

Bleeding/haematoma	Blockage	• Fibrin sheath over end of line
Cardiac tamponade	Displacement	• Thrombus at the tip of line • Blood clot or vegetations

Malposition	Thrombus on tip of line	• Line tip pressed against
		  • vessel wall
		  • heart valve
		  • atrial wall

Extravasation	Venous occlusion	• Line partially pulled out • tip no longer in vessel
Venous occlusion		• Tip eroded through vessel wall and lying outside lumen
		• Damage to line or lumen

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BROVIAC LINE INSERTION • 2/3

INSERTION

- Inserted using an ultrasound guided percutaneous approach under general anaesthetic at a paediatric surgical centre
- Blood transfusions due to bleeding as a complication of surgery are very rarely required and usually occur due to an underlying condition

Referral

- Refer urgently to on-call paediatric surgeon at planned place of surgery. Arrangements will be made on an individual basis depending on degree of urgency and clinical need
- Once procedure date set, liaise with the transport team
- Ensure a transfer letter is ready to accompany baby, together with recent FBC, clotting screen and U&E results
- Prepare baby for transfer. Follow pre-operative fasting instructions from the surgical team

Post-operative care

- All lines will be imaged in theatre unless otherwise specified
- Line will be looped on the chest under an IV3000 dressing +/- a biopatch
- biopatch used for babies >26 weeks and >7 days old
- avoid excessive pressure over the patch (risk of skin necrosis)
- Change dressing weekly for 3 weeks
- 2.7 Fr line: continuous infusion at ≥1 mL/hr to prevent blockage
- 4.2 Fr line: when not in use:
- heplock twice weekly with prescribed heparin 0.4 mL (10 iu/ml)
- **please note this is a reduction in heparin concentration from previous guidelines**
- use aseptic technique
- clamp catheter immediately following instillation of heparin
- to use a heplocked line, aspirate the lumen until blood is withdrawn and discard the aspirated solution

REMOVAL

- Neonatal consultant will decide when line to be removed, often following discussion with surgeons

Indications

- Line no longer needed
- Line blocked or damaged
- Cuff dislodged so that it is visible outside the skin
- Central line infection, not controlled by antibiotics
- Evidence of sepsis with no obvious cause, not controlled by antibiotics
- Repeated (>2) episodes of Broviac line related sepsis

Preparation for removal

- Discuss with surgical team or surgical outreach nurse
- Discuss procedure, benefits and risks with parents and document discussion in baby's healthcare record
- Most Broviac line removals are performed at the neonatal surgical centre on an elective basis according to the degree of urgency and other clinical needs (occasionally a consultant surgeon may perform the procedure at the neonatal unit)
- Once a date is agreed, inform transport team
- Ensure transfer letter is ready to accompany baby, together with results of recent FBC, clotting screen and U&E
- Prepare baby for transfer. Follow pre-operative fasting instructions from the surgical team

Equipment required if surgeon removing line on neonatal unit

- Surgical consent form
- Trolley
- Sterile dressings pack
- Cut-down pack (e.g. insertion of a UVC or a chest drain)
- Local anaesthetic (lidocaine 1% or marcaine 0.25%)
- Sterile pot to send tip to microbiology
- Sterile gauze
- Cleaning fluid i.e. chlorhexidine etc.
- Steristrips
- Mepore dressing

Potential complications of line removal

- Bleeding – usually oozes from exit site that will settle with pressure
- pressure may need to be applied to neck, just above clavicle (venous puncture site)
- Infection
- Line breaking during removal (embolisation) – very rare but line tip may require removal
- Wound problems

Embolised line

- Very rare but occasionally line will break causing the tip to embolise into the right atrium or pulmonary artery
- If line stops working, perform chest X-ray
- Requires retrieval by interventional cardiologist at paediatric surgical centre. Liaise with either on-call paediatric surgeon or vascular access team at planned place of surgery

Useful Information

- http://www.bch.nhs.uk/content/neonatal-surgery
- http://www.bch.nhs.uk/find-us/maps-directions

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CANNULATION

INDICATIONS

- Access for intravenous infusion and medications

CONTRAINDICATIONS

- Sore or broken skin

EQUIPMENT

- Cleaning solution (see your Trust's policy)
- Appropriately labelled blood bottles and request cards
- Non-sterile disposable gloves
- 24 gauge cannula
- T-piece connected to a syringe of sodium chloride 0.9%, flushed and ready
- Tape and splint to secure cannula
- 3-way tap if necessary

EMLA cream is not used in neonates

PROCEDURE

Preparation

- Identify suitable site:
  - preferably back of hand or foot
  - save long saphenous and antecubital fossa veins for long line insertion
  - scalp: shave area if using scalp vein (do not use as first priority site)
  - inform parents before procedure if possible
- Identify suitable vein, which should be clearly visible. Unlike in adults, neonatal veins are rarely palpable

When baby likely to need numerous cannulations, avoid using potential long line veins

- It can be helpful to flush cannula with sodium chloride 0.9% to assist in identification of point at which cannula enters vein. If blood samples taken at time of cannula insertion, **do not** flush cannula as this will contaminate sample for analysis
- Wash hands and put on gloves

Insertion

- Apply hand pressure around limb to distend vein
- Place thumb on skin slightly distal to proposed puncture site
- Hold cannula at 10–20º angle and puncture skin
- Advance cannula toward vein
  - resistance may diminish slightly as it enters vein and a speck of blood may be seen in hub of needle (this is easier to see if cannula has been flushed with sodium chloride 0.9%). Do **not** advance needle further as it can pierce back wall of vein
- When this occurs, hold needle steady and advance cannula a short distance within vein
- Withdraw needle from cannula
- Connect T-piece and flush cannula gently with 0.5 mL sodium chloride 0.9% to confirm it is in the vein
- Secure cannula with clear dressing (e.g. Tegaderm/Opsite) to ensure IV site visible at all times, and connect to infusion

Documentation

- Record date, time and site of cannula insertion in notes with identification and signature of person carrying out procedure (use local sticker if available)
- Record date and time of removal of cannula
- Use visual phlebitis scoring for ongoing monitoring of cannula, according to local Trust policy

CARDIAC MURMURS • 1/1

Failed oximetry:
See **Pulse-oximetry screening** guideline
- Lower limb SpO_2 <95%
- Pre and post- ductal difference of >2%

Cardiac murmur detected on routine postnatal examination

- Thorough cardiovascular examination
- Pre and post ductal saturations
- Senior paediatric review

Any of the following
- Failed oximetry
- Weak or absent femoral pulses
- Symptoms of heart failure
- Signs of heart failure
- Cardiovascular shock

Significant congenital heart disease

URGENT
- Admit to NNU
- +/- ECG, chest X-ray, four-limb BP and blood gas analysis
- Hyperoxia test +/- Prostin (see **Congenital heart disease:duct dependent lesions and Prostaglandin infusion** guidelines)
- Echo (performed locally, if available)
- Liaise with regional cardiologist

Any of the following
- Loud murmur (>2/6 intensity)
- Pansystolic/ diastolic/continuous
- Heave
- Location other than LSE
- Murmur plus dysmorphic features

Possible congenital heart disease

SOON
- Senior review
- ECG +/- echo before discharge if available
- Review by paediatrician with echocardiography skills or paediatric cardiologist within 2–3 weeks
- Advise parents to watch for signs of heart failure
- Inform GP

All of the following
- Asymptomatic well baby
- No signs of heart failure
- Normal pulses
- Normal saturations
- Soft systolic murmur (<2/6)

Likely innocent heart murmur

ROUTINE
- Echo before discharge if available or
- Review in paediatrician out-patient clinic within 2–6 weeks
- Advise parents to watch for signs of heart failure
- Inform GP

Grades of cardiac murmur

Grade 1 – barely audible

Grade 2 – soft but easily audible

Grade 3 – moderately loud, no thrill

Grade 4 – louder, with thrill

Grade 5 – audible with stethoscope barely on chest

Grade 6 – audible with stethoscope off chest

Signs and symptoms of heart failure:
- Lethargy, not waking up for feeds
- Poor feeding
- Not completing feeds
- Fast or abnormal breathing
- Chest recessions
- Sweaty during feeds
- Colour changes
- Poor weight gain

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CHEST DRAIN INSERTION – TRADITIONAL • 1/2

INDICATIONS

- Treatment of pneumothorax or pleural effusion

EQUIPMENT

- Sterile dressing pack
- Cleaning solution as per unit policy and wash off with sodium chloride 0.9% once dried for babies <26 weeks' gestation
- Lidocaine 1%, with syringe and needle for preparation and injection
- Chest drains size FG 8,10,12 (use largest possible depending on size of baby)
- Low pressure suction unit
- Scalpel and fine straight blade (size 11)
- Fine blunt forceps
- Underwater seal chest drainage bottle and tubing or flutter (Heimlich) valve
- Steristrips and transparent dressing (e.g. Opsite/Tegaderm)

SITES

- Site of insertion depends on position of pneumothorax
- preferred site is in anterior axillary line, between fourth and sixth intercostal space, to conceal subsequent scarring and avoid interference with breast development
- alternative site is just lateral to midclavicular line, in second or third intercostal space
- if pneumothorax does not drain satisfactorily, it may be necessary to insert more than one drain
- for pleural effusion, use midaxillary line between fourth and fifth intercostal spaces, and direct drain posteriorly

PROCEDURE

Preparation and position of baby

- Inform parents and obtain verbal consent as recommended by BAPM (unless emergency procedure)
- Use 10–12 FG pleural catheter (small babies may need 8 FG)
- Position baby supine and flat with affected side slightly tilted up (for example, by using a folded blanket)
- Prepare skin with full aseptic technique
- Infiltrate with lidocaine 1%, **even in babies being given systemic analgesia**

Insertion of tube

- Make small incision in skin with scalpel at lower edge of intercostal space to avoid injury to intercostal vessels
- Dissect bluntly with fine forceps through intercostal muscle and pleura
- Use fine forceps to gently advance tip of catheter
- Push and twist tube gently through incision into pleural space
- Insert chest drain 2–3 cm for small preterm and 3 cm for term babies
- Use of trocar not generally recommended. If used (in bigger baby), protect lung by clamping artery forceps onto trocar 1 cm from the tip
- Connect tube to prepared underwater seal or flutter (Heimlich) valve (according to local practice)
- Manipulate tube gently so that tip lies anteriorly in thoracic cavity for pneumothorax, and posteriorly for effusion
- Secure tube with Steristrips, and cover with gauze dressing. A suture may be required; **do not use purse-string suture**
- Secure tube to chest wall using suitable tape (Opsite/Tegaderm)

CHEST DRAIN INSERTION – TRADITIONAL • 2/2

AFTERCARE

- Check bubbling or oscillation of water column seen with every inspiration
- Check tube position with chest X-ray (consider lateral X-ray to confirm position)

Suction

- If bubbling poor and X-ray confirms drain is in correct position but pneumothorax not fully draining on X-ray or cold light, apply continuous suction of 5–10 cm of water. Thoracic suction is better suited for this purpose than routine wall suction. Occasionally, a second drain may be necessary

Flutter valve

- As an alternative to underwater chest drain system, especially during transport, a flutter valve can be used

Document

- Record presence of bubbling (continuous/intermittent/none) on nursing care chart
- Record with nursing observations, bubbling and/or oscillation of water column, or fluttering of valve seen with every inspiration

REMOVAL OF CHEST DRAIN

- Remove tubing when no bubbling or oscillation of water column has occurred for 24 hr
- Clamp chest drain for 12 hr and repeat chest X-ray before removal. While removing drain, ask an assistant to hold wound edges close together
- After removing drain, close wound with steristrips, a suture is seldom necessary
- Close clinical observation after removal of drain is sufficient to diagnose re-accumulation of the air leak, routine chest X-ray not generally warranted

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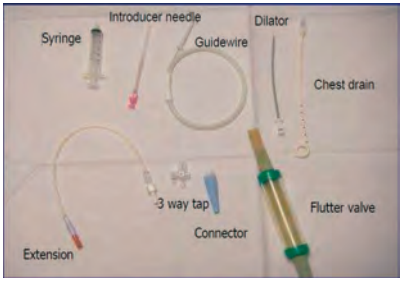
CHEST DRAIN INSERTION – SELDINGER TECHNIQUE • 1/2

INDICATIONS

- Treatment of pneumothorax or pleural effusion



EQUIPMENT

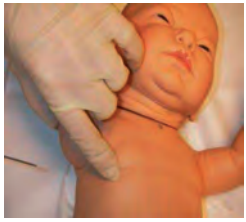
- Introducer needle
- Chest drain
- Guide wire
- Dilator
- 3-way tap, connector
- Extension
- Flutter valve

PROCEDURE

Step 1: Analgesia

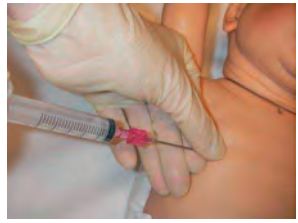
- Ensure baby has adequate analgesia
  - if ventilated – use morphine bolus
  - if non-ventilated – use low-dose fentanyl (watch for chest wall rigidity)
  - lidocaine locally

Step 2: Aseptic technique



- Use sterile gloves and gown
- Identify site
- Clean skin according to local policy

Step 3: Insert needle



- Select location for chest drain – usually 5th intercostal space, anterior axillary line
- Insert needle whilst aspirating syringe
- Stop advancing once air aspirated (<1 cm)

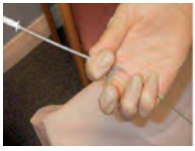
CHEST DRAIN INSERTION – SELDINGER TECHNIQUE • 2/2

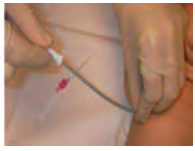
Step 4: Insert wire

- Pass wire through needle to mark on wire
- Holding wire still, remove needle

Take care to keep equipment sterile at all times. This may require an assistant to 'control' wire

Step 5: Dilate the skin

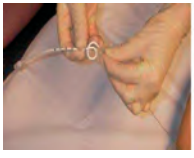




- Pass dilator along wire
- Push dilator through skin about 1 cm, angling anteriorly
- Skin may require small incision
- Following dilation, dilator can be removed

At all times wire must be held still, not advanced or withdrawn

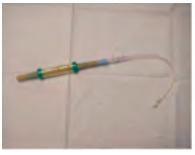
Step 6: Insert the drain

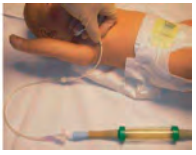


- Advance drain over wire (this often needs an assistant)
- Advance drain through skin so holes are inside baby
- Wire can now be removed

Step 7: Add the flutter valve or connect to underwater seal

- Assemble drainage equipment
  - extension
  - 3-way tap
  - connector and flutter valve or underwater seal and suction
  - if connected to underwater seal use 5–8 cm water pressure suction





- Attach valve/underwater drain to end of drain (as above)
- Chest X-ray to confirm position and monitor progress/resolution in pneumothorax or pleural effusion

Step 8: Secure the drain

- Carefully secure the drain
  - DO NOT use a purse string suture
  - suture can be placed through skin and knotted to drain
  - secure chest drain with steristrips and tegaderm

HOW TO REMOVE

- Wear personal protective equipment, i.e. gloves, eye protection
- Remove sutures and tegaderm
- Gently pull drain – pigtail will uncurl
- Beware of splashing body fluids – as drain comes out of skin, pigtail catheter will spring back

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CHEST PHYSIOTHERAPY • 1/2

INTRODUCTION

- The neonatal toolkit recommends that all units caring for babies requiring intensive and high dependency care who provide a chest clearance should have access to a paediatric/neonatal specialised respiratory physiotherapist
- All staff undertaking percussion must be competent and seek advice where required
- Contact a respiratory physiotherapist to review babies with difficulties clearing secretions

PERCUSSION

Definition

- Rhythmic patting over chest wall using a palm cup percussor to generate pressure changes stimulating mucous clearance by ciliary stimulation

Indications

- Tenacious secretions not cleared effectively with suction +/- sodium chloride 0.9%
- Signs of respiratory compromise
- changes in ventilation suggestive of secretion retention (e.g. tidal volumes, peak pressures)
- decreased SpO_2/PaO_2
- increased $PaCO_2$
- Auscultation findings
- Chest X-ray changes e.g. focal collapse/consolidation
- Consider neuromuscular pathologies resulting in poor airway protection, and respiratory conditions such as cystic fibrosis (CF). These conditions may require prophylactic physiotherapy and parental training before discharge – refer to physiotherapist

Contraindications

- Cardiovascular instability
- Undrained pneumothorax/bullae
- Pulmonary interstitial emphysema (PIE)
- Acute pulmonary haemorrhage
- Metabolic bone disease/fractured ribs
- Intraventricular haemorrhage (IVH) within 48 hr
- Extreme prematurity (<1500 g/<26 weeks' gestation) in first week of life
- Platelet count <50 x 10^9/L and/or prolonged clotting and/or active bleeding

Precautions

- Poor skin integrity
- Platelet count <100 x 10^9/L
- Avoid chest drain sites and Broviac lines/proximity of wounds/stomas
- Effectiveness reduced in chest wall oedema
- Distended abdomen

PROCEDURE

- Always assess cardiorespiratory status before intervention
- Ensure nesting and developmental care support throughout procedure (see **Developmental care** guideline and **Positioning** guideline)
- Plan treatment episodes pre-feed or more than 30 min post-feed

Positioning

- See **Positioning** guideline
- **Do not** disconnect baby from the ventilator for a turn
- Different positions can be used to target specific areas of collapse and/or consolidation
- Ventilation/perfusion mismatch may necessitate increasing oxygen delivery
- Variety in positions is important but very frequent position changes are discouraged. Do not leave baby for prolonged periods – dependant (lower) lung can retain secretions/collapse, as well as risk of pressure areas
- **Never** use head-down tilt due to risk of IVH/reflux/respiratory compromise

Percussion

- **Stabilise head** with one hand at all times
- Ensure whole circumference of the percussor makes contact with baby's chest, ideally directly on baby's skin.

If not practical, a layer of vest is acceptable. The pressure should not cause any movement of baby/skin reaction

- Ideal rate approximately 3/sec
- Use short percussion episodes according to baby's stability/tolerance/gestational age
  - generally maximum of 1–2 min (up to 2–3 min for more robust self-ventilating babies)
- Address signs of stress by pacing baby or giving time-out/comfort holding
- Treat only when clinically indicated and a maximum of 4-hrly, except when an acute deterioration necessitates additional treatments
- Use a maximum of 2 positions
- Suction following percussion
- Keep percussor in the incubator. Wash with soap and warm water and Alco wipe

Risks of percussion

Vigorous percussion in vulnerable extremely preterm babies and poor use of supportive developmental care techniques have previously been linked with IVH and periventricular leucomalacia

Suction

- Endotracheal tube (ETT) suctioning – see **Endotracheal tube suctioning** guideline
- Suction only when indicated, not routinely
- Maintain normal saturation range for gestational age by titrated pre/post-oxygenation. **Avoid hyperoxia**
- Catheter for open suction must be graduated and have a Mülly tip (larger end hole and 2 opposite pressure relieving side-eyes) and be no larger than two-thirds diameter of ETT
- Use measured suction to minimise cardiovascular instability and trauma
- Suction pressures
  - should not exceed 100 mmHg/13 kPa
  - apply on withdrawal only
- Oral suction must follow to clear secretions from around ETT – use a catheter no larger than 10 FG
- When not in use, turn suction off to reduce noise

Other considerations

- Sodium chloride 0.9% to mobilise tenacious secretions/mucus plug(s)
  - do not use routinely
  - instil 0.2–0.3 mL (up to 0.5 mL in term baby) via ETT before suction
  - warm unopened ampoules in incubator
- **High frequency oscillatory ventilation (HFOV)**
  - after suction, increase mean airway pressure by 1 cm H_2O to recruit lung at the discretion of medical staff
- **Mucoactives**
  - may be helpful for viscous secretions with persistent collapse/consolidation. Discuss with medical team
- **Non–ventilated babies**
  - oral suction with size 8 or 10 catheter. Always position in side lying for suction. This reduces risk of aspiration if baby vomits

AFTERCARE

- Assess and document effectiveness of interventions
- If baby shows no improvement, or is worse, seek advice from MDT and refer to physiotherapist
- Assess indication for percussion at each episode and discontinue when desired outcomes achieved
- Ensure timely and detailed documentation including time, indications, intervention and outcomes

Further information

- For babies with difficulty clearing secretions and for individual/group training, contact a neonatal respiratory physiotherapist

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RECOGNITION AND ASSESSMENT

Definition

	Gestational age	
	<32 weeks	**≥32 weeks**
Time of assessment	36 weeks CGA or discharge	>28 days, but <56 days postnatal age or discharge
Treatment with oxygen	≥28 days	≥28 days
	Bronchopulmonary dysplasia	
Mild	In air at 36 weeks CGA or discharge	In air by 56 days postnatal age or discharge
Moderate	<30% oxygen at 36 weeks CGA or discharge	<30% oxygen at 56 days postnatal age or discharge
Severe	>30% oxygen +/- CPAP or ventilation at 36 weeks CGA or discharge	>30% oxygen +/- CPAP or ventilation at 56 days postnatal age or discharge

Target saturations ≥95% at 36 weeks CGA (see **Oxygen saturation** guideline for details)

Investigations at time of assessment (see above)

- Blood gas
- Chest X-ray: homogenous opacification of lung fields developing after first week of life (Type 1) or coarse streaky opacities with cystic translucencies in lung fields (Type 2)
- Echocardiography to rule out pulmonary hypertension or structural pathology
- Electrocardiography (ECG) to rule out pulmonary hypertension
- Overnight oximetry study (see **Oxygen on discharge** guideline)

TREATMENT

Optimise ventilation strategies

- Use lowest possible ventilator pressures to deliver appropriate tidal volumes to minimise barotrauma and volutrauma. Volume-targeted/volume-guarantee ventilation may be helpful if available

Optimise nutrition

- Ensure adequate calorie intake (at least 120 Kcal/kg/day) because of increased work of breathing
- If growth unsatisfactory, involve dietitian
- Avoid fluid overload

Corticosteroids

- If ventilator-dependent and requiring increasing or persistently high oxygen intake, consider using corticosteroids
- Treatment with corticosteroids is a consultant led decision
- Inform parents of potential short-term and long-term adverse effects
- Obtain oral consent and record in notes
- Give BLISS information leaflet **Going home on oxygen** http://www.bliss.org.uk/shop

Short-term side effects of corticosteroids

- Risk of infection
- Poor growth
- Reversible ventricular hypertrophy
- Gastrointestinal perforation and bleeding
- Adrenal suppression
- Glucose intolerance

Long-term side effects of corticosteroids

- Increased risk of neurodisability

Doses

- Use **Neonatal Formulary** for dexamethasone dosage regimen (consultant decision on DART versus minidex regimen)
- If respiratory status worsens after initial improvement consider repeating course of corticosteroids (consultant led decision)

Monitoring while on corticosteroids

- Daily BP and urinary glucose

Diuretics

- Use of diuretics to improve lung function (consultant decision). Diuretics of choice are chlorothiazide and spironolactone (use of spironolactone can be guided by serum potassium). Avoid amiloride due to its lung fluid retaining properties
- Side-effects include hyponatraemia, hypo/hyperkalaemia, hypercalciuria (leading to nephrocalcinosis) and metabolic alkalosis
- If no improvement on diuretics stop after 1 week

SUBSEQUENT MANAGEMENT

Monitoring treatment

Continuous

- Aim for SpO_2 of 91–95% until 36 weeks corrected gestational age
- After 36 weeks gestational age, maintain SpO_2 ≥95% to prevent pulmonary hypertension
- Warm and humidify supplemental oxygen unless on low-flow oxygen
- Monitor weight and head growth
- Assess for gastro-oesophageal reflux (see **Gastro-oesophageal reflux** guideline)
- Aim to stop diuretic therapy before discharge (consultant decision)

DISCHARGE AND FOLLOW-UP

- If still oxygen-dependent at time of discharge (see **Oxygen at discharge** guideline)
- Long-term neuro-developmental and respiratory follow-up

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In utero transmission of CMV can occur during primary maternal infection, reactivation, or reinfection of seropositive mothers

MATERNAL TESTS

CMV serology (IgG and IgM) and viral loads

- Both IgG and IgM negative: unlikely to be CMV infection
- IgG positive, IgM negative: past maternal infection
- IgG positive, IgM positive: check CMV IgG avidity – if low likely to be acute maternal CMV infection. High CMV viral load in maternal blood indicative of acute maternal CMV infection

Antenatal ultrasound

Features include:

- IUGR
- Hydrocephalus (ventricular dilatation), intracranial calcification, microcephaly
- Ascites, hydrops fetalis
- Pleural or pericardial effusions
- Oligo- or polyhydramnios
- Hepatomegaly
- Abdominal calcification
- Pseudomeconium ileus
- Thickened placenta

NEONATAL FEATURES

Main clinical signs

- Small for gestational age
- Petechiae/purpura
- Hepatosplenomegaly
- Jaundice
- Pneumonia

Investigation results

- CMV IgM positive
- CMV PCR urine positive
- Haemolytic anaemia
- Thrombocytopenia
- Conjugated hyperbilirubinaemia
- Raised liver enzymes
- HIV antibody test
- **If CMV positive, continue with further investigations**

FURTHER INVESTIGATIONS

- Blood and urine CMV viral load
- Ophthalmology: chorioretinitis
- Audiology: formal hearing test (not just screening ABR) sensorineural hearing loss
- Head ultrasound: hydrocephalus, cysts

CT scan of brain

- Intracranial calcification
- Ventriculomegaly
- Cerebral atrophy

TREATMENT

Asymptomatic

(CMV IgM or PCR positive +/- thrombocytopenia)

- Treatment not indicated

Symptoms other than neurological

- Seek expert advice from paediatric infectious disease specialist regarding offering valganciclovir

Neurologically symptomatic

- Ganciclovir [prepared by pharmacy (cytotoxic)] 6 mg/kg IV over 1 hr 12-hrly for 6 weeks or valganciclovir 16 mg/kg oral 12-hrly for 6 months
- Discuss side effects vs benefits with parents:
- **advantages:** potential reduced risk of deafness and developmental delay
- **disadvantages:** during treatment reversible blood dyscrasia; long-term unknown risk to fertility and malignancy
- Monitor for neutropenia, thrombocytopenia, hepatic and renal function throughout: may need dose reduction
- discuss with specialist in paediatric infectious diseases
- Start treatment as soon as possible; if diagnosis delayed, treatment can be started up to 1 month of age

FEEDING

- Do not discourage infected women from breastfeeding their own uninfected, term babies (CMV can be transmitted via breastfeeding, but benefits of feeding outweigh risks posed by breastfeeding as a source of transmission)
- Avoid breastfeeding of premature neonates if mother is positive and baby asymptomatic

FOLLOW-UP

- Enter on European Congenital CMV Initiative register www.ecci.ac.uk if treated
- Annual hearing and ophthalmology assessment for both asymptomatic and symptomatic congenitally infected babies
- MRI brain discuss with radiology

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- Haemostasis is immature during the neonatal period and does not attain full function until 6 months of age
- prolonged prothrombin time (PT) and activated partial thromboplastin time (APTT) are associated with intraventricular haemorrhage (IVH) in unstable (e.g. hypotensive or hypoxic) or bruised extremely preterm babies
- 75% of cases of IVH occur within first 24 hr of life and 90% within first 7 days
- prophylactic fresh frozen plasma (FFP) does not prevent IVH in preterm baby without evidence of coagulopathy

INVESTIGATIONS

Check clotting in:

- Any bruised or bleeding baby (e.g. IVH, pulmonary haemorrhage, gastrointestinal bleeding, suspected haemorrhagic disease of newborn etc.)
- Preterm <30 weeks' gestation (due to IVH risk) if clinical concerns about bleeding
- Moderate-to-severe encephalopathy (e.g. babies who are being cooled)
- Septicaemia
- Necrotising enterocolitis (NEC)
- Sick or unstable baby (e.g. ventilated, inotropic support etc.)
- Metabolic disease: urea cycle disorder, galactosaemia, tyrosinaemia, organic acidaemia
- Liver dysfunction or conjugated jaundice
- Babies undergoing surgery or tissue biopsy who have had previous bleeding problems
- Family history of inherited bleeding disorder (after discussion with consultant haematologist)
- Thrombocytopenia – see **Thrombocytopenia** guideline

Sampling

- Ensure sample from a free-flowing vein (peripheral or umbilical) or from an arterial line before heparinising
- Use appropriate coagulation tubes as per local policy
- Fill exactly to black mark on tube (usually 1.3 mL)
- If sample clots (this does not confirm normal coagulation), take another
- If sampling from arterial line with heparin infusion, take larger volume from dead-space (e.g. 2.5 mL), see **Arterial line sampling** guideline

Request

- PT
- APTT
- Fibrinogen
- If features of DIC (e.g. bruising, bleeding, sepsis), request:
- fibrin degradation products and D-dimer (if available)

Acceptable reference values

Clotting parameter	Gestation	Ratio INR	Value (laboratory control PT 11–14 sec and APTT 30–33 sec)
PT	Term	1–1.6	10–16 sec
	Preterm (<37 weeks)	1–2	11–22 sec
APTT	Term	1–1.6	31–55 sec
	Preterm (<37 weeks)	1–2	28–70 sec
Fibrinogen	Term		1.7–4.0
	Preterm (<37 weeks)		1.5–3.7

IMMEDIATE TREATMENT

- If INR alone is prolonged, check whether clotting samples were performed before first dose of vitamin K. If so, repeat clotting screen
- If prolonged INR (see thresholds below) and normal APTT in stable term baby (e.g. clotting screen performed as part of conjugated jaundice screen), give repeat dose of vitamin K 100 micrograms/kg (up to 1 mg) IV. If repeat INR not improving after 6 hr, discuss with senior/haematologist to explore other causes and the need for FFP or regular vitamin K
- In preterm baby <30 weeks (with risk of IVH) or unwell with prolonged INR, repeat vitamin K 1 mg IV with FFP
- If APTT beyond upper limit of reference range, give FFP (see below)
- In case of persistently prolonged INR or liver disorder/conjugated jaundice, give regular doses of vitamin K
- In persistently prolonged APTT, give further doses of FFP (or cryoprecipitate – see below)

Use of FFP and cryoprecipitate

Do not use FFP or cryoprecipitate purely for volume replacement or polycythaemia without coagulopathy

Treatment thresholds for use of FFP

- If PT or APTT below treatment thresholds:
- FFP 10–20 mL/kg over 30–60 min

Clotting parameter	Gestation	Stable baby	Unstable*, significant**, bleeding or invasive procedure***
PT	Term	Ratio (INR) ≥1.6 or Value ≥16 sec	Ratio (INR) ≥1.5 or Value ≥15 sec
	Preterm (<37 weeks)	Ratio (INR) ≥2 or Value ≥22 sec	Ratio (INR) ≥1.8 or Value ≥20 sec
APTT	Term	Ratio (INR) ≥1.6 or Value ≥55 sec	Ratio (INR) ≥1.5 or Value ≥45 sec
	Preterm (<37 weeks)	Ratio (INR) ≥2 or Value ≥70 sec	Ratio (INR) ≥1.8 or Value ≥60 sec

* Unstable (e.g. DIC, significant sepsis, NEC, ventilated, hypotensive etc.)

** Significant bleeding (e.g. significant bruising, IVH, gastrointestinal bleeding, pulmonary haemorrhage etc.)

*** Invasive procedures (e.g. lumbar puncture, umbilical lines, long lines, chest drain, exchange transfusion etc.)

- In inherited clotting factor deficiencies, use FFP only when pathogen inactivated factor unavailable. Discuss with consultant haematologist before giving FFP
- If APTT ratio still ≥1.8 after giving FFP (especially if fibrinogen <1.2), consider cryoprecipitate (5–10 mL/kg over 30–60 min) after discussion with on-call consultant and haematologist

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MONITORING

- Repeat coagulation profile 2–4 hr after FFP/cryoprecipitate or every 12–24 hr
- Look for and treat causes of abnormal coagulation:
  - sepsis
  - shock
  - haemorrhage
  - severe hypothermia
  - hypoxia
- If abnormal coagulation persists for >24 hr in the absence of any precipitating factors, seek advice from paediatric haematologist about factor assays and 50:50 mixture correction test

CONGENITAL HEART DISEASE: DUCT-DEPENDENT LESIONS

[Including hypoplastic left heart syndrome (HLHS) and left-sided outflow tract obstructions] • 1/4

INTRODUCTION

Duct-dependent congenital heart disease can be broadly divided into 3 categories

1	Mixing lesions e.g. transposition of great arteries	Usually presents as cyanosis ('blue baby')
2	Obstruction to pulmonary circulation e.g. pulmonary or tricuspid atresia, Fallot's tetralogy, critical pulmonary stenosis	Usually presents as cyanosis ('blue baby')
3	Obstruction to systemic circulation e.g. hypoplastic left heart syndrome (HLHS), critical aortic stenosis, coarctation of aorta, interrupted aortic arch	Usually presents as poor perfusion (shock)

Differential diagnosis of central cyanosis ('blue baby') or persistently low SpO_2 (<95%)

- Cyanosis is the abnormal blue discoloration of skin and mucous membranes

Without echocardiography, clinical distinction between significant persistent pulmonary hypertension (PPHN) and a duct-dependent pulmonary circulation can be extremely challenging

If duct-dependent lesion, discuss commencing prostaglandin with a senior even if in doubt about cause

Cardiac causes of central cyanosis

- Duct-dependent lesions (see above)
- Other cardiac conditions e.g. anomalous pulmonary venous drainage, Fallot's tetralogy, truncus arteriosus etc.

Respiratory causes of central cyanosis

- Persistent pulmonary hypertension
- Other respiratory conditions, e.g. congenital pneumonia, pneumothorax, meconium aspiration, congenital diaphragmatic hernia, respiratory tract obstruction

Other rare causes of central cyanosis

- Methaemoglobinemia

Differential diagnosis of babies presenting with poor perfusion (shock)

Cardiac causes of shock

- Duct-dependent lesion (see above)
- Other cardiac causes e.g. arrhythmias (supraventricular/ventricular tachycardia) cardiomyopathy etc.

Other causes of shock

- Sepsis, bleeding, dehydration, metabolic

RECOGNITION AND ASSESSMENT OF DUCT-DEPENDENT LESIONS

In-utero (antenatal) diagnosis

- If diagnosed in-utero, see management plan in mother's healthcare record
- Deliver at local neonatal unit (NNU) or neonatal intensive care unit (NICU) equipped for serious congenital heart disease. Stabilise before non-urgent transfer to regional paediatric cardiac centre for full cardiology assessment

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CONGENITAL HEART DISEASE: DUCT-DEPENDENT LESIONS

[Including hypoplastic left heart syndrome (HLHS) and left-sided outflow tract obstructions] • 2/4

- If urgent septostomy anticipated for closed or small (restrictive) atrial septum, cardiologists may recommend delivery at regional NICU – liaise with cardiologist at tertiary centre prior to delivery
- Neonatal team meet parent(s) pre-delivery
- In some cases of HLHS or complex congenital heart disease, comfort care plan may be in place antenatally – clarify with cardiac team and parents before delivery
- When delivery expected, notify on-call neonatal consultant, NNU and paediatric cardiology team at local referral centre

Postnatal

- Some babies, particularly if left heart lesion developed later in gestation, will present when duct closes
- can happen any time during neonatal period and early infancy
- baby is often asymptomatic before duct closes

A baby presenting with cyanosis or shock is a neonatal emergency requiring senior input. These babies can deteriorate very quickly

Symptoms and signs of duct-dependent cardiac disease

- Central cyanosis and/or SpO_2 <95%
- Poor perfusion and shock
- Weak or absent femoral pulses
- Usually limited signs of respiratory distress
- Murmur (in some) – see **Cardiac murmurs** guideline
- Hepatomegaly or other signs of cardiac failure

Investigations

- Chest X-ray
- oligaemia/plethora/congenital anomaly
- 'classic' appearance (e.g. 'boot shaped' heart) is unusual
- Blood gas including lactate
- Echocardiogram if available
- Blood pressure in right upper limb and a lower limb (>20 mmHg difference between upper and lower limb is abnormal)
- Pre-ductal (right upper limb) and post-ductal (lower limb) saturations (SpO_2 of <95% in both limbs or >3% difference is significant) – see **Pulse-oximetry screening** guideline
- Modified hyperoxia test (carries risk of duct closure: discuss with consultant first) to differentiate between respiratory (parenchymal) and cardiac cause of cyanosis including baseline saturation (and blood gas if arterial line *in situ*)
- place baby in 100% ambient oxygen for 10 min
- if there is respiratory pathology, SpO_2 usually rise to ≥95%

IMMEDIATE MANAGEMENT

A suspected cardiac baby presenting collapsed, shocked and/or cyanosed is a challenging neonatal emergency, discuss commencement of prostaglandin infusion urgently with a senior.

Discuss urgently with cardiac centre

Immediate post-delivery and resuscitation

- If antenatally diagnosed duct-dependent lesion, neonatal team (junior and middle grade) should be present at delivery

CONGENITAL HEART DISEASE: DUCT-DEPENDENT LESIONS

[Including hypoplastic left heart syndrome (HLHS) and left-sided outflow tract obstructions] • 3/4

- If baby requires resuscitation do not delay – see **Resuscitation** guideline
- Check SpO_2 using pulse oximetry
- Once stable, transfer baby to NNU immediately in transport incubator (if on saturation monitor, SpO_2 75–85% should be acceptable)

Stable babies with normal breathing and SpO_2 ≥75% may not require intubation

Management in NNU

- Aim to maintain patency of (or open a closed) ductus arteriosus, and optimise systemic perfusion
- Commence prostaglandin infusion (as per antenatal plan if known) through peripheral IV line, or long line (see **Prostaglandin infusion** guideline)
- Unless access extremely difficult, avoid umbilical venous line (cardiac unit may need UVC for septostomy)
- Use **dinoprostone** (prostaglandin E_2, prostin E_2) – see **Prostaglandin infusion** guideline
  - start IV infusion at 5–15 nanogram/kg/min as indicated dose may be increased up to 50 nanogram/kg/min if no response within 1 hr
  - oral Dinoprostin used temporarily on very rare occasions when IV access is extremely difficult – see **Neonatal Formulary**
  - if dinoprostone not available, use prostaglandin E1 (Alprostadil); see **Neonatal Formulary**
- Make fresh solution every 24 hr
- **Be vigilant:** if apnoea occurs secondary to a prostaglandin infusion, intubate baby but do not reduce infusion dose (see **Intubation** guideline)
- Discuss management with cardiac team at regional paediatric cardiac centre
- Echocardiogram if available

Monitor

- SpO_2
- Heart rate and ECG
- Blood gases (including lactate) and avoid acidosis
- Blood pressure (preferably using a peripheral arterial cannula – avoid umbilical lines)
- Avoid hypothermia

Ventilation (see also **Ventilation** guideline)

Indications

- If intubation not needed as emergency, discuss with paediatric intensive care unit (PICU)/cardiac team
- Severe hypoxaemia, acidosis and cardiorespiratory failure
- Apnoea after starting prostaglandin infusion
  - dose >20 nanogram/kg/min (review need for such a high dosage in stable baby)
- Features of high pulmonary flow in case of HLHS
- Elective ventilation, if preferred by paediatric cardiologist or retrieval team lead

Technique

- Use sedation/muscle relaxants as needed
- Avoid hyperventilation, which can increase pulmonary blood flow
- Use supplemental oxygen judiciously if SpO_2 <75%
- Initial settings: PEEP 4–5 cm H_2O, low mean airway pressure, tidal volume 4–6 mL/kg and FiO_2 0.21, adjusted accordingly

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CONGENITAL HEART DISEASE: DUCT-DEPENDENT LESIONS

[Including hypoplastic left heart syndrome (HLHS) and left-sided outflow tract obstructions] • 4/4

- Aim for:
  - $PaCO_2$ 5–7 kPa
  - PaO_2 4–6 kPa
  - pH 7.35–7.40
  - SpO_2 75–85% (although many will run higher in room air)

Inotropes

- If signs of peripheral under-perfusion, discuss using fluid boluses and inotropes (e.g. dobutamine, milrinone etc.) with cardiac centre
- Arrange local echocardiography (if available) to assess contractility

Restrictive atrial septum

- Signs:
  - severe cyanosis
  - cool peripheries
  - pallor
  - respiratory distress
  - X-ray signs of pulmonary oedema with relatively normal heart size. In contrast, if atrial septum is non-restrictive, pulmonary congestion with cardiomegaly and prominent right heart border is likely
- May require balloon atrial septostomy as an urgent procedure. If too unstable for transfer or no beds at cardiac centre, cardiac team may perform as emergency outreach procedure in NNU

High pulmonary blood flow

(especially in left-sided lesions such as HLHS)

Presentation

- If there is too much pulmonary blood flow due to pulmonary 'steal' phenomenon, baby may have:
  - high or near normal saturations
  - metabolic acidosis with a rising lactate
  - low blood pressure (especially low diastolic)
  - cool peripheries
  - tachycardia

Management

- Aim is to improve perfusion and acidosis by balancing systemic versus pulmonary circulation
- Discuss urgently with cardiac centre
- Intubate and ventilate (technique as above)
- Fluid boluses and inotropes as needed

CONJUNCTIVITIS • 1/1

Conjunctivitis is a potentially blinding condition with associated systemic manifestations

RECOGNITION AND ASSESSMENT

- Conjunctival redness
- Swelling of conjunctiva and eyelids
- Purulent discharge

Differential diagnosis

- Sticky eye with blocked tear duct in which there is no inflammation of conjunctiva
- Congenital glaucoma in which there is corneal opacity

AETIOLOGY

- **Bacterial**
  - *Staphylococcus aureus and epidemidis*
  - *Haemophilus influenzae*
  - *Streptococcus* pneumoniae
  - Serratia spp, E Coli, Pseudomonas spp
  - *Neisseria gonorrhoeae* – typical onset 0–5 days of age – mild inflammation with sero-sanguineous discharge to thick, purulent discharge with tense oedema of eyelids
  - *Chlamydia trachomatis* – typical onset 5–14 days of age: mild-to-severe swelling with purulent discharge (may be blood-stained)

Viral

- Herpes simplex virus (HSV)

MANAGEMENT

Sticky eye/blocked tear duct

- 4–6 hrly eye toilet using sodium chloride 0.9%

Conjunctivitis (see signs above)

- Swab all for:
  - Gram stain and bacterial culture and sensitivities
  - if other suspicions of HSV (e.g. vesicles etc.), viral swab for HSV PCR
  - Chlamydia swab (specific for chlamydia PCR)
- Treat both eyes with:
  - frequent eye toilet as necessary
  - chloramphenicol 0.5% eye drops
  - fusidic acid 1% eye drops for *staphylococcus*
- Presentation within first 24 hr suggests gonococcal infection – inform senior paediatrician

SUBSEQUENT MANAGEMENT

In severe non-resolving cases

- Take throat and eye swabs for viral PCR
- If herpes suspected, look for other signs of herpetic infection
- Treat suspected herpes with IV and topical aciclovir for 14 days
- Refer to ophthalmology

Neisseria gonorrhoeae suspected

- Request urgent Gram stain and culture
- Assess baby for septicaemia

Neisseria gonorrhoeae confirmed

- Give single dose cefotaxime 100 mg/kg IV stat
- For severe cases, frequent sodium chloride 0.9% irrigation of the eyes and continue treatment with IV cefotaxime for up to 5 days (consultant decision)
- Refer to ophthalmology
- If due to N gonorrhoea or chlamydia discuss referral to the genitourinary medicine services

Chlamydia result positive

- Treat with erythromycin 12.5 mg/kg 6-hrly for 14 days

Gonococcal or chlamydia infection detected

- Refer mother and partner to genito-urinary medicine for immediate treatment

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FOR COMMON NEONATAL INVESTIGATIONS, INTERVENTIONS AND TREATMENTS

The following guidance is taken from 'Good practice framework for consent in neonatal clinical care' produced by the British Association of Perinatal Medicine (BAPM)

- It is a legal and ethical requirement to gain valid consent before examining and initiating any investigation or treatment for any patient
- Consent is obtained from someone with parental responsibilities:
  - if married, parents
  - if not married, mother but not father, unless father has acquired parental responsibility via a court order, being registered on birth certificate or parental responsibility agreement
  - a legally appointed guardian
  - a local authority designated in a care order or holding an emergency protection order
- Consent is valid only when information has been understood by the parent(s) and explains why the intervention is recommended, its risks and implications, and other options should consent be withheld

Documentation of information given and parent(s) understanding and agreement to proceed is the most important validation of consent. A signature does not in itself confirm informed consent

- Witness consent wherever possible, and record name of witness
- In neonatal practice, there are frequent occasions when no one is available to provide valid consent and treatment is initiated in its absence (e.g. emergency ABC resuscitation, stabilisation, chest drainage or exchange transfusion when delayed treatment would not be in the baby's best interests, or following maternal general anaesthetic when mother is unmarried to baby's father). It should always be possible later to justify the action to the parents and to reassure them that it was in the baby's best interests

GOOD PRACTICE

- Give parents of babies admitted to neonatal unit written information (BLISS booklet http://www.bliss.org.uk/information-for-parents/) describing low-risk procedures such as venesection, for which explicit consent is not normally sought
- Give parents information leaflet for data collection, allowing them to opt out

Written explicit consent

Purpose and risks of an intervention are formally explained and consent obtained and recorded before the intervention

Table 1: Explicit consent (recorded in patient notes, and supported by a signature) is required for:

Investigation/intervention	
Clinical photographs and video-recordings	Use consent form specific for this purpose
Any biopsy or aspiration	For example: skin, liver, bone marrow
Exchange transfusion	
Treatment for retinopathy	Obtained by ophthalmologist
Surgical procedures	Consent taken by surgical team. If telephone consent required and mother still an in-patient, midwife on postnatal ward or neonatal team to act as witness
Post-mortem	See **Death** guideline and use specific form. Usually obtained through consultant or senior middle grade staff

Table 2: Explicit oral consent
Explicit consent as defined above, documented, but not supported by a signature, required for the following:

Explicit oral consent	
Investigations	● Screening baby and/or mother in high-risk situations with no knowledge of maternal status (e.g. HIV, substance misuse) ● Genetic testing ● Gut imaging involving contrast ● MR/CT imaging
Practical procedures	● Therapeutic lumbar puncture (LP) or ventricular tap in absence of reservoir* ● Peripherally-placed long lines* ● Brachial or femoral arterial line ● Chest drain insertion/replacement* ● Abdominal drainage for perforation or ascites* ● Irrigation following extravasation* ● Hearing screening
Immunisations	See **Immunisations** guideline
Treatments	● Vitamin K for normal term babies ● Nitric oxide ● Postnatal steroids for chronic lung disease ● Use of donor breast milk
Transport	● Emergency transfers ● Routine transfers for out-patients or back-transfers ● **NB:** Initiation of cooling for neuroprotection does not require explicit consent, but transfer to another unit for formal cooling does

* It is accepted that, in some circumstances, these procedures are performed in an emergency in baby's best interests and may be performed without oral consent; owing to risks associated with procedures or conditions in which they are necessary, it is considered best practice to inform parents as soon as possible and to document this in baby's notes

Others: Implicit consent

- Where the nature and risk of the procedure is such that a less formal transfer of information is considered sufficient, and is often retrospective
- List of investigations, procedures and treatments is long, see **Table 3**
- If unsure, seek senior advice

Explain all investigations, procedures and treatments to parents at earliest opportunity

Table 3: Implicit consent

Implicit consent	
Examination and investigations	● Examining and assessing baby ● Routine blood sampling ● Septic screen ● Diagnostic LP (possible infectious or metabolic illness) ● Suprapubic aspiration of urine ● Screening for infection in response to positive results of maternal screening (e.g. known maternal HIV or substance abuse) ● CMV, toxoplasmosis, rubella and herpes screening ● X-ray and ultrasound ● ECG ● Retinopathy of prematurity (ROP) screening
Practical procedures	● Umbilical line insertion ● Percutaneous arterial lines (radial, posterior tibial only) ● Peripheral venous lines ● Nasogastric tube insertion ● Tracheal intubation ● Ventilation/CPAP ● Urethral catheterisation
Treatments: blood products	● Blood transfusion ● Use of pooled blood products e.g. FFP ● Partial exchange transfusion
Treatments: drugs	● Antibiotics ● Vitamins/minerals ● Surfactant ● Anticonvulsants ● Sedation for intubation and ventilation ● Inotropes ● Indometacin or ibuprofen for patent ductus arteriosus (PDA) ● Prophylactic indometacin ● Postnatal dexamethasone for laryngeal oedema
Nutrition/fluids	● Breast milk fortification ● Intravenous fluids ● Parenteral nutrition

DOCUMENTATION

- Documentation, supported by a signature for written explicit consent
- Documentation of oral explicit consent
- Provide parents with information sheets

CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) • 1/4

DEFINITION

- Non-invasive respiratory support utilising continuous distending pressure during inspiration and expiration in spontaneously breathing babies

Benefits

- Improves oxygenation
- Reduces work of breathing
- Maintains lung volume
- Lowers upper airway resistance
- Conserves surfactant

INDICATIONS

- Early onset respiratory distress in preterm babies
- Respiratory support following extubation
- Respiratory support in preterm babies with evolving chronic lung disease
- Recurrent apnoea (in preterm babies)
- Atelectasis
- Tracheomalacia

CPAP following extubation

- Consider in babies of <32 weeks' gestation

CONTRAINDICATIONS

- Any baby fulfilling the criteria for ventilation
- Irregular respirations
- Pneumothorax without chest drain
- Nasal trauma/deformity that might be exacerbated by use of nasal prongs
- Larger, more mature babies often do not tolerate the application of CPAP devices well
- Congenital anomalies:
  - diaphragmatic hernia
  - choanal atresia
  - tracheo-oesophageal fistula
  - gastroschisis

When in doubt about CPAP indications or contraindications, discuss with consultant

TYPES OF CPAP (exact CPAP device will vary from unit to unit)

1. **Standard CPAP**
2. **Two-level CPAP**
3. **Bubble CPAP**

1. STANDARD CPAP

Equipment

- Short binasal prongs and/or nasal mask
- Circuit
- Humidification
- CPAP generating device with gas mixing and pressure monitoring
- All require high gas flow (usual starting rate 8 L/min)

Fixing nasal CPAP device: short binasal prongs (preferred)

- To avoid loss of pressure, use largest prongs that fit nostrils comfortably
- Ensure device is straight and not pressed hard against nasal septum or lateral walls of nostrils. Excessive pressure can cause tissue damage

Nasal mask

- Fit securely over nose
- consider alternating mask with prongs, particularly if baby developing excoriation or erosion of nasal septum. Masks can also result in trauma, usually at the junction between the nasal septum and philtrum
- Masks can give a poor seal and can obstruct

Procedure

Position baby

- Prone position is preferable
- Avoid excessive flexion, extension or rotation of the head

Set up equipment (see specific manufacturer instructions)

- Connect humidification to CPAP
- Connect CPAP circuit with prongs to CPAP device
- Place CPAP hat on baby
- Turn on CPAP flow and set pressure
- Attach CPAP circuit to CPAP hat and apply prongs/mask

Pressure range

- Start at 5–6 cm H_2O initially and increase by 1 cm H_2O increments
- Optimum pressure depends on illness type and severity – watch baby and use lowest pressure required to improve work of breathing

High pressures (≥10 cm H_2O) may restrict pulmonary blood flow, increase air leak risk and cause over-distension

CPAP 'failure'

- 'Failure of CPAP' implies a need for ventilation. Consider intubation and surfactant for preterm babies on CPAP as initial therapy if:
- early chest X-ray demonstrates RDS and if any of the following apply:
  - FiO_2 consistently >0.5
  - marked respiratory distress
  - persistent respiratory acidosis
  - recurrent significant apnoea
  - irregular breathing

Checks

- Before accepting apparent CPAP 'failure' exclude:
- pneumothorax
- insufficient pressure
- insufficient circuit flow
- inappropriate prong size or placement
- airway obstruction from secretions
- open mouth

Complications

- Erosion of nasal septum: reduce risk by careful prong placement and regular reassessment
- Gastric distension: benign, reduce by maintaining open nasogastric tube

Weaning CPAP

When

- Start when baby consistently requiring FiO_2 <0.30, pressure 5 cmH_2O and stable clinical condition
- If nasal tissue damage significant, consider earlier weaning

How: 'Pressure reduction' or 'Time off'

- **Pressure reduction**
- more physiological approach although can increase the work of breathing if pressure is too low. Has been shown to be quicker than 'time off' mode
- wean pressures in steps of 1 cm H_2O every 12–24 hr. If no deterioration discontinue CPAP after 24 hr of 4–5 cm H_2O and minimal oxygen requirement
- **Time off CPAP**
- plan using 2 x 12 or 3 x 8 hr time periods
- The following regimen of cycling CPAP can be adapted to individual situations

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Day 1	1 hr off twice a day (1 off, 11 on)
Day 2	2 hr off twice a day (2 off, 10 on)
Day 3	3 hr off twice a day (3 off, 9 on)
Day 4	4 hr off twice a day (4 off, 8 on)
Day 5	6 hr off twice a day (6 off, 6 on)
Day 6	Off CPAP

Note: High-flow humidified oxygen therapy

- Increasingly used as non-invasive respiratory support
- Offers theoretical advantages over CPAP in ventilating upper airway spaces and producing less nasal tissue damage
- When weaning CPAP, consider using 5–6 L/min of high-flow humidified oxygen (e.g. Vapotherm or Optiflow) rather than low-flow nasal cannulae oxygen or lower pressure CPAP

Failure of weaning

- Increased oxygen requirement, increasing respiratory distress and/or worsening respiratory acidosis during weaning should necessitate a review and consider escalation of support

2. TWO-LEVEL CPAP

- Two-level CPAP at a rate set by clinician (biphasic) or triggered by baby using an abdominal sensor (biphasic trigger or Infant Flow® SiPAP)
- Inspiratory time, pressures and apnoea alarm limit set by clinician
- Indications/contraindications as CPAP and can be used when baby's clinical condition is not improving despite CPAP

Theoretical advantages over CPAP

- Improved thoraco-abdominal synchrony
- Better chest wall stabilisation
- Reduced upper airway resistance
- Reduced work of breathing

Specific modes of two-level CPAP (specific names vary with manufacturer)

CPAP and apnoea

- CPAP with added advantage of apnoea monitoring via a sensor attached to abdomen
- Apnoea alarm is triggered when no breaths are detected within set time-out period

Biphasic

- Bi-level pressure respiratory support with or without apnoea monitoring
- Higher level pressure rise above baseline CPAP that is delivered intermittently at pressure, rate and inspiratory time set by clinician
- Not synchronised with respiratory effort

Biphasic trigger (tr)

- Bi-level pressure respiratory support with inbuilt apnoea monitoring
- Higher level pressure rise above baseline CPAP at rate determined by, and in synchrony with, baby's respiratory effort sensed through an abdominal sensor
- Pressure, inspiratory time and back-up rate set by clinician

Clinical use

Biphasic

- Begin with CPAP pressure of 5–6 cm H_2O
- Set peak inspiratory pressure (PIP) at 3–4 cm H_2O above CPAP and rate 30 breaths/min
- Keep Ti and apnoea alarm delay at default setting
- If CO_2 retention occurs, review baby and consider increase in rate and/or PIP
- Avoid over-distension and keep PIP to a minimum for optimum chest expansion

Weaning

- By rate and pressure
- If rate >30 bpm, wean to 30 bpm
- Reduce MAP, by reducing PIP by 1 cm H_2O every 12–24 hr
- When baby breathing above 30 bpm change to biphasic tr mode
- When MAP 5–6 cm H_2O, change to CPAP

Biphasic trigger

- Begin with CPAP pressure of 5–6 cm H_2O with PIP at 3–4 cm H_2O
- Keep Ti and apnoea alarm delay at default setting
- Set back-up rate at 30 bpm

Weaning

- Reduce MAP by reducing PIP by 1 cm H_2O every 12–24 hr
- Once MAP 5–6 cm H_2O, change to standard CPAP
- If deterioration occurs during weaning process, assess baby and consider returning to biphasic mode

3. BUBBLE CPAP

This is an alternative method of CPAP that may reduce work of breathing through facilitated diffusion

Equipment

- Fisher & Paykel bubble CPAP system:
  - delivery system: humidifier chamber, pressure manifold, heated circuit, CPAP generator
  - patient interface: nasal tubing, nasal prongs, baby bonnet, chin strap

Procedure

- Connect bubble CPAP system to baby as per manufacturer's instructions
- Ensure appropriate size nasal prongs used
- Bubble CPAP nasal prongs are designed **not to rest on nasal septum**. Ensure prongs are not resting on the philtrum nor twisted to cause lateral pressure on septum, and allow a small gap between septum and prongs
- Commence at pressures of 5 cm H_2O

Bubble CPAP failure

- See **CPAP failure** in **1. STANDARD CPAP**

Before inferring bubble CPAP failure

- Ensure baby has been receiving bubble CPAP appropriately by checking for continuous bubbling in CPAP generator, lack of bubbling can result from pressure leaks in the circuit or baby

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COOLING IN NON-COOLING CENTRES REFERRAL AND PREPARATION OF ELIGIBLE INFANTS FOR ACTIVE COOLING • 1/3

ASSESSMENT

- **Babies ≥36 weeks gestation, meeting criteria A and B and aged ≤6 hr are** eligible for treatment with cooling
- Infants 35^{+0}–35^{+6} weeks' gestation but meeting criteria A and B and are aged ≤6 hr, discuss with a cooling centre as they may be suitable for treatment
- If in doubt about the suitability of any baby for cooling, discuss with a cooling centre

Criterion A one or more of

- Apgar score ≤5 at 10 min after birth
- Continued need for resuscitation, including endotracheal or mask ventilation at 10 min after birth
- Acidosis within 60 min of birth (defined as umbilical cord, arterial or capillary pH <7.00)
- Base deficit ≥16 mmol/L in umbilical cord or any blood sample (arterial, venous or capillary) within 60 min of birth

Criterion B

- **Seizures OR moderate-to-severe encephalopathy, consisting of:**
- altered state of consciousness (reduced or absent response to stimulation) **and**
- abnormal tone (focal or general hypotonia, or flaccid) **and**
- abnormal primitive reflexes (weak or absent suck or Moro response)

REFERRAL

Consent

- Discuss option of cooling treatment with parents as soon as practically possible. It is not necessary to wait for formal consent before starting passive cooling
- Document discussions in baby's notes

In addition

- Request cord gases (if not already obtained)
- Request midwives save placenta for histological examination

Passive cooling

- As soon as decision made to refer for cooling, referring unit telephones cooling centre and begins passive cooling
- document this time as 'age when passive cooling commenced' on TOBY cooling form (see **Stabilisation phase** below)
- document baby's temperature at this time
- begin passive cooling by switching off any overhead heater and active heating in a transport incubator
- Nurse baby in an open Babytherm cot with heater switched off
- If baby nursed in an incubator, open portholes
- Nurse baby naked apart from a nappy

Continuous rectal temperature monitoring

- Insert a rectal thermometer to 6 cm and commence continuous rectal temperature monitoring. If rectal temperature monitoring unavailable, perform axillary temperature monitoring every 15 min
- Target rectal temperature 33–34ºC

Regular communication between referring unit and cooling centre is vital

- Once baby accepted by a cooling centre, contact neonatal transport team to arrange transport of baby
- Discuss methods of cooling with cooling centre, before arrival of neonatal transport team. Use fans or gloves filled with cold water **only** if continuous rectal temperature monitoring is in place

Never use ice filled gloves to cool a baby as this can bring the temperature down to dangerously low and uncontrolled levels

STABILISATION PHASE

Passive cooling

Use the referral form from the website:

http://www.networks.nhs.uk/nhs-networks/staffordshire-shropshire-and-black-country-newborn/care-pathways

- **Ensure baby's temperature does not fall below 33ºC.** Document every 15 min
- Follow **Passive cooling protocol flowchart**
- Care continues in referring unit with advice from cooling centre
- If not already intubated at delivery, electively intubate and ventilate baby for transfer (see **Intubation** guideline)
- If possible, insert umbilical arterial and venous catheters and monitor arterial blood pressure – see **Umbilical artery catheterisation** and **Umbilical venous catheterisation** guidelines. Check position of lines on X-ray
- Aim to maintain arterial $PaCO_2$ of 6–8 kPa
- Sedate baby using either morphine at an infusion rate of 20 microgram/kg/hr or alternative sedation as per local guidelines. Aim for heart rate of 100 bpm. Faster rates may be a sign of distress, in which case increase sedation
- Maintain mean arterial blood pressure at >45 mmHg. See **Hypotension** guideline
- Restrict total fluids to 40 mL/kg/day initially
- Keep glucose within normal range – use higher glucose concentration infusion if necessary. See **Hypoglycaemia** guideline
- Take blood for blood culture, FBC, arterial blood gas, lactate, electrolytes, urea and creatinine, calcium, magnesium, prothrombin time, APTT, glucose and LFT

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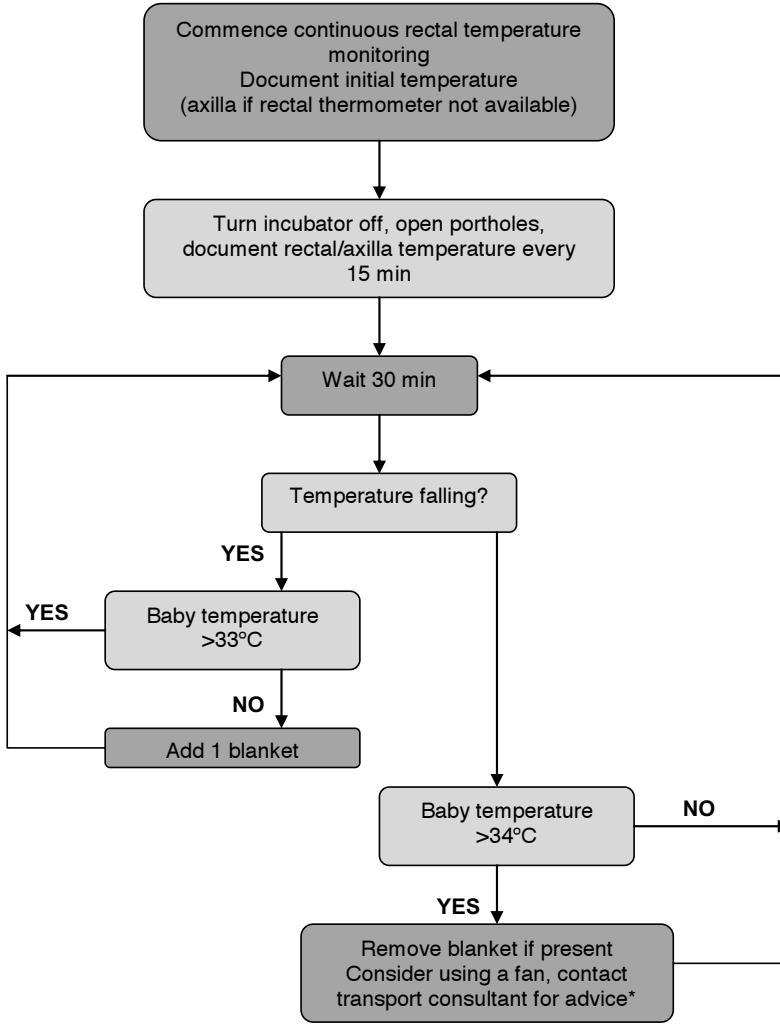
COOLING IN NON-COOLING CENTRES REFERRAL AND PREPARATION OF ELIGIBLE INFANTS FOR ACTIVE COOLING • 3/3

Passive cooling protocol



Do not use ice packs for cooling as severe hypothermia can result

Do not use active cooling (e.g. fan) unless rectal temperature is monitored

CRANIAL ULTRASOUND SCANS • 1/3

PURPOSE

- To detect brain injury in at-risk babies in order to provide appropriate medical management
- To detect lesions associated with long-term adverse neuro-developmental outcome

ROUTINE SCANNING PROTOCOL FOR PRETERM BABIES

- Scan preterm babies according to the following minimum regimen
- Scan babies of ≥33 weeks' gestation only if clinically indicated

Gestation					
<30 weeks	0–3 days		6–10 days	14–16 days	36 weeks CGA or at discharge
30–32 weeks		3–7 days			36 weeks CGA or at discharge

Additional scans

- If routine scans show a significant abnormality, discuss serial scanning with consultant
- Perform additional scans as clinically indicated or following a significant clinical event:
  - necrotising enterocolitis
  - major collapse
  - repeated severe episodes of apnoea and bradycardia
  - unexplained sharp fall in haemoglobin
  - change in neurological status
  - abnormal head growth
  - pre- and post-operatively

Follow-up

- If scan abnormal at 6 weeks, discuss the need for further imaging with consultant

INDICATIONS FOR SCANNING TERM/NEAR TERM BABIES

- Neonatal encephalopathy/ischaemic brain injury
- Neonatal seizures
- Abnormal neurological signs (e.g. floppy child, large head)
- Multiple congenital abnormalities (except trisomy 21)
- Unexplained poor feeding at term
- Unexplained hypoglycaemia, looking for pituitary and midline structures
- Meningitis
- Congenital viral infection
- Metabolic disorders
- Suspected brain malformations
- Consider further imaging e.g. MRI scan or, if ultrasound abnormal, CT scan of brain
- Significant maternal alcohol intake during pregnancy

Seizures

- In term babies with seizures, perform cranial ultrasound on admission and at 2 and 7 days while waiting for an MRI scan to be performed. MRI scan is the preferred imaging modality

Neonatal encephalopathy

- Initial scan within 24 hr
  - 2nd scan 3–4 days
  - 3rd scan 7–14 days

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- In encephalopathic babies with significant birth trauma and low haematocrit, request non-contrast CT scan to exclude extra-axial bleed
- For babies with moderate-to-severe encephalopathy, MRI scan recommended between 7–14 days of life

PROCEDURE

Operator must achieve an acceptable level of competence before performing and reporting scans independently

- Record minimum set of coronal (6+ images):
  - anterior to frontal horns of lateral ventricles
  - at anterior horns of lateral ventricles and Sylvian fissures
  - at 3rd ventricle and thalami
  - at posterior horns of lateral ventricles (with choroids)
  - posterior to choroids (posterior brain substance)
  - if lateral ventricules are dilatated, measure the ventricular index at the level of 3rd ventricle at the foramina of Munro (ventricular index) and plot on appropriate chart
- Record minimum set of sagittal (5+ images):
  - midline through 3rd ventricle, septum cavum pellucidum, cerebellum with 4th ventricle and foramen magnum
  - through each lateral ventricle showing anterior and posterior horns, with caudothalamic notch imaged if possible
  - through each hemisphere lateral to the ventricle for deep white matter
- Supplemental oblique, surface and axial images may be necessary to record pathology
- For detection of cerebellar lesions, scanning through posterior fontanelle (junction of lambdoid and sagittal sutures) and mastoid fontanelle (junction of posterior parietal, temporal and occipital bones) can be useful

SCAN REPORTING

- Appropriately trained staff must interpret cranial ultrasound scans
- Scans must be reported using categories/terminology in **Table** below

Intraventricular haemorrhage	● None ● Localised IVH without dilatation (germinal matrix haemorrhage, subependymal haemorrhage) ● IVH with ventricular dilatation ● Large IVH with parenchymal infarction
Ventricular size	● Normal ● Enlarged (measure and plot ventricular index)
Parenchymal lesions	● None ● Periventricular flare ● Cystic lesions ○ single large porencephalic cyst ○ multiple cysts (cystic periventricular leukomalacia)

COMMUNICATION

- Any member of neonatal team may communicate a normal result to parents but **note** that a normal scan does not equate to normal development and follow-up is essential
- Discuss an abnormal result with neonatal consultant before discussion with parents – an abnormal scan does not equate to abnormal development, follow-up is essential
- Offer parents the BLISS hydrocephalus information leaflet available for download from http://www.bliss.org.uk/factsheets

DOCUMENTATION

- Documentation is extremely important. Archive digital copies of scans for future review – each image must contain patient identifiers
- Record following information on investigation chart:
  - date scan requested
  - date scan carried out
- Record ultrasound result (or file a written report) in baby's notes (neonatal staff)
- Complete Cranial ultrasound ad hoc form in BadgerNet
- Record a plan for performing future scans
- Record in notes any discussion with parents, especially of abnormal scans
- Include results of all scans in discharge summary, even if normal
- If eligible baby transferred to another hospital before scanning, communicate need for scan in transfer summary

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Consultant must be involved immediately in the care of a seriously ill baby

GUIDANCE

Preparation

- Most neonatal deaths are anticipated and often occur following withdrawal of intensive care. The neonatal staff in conjunction with the parents should plan the care of the baby around death
- If baby's condition deteriorates seriously, discuss immediately with on-call consultant
- On-call consultant will assess the situation with nursing and medical team, ensuring thorough documentation

Discussion with parents

- If death is inevitable, consultant will discuss with parents
- ensure baby's nurse is present and document discussion
- Ask parents if they wish a religious or spiritual person to be involved
- Use the BLISS booklet 'Making Critical Care Decisions' as appropriate
- Complete the Midlands Newborn Network Integrated Comfort Care Pathway (ICCP). This document:
- acts as a record of events and a guide for palliative care
- contains useful links for further information
- if transfer home or to a hospice complete the Advanced Care Pathway West Midlands, as dictated by local team/hospice

Second opinion

- If there is disagreement amongst the multidisciplinary team or between the team and the parents, consultant to seek second opinion from a colleague

Further support

- If parents do not accept second clinical assessment:
- discuss with medical director or deputy
- discuss with parents the option of a further opinion from consultant neonatologist from another unit in neonatal network
- Consultant may wish to seek advice from Trust's legal advisers via medico-legal department or on-call manager
- Timescale for events in individual babies may vary from under 24 hr to over 1–2 weeks

Good documentation is essential

Saying goodbye

- Parents may request a blessing or naming ceremony by a religious representative
- Ensure all family members are allowed time and privacy with baby
- Consider an appropriate place of care for baby, including transfer to a hospice if available/appropriate and parents desire this
- Ensure parents have had opportunity to take photographs of their baby
- if local transport facility unavailable, contact regional transport team to facilitate this
- Provide a keep-sake box that can include photos, hand and foot prints, lock of hair, cot card, etc.
- If parental ethnicity and religious beliefs allow, offer parents opportunity to wash, dress and prepare baby
- A small toy or other memento may accompany baby to mortuary

DEATH

- When a baby dies, there are formalities to be completed. These should be handled as sensitively as possible to minimise emotional trauma to parents, whose wishes should be respected and who should be guided carefully through the necessary procedures
- Following notification of baby's death from attending nurse, a doctor or ANNP should confirm the death and make a suitable entry in the case notes with date and time of confirmation of death
- If the death was sudden and unexpected (e.g. resuscitation failure in delivery suite or in the A&E soon after arrival):
  - if no radiological confirmation of position of endotracheal tube (ET), another practitioner must verify position on direct laryngoscopy before removal, and the depth of insertion (from lips or nostril) should be recorded. A post mortem X-ray is not necessary for such confirmation
  - similarly, leave all central vascular catheters and drains *in situ* after cutting short and covered with dressing

Ensure baby's correct registered name appears on all documentation

Formal arrangements

- Neonatal staff will offer advice about registration and funeral arrangements with back-up support from hospital general office/bereavement office
- Involve bereavement midwife early if available
- In some areas, all deaths must be discussed with Coroner's officer. Check the requirements of your local Coroner before issuing death certificate and requesting post-mortem consent
  - if you are unable to issue death certificate, a senior clinician must report the death to the Coroner for a Coroner's post-mortem
- If death certificate can be issued:
  - parents make an appointment with Registrar of births and deaths to deliver death certificate, unless Coroner's officer recommends otherwise
- Registrar of births and deaths will issue certificate of authority for burial or cremation, which should be given to:
  - hospital general office, if hospital is burying baby
  - funeral director handling burial, if parents are making their own arrangements

Post-mortem

- Request a post-mortem in all babies not requiring investigation by the coroner. It is parents' right to have this choice
  - give parents an information leaflet to assist their choice
  - if case required Coroner investigation, Coroner determines need for post-mortem and parents cannot choose
- The post-mortem request must come from a middle grade doctor and a witness must sign the fully completed consent form
  - send original form to mortuary with baby, place copies in baby's hospital notes together with copy of death certificate
  - death summary must be completed by middle grade doctor within 24 hr of death
  - copy of death summary must be sent to mortuary to accompany baby having a post-mortem

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Baby transfer

- Special arrangements will be made to transport baby to mortuary according to local hospital policy allow parents to accompany baby if they wish
- some may prefer to see their baby on the neonatal unit if possible or chapel of rest
- Parents may take baby's body directly from the neonatal unit, once appropriate documentation has been completed (see SANDS website). Where babies are taken will depend upon religious belief of parents or designated funeral director. In all cases strict adherence of local hospital policy must apply

Parent support

- Offer bereavement support information (e.g. SANDS; Child bereavement UK, ACT) or counsellor
- consultant will offer bereavement counselling at 6–8 weeks, or following final post-mortem result
- arrange an appointment with trained bereavement nurse/midwife specialist if available

Communication

- Inform named obstetrician and neonatology consultants at referring hospital (if appropriate), GP, health visitor, and community midwife that death has occurred
- Document this in notes or on local checklists
- Ensure any pending appointments or referrals are cancelled
- follow local guidelines for notifying child death and completion of form A and B for death reviews (legal requirement)
- Use local bereavement checklist

INTRODUCTION

- Developmental needs are an integral part of care planning; these differ according to gestational age, postnatal age and health status. Assess developmental needs and plan care responsive to baby's stress threshold and sleep/wake pattern

Key concepts

- Promoting organised neuro-behavioural and physiological function
- Altering the physical environment to protect vulnerable developing sensory systems
- Family-centred care

Goals

- Improved physiological stability
- Reduced stress and pain
- Appropriate sensory experience
- Protection of postural development
- Improved sleep patterns
- Improved feeding
- Confident parenting and attachment
- Staff satisfaction
- Improved neuro-developmental outcomes

OBSERVATION AND RECOGNISING BEHAVIOURAL CUES

- Recognition of signs that baby may be experiencing stress is vital. Babies will display different cues at different stages of development according to their behavioural state (wake/sleep state)

Defensive/avoidance behaviour	Coping/approach behaviour
● Any of the following indicate baby may need help or some time out: ○ respiratory pauses, tachypnoea, gasping ○ yawning, sighing ○ gagging, posseting ○ hiccoughing ○ sneezing ○ coughing ○ straining ○ flaccidity (limp posture) trunk, limbs, face, mouth ○ hypertonicity with hyperextension (stiff posture) ○ arching ○ finger splays, 'high guard hands', 'saluting' ○ hand-on-face, fisting ○ facial grimace ● Frantic diffuse motor activity: ○ squirming ○ disorganised transition between and rapid changes of behavioural state ○ fussing or irritability ○ staring or gaze averting ○ hyper alertness ○ crying/whimpering	● The following may indicate how well baby is able to settle itself, cope with interventions and to interact ○ able to regulate colour and breathing pattern ○ reduction of tremors, twitches and autonomic stress cues ○ smooth well-modulated posture and normal tone ○ smooth movements ○ hand and foot clasping ○ grasping ○ hand-to-mouth activity ○ hand holding ○ hands to midline ○ rooting/sucking ○ defined sleep states ○ focused, shiny-eyed alertness or animated facial expression ○ 'ooh' face ○ cooing ○ attentional smiling ○ easily consoled

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CARE-GIVING AND INTERVENTIONS

- Handling and invasive procedures may cause:
  - destabilisation of blood flow, cardiac regulation, oxygenation and digestive functions
  - discomfort, pain and iatrogenic injury
  - poor thermo-regulation
  - disrupted growth
  - altered sleep patterns with disordered transition between states
  - delay in development of normal movement and posture
  - diminished parental confidence and competence

Whenever possible all care-giving and intervention should be carried out by two people, one person performs the intervention; the other provides the baby with comfort and support

Aim	Method

● Plan and deliver individualised care and interventions (nursing and medical), in accordance with baby's cues, promoting physiological stability and self-calming behaviours
● Protect baby's sleep and ability to self-regulate
● Avoid pain, distress and iatrogenic injury
● Protect developing musculoskeletal systems by promoting midline postures and symmetry
● Increase parents' confidence and competence
	● Closely observe baby's physiological, motor and behavioural cues. Plan, adapt and pace care-giving and interventions in response
	● Have all necessary equipment ready before starting
	● Approach baby carefully, using soft voice and gentle touch, allowing time to adjust before beginning
	● Keep lighting and noise levels low
	● Support and comfort baby throughout:
	  ● administer appropriate analgesia including sucrose and MEBM
	  ● avoid totally exposing baby
	  ● facilitate baby's self-calming strategies according to behavioural cues e.g. non-nutritive sucking, grasping, hand-to-mouth and foot bracing
	  ● use swaddling and containment (hands/nest/soft blanket or clothing) to provide support during care or procedure
	  ● allow baby 'time out' to recover if cues indicate stress. Recommence when baby is calm
	● Use side-lying position for cares, including nappy changes. Promote a flexed position with limbs tucked in. Do not lift baby's legs, place soles of feet together and roll side-to-side instead
	● Use containment and swaddling for transfers into/out of incubator/cot, weighing, and bathing. Move baby slowly, in flexed, side-lying position, close to carer's body
	● Promote positive touch and active parental role
	● Promote kangaroo care as soon as possible (see **Kangaroo care** guideline)
	● Ensure baby is settled, comfortable and stable before leaving the bedside

DEVELOPMENTAL DYSPLASIA OF THE HIP (DDH) • 1/2

INTRODUCTION

- DDH ranges from mild acetabular dysplasia with a stable hip through more severe forms of dysplasia, often associated with neonatal hip instability, to established hip dysplasia with or without later subluxation or dislocation
- Delayed diagnosis requires more complex treatment and has a less successful outcome than dysplasia diagnosed early
- Screening for DDH is part of the Newborn and Infant Physical Examination (NIPE)

DDH IS MORE COMMON IN BABIES WITH

- Family history of first degree relative with DDH
- Breech presentation during pregnancy
- Hip abnormality on clinical examination
- Structural foot abnormality – congenital calcaneovalgus, fixed talipes equinovarus
- Significant intrauterine moulding – congenital torticollis, congenital plagiocephaly
- Birth weight >5 kg
- Oligohydramnios
- Multiple pregnancy
- Prematurity
- Neuromuscular disorders

SCREENING FOR DDH

- All babies are offered a NIPE and it must have been completed by 72 hr of age
- The NIPE must include questions to the parents in order to find risk factors for DDH and a thorough examination looking for hip abnormalities
- parents should be asked “Is there anyone in the baby’s close family, i.e mother, father, brother or sister, who has had a hip problem that started when they were a baby or young child and that needed treatment with a splint, harness or operation?”
- examination will include Ortolani and Barlow tests. Ortolani and Barlow tests will detect an unstable hip or a hip that is dislocated or subluxed but reducible. They will not detect an irreducible hip which is best detected by identifying limited abduction of the flexed hip

ULTRASOUND SCREENING

- Selective ultrasound examination for babies with **specific risk factors** is recommended
- **A hip ultrasound should be performed if:**
- there is **a first degree family history of hip problems** in early life, unless DDH has definitely been excluded in that relative
- **breech presentation**
  - at or after 36 completed weeks of pregnancy, irrespective of presentation at delivery or mode of delivery, **or**
  - at delivery if this is earlier than 36 weeks
  - in the case of a multiple birth, if any of the babies falls into either of these categories, all the babies in this pregnancy should have an ultrasound examination
- **structural foot deformity**
  - congenital calcaneovalgus, fixed talipes equinovarus
- **significant moulding**
  - congenital torticollis, congenital plagiocephaly
- **clicky but stable hips**
  - clicks should be distinguished from ‘clunks’ during examination. Most clicks are benign and result from soft tissue movement
- **Urgent referral and urgent hip ultrasound should be performed if:**
- **abnormal hip examination**
  - positive Ortolani or Barlow test or limited hip abduction (<60º when hip is flexed to 90º)

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PROCESS

No risk factors on history and normal examination

- No further intervention needed
- Inform parents and document findings
- These babies will be rechecked at their 6–8 week check

Specific risk factor (as detailed above) on history and/or examination

- Inform parents of findings and plan for further investigation
- Document findings and plan
- Request outpatient hip ultrasound to be performed by 6 weeks
- preterm babies should be scanned at term +4 weeks
- Departments need to have a system in place to review all hip scan results and inform parents as they are reported
- babies with a normal hip scan require no further action and will be re-examined at their 6-8 week check
- babies with an abnormal hip scan require an expert consultation* by 8 weeks

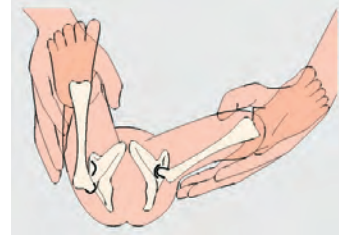
Dislocated/dislocatable/ unstable hip – positive Ortolani or Barlow test or limited hip abduction

- Review by middle grade or consultant to confirm diagnosis
- Inform parents of findings and plan for further investigation and management
- Document findings and plan
- Urgent referral to the paediatric physiotherapist/orthopaedic team
- Physiotherapist/orthopaedic team will see the patient as soon as possible
- Physiotherapist/orthopaedic team will
- assess the baby
- fit a pelvic harness if needed
- request an urgent hip ultrasound to be performed within 2 weeks
- arrange further paediatric orthopaedic review
- Babies need an expert consultation* by 4 weeks
- Check local policy regarding referring to physiotherapy/orthopaedic team and urgent ultrasound. A service may be provided locally or a referral to a tertiary centre paediatric orthopaedic team may be required

* Expert consultation is defined as 'seen by a clinician who is able to diagnose and initiate treatment for this particular condition'. In some trusts this service is run jointly by the physiotherapy and orthopaedic teams

HIP EXAMINATION (SEE DIAGRAM)

Barlow test (left) and Ortolani test (right). In the Barlow test (baby's right hip), the hip is adducted and flexed to 90º; the examiner holds the distal thigh and pushes posteriorly on the hip joint. The test is positive when the femoral head is felt to slide posteriorly as it dislocates. In the Ortolani test (baby's left hip), the pelvis is stabilised by the examiner and each hip examined separately. In a baby with limited hip abduction in flexion, the hip is flexed to 90º and gently abducted while the examiner's finger lifts the greater trochanter. In a positive test the femoral head is felt to locate into the acetabulum



DISCHARGE FROM NEONATAL UNIT • 1/2

DECISION TO DISCHARGE

- Only consultant or middle grade may discharge: check local practice
- Medical and nursing staff to agree discharge date with parents or persons with parental responsibility
- Nursing team perform majority of discharge requirements

DISCHARGE CHECKLIST

Where appropriate, the following must be achieved before discharge:

Parental competencies

- Administration of medications when required
- Baby cares (e.g. nappy changes, top and tailing, bathing etc.)
- Feeding
- Nasogastric tube feeding where necessary
- Stoma care (surgical babies)

Parent education (according to local practice)

- In addition to above, it is best practice to offer parents education on:
- basic neonatal resuscitation (practical demonstration or leaflet/DVD etc.)
- respiratory syncytial virus (give BLISS leaflet, http://www.bliss.org.uk/Shop/common-winter-illnesses)
- immunisations, if not already received (give national leaflet)

Parent communication

- Check home and discharge addresses and confirm name of GP with parents
- Complete Red book (include immunisations given and dates) and give to parents
- Give parents copy of discharge summary and time to ask questions after they have read it
- Follow local policy for breast pump loan and/or return
- Ensure parents have information regarding local breastfeeding groups for ongoing support, and BLISS support group meeting
- Ensure parents have up-to-date safety information
- if transporting in a car, use suitable car seat
- If transferring to another unit, ensure parents understand reason for transfer. Provide information about receiving unit
- Ensure remaining breast milk in hospital fridge/freezer given to take home

Parent information

Local unit discharge pack

Offer parents the following information, available from:

http://www.bliss.org.uk/Shop/going-home-the-next-big-step

Procedures/investigations

- Newborn bloodspot – see **Bloodspot screening** guideline
- for babies <32 weeks' gestation, repeat on day 28 or the day of discharge if sooner
- When immunisation (2, 3 and 4 month) not complete in preterm babies, inform GP and health visitor
- Give BCG immunisation if required – see **BCG immunisation** guideline
- Complete audiology screening – see **Hearing screening** guideline
- Where required, confirm ophthalmology appointment date – see **Retinopathy of prematurity (ROP) screening** guideline
- If going home on oxygen, follow appropriate guidelines

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Professional communication

- Complete admission book entries
- Inform:
  - health visitor of discharge
  - community midwife if baby <10 days old
  - if safeguarding concerns and baby <28 days old, notify community midwife
  - GP
  - community neonatal or paediatric team as required locally

Multidisciplinary (MDT) review/discharge planning meeting

- Babies with safeguarding concerns (to formulate child protection plan)
- Babies with complex needs
- Other appropriate babies

Medical team

- Complete discharge summary by date of discharge
- Complete neonatal dataset by date of discharge
- Answer parents' questions after they have read discharge summary
- Ensure all follow-up appointments made – see **Follow-up**
- Perform and record discharge examination

FOLLOW-UP

Appointments

- Ensure these are written on discharge summary and in Red book
- Likely appointments could include:
  - neonatal/paediatric consultant out-patient clinic
  - ophthalmology screening
  - audiology referral
  - cranial ultrasound
  - brain US/MR scan
  - physiotherapy
  - hip or renal ultrasound
  - dietitian
  - community paediatrician
  - child development centre
  - BCG immunisation or palivizumab
  - planned future admission (e.g. for immunisations)
  - planned future review for blood taking, wound review
  - tertiary consultant out-patients
- Open access to children's wards where available and appropriate
- See also **Follow-up of babies discharged from the Neonatal Unit** guideline

DISORDERS OF SEXUAL DEVELOPMENT • 1/2

RECOGNITION AND ASSESSMENT

Definition

- New nomenclature: disorders of sexual development (DSD) known formerly as ambiguous genitalia
- Congenital conditions in which development of chromosomal, gonadal or anatomical sex is atypical, most commonly:
  - congenital adrenal hyperplasia
  - gonadal dysgenesis
  - partial androgen insensitivity
- For DSD classification, see **Supporting information**

Factors suggesting DSD

- Overt genital ambiguity (e.g. cloacal extrophy)
- Apparent female genitalia with enlarged clitoris, posterior labial fusion or inguinal/labial masses
- Apparent male genitalia with bilateral undescended testes, isolated perineal hypospadias, mild hypospadias with undescended testis
- Family history of DSD e.g. complete androgen insensitivity syndrome (CAIS)
- Discordance between genital appearance and antenatal karyotype
- Pseudo-ambiguity (atrophic vulva and clitoral oedema) in growth-restricted or preterm female babies

PRINCIPLES OF MANAGEMENT

This is a medical emergency: involve consultant immediately

- Avoid gender assignment before expert evaluation
- Consultant to discuss with parents
  - always use the term ‘baby’ and avoid using ‘he’, ‘she’ or, most importantly, ‘it’
  - advise parents about delaying registration and informing wider family and friends until gender assignment complete
  - liaise with laboratory to enable evaluation without indicating gender in lab request forms
- Link with expert centre for appropriate evaluation
- Communicate openly with family
- Respect family concerns and culture
- DSD is not shameful
  - potential for well-adjusted individual and a functioning member of society
  - best course of action may not be clear initially
  - parents need time to understand sexual development

First line investigations

- Blood pressure
- Karyotype (urgent)
- Imaging
  - abdominal and pelvic ultrasound by an experienced paediatric sonographer
- 17-OHP (delay until day 4–5 to allow maternal hormonal effects to decline)
- Testosterone and oestradiol
- LH, FSH
- U&E and glucose
- Cortisol

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Further investigations (locally and/or in conjunction with specialist advice)

- dHT (dihydrotestosterone)
- DHEA (dihydroepiandrosterone)
- Androstenedione
- Urine steroid analysis
- ACTH
- LHRH and hCG stimulation
- ACTH stimulation test
- AMH (anti-mullerian hormone) imaging studies
- Biopsy of gonad
- Molecular genetic studies (e.g. for CAIS)

TREATMENT

- Avoid unnecessary admission to the neonatal unit
- Check serum electrolytes and plasma glucose
- Involves a multidisciplinary team with an identified person (usually consultant neonatologist) acting as primary contact with family
- Specific treatment dependent on many factors and the diagnosis
- discuss with specialists

SINUS TACHYCARDIA

Recognition and assessment

- Sinus rhythm (P wave precedes every QRS complex) with a heart rate above normal limit for age and gestation

Causes

- Fever
- Infection
- Low haemoglobin
- Pain
- Prematurity
- Hypovolaemia
- Hyperthyroidism
- Myocarditis
- Drugs (e.g. caffeine and salbutamol)

Management

- Treat the cause

SINUS BRADYCARDIA

Recognition and assessment

- Sinus rhythm (P wave precedes every QRS complex) with a heart rate below normal limit for age and gestation

Differential diagnosis

- Hypoxia (most likely cause)
- Vagal stimulation
- Post-intubation
- Hypovolaemia
- Hypothermia
- Metabolic derangement

Immediate management

- Manage airway and breathing
- If intubation required, optimise ET position
- If bradycardia occurs post-intubation, use atropine (see **Neonatal Formulary**)
- Correct hypovolaemia
- Correct metabolic derangement
- If persistent, obtain 12-lead ECG

PREMATURE ATRIAL BEAT

Recognition and assessment

- Most common form of arrhythmia
- In a regular sinus rhythm at a normal rate, a P wave occurring before next expected P wave is a premature atrial beat
- Most premature atrial beats are benign

Investigations

- 12-lead ECG

PREMATURE VENTRICULAR BEAT

Recognition and assessment

- Premature abnormal QRS complex not preceded by a premature P wave

Investigations

- 12-lead ECG
- Measure QTc interval on ECG during period of sinus rhythm
- Echocardiogram to rule out structural abnormality of heart

Immediate treatment

- Seek advice from paediatric cardiologist

SUPRAVENTRICULAR TACHYCARDIA

Recognition and assessment

- Rapid regular tachyarrhythmia
- Heart rate >230/min
- ECG:
  - P waves commonly absent. When present they almost always have an abnormal morphology
  - narrow QRS complex
  - in fast sinus tachycardia, P waves can be very difficult to see
  - look for delta waves consistent with Wolff-Parkinson-White syndrome as this can affect the choice of anti-arrhythmic agent used

Symptoms and signs

- Persistent SVT can cause haemodynamic compromise

Investigations

- 12-lead ECG to document SVT: if not definite SVT, treat for cause of sinus tachycardia (e.g. fluid for hypovolaemia)

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Immediate management

- Assess airway, breathing and circulation
- Check for signs of cardiac failure
- Vagal manoeuvre such as applying ice pack to face
- Adenosine IV bolus
  - use central venous access or IV access in a bigger vein (antecubital fossa)
  - connect 3-way connector to end of cannula/catheter
  - establish patency of IV access
  - connect syringe with adenosine to one port and sodium chloride 0.9% flush to another port
  - run ECG strip
  - give adenosine as a quick bolus and push the bolus of sodium chloride 0.9% at the end quickly
  - document change in cardiac rhythm on ECG

Adenosine dosage

- Start with 150 microgram/kg IV bolus
  - if no response, increase by 50 microgram/kg
- Repeat every 1–2 min
  - maximum dose 300 microgram/kg
  - if no response, discuss DC shock with paediatric cardiologist

Subsequent management

- Echocardiogram to assess ventricular function and presence of congenital heart disease
- Correct electrolyte and metabolic imbalance, if present
- Discuss with paediatric cardiologist for further management (or earlier if necessary)

VENTRICULAR TACHYCARDIA

Recognition and assessment

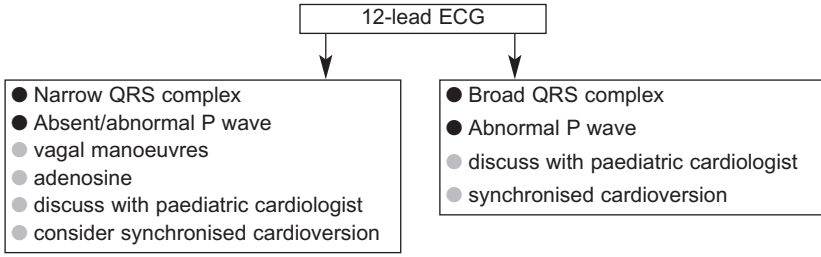
- Heart rate >200/min
- Wide QRS complexes

Immediate management

- Manage airway and breathing
- Correct hypoxia
- Correct electrolyte disturbance
- Discuss with paediatric cardiology centre
- Consider synchronised cardioversion (in very fast heart rates, defibrillators cannot synchronise with the patient and unsynchronised will be required) if intubated, with analgesia
- Amiodarone 5 mg/kg over 30 min IV (repeat if necessary)
- If no response, lidocaine 0.5–1 mg/kg IV. May be repeated after 5 min. Maximum cumulative dose 3 mg/kg

TACHYARRHYTHMIA

- True heart rate?
- Is baby crying/in pain?
- Check airway and breathing
- Check saturation
- Consider arterial/capillary gas
- Check perfusion
- Check blood pressure
- Manage airway and breathing
- Correct hypoxia
- Correct electrolyte disturbance



ENDOTRACHEAL TUBE SUCTIONING • 1/2

This procedure guideline is applicable to ventilated babies where a closed suction catheter system is used. Endotracheal tube suctioning is necessary to clear secretions and to maintain airway patency, and to optimise oxygenation and ventilation in an intubated patient. The goal of endotracheal tube suctioning should be to maximise the amount of secretions removed with minimal adverse effects

INDICATIONS

- To maintain airway patency
- To remove respiratory secretions or aspirated fluid from within the endotracheal tube
- To obtain secretions for culture analysis

EQUIPMENT

- Non-sterile disposable gloves
- Disposable apron

PROCEDURE

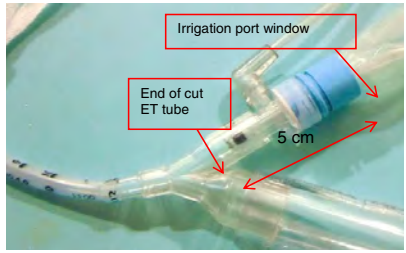
Preparation

- Wash hands and put on gloves and apron
- Auscultate chest before suctioning
- Ensure full monitoring of heart rate and SpO_2 in place
- Ensure baby is adequately oxygenated; consider increasing FiO_2 by up to 0.1 before procedure
- Ensure closed suction device is unlocked

Measuring catheter advancement

Method 1

- Note the printed number on the cut endotracheal tube
- Add 5 cm to this to give the total distance of suction catheter advancement
- Stabilise the Y adaptor with one hand and advance the catheter until calculated length is visible in the irrigation port window. The catheter tip will be within 0.5 cm and 1 cm of the end of the endotracheal tube
- Note the nearest coloured band to the irrigation port window. Coloured bands allow for easy visualisation on subsequent suction procedures



Method 2

- Stabilise the Y adaptor with one hand
- Advance the catheter until the printed depth numbers on the catheter align with the same numbers printed on the endotracheal tube
- The catheter tip will be within 0.5 cm and 1 cm of the end of the endotracheal tube

Performing suctioning

- Ensure the suction catheter is correctly advanced using either of methods 1 or 2 (above)
- Depress thumb control valve and hold while withdrawing the catheter slowly
- When the tip of the suction catheter reaches the dome, release thumb control valve and stop withdrawing
- Procedure should take ≤10 seconds and **the duration of negative pressure should be ≤5 seconds**
- Repeat procedure if necessary
- Do not use a sodium chloride flush routinely. A sodium chloride 0.9% flush may be used if secretions are thick and tenacious and cannot be extracted by suctioning alone

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DOCUMENTATION

- Record procedure in nursing documentation, noting the distance the tube was passed and the colour of the band on the catheter tube closest to this measured distance

AFTERCARE

Equipment

- Leave thumb valve in locked position when not in use to prevent inadvertent activation
- Leave catheter tip in dome between use
- Device is single use only and replace every 24 hr as per manufacturer's guidance

Monitoring

- Ensure monitoring of heart rate and SpO_2 continues after procedure
- Auscultate baby's chest after procedure and document any changes observed
- If FiO_2 was adjusted before procedure, return to original settings, or ensure that baby's target oxygen saturations are maintained

Reporting adverse events

- Report adverse incidents using local risk management procedure

COMPLICATIONS

- Hypoxaemia
- Atelectasis
- Bradycardia
- Tachycardia
- Blood pressure fluctuations
- Decreased tidal volume
- Airway mucosal trauma
- Dislodgement of the endotracheal tube
- Extubation
- Pneumothorax
- Pneumomediastinum
- Bacteraemia
- Pneumonia
- Fluctuations in intracranial pressure and cerebral blood flow velocity

FURTHER INFORMATION

- Further details on endotracheal tube closed suction can be found in the manufacturer's guidance

ENVIRONMENT

Lighting

Excessive and rapid changes in light levels may cause physiological instability, disturbed sleep and interfere with visual development. The thin eyelids of preterm babies may allow significant light to penetrate even if eyes closed

Aim	Method
● Provide flexible lighting to meet individual developmental needs and caregiver's needs ● Ensure sufficient lighting for observation and care delivery ● Promote optimal extra-uterine development and physiological stability ● Reduce stress ● Protect sleep ● Development of normal circadian rhythms	● Keep lighting levels around 200–300 lux (moderate room lighting) ● Monitor and audit light levels in nursery and baby's immediate environment regularly ● Daylight is preferable to artificial lighting. Protect babies from direct sunlight ● Avoid direct bright light during feeding ● Use dimmer switches and avoid sudden changes in light levels ● Use incubator covers or canopies for preterm, sick or neurologically compromised babies ● keep a corner/flap up to allow safe observation ● Protect babies in open cots from bright light until near term (37–40 weeks) ● Use night lights for development of day–night cycle ● Use individual task lighting for care and procedures. Shade baby's eyes throughout ● Protect babies from phototherapy and bright lights in other bed spaces ● Promote appropriate visual interactions with parents/carers ● Protect babies from bright light for a minimum of 18 hr following ROP screening

NOISE

- High levels of sound may cause:
  - baby distress
  - sleep disturbance
  - damage to hearing
  - impaired language and speech development
- A noisy environment affects behaviour and well-being of adults present, with impact on confidentiality, communication, stress levels and the ability to concentrate, make decisions and perform fine motor tasks

Aim	Method
● Promote optimal extra-uterine development and physiological stability ● Protect sleep ● Maintain confidentiality and privacy ● Promote normal speech and language development ● Provide appropriate working environment	● Monitor noise levels in nursery and within baby's immediate environment ● Maintain ambient noise levels at 45 dB, with occasional peaks of 70 dB ● Observe baby's cues to ensure noise levels do not indicate stress ● Open packaging outside incubator ● Keep monitor alarms and telephone ring tones at quiet but safe audible levels ● silence alarms quickly ● Empty 'rainout' from ventilator tubing as soon as possible ● Turn off suction when not in use ● Close incubator doors and bins gently ● Cover incubators of preterm, sick and neurologically compromised babies ● Keep conversations away from babies and speak quietly ● Encourage parents/carers to speak softly to their babies ● Maintain quiet environment during oral feeding ● Only use radios, portable music devices, musical toys etc. when clinically indicated and ensure other babies are not disturbed ● Promote at least one 'rest time' per day. Lower light and noise levels and suspend all routine procedures/ward rounds. Leave babies undisturbed to facilitate sleep. Encourage parents to view this as a quiet time to spend with baby

EXAMINATION OF THE NEWBORN • 1/4

INDICATIONS

Routine discharge check

A thorough physical examination of every newborn baby is good practice and forms a core item of the UK Child Health Surveillance programme

- Ideally performed >24 hr after birth
- many babies are discharged before 24 hr of age. Follow local policy on timing of discharge
- confirm apparent normality
- detect abnormalities/anomalies
- provide plan of care
- provide reassurance to parents and opportunity for discussion

EQUIPMENT

- Maternal and baby notes
- Stethoscope
- Ophthalmoscope
- Measuring tape

AIMS

- Identify congenital malformations
- Identify common neonatal problems and initiate management
- Continue with screening, begun antenatally, to identify need for specific interventions (e.g. immunisation)

PRE-PROCEDURE

- Before undertaking clinical examination, familiarise yourself with maternal history and pregnancy records, including:
- maternal medical, obstetric and social history
- paternal medical history, if appropriate
- family health, history of congenital diseases
- identify drugs mother may have taken during pregnancy and in labour
- health of siblings
- identify pregnancy complications, blood tests, ultrasound scans, admissions to hospital
- identify maternal blood group, presence of antibodies, serology results for sexually transmitted diseases
- duration of labour, type of delivery, duration of rupture of membranes, condition of liquor
- Apgar scores and whether resuscitation required
- birth weight, gestational age, head circumference

Consent and preparation

- Introduce yourself to mother and gain oral consent. Ask about particular concerns
- Keep baby warm and examine in quiet environment

PROCEDURE

Skin examination

- Hydration
- Rashes: including erythema toxicum, milia, miliaria, staphylococcal skin infection, candida
- Pigmented lesions: naevi, Mongolian blue spots, birth marks, café au lait spots
- Bruises: traumatic lesions, petechiae
- Cutis aplasia
- Tufts of hair not on head
- Vascular lesions: haemangioma, port wine stain, simple naevus
- Colour: pink/cyanosis/jaundice/pallor/plethora
- Acrocyanosis
- Cutis marmorata

Facial examination

- General facial appearance to identify common syndromes

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Eyes

- Shape
- Slant
- Size
- Position
- Strabismus
- Nystagmus
- Red reflex
- Presence of colobomata
- Discharges

Nose

- Nasal flaring
- Patency

Ears

- Shape
- Position
- Tags or pits

Mouth

- Size
- Cleft lip
- Symmetry of movement
- Swellings, Epstein's pearls, ranula, tongue tie (for parental reassurance)
- Teeth
- Cleft palate, hard/soft palate, (by both inspection and palpation)
- Sucking

Skull

- Palpate:
  - skull for sutures and shape/cranio-synostosis
  - swellings on scalp, especially crossing suture lines, cephalhaematoma
  - signs of trauma associated with birth (e.g. chignon from vacuum extraction)
  - sutures for ridging or undue separation

Neck

- Swellings
- Movement
- Webbing
- Traumatic lesions from forceps delivery

Clavicles

- For fracture

Arms and legs

- Position and symmetry of movement
- Swelling and bruising

Hands and feet

- Extra digits (polydactyly)
- Syndactyly, clinodactyly
- Palmer creases
- Skin tags
- Position and configuration of feet looking for fixed/positional talipes
- Overlapping toes

Hips

- Developmental dysplasia using Ortolani's and Barlow's manoeuvres. See **Development dysplasia of the hip** guideline

Spine

- Curvatures
- Dimples
- Sacrococcygeal pits
- Hairy patches/naevi
- Hairy tuft on spine

Systems

Examine (inspection, palpation, auscultation) each system

Respiratory system

- Respiratory rate
- grunting
- nasal flaring
- Chest shape, asymmetry of rib cage, swellings
- nipple position, swelling/discharge/extra nipples
- Chest movement
- presence/absence of recession
- Auscultate for breath sounds

Cardiovascular system

- Skin colour/cyanosis
- Palpate:
- precordium for thrills
- peripheral and femoral pulses for rate and volume
- central perfusion
- Auscultate for heart sounds, murmur(s), rate, rhythm
- pulse oximetry of right arm and either leg (<3% difference in SpO_2 normal)

Gastrointestinal tract

Ask mother how well baby is feeding, whether baby has vomited and, if so, colour of vomit
Bilious vomiting may have a surgical cause and needs prompt stabilisation and referral

- Abdominal shape
- Presence of distension
- Cord stump for discharge or inflammation/umbilical hernia
- Presence and position of anus and patency
- Stools passed
- Palpate abdomen for tenderness, masses and palpable liver
- Auscultation is not routinely undertaken unless there are abdominal concerns

Genito-urinary system

Ask mother if baby has passed urine, and how frequently

- Inspect appearance of genitalia: ambiguous?

Male genito-urinary system

- Penis size (>1 cm)
- Position of urethral meatus. Look for hypospadias
- Inguinal hernia
- Chordee
- Urinary stream
- Scrotum for colour
- Palpate scrotum for presence of two testes and presence of hydrocoele

Female genito-urinary system

- Presence of vaginal discharge (reassure parents about pseudomenstruation)
- Skin tags
- Inguinal hernia
- Proximity of genitalia to anal sphincter
- Routine palpation of kidneys is not always necessary as antenatal scans will have assessed presence

Neurological system

- Before beginning examination, observe baby's posture
- Assess:
- muscle tone, grasp, responses to stimulation
- behaviour
- ability to suck
- limb movements
- cry
- head size in relation to body weight
- spine, presence of sacral pits, midline spinal skin lesions/tufts of hair
- If neurological concerns, initiate Moro and stepping reflexes

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- Responses to passive movements:
  - pull-to-sit
  - ventral suspension
- Palpate anterior fontanelle size (<3 cm x 3 cm) and tone

OUTCOME

Documentation

- Complete neonatal examination record in medical notes and sign and date it. Also complete child health record (Red book) or in NIPE Smart if used
- Record any discussion or advice given to parents

Normal examination

- If no concerns raised, reassure parents of apparent normality and advise to seek advice if concerns arise at home
- GP will re-examine baby when 6 weeks old

Abnormal examination

- In first instance, seek advice from neonatal registrar/consultant
- Refer to postnatal ward guidelines for ongoing management
- Refer abnormalities to relevant senior doctor

EXCHANGE TRANSFUSION • 1/3

Exchange transfusion replaces withdrawn baby blood with an equal volume of donor blood

Discuss all cases with neonatal consultant

INDICATIONS

Haemolytic anaemia

- A newborn who has **not** had an in-utero transfusion (IUT) with a cord Hb <120 g/L and is haemolysing, may require urgent exchange transfusion to remove antibodies and correct anaemia:
  - if Hb <100 g/L, discuss **urgently** with consultant and proceed to exchange transfusion; avoid simple packed cell transfusions
  - if Hb 100–120 g/L, obtain 6-hrly bilirubin values and, if rapidly rising or close to exchange transfusion level, see **Table** in **Jaundice** guideline, use intravenous immunoglobin (IVIG)
- A newborn who has had IUTs and whose Kleihauer test (this test may not be available in your hospital) demonstrates a predominance of adult Hb, anaemia can be managed using a top-up transfusion of irradiated, CMV-negative blood

Hyperbilirubinaemia

- Discuss promptly with consultant. If bilirubin values approaching guidance below; senior decision is required:
  - guidance as determined by exchange transfusion line on gestation-specific NICE jaundice chart – see **Table** in **Jaundice** guideline
  - if bilirubin rises faster than 8.5 micromol/L/hr despite phototherapy, anticipate need for exchange transfusion

Other indications

- Chronic feto-maternal transfusion
- Disseminated intravascular coagulation (DIC)

COMPLICATIONS

- Cardiac arrhythmias
- Air embolism
- Necrotising enterocolitis
- Coagulopathy
- Apnoeas and bradycardia
- Sepsis
- Electrolyte disturbances
- Acidosis owing to non-fresh blood
- Thrombocytopenia
- Late hyporegenerative anaemia

PROCEDURE

Prepare

- Ensure full intensive care space and equipment available and ready
- Allocate one doctor/practitioner and one other member of nursing staff, both experienced in exchange transfusion, to care for each baby during procedure; document their names in baby's notes
- Obtain written consent when possible, and document in baby's notes
- Phototherapy can usually be interrupted during exchange
- Calculate volume of blood to be exchanged: 160 mL/kg (double blood volume) removes 90% of baby red cells and 50% of available intravascular bilirubin
- Order appropriate volume (usually 2 units) of blood from blood bank, stipulating that it must be:
  - crossmatched against mother's blood group and antibody status, and (if requested by your blood bank) baby's blood group
  - CMV-negative
  - irradiated (shelf-life 24 hr) for any baby who has had an in-utero blood transfusion
  - as fresh as possible, and certainly no more than 4 days old
  - plasma reduced red cells for 'exchange transfusion' (haematocrit 0.5–0.6), not SAG-M blood and not packed cells

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Prepare baby

- Empty stomach using nasogastric tube (see **Nasogastric tube insertion** guideline)
- Start intravenous infusion and allow nil-by-mouth
- Pay attention to thermoregulation, particularly if procedure to be performed under radiant heater
- Commence continuous cardiac, temperature and saturation monitoring

Monitor and document

- Blood pressure and heart rate every 15 min throughout exchange

If any change in baby's cardiorespiratory status, pause exchange by priming catheter with donor blood that will not clot. Discuss with consultant

Prepare blood

- Set up blood warmer early (aim for 37ºC)
- Check blood units as per hospital policy
- Connect donor blood to filter and prime blood giving set
- Connect to 4-way (if using UVC) or 3-way tap (outside the warmer) as indicated
- Ensure donor blood well mixed before and throughout exchange

Technique

- Ensure working area sterile

Either

- Insert UVC (see **Umbilical venous catheterisation** guideline) and confirm position. Use **UVC 'push-pull' technique** below for exchange

Or

- Insert peripheral venous ('in route') and arterial ('out route') catheters. Use **peripheral venous and arterial catheters 'continuous' technique** below for exchange

Or

- Insert UVC ('in route') and UAC ('out route') and confirm position. Use **umbilical venous and arterial 'continuous' technique** below for exchange

UVC 'push-pull' technique

- Connect catheter bag (using Vygon connector) and donor blood to 4-way tap and 4-way tap to UVC
- Remove 10 mL baby blood from UVC using syringe
- Send first sample for serum bilirubin, full blood count, blood culture, blood glucose, calcium, electrolytes, coagulation and liver function tests
- when exchange performed for reasons other than known blood group antibodies, send blood for G6PD screening and viral serology
- Replace precise volume removed with donor blood, slowly using a syringe
- Each out-in cycle should replace no more than 8.5 mL/kg and take at least 5 min; start with smaller aliquots (10 mL) and increase to 20 mL (if baby stable and weight allows) only after 30 min. As a guide:
- birth weight <1000 g: use 5 mL aliquots
- birth weight 1000–2000 g: use 10 mL aliquots
- birth weight >2000 g: use 20 mL aliquots
- Discard 'out' baby blood into catheter bag
- Continue out-in cycles every 5 min (maximum aliquot with each cycle) until complete
- Send last 'out' baby blood sample for serum bilirubin, full blood count, blood culture, blood glucose, calcium and electrolytes

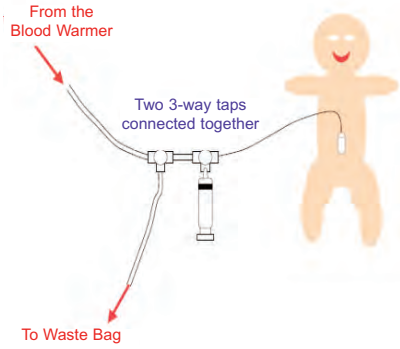
Peripheral venous and arterial catheters 'continuous' technique

- Connect catheter bag, using Vygon connector, to 3-way tap attached to arterial line extension

> ***Never leave arterial line open to catheter bag***

- Connect donor blood to venous catheter
- Remove 10 mL of baby's blood from arterial line and send for tests as listed above under **UVC 'push-pull' technique**
- Start venous infusion at rate to match withdrawal rate e.g. 120 mL/hr for a 10 mL volume withdrawal every 5 min
- Remove 'out' aliquots of baby's blood from arterial line every 5 min to match volume of donor blood being infused into venous line
- Observe limb distal to arterial line at all times and document appearance. **If concerned, pause exchange and discuss with consultant**
- Continue steps as above but note that continuous 'in' cycle requires removal of 'out' aliquots only every 5 min
- If exchange stopped for >2–3 min, discontinue procedure and ensure all lines are flushed

Equipment diagram for 'Push-Pull' Exchange Transfusion



UVC and UAC continuous technique

- Use UVC as 'in' line and UAC as 'out' line and proceed as with **Peripheral venous and arterial 'continuous' technique**

AFTERCARE

Immediate

- When Hb and bilirubin in final 'out' sample known, check with consultant before removing all lines
- Complete documentation (volumes in/out, and all observations)
- Recommence phototherapy
- Recommence feeds 4–6 hr after completion
- Monitor blood sugar 4-hrly until acceptable on 2 consecutive occasions
- Update parents

Intermediate

- In babies receiving antibiotics, a repeat dose may be required: discuss with consultant
- Delayed Guthrie spot collection will be indicated, as directed by regional centre

Follow-up

- Neuro-developmental follow-up in all babies who have undergone exchange transfusion
- Repeat full blood count at intervals (likely 1–2 weekly but to be determined individually) for up to at least 6 weeks, to detect anaemia secondary to ongoing haemolysis

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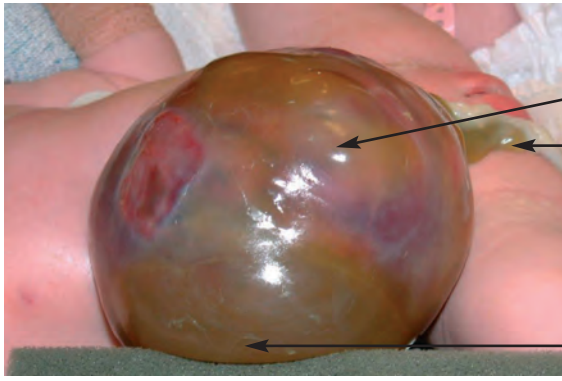
EXOMPHALOS – INITIAL MANAGEMENT • 1/3

DEFINITION

Congenital anterior abdominal wall defect, resulting in herniation of the abdominal contents through the umbilicus. Herniated viscera are covered by a sac

- *Exomphalos minor:* defect diameter <5 cm with no liver in sac
- *Exomphalos major:* defect diameter >5 cm. Sac usually contains liver (see photograph)



- Key issues to be aware of:
  - rupture or damage to protective sac
  - association with other major abnormalities (cardiac or chromosomal)
- Depending, on individual patient factors, an exomphalos can be managed either by:
  - early surgical closure of the defect (as a neonate)
  - delayed surgical closure, after epithelisation of the sac using dressings

Diagnosis and antenatal care

- Majority diagnosed antenatally
- Often associated with chromosomal and other abnormalities
- Multi-professional discussions needed to carefully plan antenatal and postnatal care
- If suspected antenatally
  - refer to fetal medicine department for further assessment
  - refer to paediatric surgery for antenatal counselling
- Give parents information leaflet
- Aim to deliver in appropriate neonatal unit (NNU) with either postnatal transfer to paediatric surgical unit or management by paediatric surgical outreach team at the NNU

Pre-delivery

- Liaise with on-call team at the paediatric surgical centre before making arrangements for elective delivery

Delivery

- Experienced paediatrician/ANNP to attend delivery
- Clamp umbilical cord only after careful assessment of the umbilical defect (to avoid any bowel present at base of cord)
- Use plastic cord clamp (not artery forceps) on umbilical cord at least 10 cm away from where normal umbilical cord starts to avoid bowel injury
- Dry baby
- Provide resuscitation, as required. Avoid prolonged mask ventilation

- Nurse in supine position
- Pass a size 8 Fr nasogastric tube (NGT) and fix securely with tape (see **Nasogastric tube insertion** guideline)
- Empty stomach by aspirating NGT with 10–20 mL syringe. If <20 mL fluid aspirated, check position of tube. Place tube on free drainage by connecting to a bile bag
- Put nappy on baby, taking care to fold it down under the defect
- Place baby's legs and trunk, feet first, into a sterile plastic bag, to protect the defect and reduce fluid loss. Pull the draw-string under the arms, so that both arms are outside the top of the bag
- Show baby to parents and transfer to NNU

In NNU

- Careful physical examination by experienced neonatal practitioner. If baby has a major lethal congenital abnormality, local consultant to decide whether referral for management is appropriate. May require discussion with on-call consultant surgeon. If the decision is not to transfer, inform surgical unit
- Nurse in supine position
- Insert IV cannula. Avoid vein which could be used for long line e.g. antecubital fossa, long saphenous or scalp
- Avoid umbilical lines
- Take blood for:
  - culture
  - FBC, CRP and clotting screen, including fibrinogen
  - U&E
  - blood glucose and venous blood gas
- Crossmatch sample will be taken at surgical centre
- Send 1 bloodspot on neonatal screening card marked as 'pre-transfusion' (for sickle cell screening) with baby to surgical centre
- Administer fluid boluses as indicated by baby's condition
- Start maintenance IV fluids (see **IV fluid therapy** guideline)
- Give vitamin K (see **Vitamin K** guideline)
- Leave NGT, on free drainage and aspirate NGT 4-hrly with a 20 mL enteral syringe
- Replace nasogastric losses mL-for-mL using IV sodium chloride 0.9% with potassium chloride 10 mmol in 500 mL bag
- Start broad spectrum antibiotics including metronidazole
- Monitor blood glucose 4–6 hrly
- Swab sac and send for culture and sensitivity
- Take a photograph of the exomphalos, with parent's consent
- Remove bowel bag and protect the sac by covering with a non-adhesive dressing (Jelonet) and sterile gauze, until assessed by the paediatric surgical outreach team
- Discuss baby's condition and treatment plan with parents and ensure they have seen the baby before transfer. Take photographs for parents

Referral

- Refer baby to planned paediatric surgical unit e.g. BCH. This may require a conference call with the on-call surgeon to discuss urgency of transfer; an emergency surgical procedure is normally not indicated
- Some babies may not require transfer to the paediatric surgical unit and can sometimes be managed at a NNU
  - for BCH this may include transfer to BWH for the Neonatal Surgical Outreach Service

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- Obtain a sample of mother's blood for crossmatch. Handwrite form, completing all relevant sections and indicating this is the mother of the baby being transferred. Include baby's name
- Complete nursing and medical documentation for transfer and obtain copies of X-rays if taken. Ensure you have mother's contact details (ward telephone number or home/mobile number if she has been discharged). Surgeon will obtain verbal telephone consent if operation is required and a parent is not able to attend surgical unit at appropriate time
- If the neonatal surgical decision is to perform a delayed closure of the exomphalos, the recommended dressing is Manuka honey gel covered with a honey net dressing, sterile gauze and crepe bandage
- If exomphalos is to be managed with dressings on NNU then this will be supported by the Surgical Neonatal Outreach Service

While awaiting transfer

- Reassess hourly for further fluid boluses and, if necessary, give 10 mL/kg of either sodium chloride 0.9% or human albumin solution (HAS) 4.5%
- If evidence of a coagulopathy, treat appropriately (see **Coagulopathy** guidelines)
- Aspirate NGT 4-hrly
- Replace nasogastric losses mL-for-mL with sodium chloride 0.9% IV with potassium chloride 10 mmol in 500 mL bag. Leave NGT on free drainage

Transfer to surgical unit

- Place baby in transport incubator
- Take baby to parents (if not yet seen) in the transport incubator, en-route to the ambulance
- Ensure mother's blood, baby's pre-transfusion bloodspots, letters for surgical team and all documentation accompanies baby
- Ensure documentation includes whether vitamin K given, the referring consultant, whether parents had antenatal counselling, mother's contact details
- Make and document all the usual observations during transport and on arrival at the surgical unit

Useful Information

- http://www.bch.nhs.uk/content/neonatal-surgery
- http://www.bch.nhs.uk/find-us/maps-directions
- Parent information/support organisation http://www.geeps.co.uk/ (GEEPS – exomphalos page)

EXTRAVASATION INJURIES • 1/3

BACKGROUND

- Approximately 4% of babies develop skin necrosis as a result of extravasation of an IV infusion
- A small proportion of these babies develop long-term cosmetic or functional compromise
- Extravasation may be due to:
  - cannula piercing the vessel wall or
  - from distal venous occlusion causing backpressure and increased vascular permeability
- Cochrane review shows that centrally placed catheters may cause extravasation as often as peripheral cannula
- Extravasation can lead to both short and long-term complications
- Use this guideline to define the grading, and management, of subcutaneous extravasation injuries in babies, either from peripheral or central lines
- Limiting the IV pump cycle to 1 hr **may** minimise the extent of tissue damage from extravasation providing the entry site is observed concurrently
- The degree of tissue damage due to extravasation is dependent upon:
  - volume of infusate, its pH and osmolality
  - the dissociation constant and pharmacological action of any drug(s) being infused

Wound dressings

- When choosing wound dressing, consider the need to prevent:
  - further trauma
  - epidermal water loss
  - contractures by allowing a full range of limb movements
- Dressings must be:
  - easy to apply to small body surface areas
  - sterile
  - suitable for use in humidified/incubator environments

Most commonly used dressings

- Hydrocolloid 9 (e.g. Duoderm) or hydrogel (e.g. Intrasite gel, Intrasite conformable)
  - if in doubt, seek advice from tissue viability nurse

ASSESSMENT

Table 1: Grading of extravasation injuries

Grade 1	Grade 2	Grade 3	Grade 4
● IV device flushes with difficulty ● Pain at infusion site ● No swelling or redness	● Pain at infusion site ● Mild swelling ● Redness ● No skin blanching ● Normal distal capillary refill and pulsation	● Pain at infusion site ● Marked swelling ● Skin blanching ● Cool blanched area ● Normal distal capillary refill and pulsation	● Pain at infusion site ● Very marked swelling ● Skin blanching ● Cool blanched area ● Reduced capillary refill ● +/- arterial occlusion ● +/- blistering/skin breakdown/necrosis

Investigations

- No specific investigations required. However, if wound appears infected:
  - wound swab
  - FBC
  - CRP
  - blood culture
  - start appropriate antibiotics – see **Infection (late onset)** guideline

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ACUTE MANAGEMENT

Table 2

Grade 1 and 2	Grade 3	Grade 4
● Stop infusion immediately ● Remove cannula and splints/tapes ● Elevate limb	● Stop infusion immediately ● Remove constricting tapes ● Leave cannula *in situ* until review by doctor/ANNP ● Withdraw as much of the drug/fluid as possible via the cannula ● Consider irrigation of affected area ● Elevate limb ● Inform tissue viability nurse	● Stop infusion immediately ● Remove constricting tapes ● Leave cannula *in situ* until review by doctor/ANNP ● Withdraw as much of the drug/fluid as possible via the cannula ● Photograph lesion – provided no delay in further treatment ● Irrigate affected area ● Elevate limb ● Inform tissue viability nurse/registrar/consultant +/- plastic surgery team

- Most extravasation injuries are of Grades 1 and 2 and do not require extensive intervention
- Grade 3 and 4 injuries have a greater potential for skin necrosis, compartment syndrome and need for future plastic surgery, depending on type of solution extravasated

FURTHER ASSESSMENT

- Following irrigation treatment, review all injuries within 24 hr of extravasation occurring
- Irrigation of major grades of extravasation has been used to prevent extensive skin loss and need for plastic surgery and skin grafting. However, the evidence for the use of irrigation in preventing long-term injury is limited

Documentation

- Document extent and management of the injury in medical record

FOLLOW-UP AND REVIEW

- Determined by grade of extravasation
- neonatal medical staff review minor grades after 24 hr
- neonatal/plastic surgery staff/tissue viability nurse review Grades 3 and 4 within 24 hr to assess degree of tissue damage and outcome of irrigation procedure if performed

Other considerations

- **Family-centred care** – inform parents of extravasation injury and management plan

Special considerations

- Infection control – observe standard infection control procedures
- Complete an incident report for Grade 3 and 4 extravasations

IRRIGATION OF EXTRAVASATION INJURIES

Procedure

- Withdraw as much of the drug and or fluid as possible via cannula or catheter
- Infiltrate the site with lidocaine 1% 0.3 mL before to reduce pain
- Using a scalpel, make 4 small incisions around periphery of extravasated site
- Insert blunt Verres needle, or pink cannula with needle removed, into each incision in turn, and irrigate damaged tissue with hyaluronidase* followed by sodium chloride 0.9%. It should flow freely out of other incisions
- Massage out any excess fluid using gentle manipulation
- Cover with paraffin gauze for 24–48 hr

*Preparation of hyaluronidase

- Reconstitute a 1500 unit vial of hyaluronidase with 3 mL of water for injection
- Use 1-2 mL shared between each incision then irrigate with sodium chloride 0.9%

When irrigating with sodium chloride 0.9%, use discretion depending on baby's weight

Documentation

- Person performing procedure must document in baby's medical record

INTRODUCTION

- Outcomes for premature babies at borderline viability generally improve with each additional week of gestational age. See EPICure studies http://www.epicure.ac.uk/
- If ultrasound scan performed within a week before delivery, an estimated fetal weight of <500 g at any gestation between $22+^{0}$ and $25+^{6}$ weeks is associated with a very poor outcome; Draper charts demonstrate predicted survival of a fetus alive at the onset of labour weighing 250–500 g at 22, 23, 24, 25 and 26 weeks are 2,4,5,7, and 8% respectively
- Estimation of gestational age by ultrasound when carried out in first trimester of pregnancy is most reliable:
- if fetal heart heard during labour, call paediatric team to attend delivery
- once baby delivered, further resuscitation and management decisions should be made in baby's best interests, taking into account clinical condition at birth e.g. heart rate, breathing, weight, severity of bruising to skin etc.; obtain urgent senior advice
- Discussion with parents before birth, if possible, should precede any action, preferably by obstetric and paediatric teams jointly
- Document all discussions in case records

MANAGEMENT

- An experienced neonatologist to be present at delivery of extremely premature babies (<27 completed weeks' gestation) and make confirmatory assessment of gestational age and condition of baby

≥24 weeks' gestation

- Unless baby has a severe abnormality incompatible with any significant period of survival, initiate intensive care and admit to neonatal intensive care unit (NICU)

<24 weeks' gestation

- Discuss with parents national and local statistical evidence for survival in babies with range of disabilities found in this age group
- explain that statistics indicate most babies born <24 weeks' gestation are likely to die and a significant proportion of survivors are likely to have some form of neurological impairment

MANAGEMENT AT SPECIFIC GESTATIONS

Between 24^{+0} and 24^{+6} weeks' gestation

- Provide full, invasive, intensive care and support from birth and admit to NICU unless parents and clinicians agree that, in view of baby's condition (or likely condition) intensive care is not in his/her best interests

Between 23^{+0} and 23^{+6} weeks' gestation

- Give precedence to parents' wishes regarding resuscitation and invasive intensive care treatment. However, when condition at birth indicates that baby will not survive for long, clinicians are not legally obliged to proceed with treatment that is wholly contrary to their clinical judgement, if they consider treatment would be futile
- as a first step, determine whether baby is suffering, whether any suffering can be alleviated, and likely burden placed on baby by intensive care treatment
- where parents would prefer clinical team to make decision about initiation of intensive care, clinicians must determine what constitutes appropriate care
- where it has not been possible to discuss a baby's treatment with mother and, where appropriate, her partner, before the birth, clinical team should consider offering full invasive intensive care until baby's condition and treatment can be discussed with parents

- If baby is born in good condition, initiate resuscitation using IPPV (via ETT or facemask if good chest movement obtained)
- if baby does not improve and heart rate remains low at 10 min after effective ventilatory support, withhold further resuscitation
- response of heart rate to ventilation is critical in deciding whether to continue or stop. Counsel parents with sensitivity that further interventions are futile

Between 22^{+0} and 22^{+6} weeks' gestation

- Standard practice should be not to resuscitate a baby and this would normally **not** be considered or proposed
- If parents request resuscitation, and reiterate this request, discuss risks and long-term outcomes with an experienced neonatologist before attempting resuscitation and offering intensive care
- Treating clinicians must all agree that this is an exceptional case where resuscitation is in a baby's best interests

<22 weeks' gestation

- Resuscitation should never occur in routine clinical practice
- any attempt to resuscitate babies born at this gestational age should take place only within the context of an approved research study

When intensive care not given, clinical team must provide palliative care until baby dies. Refer to BAPM guidelines for counselling

Parent information

'Information for parents of extremely premature babies' leaflet available to download from www.epicure.ac.uk/index.php/download_file/view/150/

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FOLLOW-UP OF BABIES DISCHARGED FROM THE NEONATAL UNIT • 1/2

INDICATIONS

- Birth weight <1501 g
- Gestation <32 weeks
- Requiring IPPV or CPAP for more than a few hours
- Significant cranial ultrasound abnormality on final scan on NNU
- Acute neonatal encephalopathy grade 2 or 3
- Seizures (of whatever cause)
- Neonatal meningitis
- Abnormal neurological examination at discharge
- Neonatal abstinence syndrome requiring treatment (see **Abstinence syndrome** guideline)
- Exchange transfusion for any reason/immunoglobulin for hyperbilirubinaemia/in-utero transfusion or serum bilirubin >10 x gestational age (weeks) in preterm infants
- Major congenital anomalies (consider early referral to general paediatrician)
- Persistent hypoglycaemia
- Consultant discretion
- Babies who have undergone surgery for congenital heart disease in early neonatal period

PROCEDURE

Refer to neonatal follow-up clinic

Follow-up timetables

- These tables are a guide to usual number of appointments according to each neonatal condition
- Adjust follow-up to individual needs
- Follow local policy to book appointments with relevant professionals

High risk preterm babies born <32 weeks or <1501 g

Indications/criteria	1st follow-up from discharge	2nd from EDD	3rd from EDD	4th from EDD	5th from EDD	6th from EDD
Prematurity	6 weeks	4 months	8 months	12 months	18 months	2 years
<32 weeks or <1501 g	Height, weight, OFC; neurological, medical and developmental assessment					

≥32 weeks and >1500 g with severe neonatal illness

Indications/criteria	1st follow-up from discharge	2nd from EDD	3rd from EDD	4th from EDD	5th from EDD	6th from EDD
Nitric oxide/ECMO or HIE grade 2/3/therapeutic cooling or intracranial bleeds/infarcts cystic PVL/significant IVH/ventricular dilatation	6–8 weeks	4–6 months		12 months	18 months	2 years
32–33+6 weeks and >1500 g well premature babies or meningitis or abnormal neurological examination, seizures or treated neonatal abstinence or severe jaundice needing exchange/immunoglobulin	6–8 weeks	4–6 months		12 months		
Term ventilation/CPAP/ culture-positive sepsis/ persistent hypoglycaemia	6–8 weeks					

Two-year neuro-developmental follow-up

- Babies born <32 weeks or weighing <1501 g or with moderate to severe encephalopathy/therapeutic cooling or who required nitric oxide/ECMO, carry out structured neuro-developmental assessment (Bayley's/SOGS/Griffith's) at 2–2.5 yr corrected age

Babies ≥34 weeks with transient problems (e.g. mild jaundice, feeding problems, hypoglycaemia, culture-negative sepsis etc.)

- May require specific advice to community team/general practitioner about monitoring/follow-up, but usually do not need neonatal follow-up
- See relevant guideline for follow-up for other conditions e.g. syphilis, HIV, hepatitis, cardiac murmurs etc.

FURTHER MANAGEMENT AT CLINIC

Neuro-developmental problems identified

- Refer to child development centre and/or specialist services e.g. physiotherapist, speech and language therapist and dietitian according to baby's individual needs
- Refer to patch consultant community paediatrician
- referral may be made at time the problem is identified or later if more appropriate for the family
- For complex medical problems, e.g. ongoing cardiac or respiratory disease, shared neonatal follow-up

Babies with problems identifiable early

- For babies with Down's syndrome, severe hypoxic ischaemic encephalopathy or at consultant discretion, involve patch consultant community paediatrician and pre-school therapy team early, before discharge if appropriate
- For babies with concurrent medical problems (e.g. cardiac problem, chronic lung disease), arrange co-ordinated follow-up (decided on individual basis following discussion between community and neonatal consultants)
- Refer children with impaired vision and/or hearing to consultant community paediatrician

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GASTRO-OESOPHAGEAL REFLUX (GOR) • 1/2

INTRODUCTION

There is very little evidence to support a causal relationship between GOR and its assumed consequences such as apnoeas, respiratory distress and failure to thrive, especially in preterm babies. Therefore, avoid widespread use of anti-reflux medications

RECOGNITION AND ASSESSMENT

Symptoms

- Frequent vomiting after feeds in an otherwise healthy baby
- Recurrent desaturation and/or apnoea
- Recurrent desaturations in ventilated babies [exclude bronchopulmonary dysplasia (BPD) spells]
- Chronic lung disease of prematurity may be worsened by recurrent aspiration caused by GOR

Risk factors

- Immaturity of the lower oesophageal sphincter
- Chronic relaxation of the sphincter
- Increased abdominal pressure
- Gastric distension
- Hiatus hernia
- Malrotation
- Oesophageal dysmotility
- Neuro-developmental abnormalities

Differential diagnosis

- Suspect cow's milk protein intolerance (CMPI) in babies who are formula milk fed or have fortifier added to maternal breast milk, and have recurrent vomiting/irritability/apnoeas despite appropriate management of GOR. Platelet count may be raised and is consistent with, though not diagnostic of, CMPI

INVESTIGATIONS

- 24 hr pH monitoring is of limited value in preterm babies. Consider in cases where repeated apnoea/bradycardia is resistant to other measures
- The following investigations to be considered after discussion with consultant:
  - if repeated apnoea/bradycardia, consider 24 hr pulse oximetry recordings to assess extent of problem and relationship to feeding
  - if apnoeas/bradycardia persist at term-equivalent, consider a video fluoroscopic assessment of sucking-swallowing co-ordination and GOR

MANAGEMENT

Position

- Head upwards, at an angle of 30º
- Nurse baby prone or in left lateral position if monitored

Feeding

- Frequent low volume feeds
- Avoid overfeeding
- Gaviscon Infant (1 dose = half dual sachet):
  - breastfed: give during or after a feed (add 5 mL sterile water/milk to make a paste, then add another 5–10 mL and give with a spoon)
  - bottle fed: add to at least 115 mL milk
  - nasogastric tube (NGT) fed: make up with 5 mL water and give 1 mL per 25 mL of feed

Caution: Gaviscon Infant contains 0.92 mmol of sodium per dose

- If symptoms persist, consider change to Instant Carobel (will thicken with cold or hand-warm milk). Add 2 scoops to 100 mL, shake well and leave for 3–4 min to thicken. Shake feed again and give immediately. Take care that thickened liquid does not block fine bore NGT

Do not give Gaviscon Infant and Carobel together as this will cause the milk to become too thick

Other measures

- If symptoms persist, consider other measures after discussion with consultant e.g:
  - dairy free diet for a breastfeeding mother or trial of cow's milk protein-free formula (in artificially fed babies)
  - some babies with suspected CMPI are also allergic to hydrolysate and will respond to an amino acid-based formula. Some can also be allergic to the lipid in Neocate
  - if trial commenced, continue for a minimum period of 2 weeks with careful symptom monitoring
  - assessment by speech and language therapy team as poor suck-swallow co-ordination can result in aspiration during feeds if unable to protect airway; can also occur following an episode of GOR

Drugs (see Neonatal Formulary)

- In severe cases with no improvement after above measures and after discussion with senior or specialist, use only with caution:
  - ranitidine (licensed) or omeprazole (non licensed)

There is no evidence to support use of drugs in GOR

H_2 receptor antagonists such as ranitidine may increase risk of sepsis or necrotising enterocolitis

Erythromycin may facilitate bacterial resistance and is not recommended

Parent information

Offer parents the following information, available from:

http://www.bliss.org.uk/reflux

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GASTROSCHISIS • 1/4

DEFINITION

Congenital defect of the anterior abdominal wall resulting in herniation of bowel. The herniated viscera are not covered by any surrounding membranes and are exposed to amniotic fluid during pregnancy and air following delivery

DIAGNOSIS

- Majority of cases diagnosed on antenatal ultrasound scan
- Refer mothers to a fetal medicine department
- Refer parents to paediatric surgery for antenatal counselling
- Give parents gastroschisis information leaflet. Offer them the opportunity to visit the neonatal intensive care unit (NICU) where the baby will be delivered

PRE-DELIVERY

- Gastroschisis is a surgical emergency, delivery should be planned in appropriate level neonatal unit aiming to transfer to paediatric surgical unit within 4 hr of birth
- Antenatal and postnatal care must be carefully planned. Communication between groups of professionals and the parents is essential
- Prior to delivery the case should be discussed with the local paediatric surgery unit
- If no surgical cot is available there and delivery cannot be postponed, then the neonatal team will need to identify a potential cot at the nearest alternative paediatric surgical centre
- Once baby is induced or mother is in labour, inform transport team or retrieval team as appropriate

DELIVERY

- Neonatal middle grade and junior grade or ANNP attend delivery
- Take a size 8 Fr nasogastric tube (NGT) and a gastroschisis bag (often labelled as a bowel bag). This is a large sterile bag which can be closed around baby's chest with a draw-string
- Babies become cold very quickly and experience fluid loss from the exposed bowel. Perform the following, as rapidly as possible:
  - clamp cord with plastic clamp (**not** artery forceps) placed approximately 5 cm from baby's abdomen, checking cord clamp is securely fastened. If in doubt, apply a second plastic cord clamp adjacent to the first
  - dry upper part of baby quickly
  - initiate resuscitation as required. Avoid prolonged mask ventilation, if resuscitation prolonged, intubate
  - pass NGT and fix securely
  - empty baby's stomach by aspirating NGT with a 10 or 20 mL syringe. If <20 mL of fluid aspirated, check position of tube
  - place tube on free drainage by connecting to a bile bag
- If stomach protruding through defect (**Image 1**), ensure it is decompressed

Image 1

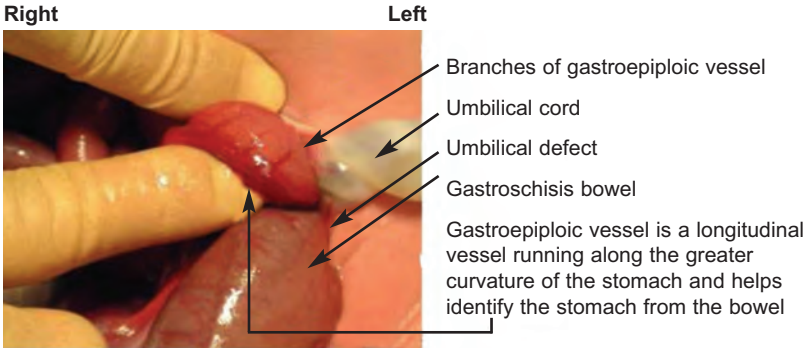
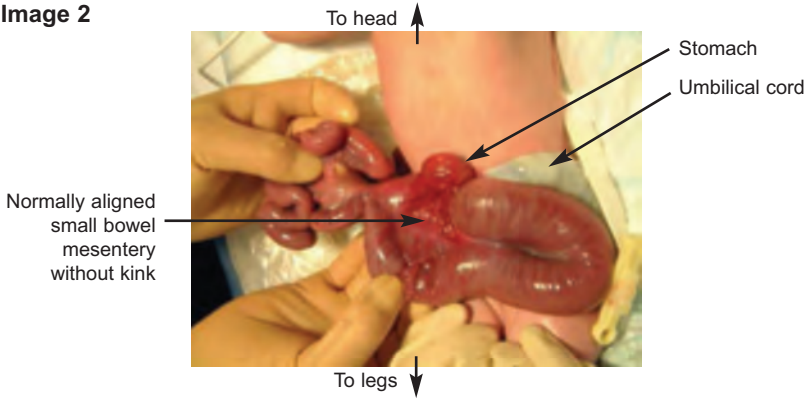


Image 1

- If stomach cannot be decompressed, call surgical registrar for further advice. Failure to decompress the stomach can cause pressure on the bowel mesentery resulting in bowel ischaemia
- Aspirate NGT gently. If the stomach fails to decompress, gently manipulate to facilitate this, whilst aspirating the NGT
- Take great care not to cause reflux of stomach contents up the oesophagus around the tube but simply aid drainage
- Assess colour and alignment of bowel
- Using sterile gloves handle the bowel carefully to ensure it is not twisted or kinked and there is no traction on the mesentery **(Image 2)**

Image 2



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- Place baby onto the same side as the defect (usually right) and support bowel on a folded nappy placed slightly under baby
- Check perfusion of bowel. If vascular compromise suspected, call consultant neonatologist
  - if compromise persists, inform surgical team immediately
- Place baby's legs and trunk into gastroschisis bag, feet first, and pull draw-string under baby's arms so both arms are outside of the bag
- Alternatively, cover and support intestines with cling film from upper chest to lower abdomen, holding intestines in central position
  - ensure intestines are visible
  - do not wrap cling film tightly as this will reduce perfusion
- Show baby to parents and transfer to NNU
- Check global perfusion using central capillary refill time
- Check perfusion of bowel again immediately before transfer to NNU and at least every 15 min thereafter

IN NNU

- Inform transport co-ordination team immediately as this is a time critical transfer (aim <4 hr from delivery)
- Monitor perfusion and alignment of bowel at least every 15 min
- Insert IV cannula, avoid potential long line veins
- Avoid umbilical lines
- Infuse 20 mL/kg either sodium chloride 0.9% or human albumin solution (HAS) 4.5% over 1 hr and start routine IV maintenance fluids – see **IV fluid therapy** guideline
- Aspirate NGT again and record volume. Replace NG losses mL-for-mL with sodium chloride 0.9% + 10 mmol potassium chloride/500 mL IV
- Monitor central perfusion, using central capillary refill time, at least every 15 min. Give further fluid boluses as required to maintain a normal CRT <2 sec. Babies with gastroschisis have a high fluid requirement until the herniated bowel is replaced in the abdomen
- Start IV antibiotics (benzyl penicillin, gentamicin and metronidazole) use **Neonatal Formulary**
- Give IM vitamin K (see **Vitamin K** guideline)
- Discuss baby's condition and treatment plan with parents and ensure they have seen the baby before transfer. Take photographs for parents
- Inform staff at the surgical unit, that baby is ready for transfer. Have available:
  - name
  - gestational age
  - weight
  - ventilatory and oxygen requirements
  - mother's name and ward (if mother admitted) – including contact number if possible (for consent)

Blood samples

Baby

- Blood culture
- FBC and clotting studies, including fibrinogen
- U&E
- Blood glucose
- Capillary/venous blood gas
- Check with surgical unit if sample from baby for group & save, Coombs' or crossmatch required (e.g. Birmingham Children's Hospital do **not** need **these** before transfer as these are done at surgical unit)
- Send 1 bloodspot on neonatal screening card marked as 'pre-transfusion' (for sickle cell screening) with the baby to surgical unit

Mother

- Obtain sample of mother's blood for crossmatch
- handwrite form, completing all relevant sections fully. Indicate this is the mother of baby being transferred and include baby's name. This information will be required by surgical unit blood bank

AWAITING TRANSFER TO SURGICAL UNIT

- Continue to assess bowel perfusion and alignment every 15 min
- Reassess baby's fluid requirements hourly. If fluid boluses required, give 10 mL/kg sodium chloride 0.9% IV
- If evidence of a coagulopathy, treat with fresh frozen plasma (FFP) or cryoprecipitate, as appropriate – see **Coagulopathy** guideline
- Aspirate NGT hourly and replace aspirate volume, mL-for-mL with sodium chloride 0.9% with 10 mmol potassium chloride/500 mL IV
- Leave the NGT on free drainage

DOCUMENTATION

- Complete nursing and medical documentation for transfer. Electronically transfer any X-rays to the surgical unit (or obtain copies of X-rays)
- Ensure mother's details are included (including ward phone number if an in-patient and own number if discharged) as if operation necessary and a parent unable to attend surgical unit, surgeon will require verbal telephone consent
- Ensure baby's documentation includes:
- whether vitamin K has been given
- name of referring consultant
- whether parents received antenatal counselling
- mother's name, ward (if admitted) and her contact details

TRANSFER TO SURGICAL UNIT

- Inform surgical unit that transfer is underway
- Place baby in transport incubator, taking care to transfer bowel and mesentery in a supported, non-kinked position. Keep stomach empty
- place baby on side of defect and support bowel on a folded nappy just slightly under baby. Check bowel perfusion immediately and at least every 15 min
- ensure mother's blood, baby's pre-transfusion bloodspots, letters for surgical team and all documentation accompanies baby

During transport

- Carry out and document usual observations, include bowel perfusion and alter its position if necessary

Arrival at surgical unit

- Record bowel perfusion and alignment

Useful information

http://www.bch.nhs.uk/content/neonatal-surgery

http://www.bch.nhs.uk/find-us/maps-directions

Parent information/support organisation (GEEPS – gastroschisis page)
http://www.geeps.co.uk/gastroschisis.htm

NHS Fetal Anomaly Screening Programme gastroschisis guideline

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GOLDEN HOUR
Preterm babies <28 weeks' gestation • 1/3

INTRODUCTION

The care preterm babies receive within the first few hours and days of life has a significant impact on their long-term outcomes. The CESDI 27–28 study highlighted the importance of good early care for preterm babies with particular reference to effective resuscitation (see **Resuscitation** guideline)

AIM

To stabilise and perform all procedures required by the baby within the first hour of life

BEFORE DELIVERY

Nurses	Doctors/ANNPs
● Identify nurse responsible for admission and redistribute existing babies	● Registrar or experienced ANNP is responsible for early care of babies <28 weeks' gestation
● Ensure incubator set up and pre-warmed with humidity set at maximum	○ counsel parents appropriate to gestation
● Check monitor and appropriate connections	○ <26 weeks, discuss delivery with consultant, who will attend whenever possible
● Set oxygen saturation limits at 91–95%	● Prescribe infusions for UAC and UVC
● Ensure ventilator and Neopuff™ plugged in and checked	● Check resuscitaire in delivery suite
● Ensure appropriate size face masks available	○ ensure overhead heater switched on and set to maximum
● Prepare suction and catheters	○ set peak inspiratory pressure (PIP) at 20 cmH_2O and FiO_2 at 0.21
● Ensure transport incubator pre-warmed and cylinders full	○ check saturation monitor and probe available
● Ensure endotracheal tube (ETT) sizes 2.5 and 3.0 are available	● Prepare plastic bag
● Set up trolley for umbilical arterial catheter (UAC) and umbilical venous catheter (UVC) beside incubator	
● Prepare infusion fluids for UAC and UVC	
● Take resuscitation bag and saturation monitor to delivery	

AFTER DELIVERY

Nurses	Doctors/ANNPs
● Keep baby warm with plastic bag and hat ● Assist with resuscitation ● Accurate time-keeping including resuscitation and procedures ● Attach oxygen saturation probe to right hand ● Assist with ETT fixation ● Set up transport incubator and transfer baby to it ● Ensure baby labels in place before transport ● Ensure midwives have taken cord gases ● Transfer baby to neonatal unit (NNU)	● Competent practitioner, ANNP or middle grade doctor to attend ● If normal delivery and baby breathing, delay clamping of cord for up to 2 min **providing baby can be kept warm** ● If operative or instrumental delivery, cut cord immediately and take baby to resuscitaire ● Place baby in plastic bag ● Cover baby's head with appropriate size warmed hat ● Assess colour tone, heart rate and breathing ● If baby breathing regularly, commence CPAP at 5 cmH_2O ● If baby not breathing regularly, give 5 inflation breaths at 20–25 cmH_2O using T piece and face mask ○ monitor response: check heart rate, colour and respiratory effort ○ if baby does not start to breath, give ventilation breaths with pressure of 20/5 and rate of 40–60/min ○ if heart rate not above 100 bpm or falls, observe chest movement and if poor, increase pressures to 25/5 ○ observe chest movement throughout and consider reducing inspiratory pressure if necessary (e.g. to 16–18) ○ when heart rate >100 bpm or chest movement seen, check saturation monitor and adjust FiO_2 aiming to bring saturations close to NLS guidance ● If continued IPPV necessary, intubate ● If unit policy is to give surfactant on labour ward, ensure appropriate ETT position and fix securely before administering surfactant ● Review baby once placed in transport incubator: ○ air entry ○ colour ○ heart rate ○ saturation ● Complete joint resuscitation record and obtain signature from maternity team ● Show baby to parents ● Senior member of staff to talk briefly to parents ● Transfer baby to NNU

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FIRST HOUR ON NNU

Nurses	Doctors/ANNPs
● Aim for at least 1:1 nursing care for first hour ● Transfer to incubator in plastic bag ● Weigh baby in plastic bag ● Leave baby in plastic bag until incubator reaches adequate humidity ● Attach baby to ventilator or CPAP driver and reassess ABC ● If ventilated, pre-warm surfactant and prepare surfactant administration equipment (e.g. TrachCare Mac™) ● Monitor heart rate and saturation ● Record blood pressure + baseline observations ● **Do not** use ECG leads on babies <26 weeks' gestation ● Measure axillary temperature on arrival ● Insert nasogastric tube (NGT) ● Assist doctor/ANNP with lines ● Give vitamin K ● Give first dose of antibiotics ● Take a photograph for parents	● Reassess ABC ● Split tasks between doctors/ANNPs **Doctor/ANNP A** ● Prescribe weight-dependent drugs and infusions and vitamin K ● Write blood test forms and prepare blood bottles ● Start admission notes (BadgerNet) **Doctor/ANNP B** ● Check ETT position clinically and administer surfactant if not previously given on labour ward ● Check ventilation – review tidal volume and chest movement ○ if tidal volume >5 mL/kg or vigorous chest movement, reduce PIP without waiting for first gas ○ check saturations and adjust FiO_2 to keep saturation 91–95% ● Insert UAC and UVC through hole in plastic bag ○ commence infusions as soon as line secured ● Take blood for: ○ FBC ○ clotting if clinically indicated ○ group and DCT ○ blood culture ○ blood glucose ○ pre-transfusion bloodspot ○ arterial gas ● Defer peripheral IV cannula insertion unless unable to gain umbilical access ● Once lines inserted, request X-rays ● Document ○ ETT position ○ NGT length ○ UAC and UVC positions at time X-ray taken ● Write X-ray report in notes ● Update parents and document in notes

Once baby set up – minimise handling
Hands off – Eyes on

HEARING SCREENING • 1/2

INTRODUCTION

- Early intervention improves the outcome for babies with a congenital hearing deficit
- Screening for congenital deafness is undertaken through the NHS Newborn Hearing Screening Programme (NHSP) by trained screeners according to national guidelines. They are automatically informed of all births and will ensure babies are screened
- Neonatal staff must understand how their local programme is organised, the risk factors for congenital deafness and know how to work with the screeners

INDICATIONS

Who

- All babies are eligible for screening, unless they have previously been diagnosed with bacterial meningitis or their ear canal is not patent on one or both sides
- neonatal staff **must** refer babies with meningitis to audiology for an urgent assessment (NHSP referral to be completed and handed to the screeners who will book a diagnostic appointment)
- screeners will refer babies with non-patent canal for urgent diagnostic assessment

PROCEDURE

Consent

- Screening can only be performed with parental consent
- screeners will obtain verbal consent from parents (if present) before screening
- if baby on neonatal unit (NNU) and parents absent, screeners will leave an explanatory leaflet and gain verbal consent from parents during their visit to NNU or over the telephone

How

- Oto-Acoustic Emissions (OAE) +/- Automated Auditory Brainstem Response (AABR) according to national 'Well baby' or 'NICU' protocols
- neonatal staff must inform screeners if baby has ever spent >48 hr on NNU so that NICU protocol can be used
- babies on transitional care are screened using the 'Well baby' protocol (unless previously on NNU for >48 hr)

When

- Screen only when baby has reached 34 weeks (corrected age)

Where

Well babies

- Screening is performed as an inpatient before discharge or in the community. See **Table 1** for local details

NNU babies

- Arrange screening as close to discharge as possible, when baby is well enough to test and preferably once major medical treatment, ototoxic or other drug treatment complete
- Do not screen babies transferring to another NNU
- Complete screening of babies on NNU >48 hr by 44 weeks (corrected age)

FOLLOW-UP

- Neonatal team must ensure all babies diagnosed with bacterial meningitis are referred for an urgent audiology assessment and are not screened
- Screeners will arrange routine follow-up according to screening results and presence of other specific risk factors

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Risk factors

- Neonatal staff must inform the screener of the following risk factors in order that the appropriate follow-up at 7–9 months can be arranged:
  - proven or possible congenital infection (CMV, rubella, toxoplasmosis)
  - cranio-facial anomalies, cleft palate, deformed pinnae (not simple ear tags)
  - syndromes associated with hearing loss (Down's, Waardenburg, Alport, Usher etc.)
  - baby has been treated with ECMO
- Babies with the following risk factors are not followed up by audiology, but data is collected for audit purposes:
  - severe jaundice (at exchange level)
  - multiple abnormalities with neurodegenerative/neuro-developmental disorder
  - mechanical ventilation >5 days
- Screener will determine presence of other risk factors before screening:
  - family history of permanent hearing loss in childhood
  - those with first-degree relative will be followed up in audiology

FURTHER INFORMATION

- Detailed information available from NHSP website: https://www.gov.uk/topic/population-screening-programmes/newborn-hearing

Table 1: Local details

● **Alexandra Hospital, Redditch** ● **Russells Hall Hospital, Dudley** ● **Shrewsbury & Telford Hospitals** ● **New Cross Hospital, Wolverhampton** ● **Worcester Royal Hospital** ● **Hereford County Hospital**	Usually performed by trained staff in the community Babies on NNU usually screened before discharge
● **Birmingham City Hospital** ● **Birmingham Heartlands Hospital** ● **Birmingham Women's Hospital** ● **Good Hope Hospital, Sutton Coldfield** ● **Manor Hospital, Walsall** ● **Royal Stoke University Hospital**	Screening for all babies usually performed while still an in-patient, usually at bedside
● **Sandwell Hospital MLU** ● **Solihull Hospital MLU**	Screening performed as an out-patient unless baby transferred into a main maternity/neonatal unit

DEFINITION

- Congestive cardiac failure occurs when heart is unable to pump sufficient blood to meet metabolic demands of body tissues
- underlying cause may be cardiac or non-cardiac

Causes

Non-cardiac

- Sepsis
- Hypoxia
- Anaemia
- Polycythaemia
- Fluid overload
- AV malformation
- Pulmonary hypertension

Cardiac

- Left ventricular outflow tract (LVOT) obstruction (see below)
- Left-to-right shunt (see **Increased left-to-right shunt** below)
- Arrhythmia
- TGA

Left ventricular outflow tract obstruction

- Hypoplastic left heart syndrome
- Critical aortic stenosis
- Coarctation
- Interrupted aortic arch

Clinical differentiation between an obstructed systemic circulation and severe sepsis is extremely difficult as a murmur and weak pulses can be common to both.

For baby in extremis, presence of abnormal pulses alone is sufficient indication to start a prostaglandin infusion until a cardiac lesion has been excluded by echocardiography – see* Prostaglandin infusion *guideline

SYMPTOMS AND SIGNS OF CARDIAC FAILURE

- Tachycardia
- Tachypnoea
- Hepatomegaly
- Excessive weight gain
- Hypotension
- Murmur
- Abnormal femoral pulses
- in obstructive left heart lesions, femoral pulses may not be absent if duct still patent
- weak femoral pulses are significant

INVESTIGATIONS

- Blood gas including lactate
- Chest X-ray
- look for cardiomegaly and pulmonary oedema
- Echocardiogram
- BP – check in right arm and one of the legs (a difference of >20 mmHg between an upper and lower limb is significant)
- Pre- and postductal saturations
- postductal saturations can be considerably lower than preductal in aortic arch defects (a difference of >2% is significant)

TREATMENT OF CARDIAC FAILURE DUE TO OBSTRUCTIVE HEART DISEASE

If left-sided obstructive lesion suspected, treat with inotropes and use diuretics cautiously

Resuscitation

Airway

- Intubate and ventilate babies presenting collapsed or with obvious cyanosis in association with cardiac failure

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- Routine intubation not indicated
- If apnoea occurs secondary to a prostaglandin infusion, intubate baby but do not alter infusion

Breathing

- See **Ventilation – conventional** guideline
- Ventilate with PEEP 5–6 cm
- Adjust ventilation to maintain:
- $PaCO_2$ 5–6 kPa
- pH >7.25

Circulation

- Vascular access with 2 IV cannulae or umbilical venous catheter (UVC) – see **Umbilical venous catheterisation** guideline

Presence of cyanosis and a murmur suggest baby likely to respond to prostaglandin infusion

- Prostaglandin infusion to maintain ductal patency (see **Prostaglandin infusion** guideline)
- open duct with dinoprostone (prostaglandin E_2, prostin E_2), see **Neonatal Formulary**. Start at 5–10 nanogram/kg/min, may be increased to 50 nanogram/kg/min, but only on cardiologist advice
- Monitor blood pressure invasively [ideally using a peripheral arterial cannula rather than an umbilical arterial catheter (UAC)]

Cardiac output

- Assess cardiac output, it is likely to be low when:
- tachycardia persists
- BP remains low
- acidosis persists
- high lactate
- peripheral perfusion poor
- ensure prostaglandin infusion adequate
- When cardiac output low:
- ensure adequate intravascular volume
- correct anaemia
- dobutamine may be required for poor perfusion

SUBSEQUENT MANAGEMENT – TRANSFER

Baby must be kept warm and normoglycaemic

- Discuss further management and transfer with regional cardiac centre
- Babies who respond to a prostaglandin infusion may not need transferring out-of-hours
- Appropriately skilled medical and nursing staff are necessary for transfer

Intubation

An intubated baby requires a cardiac centre ITU bed: do not intubate routinely for transfer

- Intubate if:
- continuing metabolic acidosis and poor perfusion
- long-distance transfer necessary
- inotropic support needed
- apnoea occurring
- recommended by cardiac team

DISCHARGE FROM CARDIAC CENTRE

Baby may go home or return to a paediatric ward or neonatal unit, possibly on a prostaglandin infusion whilst awaiting surgery or for continuing care after a palliative procedure (e.g. septostomy)

Management plan

- Regardless of outcome, obtain a management plan from cardiac centre, defining:
- acceptable vital signs (e.g. saturations)
- medication, including dosage
- follow-up arrangements

INCREASED LEFT-TO-RIGHT SHUNT

RECOGNITION AND ASSESSMENT

Definition

- Any lesion causing increased pulmonary blood flow
- Usually presents when pulmonary resistance falls after 48 hr
- Size and type of lesion will influence time of presentation

Differential diagnosis

- AVSD
- Partial AVSD
- VSD
- Truncus arteriosus
- PDA

Investigations

- Chest X-ray looking for fluid overload
- Echocardiogram

MANAGEMENT

- If in cardiac failure, give immediate dose of diuretic
- May require maintenance diuretics (discuss with cardiologist)
- usually furosemide 1 mg/kg twice daily and amiloride 100 microgram/kg twice daily orally
- Discuss with cardiac centre for definitive management and follow-up

Issue 6
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HEPATITIS B

Check mother's hepatitis B status **before birth**

Antenatal

- Midwife to inform obstetrician, neonatologist, public health team and GP of plan to immunise
- Hepatitis B immunoglobulin (HBIG) issued by Public Health England (PHE) via local consultant microbiologist. Order well in advance of birth

Labour

- When an HBsAg +ve mother arrives in labour or for caesarean section, labour ward must inform on-call neonatal team

Postnatal

- For all newborns, check screening results of mother's antenatal tests
- If antenatal testing not done, request urgent maternal HBsAg test
- Mother may breastfeed

IMMEDIATE POSTNATAL TREATMENT OF BABY

To which babies

Maternal status	Vaccine required by baby	Immunoglobulin (HBIG) required by baby
HBsAg positive, HbeAg positive	Y	Y
HBsAg positive, HBeAg negative, HBe antibody (anti-HBe) negative	Y	Y
HBsAg positive where e markers have not been determined	Y	Y
Acute hepatitis B during pregnancy	Y	Y
HBsAg positive and baby <1.5 kg	Y	Y
HBsAg positive, anti-HBe positive	Y	N
HBsAg positive and >10^6 iu/mL Hepatitis B DNA in antenatal sample	Y	Y
Other high risk group	Y	N

- Give low-birth-weight and premature babies full neonatal dose hepatitis B vaccine
- Give HBIG and hepatitis B vaccine to babies with birth weight <1.5 kg born to mother with hepatitis B, regardless of mother's HBeAg status
- Give hepatitis B vaccine to HIV exposed/infected babies

When

- Give within 24 hr of birth, ideally as soon as possible after delivery

What

- Give hepatitis B vaccine 0.5 mL IM. **Caution:** brands have different doses [e.g. Engerix-B® 10 microgram (recommended), HBVaxPro Paediatric® 5 microgram]
- HBIG 200 units additionally given to babies of highly infectious mothers (see **Table** above)
- Monitor infants born <28 weeks' gestation for 72 hr after HBIG

How

- Use two separate injection sites for hepatitis B vaccine and HBIG, in anterolateral thighs (not buttocks)
- Give hepatitis B vaccine IM, except in bleeding disorder where it may be given deep subcutaneously

Relationship to other immunisations

- No need to delay BCG following HBIG
- Hepatitis B vaccine may be given with other vaccines, but use separate site. If same limb used, give vaccines >2.5 cm apart

Documentation

- Record immunisation in red book

SUBSEQUENT MANAGEMENT

Further doses

- 2nd dose at 1 month
- 3rd dose at 2 months
- 4th dose at 12 months
- Give appointment for next dose or ensure agreement to give vaccine at GP practice or immunisation team

1 year follow-up

- Book 1 year hospital blood test before neonatal discharge
- Check child's HBsAg status at one year old
- if HBsAb, refer to infectious disease or liver team for further management

ROUTINE HEPATITIS IMMUNISATION

To whom

- Hepatitis B immunisation recommended with other routine immunisations for high-risk babies born to mothers:
- with partners who are hepatitis B surface antigen (HBsAg) positive
- with partners who are intravenous drug users (even if HBsAg negative)
- who change sexual partners frequently (e.g. commercial sex workers)
- with close family contacts known to be HBsAg positive
- who intend to live in a country with high prevalence of hepatitis B (Africa, Asia, Eastern Europe, Northern Canada, Alaska)

Dose regimen

- If mother HBsAg +ve, 1st dose within 24 hr, 2nd dose at 1 month, 3rd at 2 months, 4th at 12 months and pre-school booster
- If mother HBsAg –ve, 1st dose before discharge, 2nd at 1 month, 3rd at 6 months and pre-school booster
- Advise GP of schedule or give in hospital

HEPATITIS C

Antenatal

- High-risk groups:
- intravenous drug users (or women with partners who are IVDU)
- from a country of high prevalence [e.g. North Africa (particularly Egypt), Middle East]
- Discuss baby testing with mothers who had hepatitis C during antenatal period
- If maternal HCV RNA -ve, baby not at risk

Postnatal

- Hepatitis C antibody testing after 18 months (serum, clotted specimen)
- If antibody +ve or if HIV co-infected, test for HCV RNA (EDTA)
- If RNA +ve, check ALT and refer to regional hepatitis unit

Documentation

- Document hepatitis C follow-up visits in Red book to ensure health visitor aware and baby followed up

Breastfeeding

- Mother may breastfeed

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MOTHER WITH GENITAL LESIONS, SUSPECTED HSV

- Strict infection control for mother and baby
- Recommend breastfeeding unless herpetic lesions around nipple
- Vaginal delivery **or**
- Rupture of membranes >6 hr **or**
- Fetal scalp electrode or other instrumentation

Mother

- Swab lesions in viral transport medium for HSV PCR

Infant

- Within 24 hr of delivery swab nasopharynx, conjunctiva, mouth and rectum
- in viral transport medium for HSV PCR
- Send EDTA blood for HSV PCR

MOTHER WITH HISTORY OF GENITAL HERPES BEFORE PREGNANCY (PREVIOUS HSV INFECTION) BUT NO ACTIVE LESIONS OR DELIVERY BY CAESAREAN SECTION

- No swabs or treatment
- Good hand hygiene
- Advise to seek medical help if skin, eye or mucous membrane lesions, lethargy/irritability, poor feeding

MOTHER WITH NO HISTORY OF GENITAL HERPES BEFORE PREGNANCY (PRIMARY HSV)

- Swab nasopharynx, conjunctiva, mouth and rectum in viral transport medium for HSV PCR
- Check infant's ALT and send blood for HSV PCR
- Start aciclovir 20 mg/kg IVI over 1 hr 8-hrly. If ALT abnormal or other signs of infection send CSF for HSV PCR
- Stop aciclovir if neonatal HSV PCR -ve

TREATMENT

- Duration aciclovir
- if CSF HSV -ve and ALT normal give 10 days IV aciclovir
- if ALT raised and CSF -ve give 14 days aciclovir IV
- if skin, eye or mouth lesions give 10 days aciclovir IV
- if CSF HSV +ve, repeat LP at 14 days and if -ve stop at 21 days
- If HSV disease give aciclovir 300 mg/m^2 oral 8-hrly for 6 months

HIGH-FLOW NASAL CANNULAE (HFNC) RESPIRATORY SUPPORT • 1/1

DEFINITION

Delivery of humidified, heated and blended oxygen/air at flow rates between 1–8 L/min via nasal cannula

INDICATIONS

- Treating or preventing apnoea of prematurity
- Respiratory support for babies with:
  - Respiratory distress syndrome (RDS) – first-line or post extubation
  - chronic lung disease
  - meconium aspiration
  - pulmonary oedema
  - pulmonary hypoplasia
  - pneumonia
- Babies slow to wean off nasal CPAP
- Babies with nasal trauma from nasal CPAP

SETTING AND FLOW RATE

- Set operating temperature at 36–38ºC
- Start at flow rate of 4–6 L/min (flow rates >6 L/min in babies <1 kg – discuss with on-call consultant)
- Use up to 8 L/min in babies >1 kg, unless baby requires FiO_2 >0.4 or has CO_2 retention, acidosis or apnoea, in which case consider alternative support
- Ensure there is leak around the prongs

MONITORING

Continually

- Heart rate
- Respiratory rate
- SpO_2
- If on supplemental oxygen or on clinical grounds – blood gases
- Prescribe supplemental oxygen on drug chart

WEANING FLOW RATES

FiO_2 >0.3	May not be possible to wean flow rate
FiO_2 <0.25 in baby >1.5 kg	Attempt to reduce by 1.0 L/min 24-hrly
FiO_2 <0.25 in baby <1.5 kg	Attempt to reduce by 1.0 L/min 48-hrly
FiO_2 0.25–0.3	Attempt to reduce by 1.0 L/min 48-hrly
Requiring ≤2.0 L/min	● Attempt to stop (baby in air does not require nasal prong oxygen) ● If baby in oxygen, put in 0.2 L/min of nasal prong oxygen initially
● Clinical instability ● Increased work of breathing ● Significant increase in FiO_2	Consider pneumothorax (rare)

CONTRAINDICATIONS

- Upper airway abnormalities
- Ventilatory failure
- Severe cardiovascular instability
- Frequent apnoeas (despite caffeine in preterms)

Maternal to child transmission of HIV can be prevented only if maternal HIV status known

ANTENATAL

- Check latest version of care plan and last maternal HIV viral load
- If mother is to have IV zidovudine, prescribe it antenatally
- Confirm labour ward has the antiretrovirals indicated for this baby
- Recommend formula feeding; provide bottles/steriliser if necessary
- if mother wishes to breastfeed, refer to HIV team
- **absolutely avoid** mixed feeding with bottle and breast

Maternal blood tests

- Check every mother's HIV results
- if no result, recommend mother tested urgently (point of care if available)
- if declined, offer baby testing (urgent HIV antibody)
- if declined and from sub-Saharan Africa, refer to specialist midwife or HIV team

Low risk group

- Maternal viral load <50 copies/mL
- Give baby zidovudine for 4 weeks

High risk group

- Mother's viral load >50 copies/mL or not known
- Give baby zidovudine, lamivudine and nevirapine
- If maternal resistance and viral load >50, follow individualised plan
- If mother diagnosed postpartum, start baby on triple therapy immediately if <72 hr old

TREATMENT OF BABY

- Do not delay treatment for blood tests or any other reason
- Start as soon as possible after birth, definitely within 4 hr

Zidovudine 4 week dosing schedule

>34 weeks and feeding	4 mg/kg oral 12-hrly
>34 weeks and not tolerating feeds	1.5 mg/kg IV over 30 min 6-hrly
30–34 weeks and on feeds	2 mg/kg oral/NG 12-hrly for first 2 weeks **THEN** 2 mg/kg oral/NG 8-hrly for second 2 weeks
<30 weeks and on feeds	2 mg/kg oral/NG 12-hrly
<34 weeks and not tolerating feeds	1.5 mg/kg IV over 30 min 12-hrly

- Lamivudine 2 mg/kg oral 12-hrly for 4 weeks
- Nevirapine 2 mg/kg oral daily for 1 week then 4 mg/kg daily for 1 week, then stop
- if mother on nevirapine >3 days, give baby 4 mg/kg daily for 2 weeks then stop
- If medication cannot be given orally, give IV zidovudine
- if high risk, change to oral zidovudine for 4 weeks as soon as medication can be given orally and add oral lamivudine for 4 weeks and nevirapine for 2 weeks

- If maternal viral load >50 copies/mL and antiretroviral resistance, discuss with lead consultant for HIV perinatal care
- Advice available (24 hr) from regional hub [e.g. Birmingham Heartlands Hospital (0121 424 2000), North Manchester (0161 624 0420), London: St Mary's (0207 886 6666) or St George's (0208 725 3262)]

TESTING OF BABY

- HIV RNA PCR (viral load 2 mL EDTA) at local virology laboratory if agreed policy
- Otherwise HIV DNA PCR (1.3 mL EDTA) sent to PHE at Colindale with paired sample from mother (complete Reference Test form, available to download from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/344580/S3_HIV_Reference_Test.pdf
- Day 1 (or within 48 hr after birth if weekend/bank holiday)

DISCHARGE AND FOLLOW-UP

- Advise postnatal staff not to recommend breastfeeding
- Give mother cabergoline to suppress milk
- If mother does breastfeed, monthly HIV RNA PCR testing for mother and baby
- If baby vomits within 30 min of taking medicines, or if medicine is seen in the vomit, give the dose again
- Bring next dose forward up to 6 hr after last dose for mother to give at a convenient time
- Round dose up to nearest easily measurable volume
- Dose does not need to be changed with baby's weight gain
- Ensure mother confident to give antiretrovirals to baby
- Dispense 4 weeks' supply on discharge
- Notify lead consultant for HIV who will notify British Paediatric Surveillance Unit (BPSU)
- Follow-up appointment with lead consultant for HIV at 6 weeks
- Ensure all involved have record of perinatal care: mother, paediatrician, obstetrician, infectious diseases consultant

SUBSEQUENT MANAGEMENT

Investigations

- HIV RNA (or DNA) PCR at 6 weeks and 3 months
- HIV antibody at 2 yr if laboratory only using combined antibody/antigen test, (or 18 months if earlier generation antibody test used)

PCP prophylaxis

- If maternal viral load >1000 copies/mL or unknown, give baby co-trimoxazole 120 mg babies >2 kg; babies <2 kg 900 mg/m^2 or 24 mg/kg
  - once daily 3 times a week (Monday, Wednesday, Friday)
  - start at 4 weeks
  - stop if HIV PCR still negative at 3 months

Immunisations

- Unless high risk of TB and last maternal viral load <50 copies/mL, and exclusively formula fed, delay BCG vaccination of baby until results of 3 month PCR tests negative
- Recommend all other vaccinations as per routine schedule (including MMR)

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HYDROPS FETALIS • 1/2

DEFINITION

- Abnormal accumulation of fluid in two or more compartments of the fetus (a compartment can be skin, pleura, pericardium, placenta, peritoneum or amniotic fluid)
- Two recognised types – immune and non-immune
  - immune hydrops fetalis occurs when maternal allo-immune antibodies are produced against fetal red cells causing haemolysis
  - non-immune hydrops fetalis occurs in the absence of maternal antibodies
- Mortality is high – between 56% and 78.2% in developed countries

SYMPTOMS AND SIGNS

- Hydrops fetalis is diagnosed antenatally

Refer all antenatally diagnosed hydrops fetalis to a regional fetal medicine centre for further assessment and management

INVESTIGATIONS

- Refer to fetal medicine team to investigate both mother and baby to determine the cause. (Investigations carried out by the fetal medicine team are beyond the scope of this guideline)
- Due to the extensive list of causes of hydrops fetalis, investigations should be directed according to clinical history and presentation. Initial investigations to consider include:

Cause	Initial investigations	Further investigations to be considered if underlying cause is not ascertained
Anaemia	• Full blood count (including blood film) • Group and Direct Coombs' test • Maternal Kleihauer test	• Red cell enzyme deficiency (e.g. G6PD deficiency) • Red cell membrane defects (e.g. hereditary spherocytosis) • Haemoglobinopathies (e.g. thalassaemia)
Biochemistry	• Liver function tests including albumin • Urea, creatinine and electrolytes	• If pleural/ascitic tap done – send for fluid MC+S and biochemistry
Cardiac	• ECG to exclude cardiac dysrhythmias • Echocardiography to exclude structural heart defects	
Placenta	• Send to pathologist	
Genetic testing	• Chromosomes • Microarray	• Investigate for congenital metabolic conditions
Infection	Toxoplasma, rubella, CMV, parvo virus, herpes simplex virus	
Radiology	• Chest X-ray • Abdominal X-ray • Cranial ultrasound scan	• Further investigations to be guided by clinical picture
15–25% of babies diagnosed have no clearly discernible cause		

TREATMENT

Antenatal treatment

- For immune hydrops the fetal medicine team may carry out intrauterine blood transfusions
- Further intensive monitoring is also provided (discussion of this is beyond the scope of this guideline)

Immediate neonatal management

- An expert team, including a neonatal consultant must attend delivery of a baby diagnosed with having hydrops fetalis as resuscitation and stabilisation can be difficult
- Manage according to Neonatal Life Support (NLS)

Consider concurrent pleural/ascitic drains to facilitate resuscitation

- In cases of severe anaemia, give urgent O negative blood transfusions. Baby may need further grouped and cross matched blood transfusions in the neonatal unit

Give only CMV negative and irradiated blood

SUBSEQUENT MANAGEMENT

Ventilation

- Ensure adequate oxygenation and ventilation
- May require high frequency oscillatory ventilation (see **HFOV** guideline) and muscle relaxation
- If pulmonary hypertension present may require nitric oxide (see **Nitric oxide** guideline)

Cardiovascular system

- Use inotropes to support heart and blood pressure
- If intravascular fluid depletion give colloid
- Strict fluid balance
- If severe compromise may require further pleural and ascitic taps
- Immune hydrops may require exchange transfusion. See **Jaundice** and **Exchange transfusion** guidelines

Even with optimal management, the mortality rate is high. Consider a post mortem in the event of a death

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DEFINITION

- There is no established definition of hyperglycaemia. However, treat if:
- two blood sugars are ≥14 on 2 occasions measured at least 2 hr apart **or**
- blood sugars ≥12 on 2 occasions measured at least 2 hr apart with evidence of significant glycosuria (++ on the urine dipstick)

Do not take sample from an infusion line that has glucose running through it

CLINICAL FEATURES

- Osmotic diuresis leading to dehydration
- Poor weight gain

Risk factors

- Immaturity of pancreatic function (e.g. extremely premature infants and small-for-gestational-age)
- Insulin resistance
- Glucose overload (e.g. equipment failure, administrator error)
- Stress (e.g. infection, pain)
- Side effects of a medication (e.g. glucocorticoid treatment)

MONITORING

Twice-daily

- Check blood glucose at least 6–8 hrly in:
- unstable or acutely ill babies [respiratory distress syndrome (RDS), septicaemia, necrotising enterocolitis (NEC)]
- Most blood gas machines provide blood glucose measurements

Daily

- Check blood glucose at least once a day in stable babies:
- <32 weeks' gestation for first week
- receiving TPN
- with severe unexpected dehydration or metabolic acidosis
- with poor weight gain while receiving >120 kcal/kg/day

Babies treated with corticosteroids

- Check urine for glycosuria daily
- Check blood glucose if ≥2+ glucose in urine

TREATMENT

- If possible, discontinue or decrease medications that worsen hyperglycaemia

Suspected infection/NEC

- Hyperglycaemia in baby with previously stable blood glucose may be an early indicator of infection or NEC
- Assess baby clinically
- After taking appropriate cultures, treat empirically

Fluids

- If blood glucose ≥12 mmol/L, check urine for glycosuria (of ≥2+) and assess clinical hydration and fluid input/output. Check for fluid administration errors
- Calculate amount of glucose baby is receiving (as mg/kg/min) using the formula:

$$\text{Glucose infusion rate (mg/kg/min)} = \frac{\%\ \text{glucose} \times \text{fluid rate (mL/kg/day)}}{144}$$

- If glucose delivery rate >10 mg/kg/min, decrease glucose in increments to 6–10 mg/kg/min. If on TPN, 8–10 mg/kg/min is acceptable
- If glycosuria and hyperglycaemia >12 mmol/L persists despite an appropriate glucose infusion rate, consider treating with insulin

Insulin

- Commence insulin therapy at 0.05 units/kg/hr and titrate according to response – see **Administration of Actrapid insulin** below
- Check blood glucose 1 hr from starting and hourly until target reached
- Increase by 0.02 units/kg/hr until blood glucose decreasing by at least 1 mmol/L between blood samples
- Target blood glucose while on insulin is 6–8 mmol/L
- Once blood glucose is stable, decide frequency of checking glucose clinically
- When a baby is on insulin it is very important to prevent hypoglycaemia – see below

Preventing hypoglycaemia

Blood sugar	Action
6–8 mmol/L and stable	Maintain insulin infusion rate
6–8 mmol/L and decreasing	Reduce insulin infusion rate to 50% of present rate
<6 mmol/L	Stop infusion

- Re-check blood glucose 1 hr after reducing dose, then 1–2 hrly until stable
- If unable to wean off insulin after 1 week, transient neonatal diabetes is likely; consult paediatric endocrinologist
- Early introduction of PN and early trophic enteral feeding will help reduce incidence of hyperglycaemia requiring insulin

ADMINISTRATION OF ACTRAPID INSULIN (SOLUBLE INSULIN)

- Follow instructions in **Neonatal Formulary** for making up insulin infusion
- Administer Actrapid insulin infusion via a central line or a dedicated peripheral cannula
- Before starting infusion, prime all IV connecting and extension sets and T-connectors with insulin infusion fluid. Check manufacturer's guide on lumen capacity for priming volumes

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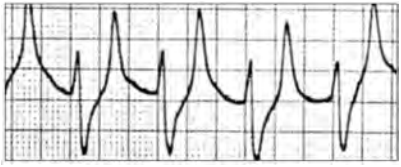
RECOGNITION AND ASSESSMENT

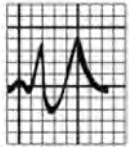
- Plasma potassium >6 mmol/L (normal 3.0–5.5 lithium heparin specimen)
- Babies often tolerate concentrations up to 7.5–8.0 mmol/L without ECG changes

SYMPTOMS AND SIGNS

- Cardiac arrest
- ECG abnormalities (see below):
  - tall peaked T waves
  - widened QRS complex
  - sine waves (widened QRS complex merging with T wave)
  - prolonged PR interval, bradycardia, absent P wave



Tall, peaked T wave, widening of QRS



Sine wave QRS complex (before cardiac arrest)

CAUSES

- Renal failure: secondary to hypoxic ischaemic encephalopathy (HIE), sepsis and hypotension, or structural abnormalities
- Cellular injury with potassium release e.g. large intraventricular haemorrhage, haemolysis
- Very low-birth-weight babies without renal failure (non-oliguric hyperkalaemia) in first 12–48 hr
- Excess K^+ in IV solutions
- Endocrine (congenital adrenal hyperplasia)

INVESTIGATIONS

- If sample haemolysed, repeat and send free-flowing venous or arterial sample
- If potassium >6.0 mmol/L, connect to cardiac monitor

IMMEDIATE TREATMENT

Serum potassium >6.0 mmol/L (stable with normal ECG)

- Stop all K^+ IV solutions, oral supplements and potassium-sparing diuretics
- Reconfirm hyperkalaemia
- Institute continuous ECG monitoring

Serum potassium >7.0 mmol/L without ECG changes

- As above
- Give salbutamol 4 microgram/kg IV in glucose 10% over 5–10 min: effect evident within 30 min but sustained benefit may require repeat infusion after at least 2 hr
  - if IV access difficult, give nebulized salbutamol 2.5 mg as a single dose (difficult to administer if ventilated and not formally evaluated in babies) and repeat if necessary
  - give furosemide 1 mg/kg IV
- If serum potassium still >7.0 mmol/L, give insulin 0.5 units/kg IV in glucose 10% (made up to 2.5 mL and given over 30 min): very effective and has an additive effect with salbutamol
- Repeat U&E
- Repeat insulin infusion as necessary until K^+ <7 mmol/L
- **Monitor blood glucose every 15 min for first 2 hr during and after infusion**
  - aim for blood glucose 4–7 mmol/L

Serum potassium >7.5 mmol/L with ECG changes

- **As above, but first institute emergency measures below:**
- give 10% calcium gluconate 0.5 mL/kg IV over 5–10 min
- flush line with sodium chloride 0.9% or preferably use a different line
- give IV sodium bicarbonate (1 mmol/kg over 2 min) this is effective even in babies who are not acidotic (2 mL of sodium bicarbonate 4.2% = 1 mmol)

Further treatments: discuss with consultant

- A cation-exchange resin, such as calcium resonium (500 mg/kg rectally, with removal by colonic irrigation 8–12 hrly, repeat every 12 hr. Dose can be doubled at least once to 1 g/kg in severe hyperkalaemia). Useful for sustained reduction in serum potassium but takes many hours to act and is best avoided **in sick preterms who are at risk of necrotising enterocolitis (NEC)**
- If severe hyperkalaemia persists despite above measures in term babies with otherwise good prognosis, contact renal team for consideration of dialysis
- Exchange transfusion using fresh blood or washed red blood cells is another strategy for sustained and reliable reduction in serum K^+ concentration – see **Exchange transfusion** guideline

SUBSEQUENT MANAGEMENT

- Recheck serum K^+ 4–6 hrly; when arrhythmias present with renal failure, monitor hourly
- Monitor urine output and maintain good fluid balance
- If urine output <1 mL/kg/hr, unless baby volume depleted, give furosemide 1 mg/kg IV until volume corrected
- Treat any underlying cause (e.g. renal failure)

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HYPERNATRAEMIC DEHYDRATION • 1/4

DEFINITION

- Serum sodium >145 mmol/L
- mild: 146–149 mmol/L
- moderate: 150–160 mmol/L
- severe: >160 mmol/L

Most common cause is failure to establish adequate oral intake while attempting breastfeeding

AIM

To prevent/treat hypernatraemic dehydration while encouraging breastfeeding

Other causes of hypernatraemia

- Diarrhoea/vomiting
- Infection and poor feeding
- Renal dysplasia
- Obstructive uropathy
- Diuretic phase following acute kidney injury
- Osmotic diuresis
- Diabetes insipidus
- Idiopathic causes
- Sodium bicarbonate or sodium chloride administration
- Excessive insensible losses in extremely premature babies
- Improperly prepared formula

PREVENTION

Babies at high risk

- Preterm <37 weeks
- Born to primiparous women
- Maternal prolonged second stage of labour >1 hr
- Use of labour medications
- Caesarean section with delayed initiation of feeding
- Cleft lip and/or palate
- Maternal breast abnormalities (flat, inverted nipples)/surgery
- Maternal illness, haemorrhage
- Maternal obesity
- Maternal diabetes
- Polycystic ovary syndrome (PCOS)
- Skin conditions that increase insensible water loss

Action

- Identify babies at risk
- Immediate skin-to-skin contact at birth and breastfeed within 1 hr of life
- Offer breastfeeding assistance within 6 hr of life
- Assess baby to ensure feeding adequate
- Ensure baby feeds at least 6 times within 24 hr
- If baby reluctant to feed, express breast milk (see **Breast milk expression** guideline) and offer by cup or syringe
- Calculate required volume of feeds using local guidelines
- Avoid bottle feeding as far as possible and avoid dummies
- Assess feeding, number of wet nappies and stools using **Table**
- Avoid early discharge of at-risk babies
- Early re-weighing of at risk babies (at 72–96 hr) with breastfeeding support can reduce severity of hypernatremic dehydration

Day	Wet nappies	Stool
1–2	≥2/day	>1/day
3–4	≥3/day	≥2/day, changing in colour and consistency
5–6	≥5/day	≥2/day, yellow in colour

- Weigh between 72 and 96 hr
- Refer all who have lost >10% weight
- weight loss % = weight loss (g)/birth weight (g) x 100

Symptoms and signs

- Irritability/high pitched cry: unsettled during breastfeeding
- Prolonged feeding >45 min
- Demanding <6 feeds in 24 hr
- Reduced urinary frequency
- Delayed change from meconium to transitional stools
- Weight loss
- Fever
- Jaundice
- Lethargy/altered level of consciousness
- Tremor
- Increased tone
- Doughy skin
- Seizures (usually during rehydration)
- Physical examination may be unremarkable
- Usual signs of dehydration (sunken fontanelle, reduced skin turgor) may be absent

Complications

- Venous and arterial thrombosis
- Subdural and cerebral haemorrhage
- Cerebral oedema (especially during rehydration)
- Seizures (especially following rehydration)
- Apnoea and bradycardia
- Cognitive and motor deficits
- Hearing impairment – may be transient
- Hypertension
- Cerebral infarction
- Renal failure
- Death
- Long term developmental delay

Investigations

- U&E
- Calcium
- Total bilirubin
- Blood glucose
- CRP
- Blood culture
- Paired urinary electrolytes

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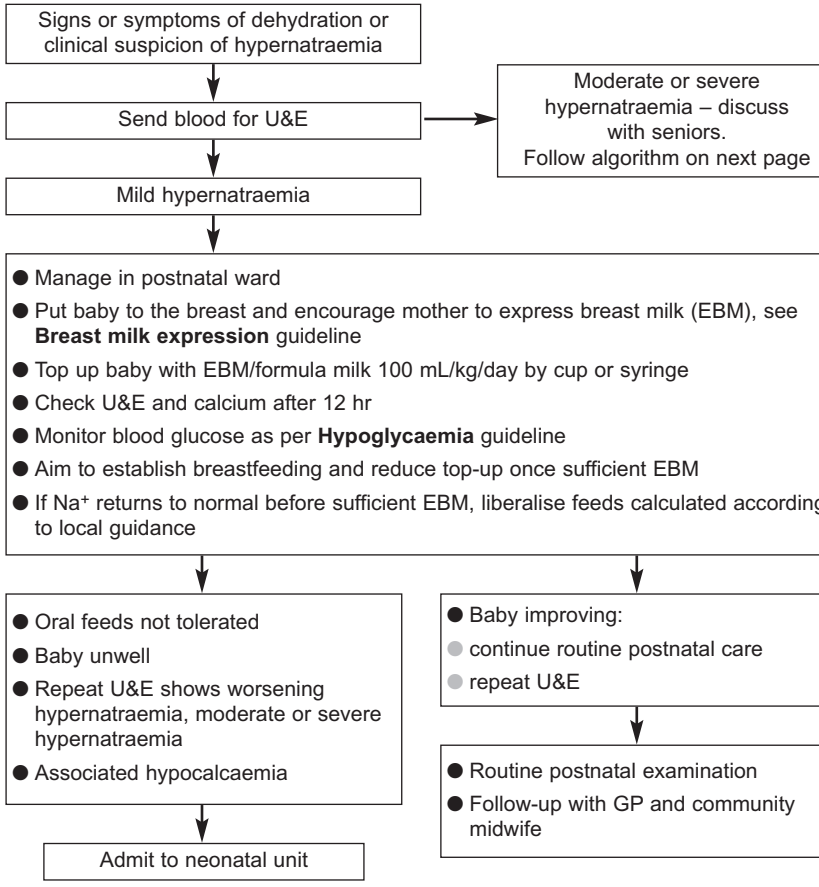
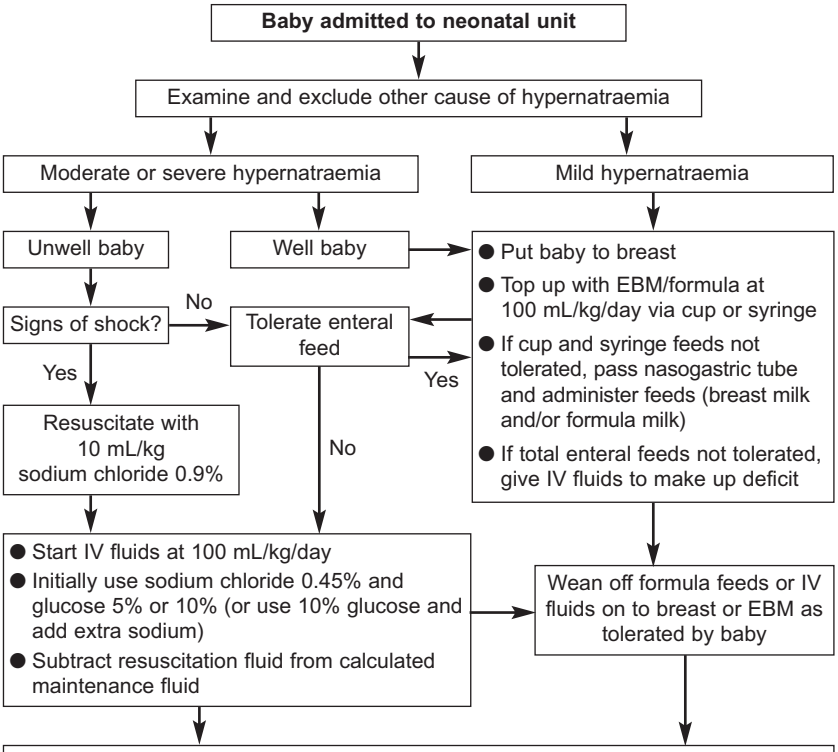
MANAGEMENT


Signs or symptoms of dehydration or clinical suspicion of hypernatraemia
Send blood for U&E
Moderate or severe hypernatraemia – discuss with seniors. Follow algorithm on next page
Mild hypernatraemia
Manage in postnatal ward
Put baby to the breast and encourage mother to express breast milk (EBM), see Breast milk expression guideline
Top up baby with EBM/formula milk 100 mL/kg/day by cup or syringe
Check U&E and calcium after 12 hr
Monitor blood glucose as per Hypoglycaemia guideline
Aim to establish breastfeeding and reduce top-up once sufficient EBM
If Na+ returns to normal before sufficient EBM, liberalise feeds calculated according to local guidance
Oral feeds not tolerated
Baby unwell
Repeat U&E shows worsening hypernatraemia, moderate or severe hypernatraemia
Associated hypocalcaemia
Admit to neonatal unit
Baby improving:
continue routine postnatal care
repeat U&E
Routine postnatal examination
Follow-up with GP and community midwife



- Enteral rehydration is safe and effective if baby is clinically stable and should be used in preference to IV
- Repeat U&E 4-hrly
- Aim for rate of fall in Na^+ of 0.5 mmol/L/hr. If Na^+ falling any faster, reduce rate of rehydration or change fluids to sodium chloride 0.9% with glucose
- If severe hypernatraemia, contact consultant
- If low blood glucose, see **Hypoglycaemia** guideline
- If in renal failure, suspected renal cause or Na^+ >170 mmol/L, discuss with paediatric nephrologist – may need dialysis
- Monitor:
  - temperature
  - heart rate
  - blood pressure
- Keep strict fluid balance chart
- Monitor weight once or twice daily
- Aim to correct dehydration over 48–72 hr or slower in severe cases
- **Do not correct hyperglycaemia with insulin**, this can reduce plasma osmolality rapidly and precipitate cerebral oedema
- Once sufficient EBM available, aim to establish breastfeeding and reduce top-up
- Neuro-developmental follow-up for all babies with moderate and severe hypernatraemia

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DEFINITION

There is no agreed definition of hypoglycaemia in babies. Thresholds are therefore, chosen as pragmatic approaches prompting clinical interventions if blood glucose falls below certain levels (**Table 1**)

Table 1: Blood glucose thresholds for initiating treatment

Symptomatic and preterm babies	<2.6 mmol/L
Asymptomatic term babies	<2.0 mmol/L (no simple correlation between blood glucose levels and neuroglycopaenia)

PREVENTION

- Dry baby and keep warm with skin-to-skin contact after birth
- Encourage breastfeeding in accordance with 'Baby Friendly' guidelines
- baby should feed within **1–2 hr** after birth and continue breastfeeding at regular intervals (3–4 hrly as a minimum)
- it is particularly important that mothers of babies who are at risk of hypoglycaemia are encouraged to breastfeed as colostrum and breast milk contain metabolites thought to help babies cope with the physiological drop in blood glucose
- if baby not able to suck effectively, use mother's expressed breast milk (EBM)
- Do not offer formula milk to breast-fed babies (unless it is mother's informed choice)
- Identify babies at risk of hypoglycaemia (**Table 2**) and initiate blood glucose monitoring as soon as possible after birth

Table 2: Babies with risk factors for hypoglycaemia

Maternal conditions	Neonatal conditions
● Diabetes during pregnancy ● Drug treatment (beta blocker/or hypoglycaemic agents)	● IUGR and SGA (<10th centile on WHO growth chart or clinically wasted) ● Preterm (<37 weeks) ● Hypothermia ● Unwell baby ● Suspected endocrine condition (e.g. CAH) ● Haemolytic disease of baby ● Severe fluid restriction ● Obvious syndromes (e.g. midline defects Bethwith-Weidemann syndrome) ● Screening for metabolic disorders (e.g. family history of MCADD) ● Babies on IV fluids or PN

TESTING BLOOD GLUCOSE

- Obtain glucose using a ward-based glucometer (e.g. Medisense®) or a blood gas analyser. Ensure equipment is calibrated regularly according to manufacturer's instructions
- Record results as 'blood glucose' or 'BG' (**not BM**) in baby's medical record

Who to test

- Babies at risk of hypoglycaemia (see **Table 2**)
- Babies with signs and symptoms suggestive of hypoglycaemia
  - feeding poorly (despite support)
  - hypothermia
  - hypotonia, limpness
  - lethargy or sleepy
  - seizures
  - changes in levels of consciousness (e.g. irritability, drowsy, stupor or coma)
  - apnoeic or cyanotic spells

If symptomatic hypoglycaemia, call urgently an advanced neonatal nurse practitioner (ANNP) or a paediatric doctor for assessment and immediate treatment

When to perform hypoglycaemia screen (investigations for underlying cause – see below)

All these babies are managed in NNU

- Symptomatic hypoglycaemia
- Hypoglycaemia without risk factors
- Persistent or recurrent hypoglycaemia

Symptoms cannot be attributed to hypoglycaemia if they persist with normoglycaemia within 30 min. Jitteriness is rarely associated with hypoglycaemia in term babies

Who NOT to test blood glucose

- Healthy term babies born following normal pregnancy and delivery

When to test blood glucose

Babies with risk factors for compromised metabolic adaptation (Table 2)

- Initial screening before the second feed, usually around 3–4 hr of age
- Subsequently:
  - in first 24 hr of life before each feed, 3–4 hrly
  - in second 24 hr of life 4–6 hrly
  - then as necessary
- As glucose is most likely to be low in first 24 hr, discontinue screening after this time if baby is feeding well, or before if glucose levels ≥2 mmol/L (or ≥2.6 for preterm) on 4 consecutive occasions
- If concerns persist, continue pre-feed checks
- **Babies on PN**: measure blood glucose at least daily

MANAGEMENT – see flow chart

Asymptomatic hypoglycaemia

Feeding

- Correct hypothermia (see **Hypothermia** guideline)
- If baby is feeding, increase frequency and/or volume of milk
- In breast-fed, not able to suck effectively, feeding can be supplemented by mother's expressed breast milk (EBM)

Glucose

- Repeat blood glucose measurement within 1 hr, if still low check laboratory blood glucose
- Give IV glucose if:
  - feeds not tolerated
  - intensive feeding does not normalise or improve blood glucose

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- Give glucose 10% by infusion 6 mg/kg/min (90 mL/kg/day)
- once normoglycaemia achieved, reduce infusion as feeds tolerated
- If blood glucose on 2 consecutive blood glucose results <2.0 mmol/L (<2.6 for preterm) despite extra feeding, support and interventions, admit to NNU or TCU for more intensive feeding regimen (e.g. nasogastric tube feeding and/or a glucose infusion)
- If baby symptomatic or if blood glucose is **profoundly low (<1.5 mmol/L)**, follow guidance for **Symptomatic or profound hypoglycaemia** (below) immediately
- Continue enteral feeding during glucose IV and increase as tolerated

Symptomatic or profound hypoglycaemia

Therapeutic goal of intervention is different to thresholds to initiate treatment.

Symptomatic babies and babies with suspected hyperinsulinemia are at higher risk of complications, therapeutic goal is to restore glucose to >3.3 mmol/L.

For all other babies, aim is to restore ≥2.6 mmol/L

- Check laboratory blood glucose but do not delay treatment
- Give 2.5–5 mL/kg glucose 10% IV at 1 mL/min. **Always follow with** glucose 10% infusion of 6 mg/kg/min (90 mL/kg/day). If necessary this can be increased to up to one day ahead of daily requirement
- Feeds may continue if clinical situation allows and if tolerated
- Aim for blood glucose >3.3 mmol/L and record baby's response. Once normoglycaemic, clinical signs of hypoglycaemia should disappear within 30 min
- Recheck blood glucose in 30 min; if still low, increase the infusion rate to 8 mg/kg/min by increasing volume (120 mg/kg/day) or increase the concentration (glucose up to 12.5% via peripheral venous line) depending on baby's daily requirement
- If baby able to take some enteral feed but cannot cope with the increased volume, give remaining volume as IV glucose
- Repeat blood glucose in 1 hr; if still low, increase glucose infusion rate to 10 mg/kg/min either through increasing the volume to 150 mL/kg/day or if this is not possible increase concentration to 15% and then to 20%
- If >12.5% of glucose concentration is required, give centrally through a long line or an umbilical venous catheter (UVC), ensuring the tip is not in the liver – see **Long line insertion** guideline and **Umbilical venous catheterisation** guideline

$$\text{Glucose infusion in mg/kg/min} = \frac{\%\ \text{glucose} \times \text{fluid volume in mL/kg/day}}{144}$$

- If blood glucose still low, give Glucagon 200 microgram/kg IM, IV or SC (maximum 1 mg repeated only once if needed)
- Check blood glucose 30 min after administration of Glucagon and hourly after that until stable

Do not use glucose concentration >20% in babies unless advised by endocrinologist

If symptomatic hypoglycaemia, always verify blood glucose by sending sample for laboratory glucose estimation

Step-down

- Once blood glucose normal and stable, wean baby onto milk feeds slowly aiming to establish 3-hrly feeding

Other strategies

Hypostop

- Although hypostop has been shown to cause slight increase in blood glucose when given to babies, the WHO expert panel found there was insufficient evidence to recommend its use in this situation

Preterm formula

- Although preterm formula milk may have a higher calorific content than breast milk, there is no evidence to support its use in place of breast milk during the management of asymptomatic neonatal hypoglycaemia. Breast milk has many other advantages

Routine additions of polymers (e.g. Maxijul)

- Not recommended. If felt necessary, discuss with neonatal dietitian and beware risk of necrotising enterocolitis (NEC)

SEVERE, PERSISTENT OR RECURRENT HYPOGLYCAEMIA

Discuss with paediatric endocrine/metabolic team. If hyperinsulinism suspected, discuss with national centre for hyperinsulinism at Manchester Children's Hospital

Causes

- Hyperinsulinism
- Endocrine deficiency, especially panhypopituitarism
- Disorder of:
  - fatty acid metabolism
  - carbohydrate metabolism
  - amino acid metabolism
- Rate of glucose infusion required is a good guide to likely cause

Substrate or endocrine deficiency	<5 mL/kg/hr of glucose 10% (<8 mg/kg/min)
Hyperinsulinism	>6 mL/kg/hr of glucose 10% (>10 mg/kg/min)

Investigations (hypoglycaemia screen)

- Paired insulin and glucose estimations while hypoglycaemic (hyperinsulinism confirmed if insulin >10 picomole/L when glucose <2 mmol/L or glucose:insulin ratio <0.3)
- LFT, TFT
- Blood gas
- Urinary ketones and organic acids
- Serum C-peptide
- Plasma cortisol and growth hormone
- Plasma amino acids
- Plasma acylcarnitine
- Free and total carnitines
- Fatty acids and beta hydroxybuturate
- Galactosaemia screen

When to investigate further

- Persistent recurrent hypoglycaemia, especially in low-risk baby
- Unexpectedly profound hypoglycaemia in a well baby
- Hypoglycaemia in association with metabolic acidosis and/or abnormal neurological signs
- Hypoglycaemia in association with other abnormalities:
  - midline defects
  - micropenis
  - exomphalos
  - erratic temperature control
- Family history of SIDS, Reye's syndrome, or developmental delay

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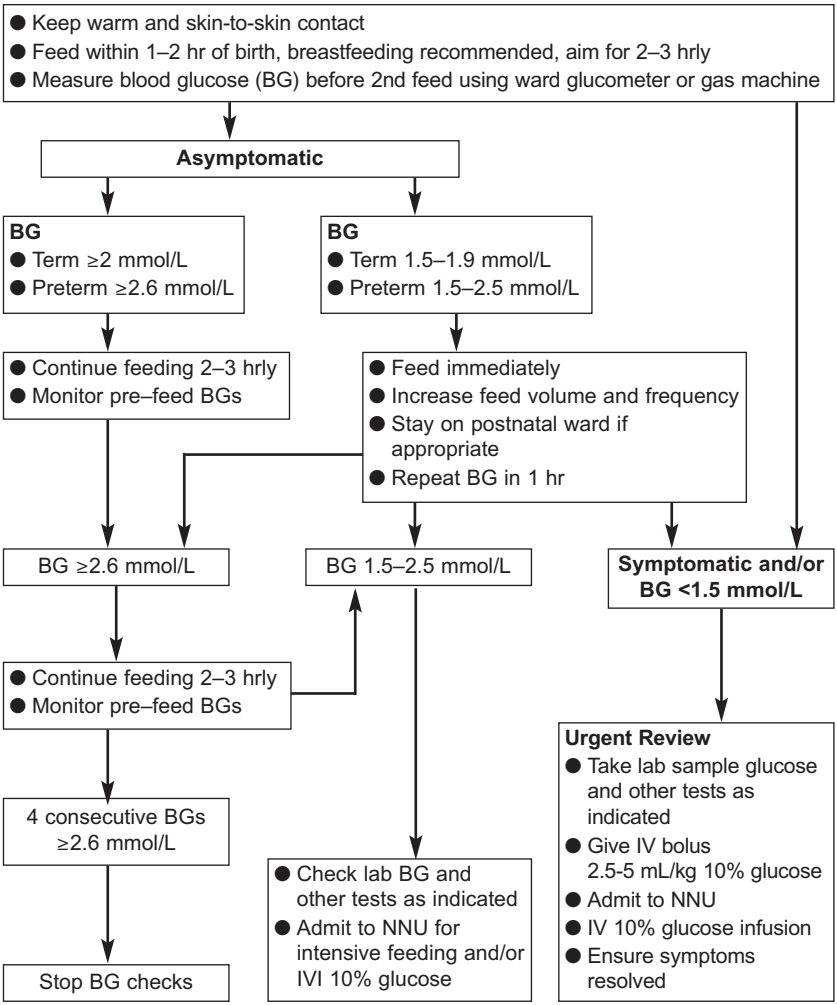
Documentation

- Neonatal hypoglycaemia may be an early sign of other significant disease processes requiring further investigation
- Accurate contemporaneous documentation of events must be made in baby's medical record, including:
  - time hypoglycaemia noted
  - baby's clinical condition when hypoglycaemia noted
  - blood glucose concentration and method by which it was measured
  - nature of treatment
  - nature and timing of clinical response to treatment
  - confirmation of improvement in blood glucose

Flowchart: Neonatal hypoglycaemia

● **Monitor at risk groups (see Table 2)**



- **If ward glucometers give value of <X.X, assume BG <1.5 and check both gas machine and lab BG to confirm**
- **If anytime baby symptomatic or BG <1.5, give bolus 10% glucose and admit to NNU for IV infusion**
- **Threshold for initiating treatment is different from therapeutic goal for intervention (most babies, BG therapeutic goal ≥2.6)**
- **Therapeutic goal for symptomatic babies and suspected hyperinsulinism is BG >3.3**

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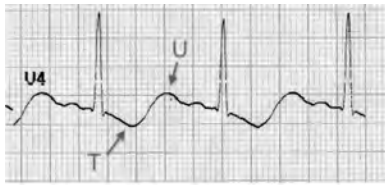
HYPOKALAEMIA • 1/2

RECOGNITION AND ASSESSMENT

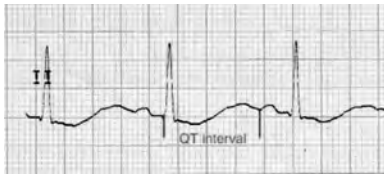
- Plasma potassium level less than 3.5 mmol/L or below normal level defined by local laboratory
- Symptoms may occur if potassium level <3 mmol/L
- Late sign of potassium depletion as plasma/serum potassium maintained by mobilizing intracellular potassium stores

SYMPTOMS AND SIGNS

- Muscle weakness and paralysis
- ECG changes
  - increased amplitude and width of P wave
  - prolongation of PR interval
  - T wave flattening and inversion
  - ST depression
  - prominent U waves (best seen in precordial leads)
  - apparent long QT interval due to fusion of T and U waves



T wave inversion and prominent U wave



Apparently long QT interval (actually T-U fusion)

- Arrhythmias (premature atrial and ventricular beats, sinus bradycardia, paroxysmal atrial or junctional tachycardia, atrioventricular block, and ventricular tachycardia or fibrillation)

CAUSES

- Low intake/K^+ concentration in IV fluids
- Alkalosis (approximately 0.4 mmol/L fall in K^+ for every 0.1 unit rise in pH)
- Insulin administration
- Diarrhoea (**Note**: K^+ content of lower GI losses is >upper GI losses)
- Renal losses – diuretics, bicarbonate administration or renal tubular acidosis
- Increased mineralocorticoid activity – as in hypovolaemia, 11 beta-hydroxylase deficiency, (rarer form of CAH – presents with virilization, hypertension, and hypokalemia)

INVESTIGATIONS

- Value confirmed on venous lab sample (**Note:** 'normal' value on capillary sample may be falsely reassuring if sample has haemolysed and true value is lower)
- ECG
- Cardiac monitor if ECG changes present
- No investigations needed if hypokalaemia is mild (serum level 3–3.5 mmol/L) and there is a reason for baby to be hypokalaemic
- Significant hypokalaemia (serum level <3 mmol/L) and no obvious cause check:
  - acid/base balance and bicarbonate level on blood gas
  - urinary K^+ level. Level >20 mmol/L suggest excess renal K^+ losses
  - if baby is hypertensive plasma renin and aldosterone
- If hypokalaemia is not responding well to replacement check magnesium level

IMMEDIATE MANAGEMENT

- Normal maintenance K^+ requirement is 2 mmol/kg/day. Higher amounts will be needed to correct hypokalaemia
- If baby is on insulin infusion, consider stopping

HYPOKALAEMIA • 2/2

Symptomatic babies

- Give rapid K^+ supplementation
- Strong potassium
  - contains 20 mmol/10 mL
  - must be **diluted at least 50-fold** with sodium chloride 0.9% or a mixture of sodium chloride 0.9% in glucose prior to administration
  - maximal peripheral concentration 40 mmol/L (1 mmol in 25 mL)
  - maximal central concentration 80 mmol/L (1 mmol in 12.5 mL)
  - rate 0.2 mmol/kg/hr (maximum 0.5 mmol/kg/hr if severe K^+ depletion)
- Monitor of K^+ levels and cardiac monitoring necessary
- Recheck potassium at 2–4 hr and assess continuing need for infusion

Asymptomatic babies

- Potassium replacement given according to how baby is being fed
  - orally fed babies
    - oral supplementation should be given e.g. potassium chloride 1 mmol/kg 12–hrly dose – increased/titrated according to response
  - babies on intravenous fluids
    - potassium chloride 3–5 mmol/kg/day, depending on electrolyte levels, may be added to intravenous fluid
  - babies receiving parenteral nutrition (PN)
    - increase K^+ concentration in the PN to 3–5 mmol/kg/day
    - if modified PN not available run K^+ infusion 3–5 mmol/kg/day to run alongside current PN

SUBSEQUENT MANAGEMENT

- Monitor potassium levels according to clinical need
- Well babies receiving oral K^+ check level 1–2 weekly
- Babies on IV fluids or PN with mild hypokalaemia (potassium 3–3.5 mmol/L) check daily
- Check more frequently in significant hypokalaemia (serum level <3 mmol/L), symptomatic hypokalaemia or if concentrations of potassium >5 mmol/kg/day are being given
- Once plasma/serum potassium level is normal, continue potassium supplementation for a further week if baby is orally fed to allow replenishment of total body potassium (intracellular) stores, or reduce potassium down to 2 mmol/kg/day if baby is on IV fluids/TPN
- Re-check the potassium level following this to ensure hypokalaemia does not recur

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Hypovolaemia is an uncommon cause of hypotension in the preterm newborn. Excessive volume expansion can increase mortality

DEFINITION

Thresholds for intervention

- Aim to maintain **mean arterial BP** ≥ gestational age in weeks
- Aim for even higher mean arterial blood pressure in case of persistent pulmonary hypertension of the newborn – see **PPHN** guideline

RECOGNITION AND ASSESSMENT

Assessment of BP

- Measure mean arterial pressure (MAP):
  - by direct intra-arterial BP [umbilical arterial catheter (see **Umbilical artery catheterisation** guideline) or peripheral arterial line]
  - automated oscillometry (Dinamap) has limited accuracy in hypotensive preterm babies; usually over-reads BP in the lower ranges
- Assess as many of the following indices of tissue perfusion as possible (thresholds for abnormality in brackets):
  - capillary refill time (>3 sec)
  - toe-core temperature difference (>2ºC)
  - urine output (<1 mL/kg/hr)
  - blood lactate (>2.5 mmol/L)

Causes of hypotension

- Sepsis
- Extreme prematurity
- Tension pneumothorax
- Blood loss
- Large patent ductus arteriosus (PDA) – see **Patent ductus arteriosus** guideline
- Poor myocardial contractility (very-low-birth-weight, hypoxia, cardiomyopathy or hypocalcaemia)
- Polyuria secondary to glucosuria
- Third spacing (surgical causes – NEC/perforation/malrotation/obstruction)
- High positive intrathoracic pressure (high MAP on conventional/HFOV)
- Severe acidosis (pH <7)
- Drugs (morphine, muscle relaxants and anti-hypertensives)

IMMEDIATE TREATMENT

Aim is to treat cause and improve organ perfusion, not to correct a 'BP reading'
Seek senior advice throughout

Transilluminate chest to exclude pneumothorax – see **Transillumination of the chest** guideline

Fluid

- Give if hypovolaemic (**not >10 mL/kg** unless there is evidence of fluid/blood loss). Otherwise, start inotropes first (see below)
- If clinical condition poor, BP very low, or mother has been treated with IV antihypertensive agent, give inotrope after fluid bolus

Which fluid?

- Use sodium chloride 0.9% 10 mL/kg over 10–15 min **EXCEPT** when there is:
  - coagulopathy with bruising: give fresh frozen plasma 10 mL/kg over 30 min (see **Coagulopathy** guideline)
- Acute blood loss: give packed cells 10 mL/kg over 30 min

Reassess clinically within 10 min of bolus

- If hypotension persists, start inotropes – seek senior advice

Inotropes

Evidence for the best choice of inotropes is lacking and thus this guideline is suggested from the best possible evidence and the safety of the commonly used inotropes

- Start dopamine at 5 microgram/kg/min
- Reassess every 15–20 min
- If still hypotensive, increase dopamine to 10 microgram/kg/min
- if still hypotensive, add dobutamine at 10 microgram/kg/min
- if still hypotensive, increase dobutamine up to 20 microgram/kg/min
- if still hypotensive, increase dopamine up to 20 microgram/kg/min
- give hydrocortisone 2.5 mg/kg IV (over 3–4 min) followed by 2.5 mg/kg IV 6–8 hrly for 2–3 days as necessary

Do not use >20 microgram/kg/min of dopamine (alpha effect causes vasoconstriction)

- In babies with poor cardiac function, consider starting dobutamine first (also discuss with cardiologist)
- In term babies requiring inotropes for pulmonary hypertension an infusion of noradrenaline or adrenaline may be required (see **PPHN** guideline)

How

- Inotropes ideally given via central line
- When peripheral line used during emergency (see BNFc for dilutions), monitor site carefully for extravasation injury (see **Extravasation injuries** guideline)

Continuing hypotension

- Echocardiogram where possible to assess myocardial dysfunction/congenital heart disease

Refractory hypotension

Seek senior advice before starting adrenaline infusion. Depending on individual circumstances, discuss alternative agents (e.g. noradrenaline, vasopressin)

Use of adrenaline in <26 weeks' gestation should only occur after discussion with consultant and used only as a temporary measure and withdrawn as quickly as possible

If acidotic with severe hypotension, but not hypovolaemic

- Give adrenaline 100–1000 nanogram/kg/min (see BNFc for instructions on making up solution). If baby requires more than 1000 nanograms/kg/min, consider other inotropes
- Monitor limb perfusion and urine output

If cooling for hypoxic ischaemic encephalopathy (HIE) – refer to* Cooling *guideline. Vaso-constrictive agents can reduce peripheral perfusion

MONITORING

- BP via arterial line (peripheral or UAC) – see **Umbilical artery catheterisation** guideline
- Check effective delivery of drugs:
  - record volume in syringe hourly
  - check for leaks
  - ensure correct position of UVC or long line delivering inotropes
- Chest X-ray:
  - if intubated
  - urgent, if respiratory status worsening
  - look for air leak or over-inflation

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- Signs of tissue perfusion:
  - blood gases including lactate
  - urine output
  - capillary refill
  - heart rate
- Echocardiogram, where possible to assess function and structure

SUBSEQUENT MANAGEMENT

- If already on morphine and muscle relaxant infusion, reduce dosage if possible
- If ventilated, try to reduce mean airway pressure without compromising chest inflation and oxygenation
- If baby acidotic and not responding to treatment, consider sodium bicarbonate

Weaning inotropes if hypotension improves

- Wean inotropes (dopamine or dobutamine) in 5 microgram/kg/min decrements and adrenaline in 100 nanogram/kg/min decrements) as tolerated and directed by senior advice

HYPOTHERMIA • 1/2

DEFINITION

- Axillary temperature <36.0ºC

ASSESSMENT

Babies at risk

- Preterm <30 weeks' gestation
- Low-birth-weight
- Sick baby
- Small for dates

Consequences (<36.0ºC)

- Hypoglycaemia
- Metabolic acidosis
- Hypoxia with increased oxygen demands
- Increased metabolic rate
- Clotting disorders
- Shock
- Apnoea
- Intraventricular haemorrhage
- Persistent pulmonary hypertension
- Decreased surfactant production and function

Causes of heat loss

- Radiation: heat lost to cooler objects in the room
- in cold environment, whether in incubator or not, excessive heat may be lost
- in excessively hot environment or in direct sunlight, baby could overheat in incubator
- Conduction: heat lost to cooler surfaces on which baby is placed
- Convection: heat lost due to drafts
- Evaporation: heat lost through water evaporating from skin

PREVENTION

Delivery suite

- Keep room 23–28ºC and free from draughts, especially when babies are due to be delivered

Babies <32 weeks

- Dry head and put on hat
- Do not dry remainder of baby
- Place in polythene bag feet first immediately and keep inside bag until placed in pre-heated pre-humidified incubator. Do not cover the polythene bag during transfer

Other babies

- Use pre-warmed towel, dry immediately after delivery
- Discard towel and wrap in another pre-warmed towel and blanket
- Ensure room warm enough to enable skin-to-skin contact and early breastfeeding
- Cover exposed skin with warm blanket
- Avoid giving bath immediately after birth

Neonatal unit

- Keep at 24–25ºC to avoid cooling from radiant heat loss, and 'misting' (condensation) in incubators
- Keep incubators and cots away from windows to prevent radiation heat loss
- Nurse babies requiring intensive care in pre-warmed incubator
- For very premature babies, use humidification

Incubator temperature during first 3 days

Birth weight (g)	Incubator temperature (ºC)
1000	35
1500	34
2000	33.5
2500	33.2
3000	33
4000	32.5

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- Babies <1000 g may require even higher temperatures, occasionally >37ºC
- If baby's temperature remains within normal limits for 24 hr, reduce incubator temperature according to baby's needs
- When baby's weight reaches about 1600 g, or according to local practice, transfer to open cot

Rainout may occur if the difference between temperature in incubator and room temperature is >5ºC: ensure room temperature kept at locally agreed level

Babies not at risk of hypothermia

- If not requiring observation of respiratory status or excessive invasive procedures, babies may be:
  - dressed
  - kept wrapped
  - placed in a cot
- Mild hypothermia can be managed with the addition of:
  - hats
  - cot lids
  - heated mattresses
- If baby's temperature <36.0ºC consider:
  - use of incubator, if available
  - increasing humidity, if appropriate for gestational age
  - bubble wrap
  - skin-to-skin
- Recheck temperature in 1 hr

REWARMING OF HYPOTHERMIC BABIES

- Rewarm in incubator
  - >1200 g, rewarm at 1ºC/hr
  - <1200 g, rewarm more slowly

Take care not to overheat babies. Aim for 36.5–37.5ºC

HYPOTHYROIDISM • 1/3

SCREENING

- Congenital hypothyroidism (CHT) is included in routine neonatal blood spot screening at age 5–8 days
- In preterm babies of ≤31+6 weeks' gestation, repeat at 28 days of age or at discharge, whichever is sooner
- Screening relies on measurement of raised blood spot TSH

Reporting of screening result

- Initial TSH concentration of:
  - <10 mU/L: negative result – CHT not suspected
  - ≥20 mU/L: positive result – CHT suspected
- If CHT suspected, newborn screening laboratory will notify designated consultant or on-call consultant
  - ≥10 mU/L but <20 mU/L: borderline result
- Newborn screening laboratory will arrange a repeat sample to be collected and tested. If repeat sample result is:
  - <10 mU/L: negative result – CHT not suspected
  - ≥10 mU/L: positive result – CHT suspected

IMMEDIATE MANAGEMENT

Informing diagnosis

- If screening test result indicates congenital hypothyroidism, a well-informed healthcare professional (community midwife, neonatal outreach nurse, health visitor or GP) must inform parents face-to-face
  - do not communicate an abnormal result on Friday, Saturday or just before a weekend if consultant meeting cannot be arranged within next 24 hr
  - provide parents with information leaflet 'congenital hypothyroidism suspected' (available from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/396288/CHT_is_suspected_LR.pdf

Consultant meeting

- Consultant to arrange to meet parents on same or next day to:
  - explain abnormal result
  - examine baby using screening laboratory proforma as an aide-mémoire
  - look for other abnormalities (10% in CHT versus 3% in baby without CHT), congenital heart disease (pulmonary stenosis, ASD and VSD) is commonest anomaly
  - commence treatment
  - stress importance of daily and life-long treatment
  - provide parent information leaflet (available from http://www.gosh.nhs.uk/medical-information/search-medical-conditions/congenital-hypothyroidism)
- Document discussion and management plan and follow-up and send to GP and parents
- Complete and return data form to clinical biochemist at screening laboratory

Obtain further diagnostic tests

- **Baby**
  - 1 mL venous blood in heparinised container for FT_4 and TSH
  - send repeat dried blood spot card to screening laboratory
  - 1 mL venous blood for serum thyroglobulin
  - ultrasound or radionuclide scan of thyroid, the latter preferably within 5 days of starting levothyroxine; ultrasound can be performed at any age
- **Mother**
  - take 3 mL venous blood from mother into a heparinised container for FT_4, TSH and thyroid antibodies

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TREATMENT

- Start treatment with levothyroxine after obtaining confirmatory blood tests. Do not wait for results unless transient hypothyroidism suspected. Treatment must start before 18 days of age, and preferably by 14 days. For those detected on repeat sampling, treatment should ideally commence by 21 days and certainly before 24 days
  - after discussion with paediatric endocrinologist, consultant may withhold treatment if transient hypothyroidism suspected
- Starting dose levothyroxine 10–15 microgram/kg/day with a maximum daily dose of 50 microgram. Aim to maintain serum FT_4 in upper half of normal range by 2 weeks treatment and for normalisation of TSH by 4 weeks
- Adjustment required depending on thyroid function test results
- Tablets are 25 microgram strength
  - it is not necessary to divide tablets for intermediate dose; administer intermediate dose, such as 37.5 microgram, as 25 and 50 microgram on alternate days
- Crush required levothyroxine dose using tablet crusher (if tablet crusher not available, between 2 metal spoons) and mix with a little milk or water, using teaspoon or syringe
  - do not add to bottle of formula
  - suspensions not advised due to variable bioavailability
  - repeat dose if baby vomits or regurgitates immediately
- Record date treatment commenced
- Provide parents with 28 day prescription for levothyroxine
- Arrange continued prescription with GP, emphasising need to avoid suspensions

FOLLOW–UP

- Arrange follow-up after commencement of hormone replacement therapy as follows:
  - 2 weeks, 4 weeks, 8 weeks, 3 months, 6 months, 9 months, 1 yr, 18 months, 2 yr, 30 months, 3 yr, yearly thereafter
- At each clinic visit:
  - physical examination, including height, weight and head circumference
  - developmental progress
  - blood sample for thyroid function test (FT_4, FT_3 and TSH, just before usual daily medication dose)
  - request as **FT_4 priority, then TSH**

Interpretation of thyroid function test results

Analyte	Age	Concentration
FT_4 (pmol/L)	0–5 days	17–52
	5–14 days	12–30
	14 days–2 yr	12–25
TSH (mU/L)	0–14 days	1–10
	15 days–2 yr	3.6–8.5

Check reference ranges with your laboratory's assay

- Aim for FT_4 towards upper limit of normal range
- at higher concentrations of FT_4, normal concentrations of T_3 (produced by peripheral conversion) are achieved
- if $FT4_4$ concentration satisfactory but with significantly raised TSH, consider non-compliance
- TSH concentration does not always normalise under 6 months and may be slightly raised up to 3 yr of age in absence of non-compliance, probably due to reset feedback mechanism
- Overtreatment may induce tachycardia, nervousness and disturbed sleep patterns, and can produce premature fusion of cranial sutures and epiphyses. If symptoms of overtreatment or very suppressed TSH, reduce dose of levothyroxine

AFTERCARE

- Reassure parents that baby will grow into healthy adult with normal intelligence
- Stress importance of regular treatment. **As half-life is long, it is not necessary to give an extra tablet next day if a day's treatment missed**
- Give details of:
- British Thyroid Foundation, 2nd floor, 3 Devonshire Place, Harrogate HG1 4AA 01423 709707/709448 http://www.bsped.org.uk

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HYPOXIC ISCHAEMIC ENCEPHALOPATHY (HIE) • 1/4

RECOGNITION AND ASSESSMENT

Risk factors

- History of non-reassuring cardiotocography (CTG)
- Fetal heart rate abnormalities during labour
- Low Apgar score
- Acidotic umbilical arterial or venous gas
- Need for prolonged resuscitation

SYMPTOMS AND SIGNS

Acute neonatal encephalopathy

- Altered state of consciousness (irritability, unresponsiveness to stimulation)
- Abnormal tone (hypo/hypertonia, abnormal posturing, decerebrate rigidity, extensor response to painful stimulus)
- Seizures
- Weak (or no) suck
- Hypo/hyperventilation

Other signs and symptoms related to effects on other organ systems

- Renal failure
- Respiratory distress syndrome, particularly if preterm
- Pulmonary haemorrhage
- Persistent pulmonary hypertension of the newborn
- Myocardial ischaemia and hypotension
- Hepatic failure
- Necrotising enterocolitis
- Hypoglycaemia
- Fluid retention
- Disseminated intravascular coagulation (DIC)

INVESTIGATIONS

Bloods

- FBC
- Blood culture
- Clotting screen
- Renal and liver profile, calcium, magnesium
- Glucose
- Blood gas including lactate
- Urine dipsticks

Cranial ultrasound

- Generalised increase in echogenicity, indistinct sulci and narrow ventricles
- After 2–3 days of age, increased echogenicity of thalami and parenchymal echodensities
- After 1 week, parenchymal cysts, ventriculomegaly and cortical atrophy
- Cerebral Doppler used early, but does not affect management
- relative increase of end-diastolic blood flow velocity compared to peak systolic blood flow velocity (Resistive Index <0.55) in anterior cerebral artery predicts poor outcome (repeat after 24 hr)

MR scan of brain between days 10–14 of life

For baby with moderate and severe encephalopathy (see Table) and in baby with seizures due to encephalopathy

- Hypodense areas in thalamus, basal ganglia and internal capsule indicate poor prognosis

Cerebral function monitoring (aEEG)

- Normal trace upper margin above 10 microvolts and lower margin above 5 microvolts
- Moderately abnormal trace upper margin above 10 microvolts and lower margin below 5 microvolts
- Severely abnormal upper margin below 10 microvolts and lower margin below 5 microvolts

EEG

- Normal EEG during first 3 days has good prognosis
- Lack of normal background activity is associated with a poor outcome

IMMEDIATE TREATMENT

- Prompt and effective resuscitation
- Maintain body temperature, avoid hyperthermia
- In babies ≥36 weeks' gestation requiring continued resuscitation at 10 min after birth, institute passive cooling by switching off overhead warmer
- IV access
- Isotonic glucose-containing IV fluids at 40 mL/kg/day. See **Intravenous fluid therapy** guideline

WHEN TO CONSIDER TREATMENT WITH TOTAL BODY COOLING

Treatment criteria

- Babies meeting criteria A and B for treatment with cooling – see **Cooling** guideline

Criterion A

- **Babies ≥36 completed weeks' gestation admitted to neonatal unit with at least one of the following:**
  - Apgar score ≤5 at 10 min after birth
  - continued need for resuscitation, including endotracheal or mask ventilation, at 10 min after birth
  - acidosis within 60 min of birth (defined as umbilical cord, arterial or capillary pH <7.00)
  - base deficit ≥16 mmol/L in umbilical cord or any blood sample (arterial, venous or capillary) within 60 min of birth
- For babies meeting criterion A, assess whether they meet neurological abnormality entry criteria (B) with at least one of the following:

Criterion B

- **Seizures or moderate-to-severe encephalopathy comprising:**
  - altered state of consciousness (reduced or absent response to stimulation) **and**
  - abnormal tone (focal or general hypotonia, or flaccid) **and**
  - abnormal primitive reflexes (weak or absent suck or Moro response)

Criteria for defining moderate and severe encephalopathy

Parameter	Moderate encephalopathy	Severe encephalopathy
Level of consciousness	Reduced response to stimulation	Absent response to stimulation
Spontaneous activity	Decreased activity	No activity
Posture	Distal flexion, complete extension	Decerebrate
Tone	Hypotonia (focal or general)	Flaccid
Suck	Weak	Absent
Moro	Incomplete	Absent
Pupils	Constricted	Constricted
Heart rate	Bradycardia	Variable
Respiration	Periodic breathing	Apnoea

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SUBSEQUENT MANAGEMENT

If decision made to treat baby with total body cooling, see* Cooling *guideline
This should always be a consultant decision

- **If not using total body cooling,** continue with management below

Oxygen

- Avoid hypoxaemia. Maintain PaO_2 10–12 kPa and SpO_2 >94%
- Episodes of hypoxaemia (possibly associated with convulsions) are an indication for IPPV

Carbon dioxide

- Maintain $PaCO_2$ 5.0–7.0 kPa
- Hypoventilation leading to hypercapnia (>7 kPa) is an indication for IPPV
- Hyperventilation is contraindicated but, if baby spontaneously hyperventilating, mechanical ventilation, with or without paralysis, may be necessary to control $PaCO_2$

Circulatory support

- Maintain mean arterial blood pressure at ≥40 mmHg for term babies
- If cardiac output poor (e.g. poor perfusion: blood pressure is a poor predictor of cardiac output) use inotropes
- Avoid volume replacement unless evidence of hypovolaemia

Fluid balance and renal function

- Start fluids at 40 mL/kg/day. See **Intravenous fluid therapy** guideline
- Some babies develop inappropriate ADH secretion at 3–4 days (suggested by hypo-osmolar serum with low serum sodium associated with an inappropriately high urine sodium and osmolality)
- Further fluid restriction if serum sodium falls and weight gain/failure to lose weight
- If in renal failure, follow **Renal failure** guideline

Acidosis

- Will normally correct itself once adequate respiratory and circulatory support provided (correction occasionally required during initial resuscitation)
- Sodium bicarbonate correction is rarely required post resuscitation and it is better to allow spontaneous correction

Glucose

- Regular blood glucose monitoring
- Target >2.6 mmol/L
- Fluid restriction may require use of higher concentrations of glucose to maintain satisfactory blood glucose
- Avoid hyperglycaemia (>8 mmol/L)

Calcium

- Asphyxiated babies are at increased risk of hypocalcaemia
- Treat with calcium gluconate when serum corrected calcium <1.7 mmol/L or if ionized calcium <0.8

Convulsions

- Prophylactic anticonvulsants not indicated
- In muscle-relaxed baby, abrupt changes in blood pressure, SpO_2 and heart rate can indicate convulsions
- Treat persistent (>3/hr) or prolonged convulsions (>3 min, recur >3 times/hr) – see **Seizures** guideline
  - give phenobarbital
  - if ineffective or contraindicated, give phenytoin. If no response, give clonazepam or midazolam – see **Seizures** guideline
- Convulsions associated with HIE can be notoriously difficult to control (preventing every twitch is unrealistic)

- Regular fits causing respiratory insufficiency are an indication for IPPV
- Once baby stable for 2–3 days, anticonvulsants can usually be withdrawn although phenobarbital can be continued for a little longer (duration can vary depending on individual practice and clinical severity of seizures)
- Avoid corticosteroids and mannitol

Thermal control

- Maintain normal body temperature (36.5–37.2ºC). Avoid hyperthermia

Gastrointestinal system

- Term babies who suffer a severe asphyxial insult are at risk of developing necrotising enterocolitis – see **Necrotising enterocolitis** guideline
- In other babies, gastric motility can be reduced: introduce enteral feeds slowly

PROGNOSIS

- Risk of long-term problems increases with the degree of encephalopathy
- Overall risk of death or significant handicap is negligible for mild HIE, 26% for moderate and almost 100% for severe HIE
- Prolonged encephalopathy (e.g. moderate HIE lasting >6 days) also associated with poor outcome
- Persistent oliguria is associated with poor outcome in 90%
- Prognostic factors indicative of worse outcome:
  - prolonged duration of ventilation
  - prolonged need for anticonvulsants
  - time taken to establish oral feeding

DISCONTINUING INTENSIVE CARE

- When prognosis very poor, discuss withdrawing intensive care support and consider palliative care
- Very poor prognostic factors include:
  - need for prolonged resuscitation at birth
  - evidence of severe asphyxia
  - multi-organ failure
  - intractable seizures
  - coma
  - very abnormal cranial ultrasound scan
  - abnormal Doppler cerebral blood flow velocities
  - persistent burst suppression pattern on cerebral function monitoring and/or EEG
- Decision to withdraw care requires discussion with parents, and other nursing and medical staff. Such decisions are frequently reached, by baby's consultant, after a series of discussions
- It helps if the same staff speak to parents on each occasion
- The best interests of the child are paramount
- Record a summary of discussion in notes

DISCHARGE AND FOLLOW-UP

- Arrange clinic follow-up in 4–6 weeks for babies discharged
- Repeat cranial ultrasound scan before discharge
- Arrange hearing screen – see **Hearing screening** guideline
- For babies with moderate and severe encephalopathy (see **Table**) and in those with seizures due to encephalopathy, arrange MR scan as an out-patient (if not already performed as an in-patient), preferably 7–14 days of life

Information for parents

Offer parents information on HIE, available from:

http://www.bliss.org.uk/Shop/hie-hypoxic-ischaemic-encephalopathy-information-for-parents/

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ROUTINE IMMUNISATIONS FOR ALL BABIES

Plan to achieve immunity to diphtheria, tetanus, pertussis, (DTaP), polio, haemophilus (Hib), meningococcus B, meningococcus C and pneumococcus within 4 months of birth (see also **BCG immunisation** guideline)

Do not delay immunisation in preterm babies because of prematurity or low body weight

CONTRAINDICATIONS

- Cardiorespiratory events (apnoeas, bradycardia and desaturations) are not contraindications to immunisation, but continue to monitor for a further 72 hr following immunisation
- See **Precautions with rotavirus vaccine** below

PROCEDURE

Consent

- Inform parents of process, benefits and risks
- For further information refer parents to www.nhs.uk/Conditions/vaccinations
- Offer parents opportunity to ask questions
- Informed consent (can be written or oral) must be obtained and recorded in notes at time of each immunisation
- Complete 'unscheduled immunisation form' before immunisation and send to local Child Health Information

Prescription

Use immunisation listed in **Schedule** below

- Keep strictly to schedule to avoid delay
- Order vaccines in advance unless held as stock on neonatal unit (NNU)
- Prescribe on treatment sheet

ADMINISTRATION

- DTaP/IPV/Hib (Pediacel) is a 5-in-1 preparation
- Administer by IM injection into thigh
- Dose for all primary immunisations (DTaP/IPV/Hib, meningococcal C, pneumococcal) is 0.5 mL
- Give meningococcal C and pneumococcal (Prevenar 13) vaccine into separate injection sites in other thigh
- Rotavirus vaccine must NOT be injected and preferably NOT given via an NGT
- Meningitis B vaccine is administered 0.5 mL IM
  - can be given with DTaP/IPV/Hib
  - if given on the same limb, give ≥2.5 cm apart

DOCUMENTATION

- After immunisation, document the following in case notes as well as in Child Health Record (Red book):
  - consent gained from parents
  - vaccine given and reasons for any omissions
  - site of injection(s) in case of reactions
  - batch number of product(s)
  - expiry date of product(s)
  - legible signature of doctor administering immunisations
  - adverse reactions
- Sign treatment sheet
- Complete immunisation form in BadgerNet system. Document all information on discharge summary and medical case notes including recommendations for future immunisations and need for any special vaccinations, such as influenza, palivizumab, etc.

MONITORING

- Babies born <28 weeks may have an impaired immune response. Check functional antibodies 1 month after booster at 1 year old, if needed

- Babies <28 weeks' gestation at birth, who are in hospital, respiratory monitoring for 48–72 hr when given first routine immunisations
- If baby has apnoea, bradycardias or desaturations after first routine immunisations, second immunisation should ideally be given in hospital with respiratory monitoring for 48–72 hr

ADVERSE REACTIONS

- Local:
  - extensive area of redness or swelling
- General:
  - fever >39.5ºC within 48 hr
  - anaphylaxis
  - bronchospasm
  - laryngeal oedema
  - generalised collapse
  - episodes of severe apnoea
  - diarrhoea
  - irritability
  - vomiting
  - flatulence
  - loss of appetite
  - regurgitation

Specific notes for rotavirus vaccination

- Do not give Rotarix® to infants <6 weeks of age
  - minimum age for first dose of Rotarix® is 6^{+0} weeks
  - maximum age for first dose is 14^{+6} weeks
- Do not vaccinate with Rotarix® in infants aged ≥15^{+0} weeks. Infants who have received their first dose of vaccine under 15^{+0} weeks of age should receive their second dose of Rotarix® after a minimum interval of 4 weeks and by 23^{+6} weeks of age
- Do not give Rotarix® vaccine to infants who are ≥24^{+0} weeks of age

Precautions with rotavirus vaccination

- Postpone administration of rotavirus vaccine in infants suffering from:
  - acute severe febrile illness
  - acute diarrhoea or vomiting
- Do not administer Rotarix® to infants with:
  - confirmed anaphylactic reaction to a previous dose of rotavirus vaccine
  - confirmed anaphylactic reaction to any components of the vaccine
  - history of intussusception
  - ≥24^{+0} weeks of age
  - severe combined immunodeficiency (SCID) disorder
  - malformation of the gastrointestinal tract that could predispose them to intussusception
  - rare hereditary problems of fructose intolerance, glucose-galactose malabsorption or sucrase-isomaltase insufficiency

ADDITIONAL IMMUNISATIONS

Influenza (in autumn and winter only)

Indications

- Chronic lung disease (on, or has recently had, oxygen)
- Congenital heart disease, renal, liver or neurological disease
- Immunodeficiency

Recommendations

- Recommend vaccination to close family members of these babies
- Give babies >6 months–2 yr of age 0.25 mL, 2 doses 4–6 weeks apart, IM injection
- **Note:** intranasal flu vaccine is now routinely recommended for children aged 2, 3 and 4 yr

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Palivizumab

- See **Palivizumab** guideline

BCG

- See **BCG immunisation** guideline

Hepatitis B

- See **Hepatitis B** guidelines

HIV

Babies who are HIV infected, or HIV exposed (born to HIV positive mother) and status not yet known:

- Routine immunisations including rotavirus vaccine not contraindicated
- Generally do not offer BCG at birth, wait for 3 months and HIV PCR negative
- However, BHIVA guidelines indicate that babies considered low risk of HIV transmission (maternal viral load <50 HIV RNA copies/mL at or after 36 weeks' gestation) but with a high risk of tuberculosis exposure BCG may be given at birth

UK 2015 Immunisation Schedule

AGE	Immunisation (vaccine given)
2 months	● 5-in-1 (DTaP/IPV/Hib) vaccine – this single jab contains vaccines to protect against 5 separate diseases: diphtheria, tetanus, whooping cough (pertussis), polio and *Haemophilus influenzae* type b (known as Hib – a bacterial infection that can cause severe pneumonia or meningitis in young children) ● Pneumococcal (PCV) vaccine ● Rotavirus vaccine ● Men B vaccine
3 months	● 5-in-1 (DTaP/IPV/Hib) vaccine, second dose ● Men C vaccine ● Rotavirus vaccine, second dose
4 months	● 5-in-1 (DTaP/IPV/Hib) vaccine, third dose ● Pneumococcal (PCV) vaccine, second dose ● Men B vaccine second dose
12–13 months	● Hib/Men C booster, given as a single jab containing meningitis C (second dose) and Hib (fourth dose) ● Measles, mumps and rubella (MMR) vaccine, given as a single jab ● Pneumococcal (PCV) vaccine, third dose ● Men B vaccine third dose
2, 3 and 4 years	● Children's flu vaccine (annual) – nasal spray
3 years and four months – 5 yr	● Measles, mumps and rubella (MMR) vaccine, second dose ● 4-in-1 (DTaP/IPV) pre-school booster, given as a single jab containing vaccines against diphtheria, tetanus, whooping cough (pertussis) and polio
Around 12–13 yr (girls)	● HPV vaccine, which protects against cervical cancer – two injections given between six months and two years apart
Around 13–18 years	● 3-in-1 (Td/IPV) teenage booster, given as a single jab and contains vaccines against diphtheria, tetanus and polio ● Men ACWY vaccine

INFECTION IN FIRST 72 HOURS OF LIFE • 1/3

Based on NICE CG149 Antibiotics for early onset neonatal infection

RISK FACTORS FOR INFECTION

- Pre-labour rupture of membranes
- Preterm birth (<37 weeks), especially with pre-labour rupture of membranes
- Confirmed or suspected chorioamnioitis (e.g. intrapartum fever)
- Invasive group B streptococcal (GBS) infection in a previous baby
- Antibiotic treatment given to mother for confirmed or suspected invasive bacterial infection 24 hr before, during, or post labour

CLINICAL INDICATORS SUGGESTIVE OF INFECTION

- Altered behaviour or responsiveness
- Altered muscle tone
- Feeding difficulties (e.g. feed refusal)
- Feed intolerance (e.g. abdominal distension, vomiting)
- Altered heart rate
- Signs of respiratory distress
- Oxygen desaturation
- Apnoea
- Signs of perinatal asphyxia or hypoxic ischaemia
- Seizures **red flag**
- Need for mechanical ventilation (especially term baby) **red flag**
- PPHN
- Temperature abnormality not explained by environment
- Signs of shock **red flag**
- Unexplained bleeding disorder (e.g. thrombocytopenia, INR >2)
- Oliguria
- Hypo/hyperglycaemia
- Metabolic acidosis (BE ≥10)
- Local signs of infection e.g. skin, eyes
- Confirmed or suspected sepsis in a co-twin **red flag**

Red flag signs suggestive of neonatal infection

- Systemic antibiotics given to mother for suspected bacterial infection within 24 hr of birth
- Seizures
- Signs of shock
- Need for mechanical ventilation in a term baby
- Suspected or confirmed infection in a co-twin

ACTIONS

- Any red flags or no red flags but ≥2 risk factors **or** clinical indicators
- perform investigations, including blood cultures, and start antibiotics
- No red flag or clinical indicators but one risk factor **or** no red flag or risk factors but 1 clinical indicator
- use clinical judgement and consider withholding antibiotics
- monitor baby for clinical indicators of possible infection, including vital signs
- monitor for at least 12 hr from birth (at 1 hr, 2 hr and then 2-hrly for 10 hr)
- If further clinical concerns, perform investigations including blood cultures and start antibiotics
- if decision made to give antibiotics, aim to start within 30 min and always within 1 hr of decision

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INFECTION IN FIRST 72 HOURS OF LIFE • 2/3

Based on NICE CG149 Antibiotics for early onset neonatal infection

INVESTIGATIONS BEFORE STARTING ANTIBIOTICS

- Blood culture (in all)
- Measure CRP and FBC at presentation and 18–24 hr after
- If strong clinical suspicion of infection or signs/symptoms of meningitis, perform lumbar puncture (LP), if thought safe to do
  - if performing LP will delay antibiotics, give antibiotics first
- Do not carry out urine MC&S
- Take skin swabs only if clinical signs of localised infection
- If purulent eye discharge (may indicate serious infection e.g. chlamydia or gonococcus):
  - collect eye swabs for urgent MC&S, especially looking for chlamydia or gonococcus
  - start systemic antibiotics while awaiting results
- If signs of umbilical infection, including purulent discharge or periumbilical cellulitis, perform a blood culture and start IV flucloxacillin and gentamicin

Choice of antibiotics

- Use benzylpenicillin and gentamicin as first choice for empirical treatment

Benzylpenicillin

- 25 mg/kg 12-hrly
- If baby appears very ill, give 25 mg/kg 8-hrly

Gentamicin

- Follow local guideline or:
  - 5 mg/kg
  - if a second dose to be given (see below), give 36 hr after first dose
  - interval may be shortened based on clinical judgement e.g. for Gram-negative infection or if baby appears very ill
- Monitoring of gentamicin – see below

INVESTIGATIONS DURING ANTIBIOTIC TREATMENT

- CRP: measure before starting antibiotics and 18–24 hr after presentation
- Consider LP if:
  - CRP >10 mg/L
  - positive blood culture
  - baby does not respond satisfactorily to antibiotics
- Asymptomatic babies on postnatal ward/TC unit with CRP ≤60 do not require a routine LP but should be reviewed by a middle grade doctor

DURATION OF ANTIBIOTIC TREATMENT

- Stop at 36 hr if:
  - initial clinical suspicion of infection was not strong

and

  - CRP <10 mg/L on both tests

and

  - negative blood culture

and

  - baby is well with no clinical indicators of possible infection
- Treat for 7 days if:
  - strong clinical suggestion of infection
  - continued clinical concerns about infection at 36 hr
  - CRP >10 mg/L on either measurement
  - positive blood culture
- If baby not fully recovered at 7 days, continue antibiotics
  - this is advisable based on blood culture result and expert microbiological advice if necessary

INFECTION IN FIRST 72 HOURS OF LIFE • 3/3

Based on NICE CG149 Antibiotics for early onset neonatal infection

Meningitis

- If meningitis suspected but Gram stain is uninformative, use amoxicillin and cefotaxime
- Review treatment decisions taking CSF results into account
- If CSF Gram stain suggests GBS, give benzylpenicillin 50 mg/kg 12-hrly and gentamicin 5 mg/kg every 36 hr
- If CSF culture confirms GBS, continue benzylpenicillin for at least 14 days and gentamicin for 5 days
- If CSF culture or Gram stain confirms Gram-negative infection, stop amoxicillin and treat with cefotaxime alone
- If blood culture or CSF culture is positive for listeria, consider stopping cefotaxime and treating with amoxicillin and gentamicin
- If CSF Gram stain or culture suggests any organism other than GBS, use an antibiotic regimen based on local expert microbiological advice

Therapeutic monitoring of gentamicin

- Follow local guidelines or:
- **Trough concentrations:**
  - if second dose to be given, measure before administering
  - review level before giving third dose
  - monitor before every third dose, or more frequently if necessary (e.g. concern about previous level or renal impairment)
  - adjust dose interval aiming to achieve level of <2 mg/L
  - if course lasts >3 doses, level of <1 mg/L is advisable
  - if a trough level is not available, do not withhold next dose of gentamicin
- **Peak concentrations:**
  - measure in selected babies e.g.
    - with oedema
    - with macrosomia (birth weight >4.5 kg)
    - who do not respond to treatment
- Measure 1 hr after starting gentamicin infusion
- If peak is <8 mg/L, increase dose

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DEFINITION

- Infection after first 72 hr of life
- Late onset Group B *streptococcus* (GBS) infection: after first 6 days of life
- When acquired in hospital – most commonly Gram-positive organisms. Coagulase-negative staphylococci account for approximately 50% of all late onset infections
- Gram-negative bacteria accounts for 20–40% and these are increasingly resistant to gentamicin (Klebsiella>Serratia>Enterobacter> Pseudomonas>E.coli and Acinetobacter)

Risk factors

- Risk of infection is inversely related to gestational age and birth weight and directly related to severity of illness at birth, reflecting need for invasive interventions e.g. prolonged ventilation, central venous access and parenteral nutrition
- Delayed introduction of enteral feeds is associated with higher infection rates
- Increased risk of sepsis after gut surgery especially if enteral feeds slow to establish e.g. post-gastroschisis or necrotising enterocolitis (NEC) with stoma

PREVENTION

- **Strict hand washing and alcohol hand rubs:**
  - to the elbow with particular attention between digits
  - on entering the unit and between each patient
- Unless absolutely essential, avoid entering incubators or touching any part of cots
- Do not lean on incubators or other patient equipment
- Wear apron and gloves when carrying out any procedure e.g. heel prick, resiting IV cannula
- Meticulous regimen for changing drips and 3-way taps
- Initiate enteral feeds with maternal breast milk within 24 hr of birth

PRESENTATION

- Can be vague and non-specific

Symptoms

- Respiratory distress – increase in oxygen requirement/respiratory support
- Apnoea/bradycardia
- Cyanosis or poor colour
- Poor perfusion (CRT >3 sec; toe-core temperature gap >2ºC; mottling)
- Hypotension
- Tachycardia
- Temperature instability (high or low)
- Glucose instability
- Hypotonia
- Irritability
- Lethargy/inactivity
- Poor feeding and poor suck
- Jaundice
- Seizures
- Vomiting
- Abdominal distension
- Nursing staff may describe babies with a mixture of these symptoms as having 'gone off'

Signs

Look for

- Systemic signs of sepsis such as tachycardia, poor perfusion, reduced tone, quiet, lethargy
- Tachypnoea and intercostal and/or subcostal recession
- Bulging of the fontanelle suggesting raised intracranial pressure
  - not always detectable in babies with neonatal meningitis

- Abdominal distension and tenderness
- auscultate for bowel sounds; reduced or absent with infection (as a result of septic ileus) or NEC
- inspect stool for visible blood
- petechiae, bleeding diathesis
- Septic spots in eyes, umbilicus, nails and skin
- Reluctance to move or tenderness in joints and limbs suggestive of osteomyelitis or septic arthritis

INVESTIGATIONS (perform before starting antibiotics)

Swabs for culture

- Swab any suspicious lesion (e.g. skin, umbilicus or nails)
- Routine rectal swabs may detect resistant Gram-negative bacteria that require treatment with an alternative antibiotic e.g. meropenem, or MRSA which requires treatment with vancomycin. Otherwise swabs are not diagnostically useful

Blood cultures

- From a peripheral vein, using a closed system, non-touch, aseptic technique

Full blood count

- A neutrophil count <2 or >15 x 10^9/L (supportive but not diagnostic, and marginally more sensitive than a total white cell count)
- Platelet count of <100 x 10^9/L
- Toxic granulation in neutrophils [or if measured: an immature:total (I:T) neutrophil ratio >0.2]

Clotting profile

- If evidence of bleeding diathesis or in severe infection/septicaemia

CRP

- Acute phase protein synthesised in the liver in response to inflammatory cytokines
- Generally a delay of 24 hr between onset of symptoms and rise in serum CRP
- Take sample at presentation and further sample 18–24 hr after first CRP sample
- a rise may support diagnosis of infection but failure to rise does not exclude it where other findings are supportive
- if blood culture negative and clinical condition satisfactory, failure of CRP to rise during first 48 hr is a useful indicator that antibiotics may be safely stopped

Urine microscopy, culture and sensitivity

- Clean-catch or supra-pubic aspiration (SPA). Use ultrasound scan to check urine in bladder before SPA
- do not send urine collected in a bag for culture

Lumbar puncture (LP)

- If baby unstable, deranged clotting or thrombocytopenia, discuss advisability with consultant
- May be performed later but cultures often negative
- Send CSF for urgent Gram-stain and culture (MC&S), protein and glucose
- In critically ill baby, consider PCR for HSV, especially term babies

Others

- Chest X-ray
- If abdominal distension noted, abdominal X-ray

Documentation

- Always contemporaneously document symptoms and signs of infection **at the time of taking blood culture and all blood and CSF cultures** (and abdominal radiographs) on BadgerNet ad-hoc reporting field

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EMPIRICAL TREATMENT

Do not use oral antibiotics to treat infection in babies
Consult local microbiology department for current recommendations. These may differ between units according to local resident flora

Late onset sepsis

Antibiotics

- **First line:** empirical flucloxacillin and gentamicin unless microbiology isolates dictate otherwise (see **Neonatal Formulary** for dose intervals)
- **Second line:** vancomycin plus gentamicin or tazocin
- **Third line** or if cultures dictate: meropenem plus vancomycin
- When course of antibiotic prolonged >1 week, babies are very preterm and post-gut surgery, consider commencing fungal prophylaxis with either oral and topical nystatin or IV/oral fluconazole. Steroid therapy also associated with increased risk of fungal infection
- **Do not use vancomycin routinely: (consult local policy)**
  - for babies with indwelling catheters and on parenteral nutrition, unless they are very unwell
  - to treat endotracheal secretion colonisation with coagulase-negative staphylococci (CONS)
- Maintain vancomycin trough levels between 10–15 µg/mL, as bactericidal activity is related to trough concentration (or, if using continuous infusion vancomycin, as per local guidance)
- When culture results available, always change to narrowest spectrum antibiotic, or stop antibiotics if negative cultures, inflammatory markers not raised and no clinical signs of infection
- Remove indwelling catheters for all infections except CONS (unless access is a major issue). Line removal should be a considered decision
- If line 'precious' and baby responding to treatment, consider infusing vancomycin down long line and leaving it to dwell for 1 hr before flushing. Ensure therapeutic trough levels
- If meningitis diagnosed or strongly suspected clinically, treat with high dose cefotaxime 50 mg/kg/dose
- If baby has improved clinically and bacteriological cultures are negative so far, stop antibiotics after 48 hr
  - treat for at least 7 days, or for 5 days after clinical response

SPECIFIC INFECTIONS

Discharging eyes

- See **Conjunctivitis** guideline

Umbilicus sepsis (omphalitis)

- Systemic antibiotics required **only** if local induration or surrounding reddening of the skin

Meningitis

For all babies with a positive blood culture, other than CONS, consider LP. This must be discussed with an experienced clinician. Organisms such as Group B streptococcus and E. coli penetrate the CSF readily

Empirical treatment whilst CSF results pending

- CSF visually clear, give first line antibiotics as per guidance for late-onset sepsis
- CSF cloudy or high clinical suspicion of meningitis, give high-dose cefotaxime

Table of normal CSF values

Gestation	White cell count (count/mm^3)	Protein (g/L)	Glucose (mmol/L)
Preterm <28 days	9 (0–30)	1.0 (0.5–2.5)	3.0 (1.5–5.5)
Term <28 days	6 (0–21)	0.6 (0.3–2.0)	3 (1.5–5.5)

- Values are mean (range)
- **Note:** protein levels are higher in first week of life and depend on RBC count. WBC of >21/mm^3 with a protein of >1.0 g/L with <1000 RBCs is suspicious of meningitis
- If traumatic LP and strong suspicion of meningitis, repeat LP after 24–48 hr
- Manage baby as if he/she has meningitis. None of the 'correcting' formulae are reliable

Subsequent management

- Meningitis confirmed when organisms seen on urgent Gram stain and/or grown from subsequent culture
- Cultures often negative, especially if CSF taken after baby given antibiotics or if mother given intrapartum antibiotics
- No other single CSF value can reliably diagnose meningitis. However, meningitis is suggested by:
  - low CSF glucose: <2/3 simultaneous blood glucose
  - high CSF protein: >1 g/L
- Send CSF for herpes PCR and start empiric treatment with IV aciclovir until results available if:
  - neonatal herpes encephalitis suggested by symptoms and signs of infection, which may or may not include seizures and CSF showing monocytosis or lymphocytosis, increased protein and decreased glucose
- If bacterial meningitis confirmed on culture or high clinical suspicion of meningitis, treat with high-dose cefotaxime for 14–21 days, depending on organism. Seek advice from microbiologist
- If low clinical suspicion of meningitis, stop antibiotics after 48 hr if:
  - CSF glucose >2/3 simultaneous blood glucose **and**
  - CSF protein <1 g/L
  - cultures negative and baby remains well

Urinary tract infection (UTI)

- Usually occurs as late-onset infection
- Start IV empiric antibiotic treatment, as above, immediately after appropriate urine collection (not bag urine)
- Continue IV empiric antibiotics until culture results available
  - once stable, treat with oral antibiotics according to sensitivities
- Exclude obstruction by renal ultrasound scan as soon as available

Subsequent management

- Prophylaxis: single night-time dose of oral trimethoprim 2 mg/kg/dose for all babies with confirmed UTI, while completing investigations to identify predisposing factors
- For further information on management of UTI in babies – see **Urinary tract infection** guideline in **Partners in Paediatrics** guidelines

Necrotising enterocolitis

- See **Necrotising enterocolitis** guideline

Fungal infection

- Mostly late onset
- Incidence in UK up to 1.2% in very-low-birth-weight (VLBW) babies and 2.6% in extremely-low-birth-weight (ELBW) babies (versus up to 28% in the USA), hence no routine prophylaxis in the UK

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Risk factors

- <1500 g
- Parenteral nutrition
- Indwelling catheter
- No enteral feeds
- Ventilation
- H_2 antagonists
- Exposure to broad spectrum antibiotics, especially cephalosporins
- Abdominal surgery
- Peritoneal dialysis

Symptoms and signs

- Non-specific
- as for late onset infection

Additional investigations

- If fungal infection suspected or diagnosed, end-organ evaluation to include:
- abdominal ultrasound
- cerebral ultrasound
- lumbar puncture
- fundoscopy
- echocardiogram
- blood cultures 24–48 hrly to confirm clearance
- suprapubic or catheter specimen of urine

Treatment

First choice

- Standard amphotericin starting at 1 mg/kg. Can increase dose as tolerated to 1.5 g/kg. In renal failure can use liposomal amphotericin at 1–2 mg/kg, increasing to a maximum of 6 mg/kg (see **Neonatal Formulary** for doses and intervals)
- Alternative is fluconazole – see local formulary

ADJUNCTIVE THERAPY

- No substantive trials to date show benefit of IV immunoglobulin, recombinant cytokines etc.

INGUINAL HERNIA • 1/1

INTRODUCTION

- Incidence: 0.5–1% in term babies and 5–10% in premature babies
- Right-sided in 50% of cases, left-sided in 10% and both sides in 40%
- Most cases can be managed with elective surgery at time of discharge from neonatal unit (NNU)
- Manage incarcerated hernia as a surgical emergency

CLINICAL FEATURES

- Visible swelling or bulge in inguino-scrotal region in boys, inguino-labial region in girls. May be constant or intermittent, becoming more prominent with crying or straining

Simple inguinal hernia

- Usually painless

Incarcerated inguinal hernia

- Generally presents with a tender firm mass in the inguinal canal or scrotum
- Baby may be fussy, unwilling to feed and crying inconsolably
- Overlying skin may be oedematous, erythematous and discoloured
- May be associated abdominal distension with or without bilious vomiting
- Arrange emergency surgical referral

MANAGEMENT AND REFERRAL

Reducible inguinal hernia

- If asymptomatic, refer by letter to surgeon. Include likely date of discharge and parents' contact details
- Inform parents of the risk of hernia becoming incarcerated
  - if baby develops a tense, painful swelling and is in obvious pain, parents should seek **immediate** medical advice
  - if swelling not reduced within 2 hr, serious complications may arise

Incarcerated inguinal hernia

- Stabilise baby
- Administer analgesia (IV morphine), then gently try to reduce hernia
- If fully reduced, arrange elective inguinal herniotomy before discharge. Refer to paediatric surgical team for elective review
- If not reducible, request urgent help from on-call paediatrician/neonatologist
- Keep child nil-by-mouth
- Insert large bore nasogastric tube, empty stomach and leave on free drainage (see **Nasogastric tube insertion** guideline)
- Obtain IV access and send blood for FBC and U&E
- Start maintenance IV fluids
- Aspirate nasogastric tube 4-hrly in addition to free drainage and replace the aspirate volume, mL-for-mL with sodium chloride 0.9% with 10 mmol potassium chloride in 500 mL IV. Leave nasogastric tube on free drainage
- If hernia remains irreducible, refer urgently for surgical assessment
- Complete detailed transfer letter, using BadgerNet system. Ensure parental details and telephone contact numbers included
- If possible, ask parents to travel to planned place of surgery to meet with surgical team

WHILE AWAITING TRANSFER TO SURGICAL UNIT

- Reassess baby regularly
- Monitor fluid balance, blood gases, glucose and consider need for fluid resuscitation

Useful information

http://www.bch.nhs.uk/content/neonatal-surgery

http://www.bch.nhs.uk/find-us/maps-directions

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RECOGNITION

- Early recognition of IMD and prompt management are essential to prevent death or neurodisability
- diagnosis of IMD in babies is often delayed owing to non-specific nature of clinical presentation and unfamiliarity with diagnostic tests
- seek early advice from the regional clinical IMD team

Consider IMD at the same time as common acquired conditions, such as sepsis

Differential diagnosis (the lists below are not comprehensive, discuss with clinical IMD team)

Presentation	Common conditions
Encephalopathy without metabolic acidosis	● Urea cycle disorders ● Maple syrup urine disease (MSUD)
Encephalopathy with metabolic acidosis	● Organic acidaemias (e.g. propionic, methylmalonic, isovaleric, glutaric aciduria Type I) ● Congenital lactic acidosis
Liver dysfunction including jaundice, particularly conjugated	● Galactosaemia ● Tyrosinaemia ● Neonatal haemochromatosis ● α_1-antitrypsin deficiency ● Citrin deficiency ● Niemann-Pick disease type C ● Mitochondrial disease ● Congenital disorders of glycosylation – CDG 1b (uncommon)
Hypoglycaemia	● Hyperinsulinism ● Fatty acid oxidation disorders ● Glycogen storage disorders ● Gluconeogenesis defects
Metabolic acidosis	● Organic acidaemias ● Congenital lactic acidosis
Non-immune hydrops	● Lysosomal storage disorders, including: ○ Mucopolysaccharidoses ○ I-Cell disease ○ Gaucher disease ○ Niemann-Pick disease type A, B or C
Severe neonatal hypotonia	● Zellweger's syndrome ● Non-ketotic hyperglycinaemia (NKHG)
Cataracts	● Galactosaemia ● Zellweger's syndrome ● Lowe's syndrome
Dislocated lens	● Homocystinuria ● Sulphite oxidase deficiency

INHERITED METABOLIC DISORDERS (IMD) • 2/4

Presentation	Common conditions
● Congenital anomalies ○ if developmental delay or neurological signs present with dysmorphism, consider IMD	
● Apnoea or periodic breathing in term baby ● Hiccoughing	● NKHG (also likely to have hypotonia, epileptic encephalopathy) ● MSUD
Respiratory alkalosis in a tachypnoeic baby	● Hyperammonaemia
Cyclical vomiting	● Hyperammonaemia
Intractable neonatal seizures	● Pyridoxine and pyridoxal phosphate – responsive seizures ● Peroxisomal biogenesis disorders ● Neurotransmitter disorders ● Glucose transporter defect (GLUT 1) ● NKHG ● Sulphite oxidase deficiency and molybdenum cofactor deficiency

Specific indicators

Clinical context

- Unexplained and mysterious deterioration of baby (can be as short as 12 hr but more commonly after a symptom-free interval of 24 hr–14 days)

Family history

- Known metabolic disorders
- Unexplained neonatal or infant deaths
- Parental consanguinity

Obstetric history

- Acute fatty liver of pregnancy and HELLP syndrome in index pregnancy may point towards long chain fatty acid oxidation defect in baby

Non-specific indicators suggestive of metabolic disorder in an encephalopathic baby

- Encephalopathy in low-risk baby, or onset after period of normality
- Fluctuating consciousness and muscle tone
- Changes in muscle tone:
  - axial hypotonia with limb hypertonia
  - 'normal' tone in comatose baby
- Abnormal movements:
  - myoclonic or boxing movements
  - tongue thrusting
  - lip smacking
  - unexplained seizures/burst suppression/hypsarrythmia
  - seizures are uncommon or occur late in babies with metabolic encephalopathy compared to hypoxic-ischaemic encephalopathy

INITIAL INVESTIGATIONS

- Whenever IMD suspected, perform required investigations without delay
- Seek early advice about appropriate investigations and management from IMD team at tertiary metabolic centre

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Urine

- Smell
- Ketostix: presence of large amounts of urinary ketones is usually abnormal in babies and could suggest IMD, especially organic acidaemias
- Reducing substances: use Clinitest – urinary dipsticks are specific for glucose and miss galactose in babies with galactosaemia
- a negative Clinitest does not exclude galactosaemia
- Freeze 15–20 mL urine for amino and organic acid analysis
- Amino acids

Blood

- FBC, U&E, infection screen
- Glucose
- Blood gas (calculate anion gap)
- Ammonia
- Lactate
- Total and conjugated bilirubin, liver function tests including clotting studies
- Acylcarnitines, including free and total carnitine
- Uric acid
- Galactosaemia screen (GALIPUT/Beutler test)
- Red blood cell galactose-1-phosphate if transfused in previous 90 days

Imaging

- Cranial ultrasound scan
- Ophthalmic examination

SPECIFIC INVESTIGATIONS

Discuss with clinical IMD team as not all tests may be indicated in all babies with similar presentation

Unexplained/prolonged jaundice or liver synthetic dysfunction

Jaundice

- Skin (and liver) biopsy after discussion with metabolic team

Blood

- Galactosaemia screen (urinary reducing substances can be negative after short period of galactose exclusion)
- Blood spot – succinyl acetone
- Ferritin
- Very long chain fatty acids
- α_1-antitrypsin (quantitative)
- 7-dehydrocholesterol
- Transferrin isoelectric focusing
- Consider Niemann-Pick disease type C-chitotriosidase, DNA- mutation analysis

Urine

- Succinylacetone

Encephalopathy

- Paired blood and CSF glycine
- CSF lactate
- Very long chain fatty acid profile
- Urine for orotic acid
- Urine: Sulfitest for sulphite oxidase deficiency

Hypoglycaemia

(most informative when obtained at time of hypoglycaemia)

- Plasma non-esterified fatty acids
- β-hydroxybutyrate
- Insulin and C-peptide
- Acylcarnitine profile, free and total carnitine
- Cortisol, growth hormone
- Urine for organic acids

Post-mortem

(plan how best to use these precious samples in consultation with IMD team)

- Plasma (2–5 mL), urine (10–20 mL) and CSF (1 mL) frozen at -20ºC
- Red cells: blood (5 mL) in lithium heparin stored at 4ºC (fridge)
- Blood (5 mL) in EDTA: stored at 4ºC for DNA analysis
- Tissue biopsies
- skin: store in viral culture medium or sodium chloride 0.9% at 4ºC (fridge)
- muscle and liver: take within 1 hr of death, snap freeze in liquid nitrogen
- Post-mortem examination
- Bile for acylcarnitine analysis – stable for longer than other body fluids

IMMEDIATE MANAGEMENT

Commence emergency management of suspected IMD while awaiting results of initial investigations and discuss with IMD team as early as possible

- Attend to **A**irway, **B**reathing and **C**irculation; ventilate if necessary
- Omit all protein, fat and galactose/lactose (milk) intake, including TPN and lipid
- Commence glucose 10% IV infusion to provide 6–8 mg glucose kg/min
- start insulin infusion if hyperglycaemic (>15 mmol/L) or catabolic, under guidance from IMD team
- if hypertonic (concentration of glucose >10%) infusion necessary, insert central line
- Correct dehydration, acid-base and electrolyte disturbances
- Cover for infection
- Control seizures (avoid sodium valproate)
- When stable and appropriate, consider early transfer to tertiary metabolic centre

SPECIFIC MANAGEMENT

- Must be led by IMD team
- Use following as guide to general principles of management

Neonatal hyperammonaemia

A medical emergency requiring prompt intervention to lower ammonia concentration

- Renal replacement therapy (haemofiltration more efficient than peritoneal dialysis)
- Sodium benzoate
- Sodium phenylbutyrate
- L-arginine

Organic acidaemia

- Reduce/stop protein intake
- Glucose 10% infusion +/- insulin
- L-carnitine

Fatty acid oxidation disorders

- Avoid prolonged fast
- Specific management guide by IMD team

Lactic acidosis

- Dichloroacetate
- Biotin
- L-carnitine
- Thiamine

Galactosaemia

- Dietary exclusion of galactose

For further information on IMD, www.bimdg.org.uk/guidelines.asp, Emergency protocols and follow through

LOCAL CONTACT

- Birmingham Children's Hospital metabolic team (0121 333 9999)

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INTRA-ABDOMINAL CYSTS • 1/2

INTRODUCTION

This guideline does not apply to cystic structures which may be arising from the urinary tract

- Antenatally detected intra-abdominal cysts include:
  - ovarian
  - intestinal duplication
  - mesenteric
  - vitello-intestinal

SYMPTOMS AND SIGNS

- Most cysts will be asymptomatic but the following can be present:
  - abdominal pain
  - vomiting
  - abdominal distension
  - respiratory compromise
  - rectal bleeding
- Meconium pseudocyst may also be detected on an antenatal ultrasound. They will nearly always cause vomiting and abdominal distension and may be associated with an underlying diagnosis of cystic fibrosis

MANAGEMENT

Antenatal

- Refer to/discuss appropriate place for delivery with a fetal medicine unit
- Refer to paediatric surgeon for antenatal counselling

Delivery

- In the majority of cases, obstetric management will not alter

Postnatal

- Resuscitate baby as normal
- Once stable, perform full postnatal physical examination – see **Examination of the newborn** guideline

Meconium pseudocyst

- If suspected antenatally, do not feed baby at birth
- Insert a size 8 Fr nasogastric tube (NGT) immediately after birth and fix securely with tape – see **Nasogastric tube insertion** guideline
- Empty stomach by aspirating NGT with a 10 or 20 mL syringe
  - if <20 mL aspirated, check position of tube
- Place NGT on free drainage by connecting to a bile bag
- Replace nasogastric losses, mL-for-mL, using sodium chloride 0.9% with potassium chloride 10 mmol/500 mL IV
- Once stabilised, admit baby to neonatal unit (NNU)
- Commence intravenous maintenance fluids – see **IV fluid therapy** guideline
- On day of birth, refer to on-call surgical team at planned place of surgery

Other types of intra-abdominal cysts

- Unless significant abdominal distension present following birth, allow baby to feed normally and observe in the postnatal ward for at least 48 hr
- If baby well after 48 hr with no abdominal symptoms and feeding normally then discharge
- Arrange an out-patient abdominal ultrasound scan within 1 week of birth

SURGICAL REFERRAL

- Urgency will depend on clinical situation
- **Meconium pseudocyst:**
  - manage as above and refer to surgeon on day of birth
- **Symptomatic cyst:**
  - stabilise on NNU and refer to on-call surgical team on day of presentation
- **Asymptomatic cyst:**
  - abdominal ultrasound within 1 week of birth
  - when result known, written out-patient referral to consultant paediatric surgeon
- **Resolved cyst:**
  - ultrasound within 1 week of birth, even if cyst appears to have resolved during pregnancy. Arrange out-patient surgical referral

Useful information

http://www.bch.nhs.uk/content/neonatal-surgery

http://www.bch.nhs.uk/find-us/maps-directions

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PRINCIPLES

- Postnatal physiological weight loss is approximately 5–10% in first week of life
- Preterm babies have more total body water and may lose 10–15% of their weight in first week of life
- Postnatal diuresis is delayed in respiratory distress syndrome (RDS) and in babies who had significant intrapartum stress
- Preterm babies have limited capacity to excrete sodium in first 48 hr
- Sodium chloride 0.9% contributes a significant chloride (Cl^-) load which can exacerbate metabolic acidosis
- Liberal sodium and water intake before onset of natural diuresis is associated with increased incidence of patent ductus arteriosus (PDA), necrotising enterocolitis (NEC) and chronic lung disease (CLD)
- After diuresis, a positive sodium balance is necessary for tissue growth
- Preterm babies, especially if born <29 weeks' gestation, lose excessive sodium through immature kidneys
- Babies <28 weeks have significant transepidermal water loss (TEW)
- TEW loss leads to hypothermia, loss of calories and dehydration, and causes excessive weight loss and hypernatraemia

MONITORING

Weigh

- On admission
- Daily for intensive care babies: twice daily if fluid balance is a problem
- use in-line scales if available

Serum sodium

- Daily for intensive care babies
- If electrolyte problems or ≤26 weeks, measure twice daily
- admission electrolytes reflect maternal status: need not be acted upon but help to interpret trends
- serum urea not useful in monitoring fluid balance: reflects nutritional status and nitrogen load

Serum creatinine

- Daily for intensive care babies
- Reflects renal function over longer term
- trend is most useful
- tends to rise over first 2–3 days
- gradually falls over subsequent weeks
- absence of postnatal drop is significant

Urine output

- Review 8-hrly for intensive care babies
- 2–4 mL/kg/hr normal hydration
- <1 mL/kg/hr requires investigation except in first 24 hr of life
- >6–7 mL/kg/hr suggests impaired concentrating ability or excess fluids

NORMAL REQUIREMENTS

Humidification

- If <29 weeks, humidify incubator to at least 60%
- If ventilated or on CPAP ventilator, set humidifier at 39ºC negative 2 to ensure maximal humidification of inspired gas

Normal fluid volume requirements

	Fluid volume (mL/kg/day)	
Day of life	<1000 g	≥1000 g
1	90	60
2	120	90
3	150	120
4	150	150

- **Day 1**
  - glucose 10%
  - if birth weight <1000 g start parenteral nutrition (PN) (with potassium 2 mmol/kg daily)
- **Day 2**
  - glucose 10% and potassium 10 mmol in 500 mL (depending on electrolyte results) or PN
  - use sodium chloride 0.45% in arterial line fluids
  - add sodium only when there is diuresis, or weight loss >6% of birth weight
- **Day 3**
  - glucose 10%, sodium chloride 0.18% and potassium 10 mmol in 500 mL or PN (with potassium 2 mmol/kg/day and sodium 4 mmol/kg/day)
- **After day 4**
  - glucose 10% (with maintenance electrolytes adjusted according to daily U&E) or PN
- Fluid volume requirements are a guide and can be increased faster or slower depending on serum sodium values, urine output and changes in weight
- Babies receiving phototherapy may require extra fluids depending on type of phototherapy

HYPONATRAEMIA (<130 mmol/L)

Response to treatment should be proportionate to degree of hyponatraemia

Causes

- **Excessive free water**
  - reflection of maternal electrolyte status in first 24 hr
  - failure to excrete fetal extracellular fluid will lead to oedema without weight gain
  - water overload: diagnose clinically by oedema and weight gain
  - excessive IV fluids
  - inappropriate secretion of ADH in babies following major cerebral insults, or with severe lung disease
  - treatment with indometacin or ibuprofen
- **Excessive losses**
  - prematurity (most common cause after 48 hr of age)
  - adrenal insufficiency
  - GI losses
  - diuretic therapy (older babies)
  - inherited renal tubular disorders
- **Inadequate intake**
  - preterm breast fed babies aged >7 days

Management depends on cause

Excessive IV fluids and failure to excrete fetal ECF

Management

- Reduce fluid intake to 75% of expected

Inappropriate ADH

Clinical features

- Weight gain, oedema, poor urine output
- Serum osmolality low (<275 mOsm/kg) with urine not maximally dilute (osmolality >100 mOsm/kg)

Management

- Reduce fluid intake to 75% of expected
- Consider sodium infusion only if serum sodium <120 mmol/L

Risk of accidental hypernatraemia when using 30% sodium chloride. Use with caution and always dilute before use

Acute renal failure

Management

- Reduce intake to match insensible losses + urine output
- Seek advice from senior colleague

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Excessive renal sodium losses

Management

If possible, stop medication (diuretics, caffeine) that causes excess losses

- Check urinary electrolytes
- Calculate fractional excretion of sodium (FE Na^+ %):
  - FE Na^+ = [(urine Na x plasma creatinine)/(urine creatinine x plasma Na)] x 100
  - normally <1% but in sick preterm babies can be up to 10%
  - affected by sodium intake: increased intake leads to increased fractional clearance
  - if >1%, give sodium supplements
- Calculate sodium deficit
  - = (135 – plasma sodium) x 0.6 x weight in kg
  - replace over 24 hr unless sodium <120 mmol/L or symptomatic (apnoea, fits, irritability)
  - initial treatment should bring serum sodium up to about 125 mmol/L
- Use sodium chloride 30% (5 mmol/mL) diluted in maintenance fluids. Ensure bag is mixed well before administration

Adrenal insufficiency

Clinical features

- Hyperkalaemia
- Excessive weight loss
- Virilisation of females
- Increased pigmentation of both sexes
- Ambiguous genitalia

Management

- Seek consultant advice

Inadequate intake

Clinical features

- Poor weight gain and decreased urinary sodium

Management

- Give increased sodium supplementation
- If taking diuretics, stop or reduce dose

Excessive sodium intake leading to water retention

Clinical features

- Inappropriate weight gain

Management

- Reduce sodium intake

HYPERNATRAEMIA (>145 mmol/L)

Prevention

- Prevent high transepidermal water loss
  - use plastic wrap to cover babies of <32 weeks' gestation at birth
  - nurse in high ambient humidity >80%
  - use bubble wrap
  - minimise interventions
  - humidify ventilator gases

Causes

- Water loss (most commonly)
  - TEW
  - glycosuria
- Excessive sodium intake
  - sodium bicarbonate
  - repeated boluses of sodium chloride
  - congenital hyperaldosteronism/diabetes insipidus (very rare)

Management depends on cause

Hypernatraemia resulting from water loss

Clinical features

- Leads to weight-loss with hypernatraemia

Management

- Increase fluid intake and monitor serum sodium

Osmotic diuresis

Management

- Treat hyperglycaemia with an insulin infusion (see **Hyperglycaemia** guideline)
- Rehydrate with sodium chloride 0.9%

Hypernatraemia resulting from excessive intake

Management

- If acidosis requires treatment, use THAM instead of sodium bicarbonate
- Reduce sodium intake
- Change arterial line fluid to sodium chloride 0.45%
- Minimise number and volume of flushes of IA and IV lines

USING SYRINGE OR VOLUMATIC PUMP TO ADMINISTER IV FLUIDS

- Do not leave bag of fluid connected (blood components excepted)
- Nurse to check hourly:
  - infusion rate
  - infusion equipment
  - site of infusion
- Before removing giving set, close all clamps and switch off pump

IV FLUIDS: some useful information

- Percentage solution = grams in 100 mL (e.g. glucose 10% = 10 g in 100 mL)
- One millimole = molecular weight in milligrams

Compositions of commonly available solutions

FLUID	Na mmol/L	K mmol/L	Cl mmol/L	Energy kCal/L
Sodium chloride 0.9%	150	–	150	–
Glucose 10%	–	–	–	400
Glucose 10%/sodium chloride 0.18%	30	–	30	400
Albumin 4.5%	150	1	–	–
Sodium chloride 0.45%	75	–	75	–

Useful figures

- Sodium chloride 30% = 5.13 mmol/mL each of Na and Cl
- Sodium chloride 0.9% = 0.154 mmol/mL each of Na and Cl
- Potassium chloride 15% = 2 mmol/mL each of K and Cl
- Calcium gluconate 10% = 0.225 mmol/mL of Ca
- Sodium bicarbonate 8.4% = 1 mmol/mL each of Na and bicarbonate
- Sodium chloride 0.9% 1 mL/hr = 3.7 mmol Na in 24 hr

Osmolality

- Serum osmolality = 2(Na + K) + glucose + urea (normally 285–295 mOsmol/kg)
- Anion gap = $(Na^+ + K^+) - (Cl^- + HCO_3^-)$ normally 7–17 mmol/L
- Normal urine: osmolality 100–300 mOsmol/kg, specific gravity 1004–1015
- Babies can dilute urine up to 100 mOsmol/kg, but can concentrate only up to 700 mOsmol/kg

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Glucose

- To make glucose 12.5%, add 30 mL of glucose 50% to 470 mL of glucose 10%
- To make glucose 15%, add 60 mL of glucose 50% to 440 mL of glucose 10%
- Glucose 20% is commercially available
- Glucose 10% with sodium chloride 0.18% and 10 mmol potassium chloride is not commercially available but can be made up using 3 mL sodium chloride 30% and a 500 mL bag of glucose 10% with 10 mmol potassium chloride

- See also **Intubation – difficult** guideline

This procedure must be undertaken or supervised by an experienced person
Do not attempt to carry out this procedure unsupervised unless you have demonstrated your competence

ELECTIVE INTUBATION

- Use pre-medication as appropriate for your unit

Equipment

- Suction
- Oxygen with pressure limiting device and T-piece or 500 mL bag and appropriate size face mask
- Endotracheal tubes (ETT); non cuffed; 3 sizes (diameter in mm):

Weight of baby (g)	ETT
<1000–1250	2.5
1250–3000	3.0
>3000	3.5–4

- Endotracheal tube introducer/stylet
- Syringe and needles for drawing up premedication
- Neonatal stethoscope
- Hat for baby to secure tube, ETT fixing device, forceps and scissors
- Laryngoscope handle and Miller blades sizes 0 and 00, stethoscope, oropharyngeal airway
- Pedicap® end tidal CO_2 detector
- Oxygen blender

Preparation

- Ensure cannula in place and working
- Ensure laryngoscope is working, correct sized blades are available and T-piece system is working. Set pressure limits – 30 cm H_2O for term babies and 20–25 cm H_2O in preterm babies
- Check you have the correct ETT size and attachments to secure ETT
- Insert ETT introducer into ETT ensuring it does not protrude past the end of the ETT
- Ensure all drugs drawn up, checked, labelled and ready to give
- Check no contraindications to drugs
- Ensure monitoring equipment attached and working reliably
- If nasogastric tube (NGT) in place, aspirate stomach (particularly important if baby has been given enteral feeds)
- Check IV line working
- Ensure back-up plan in case intubation does not work (see **Intubation – difficult** guideline)

Premedication

- Use blended oxygen to pre-oxygenate for 2 min prior to drug administration
- start with room air and increase FiO_2 to get SpO_2 to target range appropriate for gestational age – see **Oxygen saturation target** guideline. Avoid hyperoxia in preterm baby
- Continue to pre-oxygenate until laryngoscopy and between attempts if more than one attempt necessary

Drugs

Choice of drugs depends on local practice
Analgesia and muscle relaxation can improve likelihood of successful intubation

Muscle relaxants

Administer muscle relaxants only if you are confident that the team can intubate baby quickly
Do not use a muscle relaxant unless adequate analgesia has been given
Do not use muscle relaxant for INSURE (in-and-out surfactant replacement)

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PROCEDURE

- Give premedication
- Use mask ventilation in neutral position, a shoulder roll may help
- Place laryngoscope in right side of mouth, lift up tongue and jaw to view cords and larynx. Lift laryngoscope: do not tilt
- Avoid trauma to gums
- Cricoid pressure: by person intubating or an assistant
- Suction secretions only if they are blocking the view as this can stimulate the vagal nerve and cause a bradycardia and vocal cord spasm
- Insert ETT
- Advance ETT to desired length at the lips
- General recommendation is to advance ETT no further than end of black mark at end of tube (2.5 cm beyond cords), but this length is far too long for extremely preterm babies
- See **Table: Length of ETT** for where approximate markings of the ETT should be at the lips

Table: Length of ETT

Gestation of baby	Actual weight of baby (kg)	Length of ETT (cm) at lips
23–24	0.5–0.6	5.5
25–26	0.7–0.8	6.0
27–29	0.9–1.0	6.5
30–32	1.1–1.4	7.0
33–34	1.5–1.8	7.5
35–37	1.9–2.4	8.0
38–40	2.5–3.1	8.5
41–43	3.2–4.2	9.0

- Remove stylet if used and check to ensure it is intact before proceeding
- If stylet not intact, remove ETT immediately and prepare to reintubate

Confirming position of ETT

- View ETT passing through larynx
- Observe for chest movements with ventilation breaths
- Use an end tidal CO_2 detector attached to ETT for verification of correct tube placement
- may be of limited value in the very small baby or in the presence of cardiovascular collapse. In these cases lack of colour change may not always mean tube is not in the correct position (colour change is dependant on circulation and an adequate volume of gas exchange)
- Auscultate both axillae and stomach. Breath sounds should be similar on each side and not be heard over the stomach. This may be difficult to assess in very immature infants. In some special circumstances (e.g. pneumothorax diaphragmatic hernia) there may be asymmetrical breath sounds
- if breath sounds unequal and louder on right, withdraw ETT by 0.5 cm and listen again, repeat until breath sounds equal bilaterally

- If ETT tip in the trachea, and you are using a clear ETT, mist may condense on the inside of the endotracheal tube during expiration

> ***Do not leave baby with unequal air entry***

- stabilise tube using ETT fixation method in accordance with unit practice
- request chest X-ray: adjust ETT length so that tip is at level of T2–3 vertebrae and document on nursing chart and in baby's hospital notes

Intubation failure

Definition: Unable to intubate within 30 seconds

- If intubation unsuccessful, seek help from someone more experienced
- If there is a risk of aspiration, maintain cricoid pressure
- Continue mask ventilation until successful intubation achieved
- **Limit hypoxia by:**
- limiting the intubation attempt to prevent excess fall in oxygen saturation and/or heart rate – a supportive team member should be available to determine when the attempt should cease and re-oxygenation be implemented
- providing appropriate ventilation before and between intubation attempts

Record keeping

- Indication for intubation
- Whether oral or nasal
- ETT size and position at cords and nares/lips
- Radiological position of tip of ETT and any adjustments following to X-ray
- Medication chart completed
- Baby's tolerance of procedure and any adverse events

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BACKGROUND

In most babies, direct laryngoscopy results in a clear view of the larynx. The laryngeal view is classified by Cormack and Lehane as follows:

Grade 1 Grade 2 Grade 3 Grade 4

Grade 1	Visualisation of entire laryngeal aperture There should be no difficulty in intubation
Grade 2	Visualisation of just the posterior portion of the laryngeal aperture May be slight difficulty Cricoid pressure should improve visualisation
Grade 3	Visualisation of only the epiglottis Can result in severe difficulty; cricoid pressure may be helpful
Grade 4	Visualisation of soft palate only, not even the epiglottis is visible Always difficult and usually accompanies obvious pathology but may also occur totally unexpectedly. Senior support may be required

MANAGEMENT PLAN

- Difficult neonatal intubation may occur at or after delivery and may be:
  - anticipated (e.g. Pierre Robin sequence, Treacher–Collins, cleft lip and palate, Goldenhar syndrome, Apert/Crouzon syndrome, Down's syndrome) **or**
  - unanticipated (e.g. subglottic stenosis, laryngeal atresia, laryngeal or tracheal webs, glottic oedema post extubation)
- Where difficult intubation is anticipated, ensure senior help is available before commencing (senior experienced middle grade, consultant or, if indicated, ENT consultant/anaesthetist)

Difficult airway pack

- Infant oropharyngeal airways (Guedel, sizes 000, 00, 0)
- ETT size 2–4.5 with stylet for intubation
- ETT size 2–4.5 with scissors, to cut short for use as nasopharyngeal airway support
- ETT fixation equipment
- Straight bladed laryngoscopes for big and small baby
- Forceps
- Laryngeal mask airways (size 1)
- Size 2.5–4.5 endotracheal bougies for railroading ETT
- Video laryngoscope and blades if available on your unit
- CO_2 detector e.g. Pedicap®

Can ventilate, cannot intubate

(Good chest excursion and rising/good heart rate but baby still needs intubation)

- No more than 4 attempts at intubation (2 per individual resuscitator), to avoid laryngeal oedema and convert this into a 'cannot intubate, cannot ventilate' scenario
  - ventilate between attempts at intubation
  - maximum 30 seconds per attempt to limit hypoxia
- Call for senior help

- If intubation attempts fail, stop. Continue either bag and mask ventilation or laryngeal mask airway ventilation until senior help available
- it is safer to maintain ventilation with mask ventilation with adequate chest expansion until help arrives, as baby is less likely to survive repeated unsuccessful ETT attempts
- Two further attempts by senior trainee/neonatologist
- Try indirect laryngoscopy using video laryngoscope if available. If this fails, call for ENT support for rigid bronchoscopy or surgical tracheostomy, or ENT/anaesthetist for flexible fibrescope assisted intubation depending on your hospital's availability
- Use end tidal CO_2 detectors (e.g. Pedicap®) to confirm tracheal intubation

Cannot ventilate, cannot intubate

- Reconfirm the following, and call for senior help:
- neutral head position (overextension can limit vision)
- correct size face mask being used, create a tight seal
- use correct size oropharyngeal airway (Guedel airway): too big may cause laryngospasm and too small may worsen obstruction (tip of the Guedel airway should reach the angle of the jaw when aligned with lip on side of face)
- For specific conditions (e.g. Pierre Robin sequence, micrognathia) nasopharyngeal airway may be useful. To make, take an ETT and shorten it by measuring distance between nasal tip and ear tragus. Choose a size that does not blanch the nares completely when inserted
- Laryngeal mask ventilation (smallest size = size 1, suitable for babies >1.5 kg)
- When senior help arrives:
- re-attempt intubation
- use a small towel roll under baby's shoulder to improve vision
- use indirect laryngoscopy with video laryngoscope if available
- Call ENT or anaesthetist for support (ENT for rigid bronchoscopy or surgical tracheostomy, or anaesthetist for flexible fibrescope assisted intubation as above, depending on your hospital's availability)
- Use end tidal CO_2 detector (e.g. Pedicap®) to confirm tracheal intubation

Prevent/anticipate difficult intubation/re-intubation

- For ventilated babies due for extubation, risk of difficult re-intubation can be reduced by pre-extubation dexamethasone to reduce cord oedema, especially in babies who had difficult initial intubations or chronic ventilatory course
- if ETT leak <10–15%, consider dexamethasone

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Common problems with intubation

Problem	Action
Oesophageal intubation – blade placed too deep, cords not visualised	● Retry with shallow blade insertion and use cricoid pressure
Tongue obscures vision	● Sweep tongue to left side using blade ● Use a more anterior lift ● Use straight blade (Miller)
Cannot see cords	● Ensure head not hyper-extended ● Use small towel roll under baby's shoulders
Cannot intubate	● Do not panic ● Calmly maintain chest excursions through bag or T-piece/face or laryngeal mask ventilation until help arrives ● Use Guedel oral airway if necessary ● Call for senior help

See senior support in the following situations

- **Blind intubation:** in small baby where poor visualisation due to size
- **Laryngeal mask airway (size 1):** can be inserted by juniors while awaiting senior support if trained
- **Video laryngoscope:** if available, to guide intubation through the cords
- **Railroad technique:** if laryngeal aperture narrow, insertion of stylet through cords, and railroading ETT over it:
  - usually a two-person procedure and can be carried out under direct vision/blind, depending on visual field and equipment
  - carefully insert a bougie through vocal cords, not more than 2 cm beyond aperture opening
  - keep bougie steady while colleague threads ETT over top end of stylet and into trachea. **Note:** using a stylet from the ETT pack carries risk of oesophageal/tracheal perforation
- **Ultra-small fibre-optic bronchoscopy** (if available locally): with railroading via bronchoscope
- **Surgical tracheostomy:** not undertaken by neonatal consultants – seek ENT support
- **NB: Prolonged procedure:** additional dose of muscle relaxant can be used under senior guidance
  - ensure venous access obtained
  - support cardiac system with IV fluid boluses as required
  - use inotropic agents as required, based on perfusion and blood pressure
- Keep baby warm using techniques supported by your local unit e.g. transwarmer, bubble wrap
- Empty stomach contents regularly while on face mask/T-piece ventilation

JAUNDICE (Based on NICE CG98 Jaundice in newborn babies under 28 days) • 1/3

RECOGNITION AND ASSESSMENT

Risk factors for hyperbilirubinaemia

- <38 weeks' gestation
- Previous sibling required treatment for jaundice
- Mother intends to exclusively breastfeed
- Visible jaundice in baby aged <24 hr

Risk factors for kernicterus

- High bilirubin level (>340 micromol/L in term baby)
- Rapidly rising bilirubin level (>8.5 micromol/L/hr)
- Clinical features of bilirubin encephalopathy

Symptoms and signs

- Yellow colouration of skin in a pale-skinned baby observed in natural light
- Yellow conjunctivae in dark-skinned babies

Assess

- Pallor (haemolysis)
- Poor feeding, drowsiness (neurotoxicity)
- Hepatosplenomegaly (blood-group incompatibility or cytomegalovirus)
- Splenomegaly (spherocytosis)

Causes

- Physiological
- Prematurity
- Increased bilirubin load:
  - blood group incompatibility (Rhesus or ABO)
  - G6PD deficiency and other red cell enzyme deficiencies
  - congenital spherocytosis
  - cephalhaematoma, bruising
- Rarely infection (e.g. UTI, congenital infection)
- Metabolic disorder

Persistent jaundice after 14 days of age – see **Liver dysfunction** guideline

- Breast milk jaundice
- Hypothyroidism
- Liver disease (e.g. extra hepatic biliary atresia and neonatal hepatitis)
- α_1-antitrypsin deficiency
- Galactosaemia
- TPN-induced cholestasis

Investigations

Assessment of jaundice

- Babies <72 hr old at every opportunity (risk factors and visual inspection)
- Babies with suspected or obvious jaundice, measure and record bilirubin level urgently
  - <24 hr, within 2 hr
  - ≥24 hr, within 6 hr
- If serum bilirubin >100 micromol/L in first 24 hr
  - repeat measurement in 6–12 hr
  - interpret result in accordance with baby's age and gestation – see **Table**
  - urgent medical review as soon as possible (and within 6 hr)
- Interpret bilirubin result in accordance with baby's gestational and postnatal age according to **Table**

Jaundice requiring treatment

- Total bilirubin
- Baby's blood group and Direct Coombs' test (interpret result taking into account strength of reaction and whether mother received prophylactic anti-D immunoglobulin during pregnancy)
- Mother's blood group and antibody status (should be available from maternal healthcare record)
- PCV

Plus (if clinically indicated)

- Full infection screen (in an ill baby)
- G6PD level and activity (if indicated by ethnic origin: Mediterranean, Middle Eastern, South East Asian)
- FBC and film

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Persistent jaundice >14 days term baby; >21 days preterm baby

*(*see **Liver dysfunction** guideline*)*

- Total and conjugated bilirubin
- Examine stool colour
- FBC
- Baby's blood group and Direct Coombs' test (interpret result taking into account strength of reaction and whether mother received prophylactic anti-D immunoglobulin during pregnancy)
- Ensure routine metabolic screening performed (including screening for hypothyroidism)
- Urine culture

Baby with conjugated bilirubin >25 micromol/L, refer urgently to a specialist centre

2nd line investigations

(not in NICE guideline)

- Liver function tests (ALT, AST, albumin, GGT)
- Coagulation profile
- G6PD screen in African, Asian or Mediterranean babies
- Thyroid function tests: ask for 'FT_4 priority and then TSH'
- Congenital infection screen
- Urine for CMV PCR, toxoplasma ISAGA-IgM and throat swab for HSV culture/PCR
- Metabolic investigations e.g:
  - blood galactose-1-phosphate
  - urine for reducing substances
  - α_1-antitrypsin

TREATMENT <7 DAYS

Babies ≥38 weeks' gestation

- Use conventional blue light phototherapy (not fibre optic) as treatment of choice
- Use continuous multiple phototherapy for babies who:
  - fail to respond to conventional phototherapy (bilirubin does not fall within 6 hr of starting treatment)
  - have a rapid rise in bilirubin (>8.5 micromol/L/hr)
  - have a bilirubin level at which exchange transfusion is indicated

Babies <38 weeks' gestation

- Use fibre optic or conventional blue light as 1st line treatment
- based on gestational age and postnatal age, use **Threshold graphs** (http://www.nice.org.uk/guidance/CG98 under 'Tools and resources' then 'CG98 Neonatal Jaundice: treatment threshold graphs') to determine threshold for phototherapy
- Indications for multiple phototherapy as term babies

Management during phototherapy

- Offer parents information on procedure (BLISS 'Neonatal Jaundice factsheet' available at http://www.bliss.org.uk/factsheets)
- Unless other clinical conditions prevent, place baby in supine position
- Ensure treatment applied to maximum area of skin
- Monitor baby's temperature
- Use eye protection and give routine eye care
- Provided bilirubin not significantly elevated, encourage breaks of up to 30 min for breastfeeding, nappy change and cuddles
- Do not give additional fluids routinely
- During multiple phototherapy:
  - do not interrupt for feeds
  - monitor hydration by weighing baby daily and assessing wet nappies

Monitoring during phototherapy

- Repeat serum bilirubin 4–6 hr after starting treatment
- Repeat serum bilirubin 6–12 hrly when bilirubin stable or falling
- Stop phototherapy once serum bilirubin has fallen to at least 50 micromol/L below threshold
- Check for rebound jaundice with repeat serum bilirubin 12–18 hr after stopping phototherapy

DISCHARGE AND FOLLOW-UP

- GP follow-up with routine examination at 6–8 weeks
- If exchange transfusion necessary or considered, request developmental follow-up and hearing test
- In babies with more than weakly positive Coombs' test who require phototherapy:
  - check haemoglobin at 2 and 4 weeks of age due to risk of continuing haemolysis
  - give folic acid 1 mg daily

Table: Limits for phototherapy and exchange transfusion for babies ≥38 weeks' gestation

Age (hours)	Serum bilirubin (micromol/L)	Serum bilirubin (micromol/L)	Serum bilirubin (micromol/L)	Serum bilirubin (micromol/L)
0			>100	>100
6	>100	>112	>125	>150
12	>100	>125	>150	>200
18	>100	>137	>175	>250
24	>100	>150	>200	>300
30	>112	>162	>212	>350
36	>125	>175	>225	>400
42	>137	>187	>237	>450
48	>150	>200	>250	>450
54	>162	>212	>262	>450
60	>175	>225	>275	>450
66	>187	>237	>287	>450
72	>200	>250	>300	>450
78	–	>262	>312	>450
84	–	>275	>325	>450
90	–	>287	>337	>450
96+	–	>300	>350	>450
ACTION	Repeat transcutaneous bilirubin/serum bilirubin (6–12 hr)	Consider phototherapy (repeat transcutaneous bilirubin/serum bilirubin in 6 hr)	Start phototherapy	Perform exchange transfusion

Source: http://www.nice.org.uk/guidance/CG98

- Treatment graphs giving the phototherapy and exchange transfusion limits for each gestational age can be printed from http://www.nice.org.uk/guidance/CG98 under 'Tools and resources' then 'CG98 Neonatal Jaundice: treatment threshold graphs'

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KANGAROO CARE (KC) • 1/2

DEFINITION

- Method of holding preterm and/or sick baby skin-to-skin in an upright position between mother's breasts or against carer's chest (fathers and siblings can also be Kangaroo carers)
- KC can be offered to parents of medically stable babies

Benefits of Kangaroo care

- Inform parents about the benefits of KC (use BLISS 'Skin-to-skin and Kangaroo Care' information http://www.bliss.org.uk/skin-to-skin-and-kangaroo-care or locally approved information leaflets):
- helps promote physiological stability: regulates baby's temperature, heart rate, breathing and oxygen saturation
- associated with fewer episodes of apnoea and bradycardia
- increases time in quiet sleep
- longer alert states and less crying
- analgesic effect during painful procedures
- promotes growth and earlier discharge
- improves lactation and breastfeeding success – duration and exclusivity
- promotes parent–baby attachment and family-centred care
- positive effect on parenting – reduces stress and depression, triggers healing process, increases confidence

INDICATIONS

- Medically stable baby – including those on CPAP with a stable oxygen requirement
- Medically stable ventilated babies after discussion with MDT
- Ventilated babies receiving palliative care

If concerns regarding stability of baby, discuss with senior member of medical and nursing team

CONTRAINDICATIONS

- Umbilical lines *in situ*

Consider

- Baby's condition and dependency
- Maintenance of neutral thermal environment and humidity
- Activity in the room: quiet, calm environment is preferable
- Support available from colleagues

Ensure

- Access to oxygen and suction

PARENT PREPARATION

- Ensure parents are aware that baby may be briefly unstable during transfer from/to incubator/cot
- Suggest parents do not smoke immediately before KC time
- Choose a mutually convenient time for parents and baby
- Provide privacy for parents to prepare clothing – suggest parents wear a clean loose fitting, front fastening shirt
- Provide comfortable chair and foot rest if appropriate
- Offer a hand-held mirror – to enable parent to see baby's face
- Advise parents to bring a drink and go to toilet before KC time

Nurse transfer

Recommended initial transfer method. Use this method until parents feel confident

- Parent to sit slightly reclined in a comfortable chair. Ensure clothing open and ready to receive baby
- Contain baby's limbs and move gently – use 'snuggle up' nest if appropriate
- Place baby on parent's chest, prone with head to parent's sternum
- Parent to support baby's head and body with baby's legs flexed

- Turn baby's head to side to protect airway
- Use parent's clothing and a wrap/blanket for warmth and support
- If appropriate, place hat on baby

Parent transfer

- Parent to stand at side of incubator
- Place forearm gently under 'snuggle up' nest or sheet, cup baby's head with other hand
- Gently lift baby from incubator and onto chest, resting baby's head against sternum while supporting baby's back and bottom with forearm
- Parent gently moves back to sit in chair, guided by nurse
- Nurse to check baby's position as before

Duration of KC

- When baby settled, remove screens/curtains – be guided by parental preference
- Aim to provide KC for a minimum of 1 hr
- Monitor baby's position and vital signs
- Babies may have nasogastric tube (NGT) feeds during KC time
- Discontinue KC if:
  - baby shows signs of distress
  - has a prolonged increase in oxygen requirement of 10–20%
  - at parent's request

Breast milk

- Encourage mother to express breast milk following KC time. See **Breast milk expression** guideline

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- Encourage obstetric team to warn neonatal team of expected problems **well in advance**
- Decide who should attend (e.g. Tier 1, 2 or 3 staff), and degree of urgency

Neonatal team should attend the following deliveries

- Non-reassuring electronic fetal monitoring (EFM) trace, as assessed by obstetric team
- Significant fresh meconium in liquor
- Caesarean section under general anaesthesia (see below)
- Major congenital abnormalities (minor abnormalities will wait until working hours)
- Vacuum extraction or instrumental deliveries performed for fetal reasons (see below)
- Preterm delivery <36 weeks' gestation
- Severe pre-eclampsia with seizures
- Antepartum haemorrhage
- Moderate-to-severe Rhesus disease
- Unexpected breech delivery

It is **not** necessary for neonatal team to attend the following deliveries:

- Elective caesarean section under regional anaesthesia
- Meconium staining of liquor
- Breech delivery (including caesarean section under regional anaesthesia)
- Twins (>36 weeks)
- Pre-eclampsia without seizures

The following factors may require neonatal team to attend birth or assess baby soon after birth (see antenatal plan in maternal notes)

- Maternal illness likely to affect baby:
  - diabetes mellitus
  - thyroid disease
  - systemic lupus erythematosus
  - myasthenia gravis
  - myotonic dystrophy
  - hepatitis B carriage
  - HIV
  - HELLP syndrome
- Maternal medications that may affect baby e.g. antidepressants
- Neonatal alerts:
  - abnormal antenatal scans
  - low birth weight baby <2.5 kg
- Pregnancy and past history
  - prolonged rupture of membranes
  - polyhydramnios
  - previous baby/perinatal death
  - family history of genetic or metabolic abnormalities

LIVER DYSFUNCTION IN PRETERM BABIES • 1/4

DEFINITION

- Cholestasis: conjugated hyperbilirubinaemia ≥25 micromol/L and/or ≥20% of total bilirubin
- Acute liver failure with raised transaminase and coagulopathy unresponsive to vitamin K

CAUSES

- Not all liver dysfunction in preterm babies is caused by parenteral nutrition. Extra-hepatic biliary atresia does occur and must be diagnosed and managed in a timely fashion

Biliary tract disorders	Neonatal hepatitis	Metabolic
● Extra-hepatic biliary atresia ● Bile duct stricture ● Choledochal cyst ● Alagille syndrome ● Non-syndromic bile duct paucity	**Isolated** ● Associated with: ○ parenteral nutrition ○ maternal diabetes ○ hydrops fetalis ○ trisomy 21	● α_1-antitrypsin deficiency ● Cystic fibrosis ● Galactosaemia ● Dubin-Johnson syndrome ● Bile acid disorder ● Haemochromatosis
Infection	**Endocrine**	**Toxins/injury**
● Cytomegalovirus ● Toxoplasmosis ● Sepsis	● Hypopituitarism ● Hypothyroidism	● Parenteral nutrition ● Multifactorial preterm ● Haemolytic disease ● Hypoxia

Discuss all term babies with liver dysfunction urgently with liver unit team To exclude extra-hepatic biliary atresia, admit to liver unit

SYMPTOMS AND SIGNS

- Pale or acholic stools
- Prolonged jaundice (defined as visible jaundice at day 14 in term and day 21 or older in preterm babies)
- Bleeding, including intraventricular haemorrhage from vitamin K deficiency
- Green jaundice on any day of life
- Acute collapse with liver failure
- Failure to thrive

INVESTIGATIONS

Aim to diagnose causes of liver dysfunction that will benefit from early diagnosis while avoiding unnecessary transfer and investigation of small sick babies

First-line investigations

- Complete the following as soon as possible:
  - coagulation screen
  - transaminases, bilirubin (total and conjugated), albumin, gamma GT, and alkaline phosphatase
  - galactosaemia and tyrosinaemia screen
  - α_1-antitrypsin concentration **and** phenotype
  - serum cortisol, T_4 and TSH
  - stool in opaque pot for consultant review
  - urine for MC&S
  - abdominal ultrasound scan, after 4 hr fast if possible, to include liver and gallbladder examination
  - if clinical suspicion high, toxoplasma serology, CMV IgM or PCR or urine PCR for CMV, syphilis serology, viral culture from swabs of any vesicles for herpes simplex, hepatitis E serology

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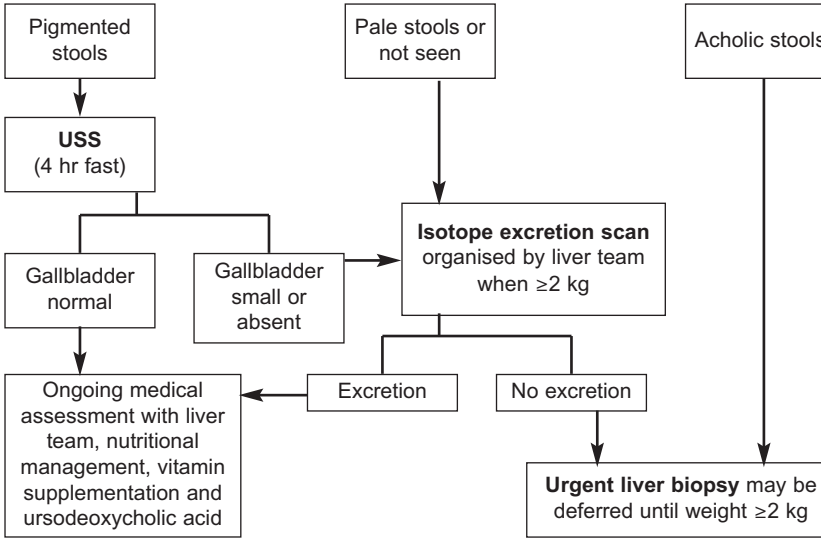
- if metabolic disorder suspected, plasma lactate, plasma and urine amino acids, and urine organic acids

As they become available, discuss results of liver function, coagulation, stool colour, weight gain and abdominal ultrasound with liver unit team

FURTHER INVESTIGATIONS

- Standard aggressive protocol used to investigate term babies is inappropriate in preterm babies because of:
- insufficient blood volume for blanket testing
- poor temperature control when attending for isotope scans
- limited size increases risk of liver biopsy
- Transfer to specialist centre often not possible owing to need for ongoing respiratory support and neonatal nursing care
- Preterm babies with diagnoses requiring surgery (e.g. Kasai procedure for biliary atresia) need to be more than term-corrected age or weigh at least 2 kg before surgery considered
- Early isotope scanning not widely available and of limited value, many babies can be investigated without this procedure
- Assessment of stool colour can determine which babies with cholestasis require urgent further investigation, as shown below:



Investigations for ongoing liver dysfunction

- Preterm babies with persistent liver dysfunction but initially normal gallbladder size or an excreting isotope scan can be further investigated locally, discuss with liver team
- If indicated by results of first-line investigations or progressive dysfunction, consider:
  - ophthalmic review (other than for retinopathy of prematurity)
  - micro-array for dysmorphism
  - very long-chain fatty acids for neurological abnormality
  - urinary bile salts
  - isotope scan, liver biopsy or bone marrow aspirate

MANAGEMENT OF CHOLESTASIS

- Surgical correction, if appropriate (e.g. Kasai, choledochal cyst), usually when ≥2 kg or term-corrected age, discuss individual cases with liver team
- Nutrition to overcome malabsorption of long-chain fat and fat-soluble vitamins
  - if breastfeeding, continue unless weight gain or linear growth inadequate
  - if breastfeeding not available or failing to thrive, provide high-calorie diet aiming for 120–150% of estimated average with increased percentage of fat as medium-chain triglycerides (such as Pepti-Junior) **or** supplement breast milk with medium-chain triglyceride fat additives, seek advice from liver unit team
  - if individually prescribed modular feed required: co-ordinated by liver unit dietitians while baby is in-patient on liver unit or attending their out-patient clinic
- Prescribe vitamins during cholestasis and for 3 months following resolution of jaundice; doses will require monitoring and adjustment if still required after discharge (co-ordinated by liver team):
  - vitamin K 1 mg oral daily: monitor PT and APTT
  - vitamin A 5,000 units daily: monitor serum vitamin A
  - vitamin E 50 mg daily: monitor serum vitamin E
  - alfacalcidol 20 nanogram/kg daily: given as 100 nanogram (1 drop) every 2–3 days dependent on weight (it is not possible to measure a smaller dose). Monitor bone biochemistry

Ursodeoxycholic acid

- BNFc dose 5–10 mg/kg three times daily but liver team will normally recommend 20–30 mg/kg/day in divided doses for most preterm babies until jaundice resolves, and to stimulate bile flow in babies and children with cystic fibrosis

Parenteral nutrition (PN)

- Wherever possible, feed enterally, as even small amounts have trophic effects on gut, reduce bacterial colonisation and promote bile flow
- Bolus feeds promote bile flow more readily than continuous feeds, but the latter may be better absorbed
- Discontinue PN as soon as possible in all preterm babies with cholestasis

Specific treatments

- Babies with cystic fibrosis, galactosaemia, tyrosinaemia type 1, hypopituitarism, hypothyroidism or bile acid disorders require additional targeted management and life-long follow-up shared by local teams and appropriate specialists

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FOLLOW-UP

- For babies with persistent cholestasis, arrange out-patient follow-up with liver team after discharge from neonatal unit
- If liver dysfunction has resolved, no follow-up with liver team necessary
- For all others with a specific diagnosis, follow-up will be directed by liver team, appropriate specialists and local consultant
- Long-term hepatic outcome for multifactorial preterm or neonatal hepatitis excellent, majority resolve within first year

LONG LINE INSERTION (PERIPHERALLY SITED) • 1/4

Central venous catheters allow administration of infusions that, if given peripherally, may cause damage to the vein and surrounding skin, or be less effective. These benefits must be weighed against the risks of line sepsis, thrombosis, embolism, and pleural and pericardial effusion. Units which use central line catheters should have a formal training package for insertion of catheters which should include assessment of technical competence and awareness of potential complications

INDICATIONS

- Total/partial parenteral nutrition
- Concentrated (>12.5%) glucose infusions
- Infusions of glucose >5% + calcium gluconate
- Inotrope infusions
- Prolonged drug or fluid administration where peripheral access difficult

CONTRAINDICATIONS

- Infection at proposed insertion site
- Systemic sepsis: defer until sepsis treatment commenced and blood cultures negative
- Tissue perfusion concerns

EQUIPMENT

- Sterile gown and sterile gloves
- Cleaning solution as per unit policy
- Sodium chloride 0.9% for injection
- Tape measure
- Overhead light
- Neonatal long line – appropriate for size of baby and expected rate of infusion
- Decide whether double or single lumen line required
- Long line insertion pack or, if not available, individual items to include:
  - dressing pack with swabs and plastic dish
  - sterile towels/sheets
  - non-toothed forceps
  - 5–10 mL syringe
  - Steristrips
  - sterile scissors
  - clear dressing (e.g. Tegaderm/Opsite)

PROCEDURE

Must be performed or directly supervised by an individual competent in the insertion of these devices

Consent and preparation

- Inform parents and obtain verbal consent as recommended by BAPM
- Discuss timing of procedure with nurses
- Keep baby warm. Work through portholes
- Identify site of insertion
  - typically long saphenous at ankle or medial/lateral antecubital vein at elbow
  - where access difficult, other large peripheral veins or scalp veins anterior to ear may be used
- Measure distance, aiming to insert tip of catheter into superior or inferior vena cava (to xiphisternum for lower limb insertion, to upper sternum for upper limb insertion)

Developmental care

- Unless contraindicated, give sucrose or breast milk and non-nutritive sucking
- Shield baby's eyes from bright light
- Second person to provide containment holding – see **Pain assessment and management** guideline

Aseptic insertion

- Maintain strict asepsis throughout
- Prime catheter and cut small piece of gauze for under hub

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- Clean site and allow to dry. Ensure that cleaning fluid does not pool beneath baby
- Puncture site with needle from pack and follow instructions for that catheter
- Avoid use of cannulae for long line insertion
- When blood flows back through the needle, insert line using non-toothed forceps
- If appropriately placed, the line will pass easily beyond the tip of the needle
- Release tourniquet if used
- There may be some resistance when the line passes joints, such as knee, and gentle repositioning of baby's limb may help
- Should catheter advancement become difficult, infuse a little fluid whilst simultaneously advancing catheter
- **Never** withdraw catheter back through needle
- When in place, withdraw needle as stated in catheter instructions
- Catheter should allow free aspiration of blood in the final position

Securing catheter in correct position

- When haemostasis achieved, fix with Steristrips. Place small piece of gauze under hub, and cover with Tegaderm/Opsite, making sure that all dressing and site is covered, but not encircling the limb tightly. Ensure line insertion site is visible through clear dressing
- Connect a sterile 5 mL syringe containing sodium chloride 0.9% and infuse at 0.5 mL/hr, while awaiting X-ray, to ensure that the line does not clot off
- X-ray to determine position
- Small gauge neonatal long lines can be difficult to see on plain X-ray
  - use X-ray magnification, contrast adjustment and inversion to aid process
  - use of contrast medium can help
  - if using contrast medium, refer to local policy
- If inserted in upper limb, ensure arm is at 90º angle to thorax during X-ray
- Determine satisfactory position
- Upper limb catheter tip should preferably be in superior vena cava (SVC). Lower limb catheter should be in inferior vena cava (IVC) above L4–5 and outside heart. Other large veins e.g. innominate, subclavian, common iliac are acceptable
- Catheter tips in axillary, cephalic and femoral veins are acceptable if the benefit outweighs increased risks of reinsertion
- Monitor site closely
- If catheter tip beyond desired location, using aseptic technique, remove dressing and, withdraw catheter the measured distance. Redress with new sterile dressing and confirm new position by X-ray

Catheter tip must not lie within heart (risk of perforation and tamponade)

Failure of insertion

- If second operator is required following an unsuccessful attempt at placement, use fresh equipment

DOCUMENTATION

- Record in case notes:
  - date and time of insertion
  - success of insertion and number of attempts
  - type and gauge of catheter
  - site and length of insertion
  - X-ray position and alterations
- Insert tracking stickers from all packs

AFTERCARE

Dressings and site care

- Routine dressing changes are unnecessary
- Replace aseptically only if dressings lift or catheter visibly kinked or becomes insecure
- Observe site every shift for bleeding, leaking of infusate and signs of infection (redness, swelling)

Line management and medication

- Minimise number of line breaks
- Intermittent medications only given via this route in extreme circumstances. (This is a senior medical decision). Plan timing to match infusion changes
- When breaking into line, observe hand hygiene, wear sterile gloves and clean connection as per local infection control policy
- Change tubing used to give blood products immediately after transfusion (use to give blood product only if it is difficult to insert alternative IV line)

Position maintenance

- Repeat X-ray weekly to detect line migration
- Never routinely resite a line
- Review continued need on daily ward rounds and remove as soon as possible

COMPLICATIONS

Clinical deterioration of a baby in whom a central venous catheter is present should raise the question of catheter related complications; particularly infection, extravasation and tamponade

Prevention

- Do not give blood products and medications routinely through long line
- Avoid the use of small syringes <2 mL for bolus injections as they generate high pressures which may result in catheter damage
- Avoid the use of alcohol or acetone to clean the catheter as this may result in catheter damage
- Limit line breaks as above
- Do not exceed the pressure limits given by the manufacturer because of the risk of damage to the line

Catheter-related sepsis

- Commonest complication
- See **Infection (late onset)** guideline

Extravasation of fluids

- Into pleural, peritoneal, pericardial (above) and subcutaneous compartments
- Seek immediate advice from senior colleagues and follow **Extravasation injuries** guideline

Suspected/proven pericardial tamponade

- Suspect if any of the following symptoms:
  - acute or refractory hypotension
  - acute respiratory deterioration
  - arrhythmias
  - tachycardia
  - unexplained metabolic acidosis
- Confirm by X-ray (widened mediastinum, enlarged cardiac shadow) or by presence of pericardial fluid on echocardiogram
- Drain pericardial fluid (see **Pericardiocentesis** guideline) and remove catheter

Embolisation of catheter fragments

- Lines can snap if anchored within a thrombus
- If undue resistance encountered during removal, do not force
- Inform consultant: if accessible it may need surgical removal

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REMOVAL

Indications

- Clinical use is no longer justified
- Remove 24 hr after stopping parenteral nutrition total (TPN) to ensure tolerance to full enteral feeds, running glucose 10% through line at 0.5 mL/hr to maintain patency
- Complications – see **Complications**

Technique

- Using aseptic technique:
  - remove adhesive dressing very carefully
  - pull line out slowly, using gentle traction in the direction of the vein, grasping line not hub
  - ensure catheter complete
  - if clinical suspicion of line infection, send tip for culture and sensitivity
  - apply pressure to achieve haemostasis
  - document removal in notes

MEDIUM-CHAIN ACYL-COA DEHYDROGENASE DEFICIENCY (MCADD) • 1/1

Early management of babies with family history

DEFINITION

- A rare autosomal recessive inherited metabolic disease where the body cannot metabolise fat properly
- With regular intake of food, individuals can lead a normal healthy life but prolonged fasting or illness with vomiting can lead to encephalopathy, coma or sudden death
- Affects 1:10,000 babies in UK. 1:80 healthy people are carriers
- Bloodspot screening at day 5 includes MCADD (see **Bloodspot screening** guideline)
- Newborn babies with MCADD are especially vulnerable in first few days of life before breast milk supply and regular feeding pattern established
- Babies with a family history of MCADD require a special feeding regimen and observation from birth

SYMPTOMS

- Often non-specific
  - hypothermia
  - jitteriness
  - irritability
  - drowsiness
  - reluctance to feed
  - lethargy
  - rapid breathing
  - seizures
  - coma
  - sudden death
- Hypoglycaemia occurs late

DIAGNOSIS

- When mother admitted in labour, inform neonatal team
- Test baby between 24-48 hr old
  - bloodspot acylcarnitines
  - urine organic acids
  - DNA mutation analysis (in most cases, genotype will be known for the index case)
- Discuss testing with metabolic laboratory at Birmingham Children's Hospital and mark request 'family history of MCADD'
- Continue special feeding regimen until results available

MANAGEMENT

- High index of suspicion antenatally
- Refer those with family history of MCADD for genetic counselling antenatally
- Advise parents baby will require specialist feeding regimen from birth and rapid testing at 24–48 hr old
- Institute specialist feeding regimen from birth
- Ensure regular milk intake
  - term baby 4-hrly feeds
  - preterm baby 3-hrly feeds
- Breast fed babies are at a particular risk in first 72 hr. Give formula top-ups until good maternal milk supply established
  - if baby not taking adequate oral feeds, start nasogastric tube feeding
- If enteral feeds not tolerated, commence IV fluid – glucose 10%, sodium chloride 0.18%
- Complete bloodspot screening as normal on day 5

LOCAL CONTACT

- For specialist advice, consult Birmingham Children's Hospital metabolic on-call consultant (0121 333 9999)

FURTHER INFORMATION

http://www.bimdg.org.uk/guidelines.asp

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RECOGNITION AND ASSESSMENT

Definition

- Decreased mineralisation of bones due to deficient phosphate (PO_4), calcium (Ca) or vitamin D in preterm babies
- Also known as osteopenia of prematurity

Causes

- Inadequate postnatal intake or absorption to support intrauterine mineral accretion rate

Risk factors

- <32 weeks' gestation
- <1500 g birth-weight
- Male gender
- Inadequate nutrition
  - suboptimal intake
  - enteral feeds with low mineral content/bioavailability [unfortified expressed breast milk (EBM), term formula]
- Phosphorus deficiency (primary nutritional reason)
- Vitamin D deficiency
- Prolonged total parenteral nutrition
- Chronic use of drugs that increase mineral excretion (diuretics, dexamethasone, sodium bicarbonate)
- Lack of mechanical stimulation e.g. sedation/paralysis
- Bronchopulmonary dysplasia
- Cholestatic jaundice
- Short gut syndrome (malabsorption of vitamin D and Ca)

Symptoms and signs

- Up to 6 weeks, most babies are asymptomatic and normal on examination
- Usually presents between 6–12 weeks of age
- Poor weight gain or faltering growth
- Respiratory difficulties
  - failure to wean off ventilator due to excessive chest wall compliance
- Fractures with minor or no trauma; may manifest as pain on handling
- Jitteriness in hypocalcaemia
- Craniotabes (softening of skull bones)
- Low bone density on X-rays (rachitic changes, cortical thinning, periosteal elevation)

Later clinical consequences

- Marked dolicocephaly (long and narrow skull)
- Myopia of prematurity
- Reduced linear growth

INVESTIGATIONS

- Measure serum Ca, PO_4 and alkaline phosphatase (ALP) levels weekly from third week of life in high risk babies
  - low serum PO_4 (<1.8 mmol/L) with elevated ALP (>900 IU/L) is 100% sensitive and 70% specific for diagnosing low bone mineral density. Low serum PO_4 concentrations (<1.8 mmol/L) have 96% specificity but only 50% sensitivity
  - serum Ca levels may remain normal until late in the disease
- Measure urinary Ca and PO_4. Urinary excretion of Ca >1.2 mmol/L and PO_4 >0.4 mmol/L signifies slight surplus of supply and correlates with highest bone mineral accretion rate
  - phospaturia can occur due to aminoglycoside, indomethacin and dexamethasone therapy
  - calciuria can occur due to diuretics, dexamethasone and theophylline

- Babies on unfortified human milk are relatively phosphate deficient and have:
- normal serum Ca, low serum PO_4 and high serum ALP
- urinary PO_4 excretion is very low or absent and urinary Ca excretion increases as serum PO_4 concentration decreases
- normal serum vitamin D and parathormone levels
- Formula-fed preterm babies have a low calcium absorption rate and therefore a very low urinary Ca and PO_4 concentrations
- X-rays can demonstrate demineralised, thin bones, signs of rickets and thoracic cage and extremity fractures
- Dual-energy X-ray absorptiometry (DXA)

PREVENTION

- Aggressive nutritional care of preterm babies
- initiate early parenteral nutrition with optimised Ca and PO_4 content [at least 12 mmol/L each of Ca and PO_4 (= 1.8 mmol/kg/day of Ca and PO_4 at 150 mL/kg/day)]
- early enteral feeds
- use of breast milk fortifier or preterm formula
- Early phosphate supplementation in high risk babies
- Gentle passive physiotherapy

TREATMENT

- Ensure an adequate intake of Ca (2.5–4 mmol/kg/day) and PO_4 (1.9–2.9 mmol/kg/d) by using fortified breast milk or preterm formula
- Ensure a daily intake of at least 800 IU vitamin D per day
- If PO_4 deficient (<1.8 mmol/L) – supplement PO_4 at 1–2 mmol/kg/day in divided doses
- If Ca deficient (<1.6 mmol/L) – supplement Ca at 1–3 mmol/kg/day in divided doses
- do not give Ca and PO_4 at the same time because they may precipitate; so give at alternate feeds
- Ca supplementation can cause intestinal obstruction and hypercalcinosis
- Consider other nutritional deficiencies e.g. zinc, in a baby with faltering growth with evidence of significant bone disease

MONITORING AND FOLLOW-UP

- Weekly monitoring of serum Ca, PO_4 and ALP along with urinary Ca and PO_4
- Continue treatment until biochemical indices are normal and radiographic evidence of healing, usually until term corrected gestation

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MULTI DRUG RESISTANT ORGANISM COLONISATION (MRSA, ESBL ETC) • 1/2

Use this guideline in conjunction with your local Trust policy

This guideline describes the screening and follow-up action for the following organisms

- Meticillin-resistant *Staphylococcus aureus* (MRSA)
- Multi-resistant Gram-negative bacilli (MGNB) including:
  - Extended spectrum beta lactamase (ESBL)
  - Carbapenemase-producing enterobacteriaceae (CPE)
  - other carbapenemase-producing GNB

SCREENING

Babies transferred from other hospitals

- Screen on arrival. Include babies who attend other hospitals for invasive day case procedures (e.g. PDA ligation)
- MRSA:
  - swab nose and perineum plus umbilicus if still moist, and any skin lesion (e.g. indwelling vascular line)
  - urine if long-term urinary catheter present
- MGNB:
  - rectal swab
  - if unable to obtain rectal swab send stool sample instead with reason stated
- Barrier nurse until swabs confirmed negative at 48 hr

MANAGEMENT OF INCIDENTAL FINDINGS

MRSA

Mother

- Screen mother with nasal, perineal, wound and skin lesion swabs, if:
  - delivery by caesarean section
  - mother had recent admission to hospital before delivery
  - mother has chronic health problem (e.g. diabetes, asthma)
  - mother has other risk factor: high BMI or is a healthcare worker with patient contact
  - mother or household member has a history of skin/soft tissue infection abscess or recurrent skin infections in the last 12 months
- If none of these risk factors present, screening contacts is not necessary unless advised by consultant microbiologist

Contacts on NICU

- Screen babies who have been in NICU >2 weeks
- Those who have been in close proximity of the index case (i.e. in the same room)
- Others (potentially all) following a risk assessment and discussion with consultant of the week, co-ordinator and consultant microbiologist
- Healthy babies about to be discharged home do not require screening unless advised by consultant microbiologist

Decolonisation of carriers

- Discharge term healthy babies without treatment
- Smaller babies with indwelling lines or CPAP probes are more at risk and should be treated
  - mupirocin (Bactroban Nasal®) ointment applied to inner surface of each nostril 3 times daily for 5 days; if MRSA reported as high level resistant to mupirocin, then discuss with consultant microbiologist
  - wash daily with antimicrobial wash, e.g. chlorhexidine or octenidine, for 5 days
- Repeat screening swabs 48 hr after all antibiotic treatment has finished and if baby not about to be discharged
- Successful eradication can be assumed if 3 consecutive swabs taken at 3–7 day intervals are negative. Do not attempt to decolonise more than twice during any one admission

MULTI DRUG RESISTANT ORGANISM COLONISATION (MRSA, ESBL ETC) • 2/2

MGNB

- Do not attempt decolonisation. Colonisation is in the gut. Drugs are ineffective, may severely damage the gut flora and encourage development of resistant organisms
- Some babies may naturally eradicate the colonisation over several months or years
- Babies colonisation with CPE and other carbapenemase producing GNB should be deemed colonised for at least 5 years after the last positive swab irrespective of the screening results

MANAGEMENT OF OUTBREAK

MRSA

- Two or more babies with same strain of MRSA constitutes an outbreak
- MRSA from different babies are considered 'the same' if they have been sent by microbiology to a reference lab for typing and have been reported by reference lab as 'indistinguishable'

Action

- Screen all babies in neonatal unit (swabs as above)
- Optimise infection control measures: see **local infection control policy**
- If further cases of the same strain occur:
  - arrange incident meeting to discuss further measures, e.g. swabs from all staff on unit
  - screening is co-ordinated by infection control team (ICT) in collaboration with occupational health (OH) department at an outbreak meeting
  - results are sent to OH and ICT but not to the unit

MGNB

- Two or more babies with same strain of MGNB constitutes an outbreak
- For CPE two or more babies with the same carbapenemase gene (OXA-48, KPC, VIM, NDM-1 etc.) irrespective of organism if associated in time and space constitutes an outbreak
- Other MGNB isolates from different babies are considered 'the same' if they have been sent by microbiology to a reference lab for typing and have been reported by reference lab as 'indistinguishable'

Action

- As MRSA

NASOGASTRIC TUBE ADMINISTRATION OF FEED, FLUID OR MEDICATION • 1/2

Procedure is the same for nasogastric and orogastric tubes. As nasogastric tubes (NGT) are more commonly used in babies, the term nasogastric will be used throughout this guideline

INDICATIONS

- Contraindications to oral feeding, or baby unable to take full requirements orally
- Nasogastric or orogastric tube in place

EQUIPMENT

- Enteral syringes (see NPSA alert 19 http://www.nrls.npsa.nhs.uk/resources/?entryid45=59808)
- pH testing strips
- Gravity/bolus feeding set
- Feed/fluids/medication according to prescription
- Prescription chart (for medication)

PROCEDURE

Preparation

- See **Nasogastric tube insertion** guideline
- Discuss procedure with parents/carer
- Wash hands and prepare equipment
- Bring milk to room temperature by removing from fridge. Never deliver fridge-cold milk directly via nasogastric or orogastric tube. See **Nutrition and enteral feeding** guideline

Position of baby for feeding

- Baby need not be lying down. It is acceptable to feed if baby receiving Kangaroo care or positioned in baby chair
- If lying flat in a cot:
  - elevate mattress to 30º before feeding and return to flat position within 1 hr

Checking pH

- Check pH before **every** feed/use of tube according to NPSA guidelines – see **Nasogastric tube insertion** guideline
  - if pH 0–5.5, commence feed and document pH
  - if pH ≥6, **do not** commence feed. Repeat aspiration and retest
- If repeated test ≥6, seek advice from senior clinician and undertake risk assessment following NPSA algorithm – see **Nasogastric tube insertion** guideline. Document decision made and rationale
- If no aspirate obtained, **do not** feed. Follow procedure outlined in NPSA guideline

Feeding

- Avoid rigid feeding patterns (e.g. 1 bottle/2 tube, alternate bottle/tube etc.)
- When handling tubes, ensure clean technique. Pay careful attention to feed preparation and administration
- Administer feed by gravity
- Remove plunger, connect to tube, pour small volume of feed into barrel, raise level of barrel above baby's stomach. Control speed of administration by raising or lowering barrel
- Do not plunge feed
- Ensure tube feed takes approximately the same time as a suckling feed e.g.:
  - 20 min for full feed volume requirement
  - 10 min for 50% volume
  - 5 min for 25% volume

Monitoring

- Observe baby throughout feed for signs of deterioration or distress (change in colour, cyanosis, apnoea, bradycardia, vomiting, straining, squirming, grimacing and other avoidance behaviour)
- Observe for abdominal distension following a feed
- If appropriate developmental stage/capabilities, offer small drops of milk to mouth to taste, but **avoid in babies with no swallow mechanism**
- Consider offering baby mother's breast for nuzzling or non-nutritive sucking during tube feed – see **Non-nutritive sucking** guideline
- On completion of feed, instil small amount of air into tube (0.5–1 mL)

DOCUMENTATION

- Document feed details:
  - pH
  - type
  - volume
  - time
  - behaviour/response during feed
  - adverse reactions (vomiting etc.)
- Ensure medication chart is signed

FURTHER MANAGEMENT

- For administration of medication, remember to check baby identity and prescription. Follow Trust policy for administration of medicines and British Association of Parenteral and Enteral Nutrition (BAPEN) guidance
- Flushing of nasogastric tubes is not routine in babies. To avoid medication remaining in NG tube try to give medications pre-feed. Where this is not possible 1 mL of feed can be used to flush tube after inserting medication

FURTHER INFORMATION

- **Nasogastric tube insertion** guideline
- Further details available from www.nrls.npsa.nhs.uk/resources/?entryid45=59794

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NASOGASTRIC TUBE INSERTION • 1/4

The procedure is the same for both nasogastric and orogastric tubes. As nasogastric tubes (NGT) are more commonly used in babies, the term nasogastric will be used throughout this guideline

INDICATIONS

- To keep stomach deflated or to instil enteral feeds when full oral feeding not possible
- Administration of medications when unable to use oral route
- Orogastric tubes are used predominantly in babies in respiratory distress or with structural abnormality of nasal cavity where full bottle feeds are contraindicated
- NGT are used short-term for all other babies until full oral feeding achievable
- An NGT is preferred over an orogastric tube with a few exceptions, such as a structural abnormality (e.g. choanal atresia, cleft lip and palate) and some respiratory distress. It may still be possible to use an NGT if baby is receiving nasal mask CPAP or nasal prong oxygen

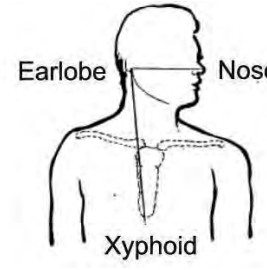
EQUIPMENT

- Smallest sized NPSA compliant NGT that will pass: 4 FG, 5 FG or 6 FG to reduce risk of nasal abrasions and ensure baby comfort
- Exceptions – surgical patient in specific clinical circumstances
- Enteral syringe (see NPSA alert 19)
- pH testing strips
- Extra-thin hydrocolloid dressing (e.g. Duoderm, Convatec)
- Soft adhesive tape (e.g. Hypafix, Tegaderm, Mefix)
- Non-sterile disposable gloves

PROCEDURE

Preparation

- Discuss procedure with parents/carer
- To prevent risk of aspiration, pass NGT before a feed
- Wash hands and prepare equipment
- Administer sucrose – see **Pain assessment and management** guideline
- To reduce risk of epidermal stripping, apply Duoderm to skin of face as an attachment for adhesive tape
- Determine length of tube to be inserted by measuring nose>ear>xiphisternum measurement. Note the cm mark on the tube or keep your fingers on the point measured
- For orogastric tube, measure as NGT but start from the centre of the bottom lip rather than the nose



Insertion

- With clean hands, put on gloves and pass tube into nose or mouth slowly and steadily until required pre-measured depth reached
- Use of a dummy (with parents permission) may help tube passage
- Observe baby throughout procedure for colour change, vomiting, respiratory distress or resistance
- if any of these features, or distress occurs, stop and remove tube and try a different angle or nostril. If resistance felt, abandon procedure – **Do NOT force the tube**

Checking position of nasogastric feeding tube

- Neonatal units and carers in the community should use pH indicator strips or paper
- Do **NOT** use radiography 'routinely' but, if baby being X-rayed for another reason, use X-ray to confirm position is satisfactory by noting position of tube on film
- Do **NOT** use 'Whoosh test' (auscultation of injected air entering the stomach) to determine position of NGT as it is unreliable

Checking position using pH

- Aspirate stomach contents with enteral syringe and test for acid response using pH testing strips
- pH ≤5.5 indicates correct gastric placement
- if pH ≥6, **do not** commence feed. Repeat aspiration and retest
- if repeated test ≥6, seek advice from senior clinician and undertake risk assessment
- Following factors can contribute to high gastric pH ≥6
- presence of amniotic fluid in baby <48 hr
- milk in baby's stomach, particularly if 1–2 hrly feeds
- use of medication to reduce stomach acid
- tube positioned in jejunum or duodenum
- tube positioned in lungs
- Multidisciplinary care team should then discuss possible actions, balancing the risk of feeding (with a possibility of the tube being in the lungs) and not feeding the baby in the short-term, and record how they reached their decision
- Ensure you work through the **NPSA flowchart** below and record findings before making any decisions

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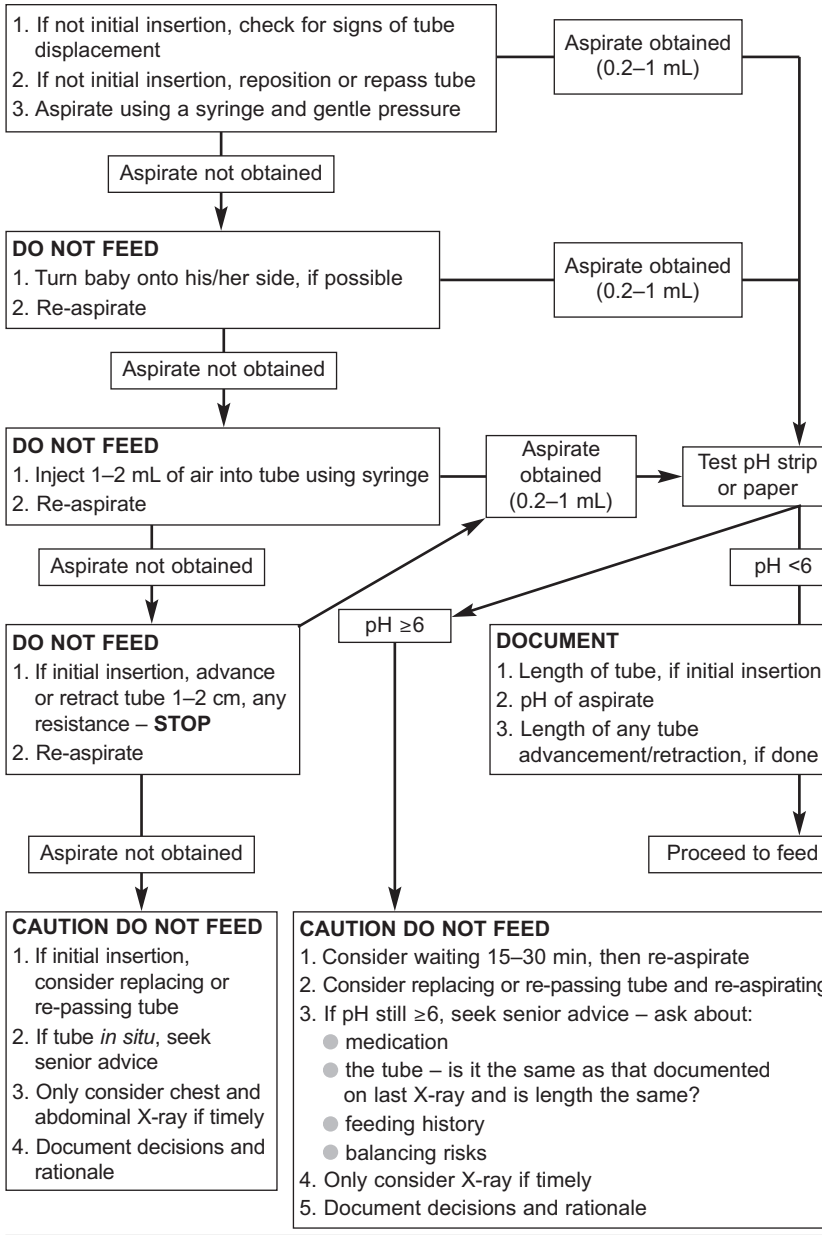
NPSA flowchart: A basis for decision-making when checking position of naso- and orogastric feeding tube in babies on neonatal units



Securing tube

- Once correct tube position ascertained, secure to face with soft adhesive tape (e.g. Hypafix or Mefix) over Duoderm

DOCUMENTATION

- Record procedure in nursing documentation, noting type and size of tube, length passed, position, pH, date passed and due for changing

FURTHER MANAGEMENT

Monitoring

- Check integrity of skin around nostril at frequent intervals for signs of deterioration
- if signs of pressure appear, reposition tube and/or tape, or re-pass NGT via opposite nostril, or use orogastric route if necessary
- Check NGT position by measuring pH of aspirate. Follow **NPSA flowchart** on previous page:
- after initial insertion and subsequent reinsertions
- before administering each feed
- before giving medication
- after vomiting, retching or coughing (absence of coughing does not rule out misplacement or migration)
- if evidence of tube displacement (e.g. if tape loose or visible tube appears longer or kinked)
- when chest X-ray taken for another reason
- If receiving continuous feeds, use appropriate giving set and check pH when changing set
- when continuous feeding has stopped, wait 15–30 min to allow stomach to empty of milk and for aspirate pH to fall

Changing NGT

- Follow manufacturer's recommendations
- Ensure safe and gentle removal of tape using water, applied with cotton bud to soften adhesive tape. **Never be tempted to rip tape directly from the skin**
- Pass new NGT via opposite nostril wherever possible
- Document removal/replacement in baby's medical record

Reporting misplaced tube incidents

- Report all misplaced feeding tube incidents using local risk management procedure

FURTHER INFORMATION

- Further details on determining correct position of oro-/nasogastric tubes in babies are available from www.nrls.npsa.nhs.uk/resources/?entryid45=59794

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RECOGNITION AND ASSESSMENT

Definition

Acute inflammatory disease in newborn intestine characterised by haemorrhagic necrosis, which may lead to perforation and destruction of the gut. Clinical presentation usually comprises triad of abdominal distension, gastrointestinal bleeding and pneumatosis intestinalis (air in bowel wall on abdominal X-ray)

Modified Bell's criteria

Stage 1: Suspected NEC: clinical signs suggestive but X-ray non-diagnostic

- Systemic signs:
  - temperature instability
  - apnoea
  - bradycardia
  - lethargy
- Intestinal signs:
  - increased gastric residuals
  - abdominal distension
  - vomiting
  - blood in stools
- Radiological signs:
  - normal or mild intestinal dilatation
  - thickened bowel loops

Stage 2: Definite NEC: mild-to-moderately ill – abdominal X-ray demonstrates pneumatosis intestinalis

- Systemic signs: see **Stage 1** +/- mild metabolic acidosis, mild thrombocytopenia, raised CRP
- Intestinal signs: see **Stage 1** + absent bowel sounds, +/- localised abdominal tenderness, abdominal cellulitis or right lower quadrant mass, bright red blood and/or mucus from rectum (exclude local pathology)
- Radiological signs: significant intestinal dilatation, pneumatosis intestinalis, portal vein gas, +/- ascites, persistently abnormal gas pattern (e.g. localised dilated loop of bowel seen on serial X-rays or gasless abdomen)

Stage 3: Advanced NEC: severely ill, bowel intact or perforated

- Systemic signs: see **Stage 2** + hypotension, bradycardia, severe apnoea, combined respiratory and metabolic acidosis, DIC, neutropenia
- Intestinal signs: see **Stage 2** + signs of generalised peritonitis, marked tenderness, distension of abdomen
- Radiological signs: see **Stage 2** + pneumoperitoneum +/- ascites

Risk factors

- Prematurity
- Intrauterine growth restriction
- Absent or reversed end-diastolic flow on umbilical arterial Doppler antenatally
- Perinatal asphyxia
- Low systemic blood flow during neonatal period (including duct-dependent congenital heart disease)
- Significant patent ductus arteriosus
- Exchange transfusion
- Formula milk
- No antenatal corticosteroids
- Infections with: klebsiella, enterobacter, anaerobes

Differential diagnosis

- Sepsis with ileus
- Bowel obstruction
- Volvulus
- Malrotation

- Spontaneous intestinal perforation:
  - associated with early postnatal corticosteroids or indomethacin
  - abdominal X-ray demonstrates pneumoperitoneum but does not show evidence of pneumatosis intestinalis
- Systemic candidiasis:
  - clinical signs can mimic NEC with abdominal distension, metabolic disturbances, hypotension and thrombocytopenia

INVESTIGATIONS

Abdominal X-ray

- Supine antero-posterior view
- If perforation suspected but not clear on supine view, left lateral view

Not all babies will have radiological findings associated with NEC (Stage 1)

Blood tests

- FBC: anaemia, neutropenia and thrombocytopenia often present; early return to normal carries good prognosis
- Blood film: evidence of haemolysis and toxic changes (e.g. spherocytes, vacuolation and toxic granulation of neutrophils, cell fragments, polychromatic cells)
- CRP, but a normal value will not be helpful in initial phase
- Urea and electrolytes
- Blood gas: evidence of metabolic acidosis (base deficit worse than -10), raised lactate
- Coagulation screen
- Blood cultures

IMMEDIATE TREATMENT

Always discuss management with senior neonatologist

In all stages

- Nil-by-mouth
- Transfer baby to neonatal intensive care and nurse in incubator to avoid cross infection
- If respiratory failure and worsening acidosis, intubate and ventilate
- Gastric decompression
- Free drainage with large nasogastric tube (size 8)
- NEC often associated with significant third spacing of fluid into peritoneum
- Triple antibiotics: penicillin/amoxicillin and gentamicin and metronidazole
- IV fluids/PN: total volume ≤150 mL/kg
- Long line when stable and bacteraemia/septicaemia excluded
- Pain relief, consider morphine/diamorphine infusion (see **Pain assessment and management** guideline)

Stage 2: Proven NEC (confirmed radiologically)

- If breathing supported by nasal CPAP, elective intubation to provide bowel decompression (see **Intubation** guideline)
- Give IV fluid resuscitation 10 mL/kg sodium chloride 0.9% for shock and repeat as necessary. Shock is most common cause of hypotension in babies with NEC (see **Hypotension** guideline)
- If coagulation abnormal, give FFP (see **Coagulopathy** guideline)
- If thrombocytopenia and/or anaemia occur, transfuse (see **Thrombocytopenia** guideline)
- Discuss with surgical team: may need transfer to surgical centre

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Stage 3 : Advanced NEC (fulminant NEC with or without intestinal perforation)

- Treat as for **Stage 2** and refer to surgical team: may need laparotomy or resection of bowel in surgical centre
- If baby unstable for transfer to surgical centre, discuss abdominal paracentesis with surgical team

SUBSEQUENT MANAGEMENT

In recovery phase

- In **Stage 1**: if improvement after 48 hr, consider restarting feeds slowly (see **Nutrition and enteral feeding** guideline) and stopping antibiotics
- In **Stage 2**: if abdominal examination normal after 7–10 days, consider restarting feeds
  - some may need longer period of total gut rest
  - stop antibiotics after 7–10 days
- In **Stage 3**: discuss with surgeon and dietitian before restarting feeds

Late complications

- Recurrence (in about 10%)
- Strictures (in about 10% non-surgical cases)
- Short bowel syndrome and problems related to gut resection
- Neuro-developmental problems

MONITORING TREATMENT

- Observe general condition closely and review at least 12-hrly
- Daily:
  - acid-base
  - fluid balance (twice daily if condition unstable)
  - electrolytes (twice daily if condition unstable)
  - FBC and coagulation (twice daily if condition unstable)
  - repeat X-ray daily or twice daily until condition stable. Discuss with consultant/surgeons

LONG-TERM MANAGEMENT

- Advise parents about signs of bowel obstruction
- Medical +/- surgical follow-up after discharge
- Contrast studies if clinically indicated for strictures
- Appropriate developmental follow-up

Parent information

Offer parents information on NEC, available from http://www.bliss.org.uk/factsheets

INDICATIONS

- Persistent pulmonary hypertension of the newborn in term babies, proven on clinical grounds or by echocardiography – see **Persistent pulmonary hypertension of the newborn (PPHN)** guideline
- Oxygen index >20
- Initiate treatment with nitric oxide (NO) only after discussion with on-call consultant
- Babies requiring NO should be referred to a NICU for ongoing management, in accordance with Toolkit principles

CAUTIONS

- Preterm baby (not routinely recommended following Cochrane review 2007)
- Grade 4 intraventricular haemorrhage (IVH)
- Recent pulmonary haemorrhage
- Platelets <50 x 10^9/L

Contraindications

- Congenital heart disease

DOSE AND ADMINISTRATION

Starting nitric oxide

Preparation

- Ensure ventilation optimal and that other aspects of the **PPHN** guideline have been followed
- A sustained inflation immediately before starting NO can enhance response

Administration

- Document FiO_2 and SpO_2 immediately before starting NO
- Start NO at 10 ppm
- If no response (see below), increase to maximum of 20 ppm
- If still no response at 20 ppm, discontinue
- NO can be stopped abruptly without weaning if given for <4 hr
- Once responding, wean to 5 ppm as soon as possible, and within 2–24 hr of starting treatment

Definition of response to NO

- **Either** increase in postductal SpO_2 >20% **or** increase in postductal PaO_2 >3 kPa occurring within 15 min of starting NO and while ventilator settings constant

Weaning

- If NO has been administered for ≥4 hr, wean gradually to prevent rebound
- in 'responders', once FiO_2 <0.5, attempt to reduce dose
- reduce NO to 5 ppm in decrements of 5 ppm every 1–2 hr. Then reduce by 1 ppm every 1–2 hr and finally to 0.5 ppm for at least 1 hr before stopping. Reverse any reduction that causes SpO_2 to drop persistently by >5%
- some babies will require low dose (<0.5 ppm) for some time (up to 24 hr) during weaning
- If sustained and significant fall in SpO_2 occurs following reduction in dosage, increase dosage to previous level and continue to wean at half previous rate
- Once discontinued, wait at least 6 hr before removing NO circuit from ventilator

MONITORING

- Use SpO_2 to monitor response
- Blood gases 4-hrly
- Monitor methaemoglobin before starting NO, 1 hr after starting and then 12-hrly. Maximum proportion of total haemoglobin is reached after 8 hr
- normal <1%
- 2–3% is acceptable
- 4% requires action: reduce NO and repeat in 1 hr
  - if still >4%, stop NO
  - if >6%, treat with methylthioninium chloride (methylene blue) 1 mg/kg IV over 1 hr
- NO inhibits platelet function and can trigger bleeding if baby has bleeding problem or thrombocytopenia. Check FBC daily while baby receiving NO

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NON-NUTRITIVE SUCKING (NNS) • 1/1

INDICATIONS

- Actively promoted for:
  - comfort
  - pain relief
  - maximising nasal CPAP delivery. Can be used for short period to assist in acquisition of an effective seal
  - developing the sucking reflex and assisting transition from tube to full breast or bottle feeding
  - normal peristalsis helping to alleviate gastro-oesophageal reflux
- Encourage preterm babies not mature enough to suck at feed times to suck on a non-nutritive device during a tube feed
- Form of non-pharmacological pain relief during painful procedures

CAUTIONS

- As baby begins to take more enteral feeds (at around 33 weeks), NNS is no longer appropriate as it may mask feeding cues

CONSENT

- Before commencing, ensure parents receive written information on suitable use of NNS on neonatal unit
- A signed informed consent form must be held in baby's medical record

AIMS

- To achieve growth and nutrient accretion similar to intrauterine rates
- To achieve best possible neuro-developmental outcome
- To prevent specific nutritional deficiencies

PRINCIPLES

- Early enteral feeds promote normal gastrointestinal structure and function, motility and enzymatic activity
- Delayed nutrition can result in growth restriction with long-term complications of short stature, poor organ growth and poorer neurological function
- Delayed introduction of minimal enteral expressed breast milk/colostrum in 'sick' infants, of any gestation, is seldom beneficial but may be appropriate in some. Decision to start enteral feeding should be made on daily ward round
- Manage feeding on an individual basis dependent upon gastrointestinal tolerance and availability of breast milk
- There is robust evidence that feeding maternal breast milk is protective for necrotising enterocolitis (NEC) when compared to formula milk
- The evidence base for how fast to increase feeds is limited and meta-analyses are inconclusive regarding implications for practice
- Enteral feeding may be a risk factor for NEC, especially in premature babies, those with IUGR and absent or reversed end-diastolic flow on umbilical artery Doppler

Target population

- Preterm babies, especially birth weight <1500 g
- Small-for-gestational age = birth weight <10th centile

NUTRITIONAL REQUIREMENTS

Daily recommended intake of nutrients for stable/growing preterm babies

Nutrient	Term baby	Preterm baby <1000 g (Tsang/ESPGHAN)	Preterm baby 1000–1800 g (Tsang/ESPGHAN)
Energy (kcal/kg)	95–115	130–150	110–135
Protein (g/kg)	2	3.8–4.5	3.4–4.2
Sodium (mmol/kg)	1.5	3–5	3–5
Potassium (mmol/kg)	3.4	2–3	2–3.5
Calcium (mmol/kg)	3.8	2.5–5.5	2.5–5.5
Phosphate (mmol/kg)	2.1	2–4.5	1.9–4.5
Vitamin A (ug RE/kg)	59	400–1000	400–1000
Vitamin D (ug/d)	8.5	10–25	10–25

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Nutrient composition of breast milk per 100 mL

	Preterm breast milk	Mature breast milk (>2 wk)	Donor EBM	Fortified breast milk (Nutriprem BMF)
Energy (kcal)	70	69	66	85
Protein (g)	1.8	1.3	0.9	2.6
Sodium (mmol)	1.3	0.7	Not specified	2.2
Calcium (mmol)	0.55	0.55	Not specified	2.2
Phosphorus (mmol)	0.5	0.5	Not specified	1.9
Vitamin A (ug)	83	57	Not specified	188
Vitamin D (ug)	0.18	0.05	Not specified	7.65

Nutrient composition of preterm formulas per 100 mL

	Nutriprem 1	SMA Gold Prem 1	SMA Gold Prem Pro
Energy (kcal)	80	82	80
Protein (g)	2.6	2.2	2.9
Sodium (mmol)	3.0	1.9	2.2
Calcium (mmol)	2.4	2.5	2.9
Phosphorus (mmol)	2.0	2.0	2.5
Vitamin A (ug)	180	189	370
Vitamin D (ug)	3	3.4	3.7

(Based on 2014 datacards)

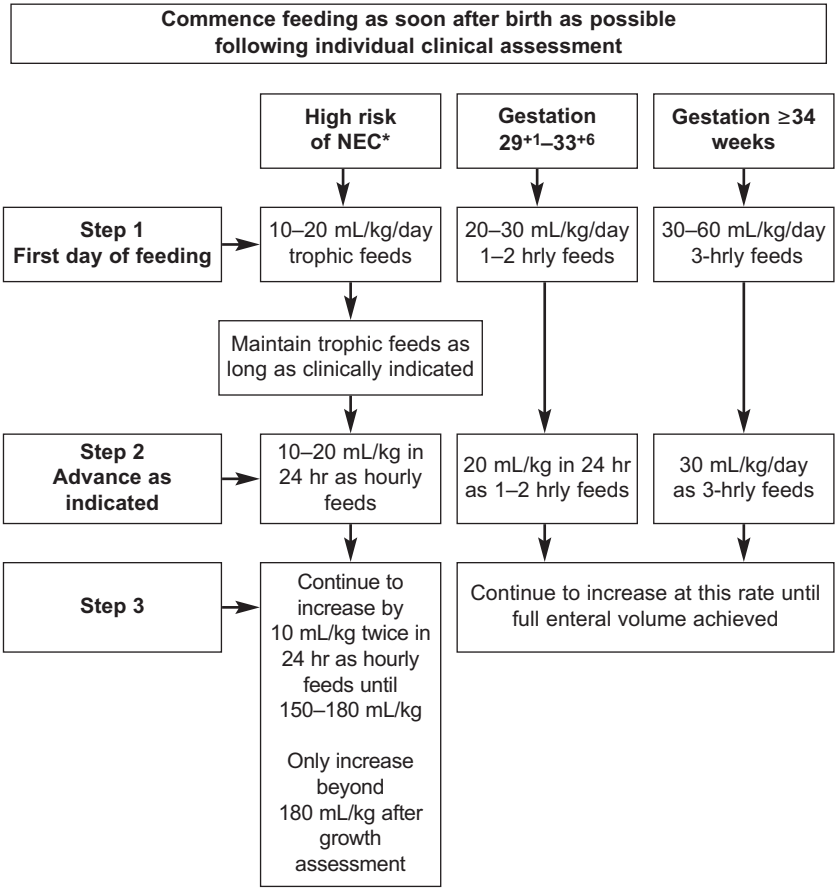
FEEDING GUIDE

Route of administration

- Babies <34 weeks cannot co-ordinate sucking, swallowing and breathing effectively and must be tube fed
- use gastric feeding with either nasogastric (NGT) or orogastric (OGT) tube

Initiating and advancing enteral feeds

Make every effort to use mother's expressed colostrum and breast milk



Babies can move between risk categories following individual clinical assessment

***High risk definition:**

- <29 weeks' gestation or <1200 g birth weight
- Absent or reversed end diastolic flow in <34 weeks or <1501 g birth weight
- Re-establishment of feeds following NEC
- Post-surgery for congenital gut abnormality or abdominal wall defects

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Caution when increasing feeds in the following (consider minimal trophic enteral feeds of expressed breast milk)

- Ibuprofen (during treatment) or surgical ligation for patent ductus arteriosus
- Complex congenital cardiac disease
- Dexamethasone treatment
- Unstable/hypotensive ventilated babies
- Perinatal hypoxia-ischaemia with significant organ dysfunction
- Requiring full or partial exchange transfusion

Which milk to use

Mother's expressed breast milk (MEBM)

- Wherever possible, use expressed breast milk for initiation of enteral feeds. Breast milk remains the ideal milk for term and preterm babies and should be strongly recommended
- Breast milk is more protective against NEC than formula milk. Encourage mothers to express breast milk as soon as possible after delivery (WHO standard within 6 hr) and to continue to express breast milk 8–12 times every 24 hr – see **Breast milk expression** guideline
- If decision to breastfeed/use MEBM is made when starting feeds, use only breast milk enterally as available. It may not be possible to follow schedules below until sufficient breast milk is being produced
- If mother's own expressed breast milk not available, consider donor milk in appropriate babies (see below). If donor milk not appropriate use preterm formula
- Provide support to all mothers in the feeding method of their choice
- Feeds to a minimum volume of 150 mL/kg increasing to 180 mL/kg as full feeds
- Increase up to 200 mL/kg as indicated by weight gain and volume tolerance

Donor expressed breast milk (DEBM)

- In the absence of a mother's own expressed breast milk, consider donor milk as the next milk of choice for babies at higher risk of NEC
- Indication for use:
  - mother's milk unavailable **and** gestational age <29 weeks **or** birth weight <1200 g **or**
  - previous proven NEC
- Due to poor nutritional profile of donor milk it is wise to restrict use to establishing feeds in high risk babies with the gradual introduction of alternative feeds one week after full volumes achieved (see **Slow change to a different type of milk feed**)

Breast milk fortifier (BMF) (Nutriprem BMF/SMA BMF)

- All preterm infants <33^{+6} weeks fed on D/MEBM require addition of BMF to meet protein requirements as recommended by ESPGHAN 2010
- When MEBM/DEBM tolerated at 150 mL/kg for 48 hr and >10 days old, add breast milk fortifier (BMF)
- Observe for signs of feed intolerance (abdominal distension, vomiting, increased aspirates, change in stool frequency) for next 24 hr
- Thereafter, gradually increase volume of milk to 180–200 mL/kg/day

Protein Supplement (Nutriprem Protein Supplement)

- Use under direction of neonatal or paediatric dietitian

- Formulated to provide extra protein to meet the requirements of ELBW infants
- Extensively hydrolysed protein alone – NO micronutrients or energy
- Calculate energy and protein intake and compare to requirements prior to addition of protein supplement
- Check blood urea if normal ranges do not add protein supplement – discuss with neonatal or paediatric dietitian
- Add to D/MEBM alongside BMF or directly to preterm formula to enhance protein intake
- 1 g sachet = 0.82 g protein
- Monitor blood urea nitrogen twice weekly in all infants on protein supplement

Preterm milk formula (Nutriprem 1/SMA Gold Prem 1)

- Indicated for babies born <1800–2000 g and <34 weeks' gestation
- Initially increase feeds to 150 mL/kg/day
- If necessary, increase to 180 mL/kg/day as indicated by weight gain

Specialised preterm formulas (Hydrolysed Nutriprem 1/SMA Gold Prem Pro)

- Hydrolysed Nutriprem 1 – extensively hydrolysed protein preterm formula
- SMA Gold Prem Pro – hydrolysed protein preterm formula (indicated especially babies <1000 g)
- See company information for nutritional breakdown
- these formulas may be suitable for babies who fail to tolerate/progress on standard preterm formula, **OR** have a family history of CMPI (Hydrolysed Nutriprem 1 only), **OR** require MCT fat (SMA Gold Prem Pro only), but only when absolutely necessary and **always** under the direction of a paediatric or neonatal dietitian

All 'specialised' term formulas

- These formulas do not provide adequate nutrition for preterm babies at standard dilution and will require modification to ensure individual requirements are met. Use specialised formulas only where absolutely necessary and always under the direction of a paediatric or neonatal dietitian

Slow change to different type of milk feed

- Occasionally, it may be necessary to change from one type of milk feed to another, mostly from DEBM/MEBM to preterm formula. Do this slowly to ensure baby tolerates the change in feed
- **Day 1:** 75% feeds with current milk, 25% with new milk (i.e. 3 old feeds: 1 new feed)
- **Day 2:** 50% feeds with current milk, 50% with new milk (i.e. 2 old feeds: 2 new feeds)
- **Day 3:** 75% feeds with new milk, 25% with current milk (i.e. 1 old feed: 3 new feeds)
- **Day 4:** 100% new milk
- It is also acceptable practice during the slow change to mix the milks together rather than using separately (**NB:** BMF should **not** be added to formula so omit during slow change if feeds are being mixed)

Nutrient additives

- Exclusively breastfed babies <34 weeks' gestation and/or <1500 g (no BMF)
- once 50% enteral feeds established 0.6 mL Abidec (NB: contains peanut oil)
- Joulie's phosphate (infants <30 weeks or 1500 g) 0.5 mmol/kg 8-hrly adjusted according to serum phosphate and alkaline phosphatase levels, and urinary reabsorption of phosphate

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- check plasma and urinary sodium. Breast milk sodium concentration is inversely proportional to the amount expressed. May need to supplement with sodium
- folic acid (if used) 50 microgram daily until discharge unless prescribed breast milk fortifier
- Fortified breast milk
- <2 kg 0.3 mL Abidec multivitamin
- >2 kg no vitamins
- may need Joulie's phosphate if PO_4 <1.8 mmol
- no folic acid
- Infants <34 weeks' gestation fed preterm formula, tolerating at least 50% enteral feeds
- 0.3 mL Abidec (**NB**: contains peanut oil)

Iron

- At 28 days of age and only for exclusively breastfed (+/- BMF) babies <34 weeks' gestation and/or 1500 g, start sodium feredetate (e.g. Sytron) once daily:
- <1500 g, 0.5 mL
- ≥1500 g, 1 mL
- Babies on term formula 1 mL Sytron
- Babies fed preterm formula or preterm discharge formula do not need iron supplements

CHANGEOVER OF MILK ON REACHING 2 kg

- If feeding on fortified EBM and baby has been gaining 15–20 g/kg/day, stop fortifier and monitor weight closely
- If feeding on fortified EBM and gaining <15 g/kg/day, refer to dietitian
- If feeding on preterm milk and gaining 15–20 g/kg/day, change to a nutrient enriched post-discharge formula (e.g. Nutriprem 2 or SMA Gold Prem 2)
- If feeding on a preterm milk and gaining <15 g/kg/day, refer to dietitian

MONITORING

Monitoring of gastrointestinal tolerance, growth and biochemical balance is critical in nutritional management of preterm babies

Clinical monitoring

- Daily assessment of gastrointestinal tolerance:
- gastric residues
- stool frequency
- abdominal examination as appropriate

Feeding intolerance

- Intolerance to feeding is common among small preterm babies and some will have episodes requiring either temporary discontinuation of feeding or delay in advancing feeds
- Seek advice early from a neonatal or paediatric dietitian if failure to progress feeds continues
- Carefully observe for signs of NEC including abdominal distension, discolouration, blood in stools, metabolic acidosis – see **Necrotising enterocolitis** guideline

ASPIRATES AND WHEN TO STOP FEEDS

- Aspirate 4-hrly, then:
- if aspirate <50% total of previous 4 hr feed volume and not bile stained, replace and continue feeds whilst observing baby closely
- if aspirate ≥50% of the total of the previous 4 hr feed volume and not bilious, replace prescribed hourly volume, discard the rest and omit next feed
- Stop feeds and seek medical review if:
- aspirates heavily bile stained and >50% of the total of the previous 4 hr feed volume, consider withholding feeds on that occasion, and assess for any signs of NEC

- blood or mucus per rectum
- abnormal abdominal examination (e.g. abdominal distension, discolouration, tenderness, poor bowel sounds, not passing stools >48 hr)

FREQUENCY OF FEEDS

- Dependent on maturity and condition of baby
- In extremely premature baby, initial 1–2 hrly feeds are appropriate
- Once baby tolerating full feeds, increase feed interval to 3-hrly – but do not give 4-hrly feed to preterm baby (<40 weeks)

ROUTE OF FEEDING

- In most premature babies: via nasogastric or orogastric tube
- Once baby more mature and able to suck offer feeds by breast (see **Progression to Oral Feeding** below), cup or bottle
- Encourage mothers who wish to breastfeed by starting skin-to-skin time

Anthropometry

- Monitor weight daily for first few days to assist with fluid management – see **Intravenous fluid therapy** guideline
- once clinically stable, measure weight twice weekly
- weight gain of 15–20 g/kg/day is adequate in growing phase
- 25–30 g/day is adequate weight gain if weight >2.0 kg
- Measure head circumference weekly to assess cerebral growth
- Measure length on admission and then monthly
- Document weight, length and head circumference regularly on RCPCH-WHO growth chart

Biochemical monitoring

- In sick or very premature babies, measure plasma urea, electrolytes, calcium, phosphate and albumin twice daily for initial few days. Reduce frequency depending on clinical stability
- Monitor glucose closely in initial few days
- once clinical stability and full enteral feeds achieved, carry out these tests at least once a week in very low birth weight (VLBW) babies
- Check urine weekly for excretion of sodium and phosphate

COMMON PROBLEMS

Poor growth

- Babies with weight gain <15 g/kg/day require further assessment
- Ensure baby receiving adequate nutrition (energy intake >120 kcal/kg/day; protein 3.3 g/100 kcal). Calculate energy and protein intake per kg/day
- Check for following factors, that may affect growth:
- clinical illness (e.g. UTI)
- medications (diuretics)
- steroid treatment can delay growth for up to 3–4 weeks after stopping
- increased energy requirement resulting from respiratory/cardiac disorders
- hyponatraemia (serum Na should be ≥132 mmol/L) and urine sodium >20 mmol/L
- hypophosphatemia (maintain serum PO_4 at 2 mmol/L)
- anaemia

Excessive weight gain

- Babies with weight gain >25 g/kg/day require further assessment
- Ensure measurement not spurious and not related to catch-up growth after a period of poor weight gain
- Evaluate for fluid retention and its causes
- consider diuretics in presence of oedema

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- If receiving >150 kcal/kg/day, reduce energy intake
- if applicable, change feed under direction of paediatric dietitian, or decrease volume of feeds

Patent ductus arteriosus (PDA)

- Preterm babies with PDA have decreased blood-flow in descending aorta and increased risk of NEC. Ibuprofen is also associated with decreased gastrointestinal blood-flow. Observe closely for feeding intolerance and signs of NEC
- As increased IV fluid rates are associated with PDA, avoid any increase >150 mL/kg/day
- Cautiously increase feeds while receiving ibuprofen
- See **Patent ductus arteriosus** guideline

PROGRESSION TO ORAL FEEDING

Aim

Safe progression to oral feeding

Principles

- Reaching a specific gestational age or body weight is not an indication for transition from NGT feeding to oral feeding but baby should be at least 32–34 weeks' gestation
- Initiation of oral feeds should follow observations of baby's behaviour e.g.:
- tolerating bolus feeds
- swallowing secretions
- physiologically stable
- stable respirations (>70 breaths/min will inhibit oral response)
- demonstrating rooting and feeding cues
- able to demonstrate rhythmic non-nutritive sucking for approximately 5 min
- Early oral feeding attempts are gradual and not expected to result in full feeding immediately
- increase breastfeeds gradually from a few minutes at the breast to one full feed per day, in response to baby's demands
- See **Breastfeeding** and **Bottle feeding** guidelines for further information

Maternal milk supply

- Ensure sufficient maternal breast milk and good lactation
- should fulfil baby's total 24 hr requirement by 72 hr postnatal

Process

- Skin-to-skin contact for extended periods as long as mother and baby can tolerate
- Non-nutritive sucking at a fully expressed breast, on a clean or gloved finger or with a dummy
- Positioning at breast should ensure mother is comfortable, can see baby's face and is able to provide good support for baby's head, neck and shoulders e.g. cross-cradle or underarm position
- Attachment – may need temporary use of premature nipple shields
- If baby awake, alert and demonstrating feeding/approach cues, offer breast
- support mother to assess a feed based on duration at the breast and features of effective latch, sucking rhythm, depth and behaviour following a feed, to determine need for supplementation
- feeds <10 min at the breast, not rhythmic or well co-ordinated, usually require a top-up of at least 50% volume of NGT feed
- if baby not waking naturally at least 8 times per 24 hr (or more) it is likely to require supplements until more established on the breast
- Optimise milk transfer – offer the breast with the best flow first. Stimulate the 'let-down' reflex before putting baby to breast e.g. hand or mechanical expression

Progression to demand feeding

- Gradual progress from NGT/enteral feeds to exclusive breastfeeding by responding to baby's behavioural cues before, during and after breastfeeds ensures nutritional needs are met and prevents baby from becoming overtired
- Before withdrawal of NGT, ensure baby can wake sufficiently frequently and breastfeed effectively
- Weight gain of 10–15 g/kg/day must be achieved before changing to full breastfeeds
- Monitor wet and dirty nappies, weight, length and head circumference regularly to assess nutritional status and adequacy of feeding
- If poor weight gain, feed volume can be increased to a maximum of 200 mL/kg/day, if tolerated, or breast milk fortifier may be added

POST-DISCHARGE NUTRITION

Nutrients vitamins and iron

Breast milk

- Babies <34 weeks' gestation and/or <1500 g, give multivitamins (Abidec) 0.6 mL until 12 months corrected gestational age (CGA)
- Give sodium feredetate (e.g. Sytron) once daily:
  - ≥1.5 kg = 1 mL
  - discontinue once mixed feeding established

Term formulas

- Babies <34 weeks gestation and/or <1500 g, give multivitamin (Abidec) 0.6 mL until 12 months CGA
- Give sodium feredetate (e.g. Sytron) once daily: ≥1500 g = 1 mL
  - discontinue once mixed feeding established

Follow-on preterm formula

- Consider post-discharge follow-on preterm milk (e.g. Nutriprem 2, SMA Gold Prem 2) in premature babies with:
  - chronic lung disease
  - restricted intake (e.g. congenital heart disease)
  - poor growth
- Give multivitamin (Abidec) 0.3 mL until 12 months old
- Continue post discharge formula until 6 months CGA if growth velocity appropriate
- For term babies with increased energy demands or reduced intake, liaise with dietitian regarding use of a higher energy formula

Department of Health Guidelines state all children aged 6 month-5 yr receive vitamin supplementation unless receiving >500 mL/day formula milk

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DEFINITION

Congenital anomaly with blind ending oesophagus which may be associated with a fistula between the abnormal oesophagus and the trachea

DIAGNOSIS

- Suspect antenatally if scans show polyhydramnios +/- absent stomach bubble
  - refer to fetal medicine specialist
  - plan appropriate place of delivery
  - parents should meet paediatric surgeon antenatally
- Most cases present shortly after birth. Suspect if:
  - history of polyhydramnios +/- absent stomach bubble
  - frothing at mouth
  - respiratory symptoms on feeding
  - difficulty in passing NG tube (NGT)
  - anorectal malformation – see **Anorectal malformation** guideline

DELIVERY

- If diagnosis suspected antenatally, avoid:
  - any positive pressure ventilation (including mask ventilation, Optiflow, CPAP and ETT): pouch distension may lead to respiratory compromise and/or aspiration via a distal pouch fistula
- If intubation indicated, site endotracheal tube (ETT) tip as close to carina as possible to minimise gas flow through a fistula. Ventilatory pressures should be as low as possible
- **If any significant respiratory compromise, instigate a time critical transfer to surgical unit**

Confirmation of diagnosis

- Experienced operator to place radio-opaque 8 Fr NGT. Typically resistance is felt 10–12 cm from nostril in term baby
  - do not use force (may lead to oesophageal perforation)
  - AP X-ray of whole chest and abdomen
  - diagnosis confirmed if NGT curled in upper oesophagus
  - gastric air bubble/bowel gas confirms presence of fistula between trachea and distal oesophagus
- Do not attempt a contrast oesophagogram

MANAGEMENT ON NEONATAL UNIT

- If respiratory support required or abdominal distension, contact surgical unit and transfer team immediately (time critical transfer)
- Nurse 30º head-up with head turned to side to facilitate drainage of secretions
- Pass 10 Fr Replogle tube into oesophageal pouch (see **Insertion and management of Replogle tube**)
  - if Replogle tube unavailable, place 10 Fr NG tube into pouch, **aspirating every 15 min**
  - an NG tube cannot be placed on suction so needs regular, intermittent aspiration
- Insert until resistance is met, then withdraw by 1 cm
- Tape securely to face. Usually 10–12 cm at nostril in a term baby
  - place mittens on baby to prevent tube being pulled out
  - attach tapered end of tube to continuous suction. Start pressure at 5 kPa aiming for continuous flow of secretions from upper oesophagus. Maximum pressure 10 kPa
  - do not share suction with other drains e.g. chest drain
- Baby should be relaxed and pink with no respiratory distress or secretions in the mouth
- Keep nil-by-mouth

- Flush Replogle tube with 0.5 mL sodium chloride 0.9% via the sidearm every 15 min. More frequently if visible oral secretions
- If using an enteral tube to drain saliva, aspirate every 15 min, more frequently if visible oral secretions or respiratory difficulty evident
- If no movement of secretions in Replogle tube after flushing with 0.5 mL sodium chloride 0.9% via the sidearm, change tube
- Do not leave syringe attached to sidearm as this will prevent the tube working effectively
- change tube every 10 days or daily if viscous secretions

Samples

- Obtain IV access
- Take blood for FBC, clotting, U&E, blood glucose and blood culture
- Birmingham Children's Hospital do not require a baby crossmatch sample before transfer
- Send 1 bloodspot on neonatal screening card to surgical unit with baby for sickle cell screening (mark card 'pre-transfusion')

Fluids and medication

- Commence maintenance IV fluids (see **Intravenous fluid therapy** guideline)
- Give vitamin K IM (see **Vitamin K** guideline)
- Start broad spectrum antibiotics

Referral

- Examine baby for other associated abnormalities (e.g. cardiac murmur, anorectal abnormalities). If major congenital abnormality detected, discuss with consultant before arranging transfer for management of oesophageal atresia as this may not be appropriate
- Discuss baby's condition and treatment plan with parents and ensure they have seen baby before transfer. Take photographs for parents
- Contact surgical centre to arrange transfer as soon as possible
- Obtain sample of mother's blood for crossmatch. Handwrite form, completing all relevant sections and indicating this is the mother of the baby being transferred. Include baby's name
- Complete nursing and medical documentation for transfer and send copies of X-rays by PACS. Ensure you have mother's contact details (ward telephone number or home/mobile number if she has been discharged). Surgeon will obtain verbal telephone consent if operation is required and a parent is not able to attend surgical unit at appropriate time
- Inform surgical unit staff when baby is ready for transfer. Have available: name, gestational age, weight, ventilatory and oxygen requirements (if applicable) and mother's name and ward (if admitted)

Useful information

- http://www.bch.nhs.uk/content/neonatal-surgery
- http://www.bch.nhs.uk/find-us/maps-directions
- http://www.tofs.org.uk
- http://www.networks.nhs.uk/nhs-networks/staffordshire-shropshire-and-black-country-newborn/documents/

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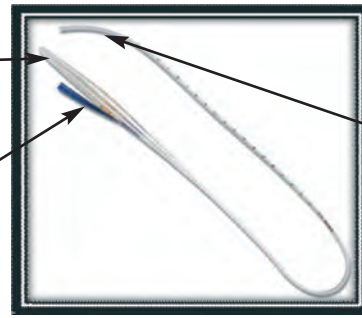
Insertion and management of Replogle tube

Connect to low-flow suction 5–10 kPa

- Flush tube to prevent blocking of lumen:
  - instil 0.5 mL sodium chloride 0.9% into blue sidearm and remove syringe immediately
  - observe flow of sodium chloride 0.9% along tube



Pass Replogle tube, ideally nasally, into upper pouch until resistance felt, (approximately 10–12 cm from nostril in a term baby), withdraw slightly and fix with Elastoplast®

AIM

To prevent aspiration of secretions by continuous drainage of upper oesophageal pouch

Equipment

- Replogle tube size 10 Fr + 1 spare to keep at bedside
- Low-flow suction
- Regular suction
- 2 mL IV syringe
- Sodium chloride 0.9%
- Duoderm dressing and Elastoplast®
- Lubricant

Monitoring

- Check Replogle tube several times an hour and flush to prevent blocking of lumen by instilling 0.5 mL sodium chloride 0.9% into blue sidearm, removing syringe immediately and observing the flow of secretions along the tube. Monitor oxygen saturation, respiratory status and heart rate continuously
- For long-term Replogle use, monitor electrolytes and consider replacement therapy

Blocked tube

- Suspect if:
  - no continuous flow of secretions along tube
  - visible oral secretions
  - baby in distress
- Clear airway with high-flow oropharyngeal suction
- Increase low-flow suction and flush Replogle tube with air, observing flow of saliva along tube
- If patency not restored, replace with new Replogle tube and return low-flow suction to previous level
- If blocked, alternate nostrils

OXYGEN ON DISCHARGE • 1/2

OBJECTIVE

- To put an effective plan in place to allow oxygen-dependent babies to be cared for safely at home

INDICATIONS FOR HOME OXYGEN THERAPY

- Chronic lung disease with ongoing demand for additional inspired oxygen

Criteria

- Clinically stable on oxygen therapy via nasal cannulae for ≥2 weeks
- SpO_2 ≥95% after 36 weeks' gestation on <0.5 L/min oxygen (if >0.5 L/min oxygen requirement at term then refer to paediatric respiratory team)
- Cyanotic congenital heart disease: a lower value may be appropriate, set threshold on an individual basis (liaise with paediatric cardiologists)
- Overnight pulse oximetry study when on stable oxygen for one week before discharge
  - mean SpO_2 should be ≥93% without frequent periods of desaturations
  - SpO_2 should not fall below 90% for >5% of the artefact-free recording period
- If using <0.5 L/min ensure baby able to cope with short periods in air in case their nasal cannulae become dislodged
- Routine continuous oxygen monitoring discontinued including at feeding, awake and sleeping times, apart from checks at 4-hrly intervals twice weekly before discharge
- Thermo-control well established
- Feeding orally 3–4 hrly and gaining weight
  - some babies may require tube feeding, if all other criteria are met, this should not hinder discharge
- Final decision on suitability for discharge lies with consultant

PREPARATION FOR DISCHARGE

Make arrangements with parents

- Discuss need for home oxygen with parents
- Obtain consent for home oxygen supply and for sharing information with oxygen supplier. This is obligatory before supplier can be contacted with patient details
- Arrange multidisciplinary meeting one week before discharge with parents/carers, community nurse, health visitor and member of neonatal unit (NNU)
- Arrange discharge plan – see **Discharge** guideline

Parent training

- Resuscitation techniques (2 adults)
- No smoking in the house or anywhere in baby's environment
- Recognition of baby's breathing pattern, colour and movements
- Use of oxygen equipment (2 adults)
- Competence in tape application for nasal prongs and skin care (water based emollients)
- What to do in case of emergency:
  - contact numbers
  - direct admission policy
  - fire safety and insurance advice (car and home)
  - discuss Disability Living Allowance (DLA)/blue badge advantage
- Give parents information leaflet available to download from http://www.bliss.org.uk/shop

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Organise oxygen

- Prescribing clinician to complete Home Oxygen Order Form (HOOF). Do not send home on less than 0.1 L (even if on <0.1 L in NNU. See BTS guidelines)
- fax completed form to appropriate supplier
- file original in babies notes

Discharge checklist

- Discharge plan implemented – see **Discharge** guideline
- Plan discharge for beginning of week to ensure staff available in event of problems
- Oxygen supply and equipment installed in the home
- Baby will go home on prescribed amount of oxygen; this may be altered on direction of medical or nursing staff, or in event of emergency
- GP and other relevant professionals (also fire and electricity companies, although oxygen supplier usually does this) informed of date and time of discharge
- Community team briefed to arrange home visit well in advance of discharge to ensure conditions suitable and equipment correctly installed
- Parents/carers trained to care for baby safely at home and have support contact numbers
- Open access to paediatric ward

AFTERCARE

- As oxygen dependent babies (e.g. chronic lung disease) are at increased risk of contracting respiratory syncytial virus (RSV), give palivizumab and influenza vaccine (see **Immunisations** guideline and **Palivizumab** guideline)
- Refer to local guidelines for follow-up

OXYGEN SATURATION TARGETS • 1/2

Maintaining oxygen saturation within target range

- Use this guideline for preterm babies <36 weeks corrected gestational age
- Alternative saturation targets or strategy may be specified for babies with congenital heart disease or those at risk of PPHN

PRINCIPLES

- Usual unit target range SpO_2 91–95% for preterm babies <36 weeks corrected gestational age who are breathing on supplemental oxygen
- If different target range, see right-hand column of table below
- Prescribe oxygen on baby's drug chart specifying target range

Setting alarm limits

If currently <36 weeks corrected age – Target range SpO_2 91–95%	If currently ≥36 weeks corrected age OR born ≥34 weeks – Target SpO_2 ≥95%
Babies breathing supplemental oxygen ● Low alarm at 89% and high alarm at 96%	Babies breathing supplemental oxygen ● Low alarm at 94% and high alarm at 99%
Babies breathing air ● Low alarm at 89% and high alarm at 100%	Babies breathing air ● Low alarm at 94% and high alarm at 100%

RESPONDING TO OXYGEN SATURATION ALARMS

General principles

Monitor

- Assess monitor trace and baby before increasing inspired oxygen. In particular, assess:
  - baby's position
  - presence of secretions that may need to be removed
  - position of endotracheal tube or other device for delivering oxygen

Adjust inspired oxygen

- Change inspired oxygen in increments of 1–3% at a time except before procedures or with significant desaturations below 70%. In these circumstances, see below
- Avoid titrating target saturation with large and frequent increases and decreases in inspired oxygen
  - small frequent tweaking of inspired oxygen by 1–3% between 40–50% oxygen is much better than intermittently swinging between 30–80% oxygen to achieve same target range

If it is necessary to increase inspired oxygen by >5–10%, or to introduce (or change) CPAP or ventilation, discuss with doctor or ANNP immediately

Specific circumstances

- **High alarm**
  - silence alarm and observe for an alarm cycle (3 min)
  - if alarm still sounding after a cycle, decrease inspired oxygen by 1–3%
  - continue reducing inspired oxygen by 1–3% every alarm cycle until saturation stable in desired range

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- **Low alarm**
  - silence alarm and observe
  - assess waveform and heart rate
  - baby: check position of endotracheal tube or other oxygen delivery device e.g. nasal prongs or mask, and consider suction or repositioning
- If desaturation persists after above checks, increase inspired oxygen by 1–3% for moderate desaturation (SpO_2 >70%)
  - significant desaturations (SpO_2 <70%), double baseline inspired oxygen (increase by at least 20%) until SpO_2 increases to 90%, then wean rapidly to within 3% of baseline inspired oxygen

Handling or procedures

- If history of significant desaturation with handling or procedures, increase inspired oxygen by 5–10% before handling or procedure
  - increase PEEP (or PIP if CO_2 rising) by 1–2 cm for a few minutes
- After procedure, once SpO_2 stabilises, wean inspired oxygen rapidly to baseline

Labile cases

- Some sick babies will be particularly labile and it is challenging to maintain SpO_2 in target range. It is important to remain patient and continue to follow guidance above
- In rare cases, individualised adjustments to alarm settings may be necessary after discussion with medical team

PAIN ASSESSMENT AND MANAGEMENT • 1/6

INTRODUCTION

- Discomfort, pain or stress can be associated with routine care and invasive procedures. Babies are unable to report pain, use observational skills and clinical judgment

Key recommendations

- Routine assessments to detect pain using a validated assessment tool
- Reduce number of painful procedures
- Prevent/reduce acute pain from invasive procedures using non-pharmacological and pharmacological methods
- Anticipate and treat post-operative pain

Types of pain

Acute pain	Skin-breaking procedures or tissue injury caused by diagnostic or therapeutic interventions
Established pain	Occurs after surgery, localised inflammatory conditions, birth-related trauma
Prolonged/chronic pain	Results from severe diseases e.g. NEC, meningitis. Pathological pain state persisting beyond normal tissue healing time

Symptoms and signs

- Lack of behavioural responses does not exclude pain

Physiological changes	Behavioural changes	Anatomical changes	Body movements
● Increase in: ○ heart rate ○ blood pressure ○ respiratory rate ○ oxygen consumption ○ mean airway pressure ○ muscle tone ○ intracranial pressure ○ skin blood flow ● Decrease in: ○ oxygen saturation and transcutaneous oxygen levels ● Apnoea ○ shallow breathing ○ fixed heart rate	● Change in facial expression: ○ grimace ○ brow bulge ○ eye squeeze ○ deepening naso-labial furrow ○ nasal flaring ○ tongue curving or quivering ● Crying ● Whimpering ● 'Silent' cry (intubated babies) ● Decreased sleep ● Heightened responses	● Dilated pupils ● Sweating ● Flushing ● Pallor	● Fisting ● Tremulousness ● Thrashing limbs ● Limb withdrawal ● Writhing ● Arching back ● Head banging ● Finger splaying ● Cycling

- Sudden pain and distress may indicate acute deterioration e.g. bowel perforation
- Physiological changes cannot be sustained long-term

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PAIN ASSESSMENT

- Assess within 1 hr of admission
- Frequency of further assessments will depend on baby's clinical condition, underlying diagnosis and pain score – see **Frequency of assessment**

Pain assessment tools

- **Separate tools may be needed to assess acute and prolonged pain**
- Use validated pain assessment tools [Pain Assessment Tool (PAT) and Premature Infant Pain Profile (PIPP)]
- See **Abstinence syndrome** guideline for assessment of babies with neonatal abstinence syndrome

Pain assessment not indicated/unsuitable

Not indicated	Unsuitable
● Pharmacologically paralysed babies; provide appropriate pain relief	● Distress is expected but easily relieved (e.g. ventilated baby requiring suction) ● For simple, routine procedures e.g. capillary blood sampling ● second person (parent, nurse or healthcare practitioner to provide support and comfort baby)

Use of pain assessment tool

- Note gestational age
- Observe baby's behaviour for 15–30 sec then gently touch baby's limb to determine muscle tone/tension (can be done during routine handling)
- Note:
  - physiological conditions that may influence score (in cyanotic heart disease, baby's colour may score normal unless there is a change in the intensity of the cyanosis or duskiness due to pain)
  - medications that may affect behaviour or physiological responses
  - environmental triggers (sudden bright lights, noise, activity) may cause a stress response. Document on chart or in notes at time of score
- When score is above tool's recommended thresholds, initiate comfort measures or analgesia

Frequency of assessment

- Score generated will dictate the frequency of assessment
- **Intensive care:** Within 1 hr of admission. Hourly with observations
- **High dependency:** Within 1 hr of admission and 4-hrly or if signs of distress/discomfort
- **Special care:** Within 1 hr of admission and subsequently if signs of distress/discomfort
- **Post-operatively:** Hourly for first 8 hr, then 4-hrly until 48 hr post-operatively (more frequently if signs of distress/discomfort)

PAIN MANAGEMENT

Indications

- Birth trauma
- Iatrogenic injury
- Before, during and after **any** painful procedure
- Severe illness e.g. NEC, meningitis
- To aid ventilation
- Babies undergoing therapeutic hypothermia
- Post-operatively
- End-of-life care

- Formal assessment indicates pain
- If appropriate, begin with non-pharmacological techniques. If moderate-severe pain evident (exceptions include post-surgery, severe illness, major injury, congenital malformations and palliative care), progress to pharmacological agents

Non-pharmacological pain relief

- Gently repositioning baby
- Light swaddling (blanket/nest) prolonged, restrictive swaddling may be associated with increased risk of developmental hip dysplasia
- Comfort/containment holding
- Reducing light, noise, and activity around baby
- Soothing voice
- Nappy change
- Non-nutritive sucking (dummy or gloved finger) – see **Non-nutritive sucking** guideline
- Kangaroo care – see **Kangaroo care** guideline
- Breastfeed – see **Breastfeeding** guideline
- Sucrose
- Mother's expressed breast milk (MEBM) – no additives

Reassess after 30 min

- If pain score in upper range, institute comfort measures and administer prescribed analgesia/seek medical review
- If score continues to rise, consider increasing dose of analgesia and reassess after 30 min
- if clinical concerns – medical review
- If score constantly below baseline and analgesia is maintained, reduce dosage
- Record effectiveness of pain management in care plan

Sucrose

- Sucrose 24% solution and breast milk provide a quick, short-term analgesic effect
- Non-nutritive sucking increases effectiveness
- Use in conjunction with environmental and behavioural measures to relieve pain (e.g. positioning, swaddling, containment holding, Kangaroo care)
- may be given to ventilated babies with care
- ineffective if not given orally. Consider MEBM as an alternative

Contraindications to sucrose

Do not use	May not be effective
● <28 weeks' gestation – use MEBM ● High risk of NEC – use MEBM ● Nil-by-mouth (if due to surgical problem, sucrose may be appropriate, discuss with surgeon) ● Sedated or on other pain medications ● Diabetic mother (until blood glucose stabilised) ● Known carbohydrate malabsorption or enzyme deficiency	● Baby with neonatal abstinence syndrome ● Baby just been fed ● Exposed to chronic in-utero stress ● >6 months

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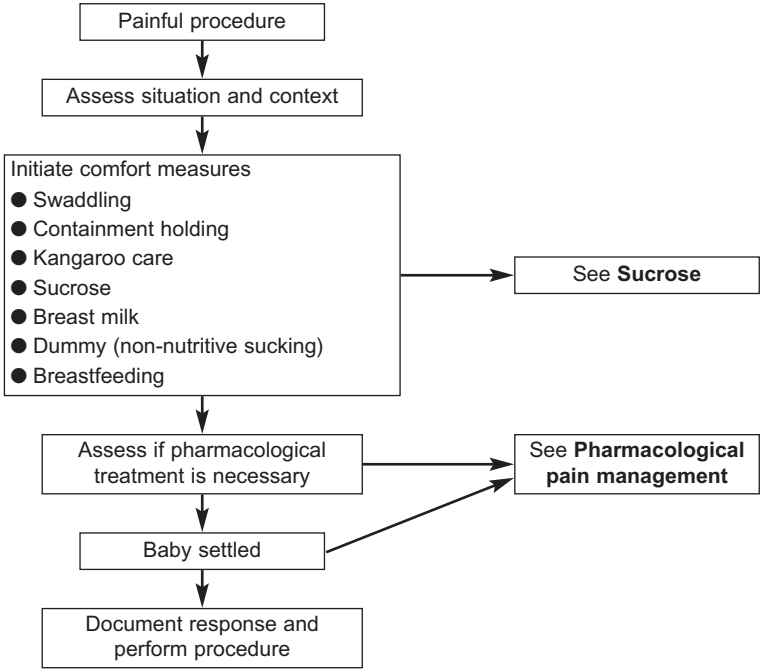
Administration

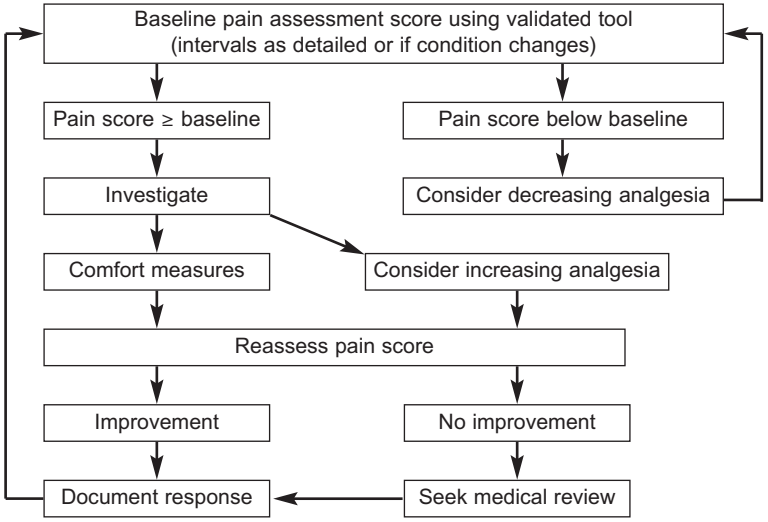
- Use commercially available sucrose 24% solution and follow manufacturer's guidelines re storage and use
- Maximum 8 doses in 24 hr
- Avoid risk of choking/aspiration – ensure baby is awake
- Drop dose onto tongue, buccal membrane, or dummy and **wait 2 min** before starting procedure
- For procedures lasting >5 min, repeat dose (maximum 2 further doses)
- Continue environmental and behavioural management strategies during procedure
- Observe baby's cues and allow 'time out' to recover
- Document administration of sucrose as per local policy

Gestation	Dose of sucrose 24%
$28+^{0}$–$30+^{6}$ weeks	0.1 mL (max 0.3 mL per procedure)
≥$31+^{0}$ weeks and 1000–2000 g	0.2 mL (max 0.6 mL per procedure)
>2000 g	0.5 mL (max 1.5 mL per procedure)

Management of procedural pain



Management of prolonged or chronic pain



Pharmacological pain management

- Give medication in conjunction with non-pharmacological measures
- The following drugs may be useful
  - diamorphine
  - fentanyl
  - morphine
  - paracetamol
- Details of these drugs can be found in local neonatal formulary

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Suggested medication for procedures

Specific situations

Non-urgent endotracheal intubation	Mechanical ventilation	Chest drain insertion	CT/MR imaging	Laser therapy for ROP	Therapeutic hypothermia
● Fentanyl ● Atropine ● Suxamethonium	● Morphine/ diamorphine continuous infusion	● Morphine/ diamorphine IV ● Lidocaine SC	● Sedation may be unnecessary if baby fed and swaddled ● Chloral hydrate ● Midazolam IV/buccal/ intranasal	● Morphine/diamorphine continuous infusion	

Simple surgical procedures

Abdominal drain insertion	Broviac line removal	Wound dressing/drain removal	Application of silo bag for gastroschisis
● Morphine/ diamorphine continuous infusion ● Lidocaine SC	● Paracetamol oral/rectal ● Lidocaine SC ● Sucrose	● Paracetamol oral/rectal ● Sucrose	● Paracetamol rectal

INDICATIONS

Lung disease

- Moderate or severe BPD in preterm infants defined as:
- preterm infants with compatible X-ray changes who continue to receive supplemental oxygen or respiratory support at 36 weeks post-menstrual age **and**
- in the shaded area in **Table 1** (age on 1st October)
- Infants with respiratory disease who are not necessarily preterm but who remain on oxygen on 1st October are considered to be at higher risk. This may include those with conditions including:
- pulmonary hypoplasia due to congenital diaphragmatic hernia
- other congenital lung abnormalities (sometimes involving heart disease or lung malformation)
- interstitial lung disease
- long-term ventilation

Table 1: Chronological age cut off for palivizumab in lung disease

	Gestational age at birth (whole weeks)						
Chronological age (months)	$\leq 24^{+0}$	24^{+1} to 26^{+0}	26^{+1} to 28^{+0}	28^{+1} to 30^{+0}	30^{+1} to 32^{+0}	32^{+1} to 34^{+0}	$>34^{+1}$
<1.5							
1.5 to <3							
3 to <6							
6 to <9							
≥9							

Congenital heart disease (CHD)

- Preterm infants with haemodynamically significant, acyanotic CHD at the chronological ages on 1st October and gestational ages covered by the shaded area in **Table 2**
- Cyanotic or acyanotic CHD plus significant co-morbidities (particularly if multiple organ systems are involved)

Table 2: Chronological age cut off for palivizumab in CHD

	Gestational age at birth (whole weeks)					
Chronological age (months)	$\leq 24^{+0}$	24^{+1} to 26^{+0}	26^{+1} to 28^{+0}	28^{+1} to 30^{+0}	30^{+1} to 32^{+0}	32^{+1}
<1.5						
1.5 to <3						
3 to <6						
≥6						

Children under the age of 24 months who have severe combined immunodeficiency syndrome (SCID) until immune reconstituted

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Other conditions

- Only patients meeting the criteria listed above will routinely be eligible for funding for palivizumab
- If a consultant feels that a baby outside of these criteria should be treated an application for approval should be made through the regional IFR process

PROCEDURE

- Consultant neonatologist will identify patient and sign accompanying letter to GP
- 5 doses monthly in RSV season at the beginning of October, November, December, January and February
- give appointment for subsequent doses at palivizumab clinic (if held)
- where possible, administer 1st dose before start of RSV season
- 15 mg/kg by IM injection into antero-lateral aspect of thigh
- Order palivizumab injection from local community or hospital pharmacy (this can take some days)
- Palivizumab must be stored at 2–8ºC. Full administration instructions are provided in the 'Summary of product characteristics' (SPC)
- Split between 2 sites if >1 mL (final concentration when reconstituted 100 mg/mL)

DOCUMENTATION

- After immunisation, document the following in case notes as well as in Child Health Record (Red book):
- consent gained from parents
- vaccine given and reasons for any omissions
- site of injection(s) in case of any reactions
- batch number of product(s)
- expiry date of product(s)
- legible signature of person administering immunisations
- adverse reactions
- Sign treatment sheet
- Update problem sheet with date and immunisations given
- Document all information on discharge summary and medical case notes including recommendations for future immunisations and need for any special vaccinations, such as influenza, palivizumab, etc.

DEFINITION

Parenteral nutrition (PN) is the intravenous infusion of some or all nutrients for tissue maintenance, metabolic requirements and growth promotion in babies unable to tolerate full enteral feeds

Seek advice from your local PN pharmacist

INDICATIONS FOR PN

Short-term supply of nutrients

- Extremely low birth weight (<1000 g) and/or gestation <30 weeks
- Very low birth weight (<1500 g) **AND** clinically unstable, absent/reversed end-diastolic flow or full enteral feeds seem unachievable by day 5
- Necrotising enterocolitis (10–14 days)
- Temporary feeding intolerance

Prolonged non-use of gastrointestinal (GI) tract >2 weeks

- Usually commenced in surgical centre before transfer back to neonatal unit (NNU):
- relapsing or complicated necrotising enterocolitis (NEC)
- surgical GI disorders (e.g. gastroschisis, large omphalocoele)
- short bowel syndrome

PRESCRIBING PARENTERAL NUTRITION (PN)

Peripheral PN

- Limited by glucose concentration [usually no more than 10–12% (dependent upon local practice)]. Osmolality needs to be considered if large quantities of electrolytes are added
- Indicated if full enteral feeds likely to be obtained relatively soon
- temporary option for some post-surgical babies
- short episodes of feeding intolerance or suspected NEC until central line inserted

Central PN

- Requires placement of a central catheter (see **Long line insertion** guideline) with tip in either superior vena cava or inferior vena cava

Central PN [long lines and umbilical venous catheters (UVC)] can introduce infection and septicaemia

PN prescription

- Most units have specific PN bags that are used to allow nutrients to be increased to meet full nutritional requirements over 4 days. These may be added to (but nothing may be removed) by discussing with PN pharmacist and obtaining consultant signature to confirm
- Modify PN infusion according to requirements and tolerance of each baby and taper as enteral feeding becomes established

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Daily requirements
Birth weight <2.5 kg

<2.5 kg	Day 1	Day 2	Day 3	Day 4	Comment
Protein (g/kg/day)	2	3	3.5	3.5	
Carbohydrate (g/kg/day)	6–15 (based on maintenance fluid volume)	↑ by 2 each day			
Fat (g/kg/day)	1	2	3	3	

Birth weight 2.5–5 kg

2.5–5 kg	Day 1	Day 2	Day 3	Day 4	Comment
Protein (g/kg/day)	1	2	2.5	2.5	
Carbohydrate (g/kg/day)	6–14 (based on maintenance) fluid volume	↑ by 2 each day	14	14	If possible calculate day 1 glucose from maintenance infusion
Fat (g/kg/day)	1	2	3	3	

Maintenance electrolyte and other nutrient requirements

	Birth weight <2.5 kg	Birth weight 2.5–5 kg
Na (mmol/kg/day)	3 (range 3–5)†	3 (range 3–5)
K (mmol/kg/day)	2.5	2.5
Ca (mmol/kg/day)	1	1
PO_4 (mmol/kg/day)	1.5	1
Mg (mmol/kg/day)	0.2	0.2
Peditrace (mL/kg/day)	0.5 (day 1) 1 (day 2 onwards)	0.5 (day 1) 1 (day 2 onwards)
Vitilipid (infant)	4 mL/kg/day	10 mL daily (total)

† **Do not add supplemental sodium on days 1–2 if <32 weeks until naturesis has occurred (measure urine Na levels daily). May not require potassium on days 1–2**

Glucose – maximum concentration

- Peripheral PN 10–12%
- Central PN up to 20–25% (may rise occasionally)

Volume

- Volume may be up to 150 mL/kg/day (see **Intravenous fluid therapy** guideline for fluid requirement) maximal fluid volume varies with individual management, although adequate nutrition may be provided in less volume
- Remember to account for volume, electrolyte and glucose content of other infusions (e.g. UAC/UVC fluid, inotropes, drugs). Giving adequate nutrition may require a more concentrated solution of PN if part of the total daily fluid volume is used for other purposes

Calories

- Healthy preterm requires 50 kcal/kg/day for basal energy expenditure (not growth) and 1–1.5 g protein to preserve endogenous protein stores; more is required for growth, particularly if unwell
- 60 kcal/kg/day will meet energy requirements during sepsis
- 90 kcal/kg/day and 2.7–3.5 g protein will support growth and positive nitrogen balance
- 120 kcal/kg/day may be required for a rapidly growing preterm baby

NUTRITIONAL SOURCES

Glucose (provides 3.4 kcal/g)

- Initiated at endogenous hepatic glucose production and utilisation rate of 4–6 mg/kg/min; [8–10 mg/kg/min in extremely low-birth-weight (ELBW) babies]. Osmolality of glucose limits its concentration

Protein (provides 3.6 kcal/g)

- At least 1 g/kg/day in preterm and 2 g/kg/day in ELBW decrease catabolism
- 3–3.5 g protein/kg/day and adequate non-protein energy meets requirements for anabolism

Fat (provides 9 kcal/mL)

- Fat of 3–3.5 g/kg/day is usually sufficient
- ≥4 g/kg/day only in very preterm with normal triglycerides not septic, not on phototherapy
- fat should ideally provide 35–40% of non-protein nitrogen calories
- To minimise essential fatty acid deficiency, hyperlipidaemia, bilirubin displacement, and respiratory compromise, lipid infusion rates ≤0.15 g/kg/hr are recommended to run throughout 24 hr
- in babies, maximal removal capacity of plasma lipids is 0.3 g/kg/hr

Energy

- Carbohydrate (glucose) and fat (lipid emulsions) provide necessary energy to meet the demands and, when provided in adequate amounts, spare protein (amino acids) to support cell maturation, remodelling, growth, activity of enzymes and transport proteins for all body organs
- PN requirement for growth 90–120 kcal/kg/day

Electrolytes

- Sodium, potassium, and chloride dependent on obligatory losses, abnormal losses and amounts necessary for growth, and can be adjusted daily
- If baby <32 weeks, do not add sodium until they have started their naturesis, monitored by daily urine Na^+
- Babies given electrolytes solely as chloride salts can develop hyperchloraemic metabolic acidosis (consider adding acetate to PN, where available)
- Monitor serum phosphate twice weekly. Aim to maintain at around 2 mmol/L

Vitamins

- Vitamin and mineral added according to best estimates based on limited data (ESPGHAN guidelines 2005)

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SPECIAL NEEDS

Hyperglycaemia

- If hyperglycaemia severe or persistent, start insulin infusion – see **Administration of actrapid insulin (soluble insulin) in Hyperglycaemia** guideline

Osteopenia

- If baby at risk of, or has established osteopenia, give higher than usual intakes of calcium and phosphate. (see **Metabolic bone disease** guideline)
  - consult dietitian and/or pharmacist regarding prescribing information
  - permissible concentrations depend on amino acid and glucose concentrations in PN solution

Metabolic acidosis

- For management of metabolic acidosis, add acetate as Na or K salt if available: consult pharmacist
  - choice of salt(s) will depend on serum electrolytes

MONITORING

Daily	● Fluid input ● Fluid output ● Energy intake ● Protein ● Non-protein nitrogen ● Calories
Daily	● Urine glucose ● Blood glucose (if urine glucose positive)
Twice weekly*	● Urine electrolytes ● Weight
Weekly	● Length ● Head circumference
Twice weekly*	● FBC ● Na ● K ● Glucose ● Urea ● Creatinine ● Albumin ● Bone chemistry ● Bilirubin** ● Blood gas (arterial or venous)
Weekly	● Serum triglycerides** ● Magnesium ● Zinc**

* Initially daily and decrease frequency once stable unless indicated for other birth weight or gestation-specific guidance – see **Intravenous fluid therapy** guideline

** In prolonged PN >2 weeks, consider giving SMOFlipid™

COMPLICATIONS

Catheter-related: (see Long line insertion guideline)

- Peripheral catheters: extravasations and skin sloughs
- Septicaemia

Electrolyte abnormalities

- Electrolyte and acid-base disturbances

Metabolic

- Hyper/hypoglycaemia, osmotic diuresis
- Metabolic bone disease: mineral abnormalities (Ca/PO_4/Mg) see **Metabolic bone disease** guideline
- Hyperlipidaemia and hypercholesterolaemia
- Conjugated hyperbilirubinaemia

PN-associated cholestatic hepatitis

- Can occur with prolonged PN (>10–14 days)
- probably due to combination of PN hepato-toxicity, sepsis and reduced oral feeding
- often transient
- usually manifests as rising serum bilirubin (with increased conjugated component) and mildly elevated transaminases
- leads to deficiencies of fatty acids and trace minerals in enterally fed babies
- even small enteral feeds will limit or prevent this problem and therefore trophic feeds should be given to all babies on PN unless there are contraindications such as acute clinical instability or NEC
- consider other causes of hyperbilirubinaemia (PN-induced cholestasis is diagnosis of exclusion) e.g. CMV, hypothyroidism
- ensure trace minerals are added to PN
- if the conjugated component is persistently >100 or if stools acholic (putty grey) or very pale, refer urgently to liver unit to discuss investigations and further management
- if failure to progress with enteral feeding in a timely fashion, seek advice from a paediatric gastroenterologist

WEANING PN

- When advancing enteral feedings, reduce rate of PN administration to achieve desired total fluid volume
- Decrease the aqueous and fat portions by 90% and 10% respectively for each volume of PN reduced e.g. if reducing PN by 1 mL/hr, reduce Vamin by 0.9 mL and Intralipid by 0.1 mL
- Assess nutrient intake from both PN and enteral feed in relation to overall nutrition goals

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RECOGNITION AND ASSESSMENT

Definition

- Persistent patency of the ductus arteriosus (PDA) is a failure of functional ductal closure by 48 hr or anatomical closure by 3 weeks of age

Factors associated with delayed closure

- Prematurity (significant PDA affects approximately 30% of very-low-birth-weight babies)
- Lack of antenatal corticosteroid prophylaxis
- Surfactant-deficient lung disease
- Hypoxaemia
- Volume overload

Adverse effects of PDA

- Haemodynamic consequences of left-to-right shunt in preterm babies can prolong ventilatory support and are associated with mortality and morbidity (chronic lung disease, pulmonary haemorrhage, intraventricular haemorrhage, necrotising enterocolitis and retinopathy of prematurity)
- Increased pulmonary blood flow (leading to increased work of breathing and respiratory deterioration)
- Reduced systemic blood flow (leading to acidosis and hypotension)

Symptoms and signs

- Can be absent even in the presence of a significant duct in first 7 days of life
- A significant left-to-right shunt is suggested by:
  - bounding pulses and wide pulse pressure (i.e. >25 mmHg)
  - hyperdynamic precordium (excessive movement of precordium)
  - low-pitched systolic or continuous murmur over left upper sternal edge (absence of a murmur does not exclude significant PDA)
  - signs of cardiac failure (tachypnoea, tachycardia, hepatomegaly, pulmonary oedema, generalised oedema etc.)
  - poor perfusion (hypotension, poor capillary refill, mottled skin and persistent acidosis)
  - increased or persistent ventilatory requirements

Differential diagnosis

- Other cardiac pathology (e.g. congenital heart disease, including duct-dependent lesions, arrhythmias or cardiomyopathy)
- Sepsis

INVESTIGATIONS

- SpO_2 monitoring
- Chest X-ray (cardiomegaly? pulmonary plethora?)
- Echocardiography is advisable as duct-dependent cardiac lesions, or other cardiac pathologies, can be difficult to detect clinically and is important if considering treatment with prostaglandin inhibitor
- Echocardiographic assessment of significant PDA includes:
  - size of PDA (>1.5 mm)
  - volume loading of left atrium (LA/aorta ratio >1.5)
  - volume loading of left ventricle
  - velocity and flow pattern of ductal flow

IMMEDIATE TREATMENT

General measures

- Optimise oxygenation by appropriate ventilatory management
- Use of a higher PEEP (i.e. ≥5 cmH_2O) can help minimise effects of pulmonary oedema and risk of pulmonary haemorrhage
- Treat anaemia – maintain Hb ≥100 g/L with blood transfusion (consider concurrent dose of IV furosemide)
- Before starting medication, restrict fluid intake to 60–80% (e.g. from 150 mL/kg/day to 90–120 mL/kg/day)
- If fluid overload or pulmonary oedema, give one IV dose of furosemide in accordance with **Neonatal Formulary**

Specific measures

- Aim to convert haemodynamically significant PDA into insignificant PDA as complete duct closure may take weeks or months

Pharmacological treatment with prostaglandin inhibitor to initiate closure

- Ibuprofen is the drug of choice for this purpose. Indometacin is not currently available in the UK
- Pharmacological treatment is best used within 2 weeks of age but can be effective up to 6 weeks

Indications

- Babies born <34 weeks' gestation with significant PDA – on clinical and/or echocardiographic assessment
- Includes ventilatory/CPAP dependent babies or PDA with haemodynamic effects (i.e. cardiac failure or poor perfusion)
- Monitor babies with non-significant PDA carefully and treat if becomes significant

Contraindications to ibuprofen

- Duct-dependent cardiac lesion
- Significant renal impairment: urine output <1 mL/kg/hr or creatinine >120 micromol/L
- Significant thrombocytopenia, i.e., platelet count <50 x 10^9/L (course started or next dose given only after platelet transfusion)
- Suspected or definite necrotising enterocolitis
- Active phase of significant bleeding (gastrointestinal or severe intracranial) – treat coagulopathy before starting course – see **Coagulopathy** guideline

Dose

- Calculate carefully and prescribe individually on single dose part of prescription chart so that contraindications checked before each dose
- Administer in accordance with **Neonatal Formulary**
- Ibuprofen has similar efficacy to indometacin but fewer renal side effects (can be used in babies with mild or previous renal dysfunction)

SUBSEQUENT MANAGEMENT

Monitoring pharmacological treatment

- Check before each dose:
  - creatinine (maintained <120 micromol/L)
  - urine output (maintained >1 mL/kg/hr)
  - platelet count (kept ≥50 x 10^9/L with platelet infusions if needed)
  - concomitant nephrotoxic drug e.g. gentamicin/vancomycin (monitor levels carefully **OR** use alternative non-nephrotoxic drug)

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- Feed tolerance (feeds cautiously initiated or continued during treatment – briefly stopped during actual infusion)
- Clinical signs of PDA and baby's progress
- Echocardiography (if clinically indicated), repeated after 2–3 days of completion
- Fluid gradually liberalised after treatment based on:
  - daily weight (weight gain suggests fluid retention)
  - serum sodium (dilutional hyponatraemia common)

Persistence or recurrence of asymptomatic PDA

- Persistence of murmur does not necessarily indicate return of PDA
- Echocardiogram sometimes demonstrates physiological branch pulmonary stenosis
- If baby with asymptomatic murmur is making progress, plan echocardiography before discharge to decide follow-up

Persistent significant PDA and surgical referral

- If PDA significant after 48 hr of completion of first course of prostaglandin inhibitor, use second course of ibuprofen
- If PDA still significant but baby making progress (i.e., can be extubated or come off CPAP):
  - commence regular diuretics (furosemide + amiloride/spironolactone) to help control haemodynamic effects – in accordance with **Neonatal Formulary**
  - monitor closely
- If PDA still significant and baby ventilatory or CPAP dependent, discuss with cardiac centre for surgical ligation when:
  - prostaglandin inhibitor contraindicated
  - prostaglandin inhibitor not indicated (≥34 weeks with cardiac failure not controlled by diuretics)
  - prostaglandin inhibitor ineffective (usually after giving second course)
- Discuss further cardiac assessment and surgical ligation of PDA with cardiologist at regional cardiac centre and transport team – follow local care pathway (e.g. West Midlands PDA Ligation Referral Pathway)
- After surgical ligation, keep baby nil-by-mouth for 24 hr before gradually building up feeds (because of risk of necrotising enterocolitis)

DISCHARGE POLICY FOR PERSISTENT PDA

- If PDA persistent clinically or echocardiographically at discharge or at 6 weeks follow-up, arrange further follow-ups in cardiac clinic (locally or at cardiac centre depending on local practice)
- If PDA reviewed locally still persistent at 1 yr of age or if clinically significant during follow-up (cardiac failure or failure to thrive), refer to paediatric cardiologist at regional cardiac centre to consider closure (first option is usually catheter closure)

PERICARDIOCENTESIS • 1/1

INDICATION

Drain a pericardial effusion only if there is cardiovascular compromise. If time allows, discuss with paediatric cardiologist before drainage

PERICARDIAL EFFUSION

Causes

- Neonatal hydrops
- Extravasation of PN from migrated long lines
- Complication of central venous catheters

Clinical signs

- Sudden collapse in baby with long line or umbilical venous catheter *in situ* – always consider pericardial tamponade
- Tachycardia
- Poor perfusion
- Soft/muffled heart sounds
- Increasing cardiomegaly
- Decreasing oxygen SpO_2
- Arrhythmias

Investigations

- Chest X-ray: widened mediastinum and enlarged cardiac shadow
- Echocardiogram (if available)

EQUIPMENT

- Sterile gown and gloves
- Sterile drapes
- Dressing pack with swabs and plastic dish
- 22/24 gauge cannula
- 5–10 mL syringe with 3-way tap attached
- Cleaning solution as per unit policy
- Lidocaine

PROCEDURE

Consent and preparation

- If time allows, inform parents and obtain consent (verbal or written)
- If skilled operator available, perform under ultrasound guidance
- In an emergency situation, the most experienced person present performs procedure without delay and without ultrasound guidance
- Ensure baby has adequate analgesia with intravenous morphine and local lidocaine instillation

Drainage

- Maintain strict aseptic technique throughout
- Clean skin around xiphisternum and allow to dry
- Attach needle to syringe and insert just below xiphisternum at 30º to skin and aiming toward left shoulder
- Continuously aspirate syringe with gentle pressure as needle is inserted. As needle enters pericardial space there will be a gush of fluid, blood or air
- Send aspirated fluid for microbiological and biochemical analysis
- Withdraw needle

AFTERCARE

- Cover entry site with clear dressing (e.g. Tegaderm/Opsite)
- Discuss further management with paediatric cardiologist

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PERSISTENT PULMONARY HYPERTENSION OF THE NEWBORN (PPHN) • 1/3

RECOGNITION AND ASSESSMENT

Definition

- Failure of normal postnatal fall in pulmonary vascular resistance
- Leads to right-to-left shunting and subsequent hypoxia
- Can be primary (idiopathic) or secondary
- Severe hypoxaemia (PaO_2 <6 kPa) in FiO_2 1.0
- Complex condition with varied causes and degrees of severity

Idiopathic

- Degree of hypoxia disproportionate to degree of hypercarbia
- Mild lung disease (in primary/idiopathic PPHN)
- Echocardiogram: structurally normal heart (may show right ventricular hypertrophy), right-to-left or bidirectional shunt at PFO and/or patent ductus arteriosus (PDA)

Secondary: may be associated with:

- Severe lung disease [e.g. meconium aspiration (MAS), surfactant deficiency]
- Perinatal asphyxia
- Infection [e.g. Group B streptococcal (GBS) pneumonia]
- Structural abnormalities: pulmonary hypoplasia, congenital diaphragmatic hernia, A-V malformations, Congenital Cystic Adenomatoid Malformation (CCAM)
- Maternal drugs: aspirin, non-steroidal anti-inflammatory drugs, SSRIs

CLINICAL FEATURES

Usually present in first 12 hr of life

- SpO_2 <95% or hypoxia (PaO_2 <6 kPa)
- Mimics cyanotic heart disease
- CVS: tricuspid regurgitant murmur, right ventricular heave, loud second heart sound and systemic hypotension
- Idiopathic PPHN: respiratory signs mild or absent
- Secondary PPHN: features of underlying disease

INVESTIGATIONS

- Blood gas shows hypoxaemia (PaO_2 <6 kPa) with oxygenation index >20 (underlying disease will produce a mixed picture)
- SpO_2 >5% difference in pre- and post-ductal saturations (pre > post)
- Hyperoxia test (100% oxygen for 5 min)
- SpO_2 may improve to ≥95% in early stage **or** may not respond, i.e., staying <95% in established PPHN (as in cyanotic heart disease)
- Chest X-ray: variable findings depending on underling diagnosis (normal or minimal changes in idiopathic PPHN)
- Electrocardiograph – often normal. Can sometimes show tall P waves in lead 2/V1/V2 or features of RVH (i.e. tall R waves V1/V2, right axis deviation or upright T waves in V1/V2)

- Echocardiogram (although not mandatory) is useful:
  - to exclude cyanotic heart disease
  - to assess pulmonary pressure
  - to evaluate ventricular function
  - one or more of the following confirm PPHN in presence of normal cardiac structures:
    a) significant tricuspid regurgitation
    b) dilated right side of heart
    c) right-to-left shunting across PFO and/or PDA
    d) pulmonary regurgitation

MANAGEMENT

- Once PPHN suspected, involve consultant neonatologist immediately
- Aims of management are to:
  - decrease pulmonary vascular resistance
  - increase systemic blood pressure
  - to treat any underlying condition
- Babies with PPHN should be referred to a NICU for on-going management

General measures

- Minimal handling, nurse in quiet environment
- Secure arterial and central venous access, see **Arterial line insertion** guideline or **Umbilical artery catheterisation** and **Umbilical venous catheterisation** guidelines
- Maintain normal temperature, biochemistry and fluid balance
- Keep Hb ≥120 g/L
- Give antibiotics (sepsis, particularly GBS, is difficult to exclude)
- Surfactant may be beneficial in MAS or GBS sepsis – discuss with consultant
- If perfusion poor, fluid bolus (10 mL/kg sodium chloride 0.9% or if coagulopathy, fresh frozen plasma – see **Coagulopathy** guideline)
- Once $PaCO_2$ in acceptable range (i.e. <6 kPa), correct metabolic acidosis to maintain pH 7.35–7.45 using full correction with sodium bicarbonate over 1 hr. If repeat correction necessary, **slow** bicarbonate infusion of calculated dose can be given over 6–12 hr (see **Neonatal Formulary**)

Ventilation

- Use conventional ventilation to start with (targeted tidal volume 5–6 mL/kg)
- Use sedation and muscle relaxation in babies with high ventilatory and oxygen requirements and/or ventilator asynchrony
  - $PaCO_2$ 4.5-5.5 kPa (accept up to 6 kPa in parenchymal lung disease). Avoid hypocarbia
  - start at FiO_2 1.0 (=100% oxygen) and reduce as tolerated. Maintain SpO_2 at 96–100% and PaO_2 at 10–12 kPa
- High frequency oscillatory ventilation (HFOV) may further improve oxygenation (see **High frequency oscillatory ventilation** guideline)
- Monitor oxygenation index (OI)

$$OI = \frac{\text{mean airway pressure } (cmH_2O) \times FiO_2 \times 100}{\text{postductal } PaO_2 \text{ (kPa)} \times 7.5}$$

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Inotropes – see **Hypotension** guideline

- Use inotropes early
- In significant PPHN, adrenaline or noradrenaline can be useful in increasing systemic blood pressure without increasing pulmonary vascular resistance
- Maintain systemic mean BP 45–55 mmHg in term baby and systemic systolic BP 60–70 mmHg or above estimated pulmonary pressures (if available by echo)

Pulmonary vasodilatation

- If OI >20 or needs 100% oxygen or significant PPHN on echo, use inhaled nitric oxide (NO) as a selective pulmonary vasodilator (see **Nitric oxide** guideline)

Severe and resistant PPHN not responding to conventional management

- May benefit from ECMO or other specialist treatment
- Discuss with KIDS team in West Midlands or nearest ECMO centre

Criteria for considering ECMO

- Baby born ≥34 weeks or ≥2 kg with PPHN
- not responding or OI >30 despite NO, inotropes and/or HFOV **OR**
- unable to maintain BP with inotropes or persistent need for adrenaline/noradrenaline infusion **OR**
- no significant progression after 3 days

Criteria for ECMO

- Baby born ≥34 weeks or ≥2 kg with PPHN
- Oxygenation index >40
- Reversible lung disease (<10 days high pressure ventilation)
- No lethal congenital malformation

Exclusion criteria (if in doubt, discuss with ECMO team)

- Major intracranial haemorrhage
- Irreversible lung injury or mechanical ventilation >10 days
- Lethal congenital or chromosomal anomalies
- Severe encephalopathy
- Major cardiac malformation

A baby accepted for transfer to ECMO centre will be retrieved by ECMO or PICU team

- ECMO centre will need:
  - a cranial ultrasound scan
  - maternal blood for group and crossmatching (check with ECMO centre)
  - a referral letter
  - copies of hospital notes/chest X-rays
- Outreach ECMO
  - ECMO team may decide to start outreach ECMO in neonatal unit before transfer to ECMO unit. Check with ECMO team regarding diathermy unit and number of packed cell units needed for procedure

Referral for ECMO

Contact KIDS team on 03002001100 (for West Midlands) or

ECMO co-ordinator/fellow at nearest ECMO Centre:

- Glenfield Hospital, Leicester 0116 287 1471
- Great Ormond Street Hospital, London 0207 829 8652
- Freeman Hospital, Newcastle 0191 223 1016
- Yorkhill Hospital, Glasgow 0141 201 0000

RECOGNITION AND ASSESSMENT

Definition

- Peripheral venous haematocrit (Hct) >65%
- Symptoms rarely occur with peripheral Hct of <70%
- Hct peaks at 2 hr after birth and then decreases with significant changes occurring by 6 hr

Clinical consequences

- Hyperviscosity
- Decreased blood flow and impaired tissue perfusion
- Thrombus formation

Complications

- Cerebral micro-infarction and adverse neuro-developmental outcome
- Renal vein thrombosis
- Necrotising enterocolitis (NEC)

Causes

Intra-uterine increased erythropoiesis	Erythrocyte transfusion
● Placental insufficiency (SGA) ● Postmaturity ● Maternal diabetes ● Maternal smoking ● Chromosomal abnormalities: trisomy 21, 18, 13 ● Beckwith–Wiedemann syndrome ● Congenital adrenal hyperplasia ● Neonatal thryotoxicosis ● Congenital hypothyroidism	● Maternal-fetal ● Twin-to-twin transfusion ● Delayed cord clamping ● Unattended delivery

Symptoms and signs

- Commonly plethoric but asymptomatic

Cardiorespiratory	● Respiratory distress ● Persistent pulmonary hypertension of the newborn (PPHN) ● Congestive cardiac failure
CNS	● Lethargy, hypotonia within 6 hr ● Difficult arousal, irritability ● Jittery ● Easily startled ● Seizures
GIT	● Poor feeding ● Vomiting ● NEC
Metabolic	● Hypoglycaemia ● Hypocalcaemia ● Jaundice
Haematological	● Thrombocytopenia
Renal	● Renal vein thrombosis ● Renal failure

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INVESTIGATIONS

In all unwell babies and at-risk babies who look plethoric (as mentioned above)

- FBC/Hct
- If Hct >65%, repeat a free-flowing venous sample or obtain arterial Hct
- If polycythaemic, check blood glucose and serum calcium

IMMEDIATE TREATMENT

- Ensure babies at risk have liberal fluid intake one day ahead see **Intravenous fluid therapy** guideline

Asymptomatic babies with Hct >70%

- Repeat venous Hct after 6 hr
- if still high, discuss with consultant (current evidence does not show any benefit in treating asymptomatic babies)

Symptomatic babies with Hct >65%

- Possible symptoms: fits and excessive jitteriness, with neurological signs and refractory hypoglycaemia

Treatment

- Dilutional exchange transfusion. Discuss with consultant
- explain to parents need for exchange and possible risks before performing dilutional exchange transfusion. Partial exchange transfusion increases risk of NEC
- use sodium chloride 0.9% – see **Exchange transfusion** guideline
- Volume to be exchanged = 20 mL/kg
- Perform exchange via peripheral arterial and IV lines or via umbilical venous catheter (UVC)
- Take 5–10 mL aliquots and complete procedure over 15–20 min

SUBSEQUENT MANAGEMENT

- Babies who required dilutional exchange transfusion require long-term neuro-developmental follow-up
- Otherwise, follow-up will be dependent on background problem

FOR COMFORT AND DEVELOPMENT

- Poor positioning may cause:
  - discomfort
  - disturbed sleep
  - physiological instability
  - impaired cerebral blood flow
  - increased intracranial pressure
  - increased gastro-oesophageal reflux (GOR)
  - poor thermo-regulation
  - compromised skin integrity
  - flattened elongated head shape and postural deformities
  - inability to interact socially
  - poor parental perception of baby
- The positions described below aim to minimise these effects

Positions

- Consider for all, including ventilated babies. See also **Kangaroo care** guideline

Position	Use for	Method
Prone	• Respiratory compromise • GOR • Unsettled babies • Older babies to encourage physical development – active neck extension, head control and subsequent gross motor skills. **When awake/alert only, in response to cues** • Lifting	• Tuck limbs with arms forward and hands near to face for self-calming • Provide head support • Place small, soft roll under baby from head to umbilicus to allow a rounded, flexed posture (prevents flattening of trunk and shoulder retraction – 'W' position) • Support with good boundaries to prevent excessive hip abduction ('frog' position) • Avoid neck hyperextension • **If baby not monitored, do not place in prone position. Give parents/carers information about The Lullaby Trust (formerly FSID) recommendations before discharge**
Supine	• Some surgical and medical conditions • Older babies ready for interaction • Intubated babies where midline head support necessary (e.g. for cooling) • Most difficult position for babies to work against gravity for self-calming and development of movement • Safest sleeping position for babies not monitored – promote supine sleeping and feet-foot position before discharge	• Provide supportive boundary to allow hands-to-face/mouth for self-calming and prevent shoulder retraction ('W' position) • Provide head support • Avoid excessive neck rotation (impairs cerebral blood flow) • If required, neck roll must be small and soft to avoid restricting cerebellar blood flow

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Position	Use for	Method
Side-lying	● Most babies ● Best position for self-regulation and calming behaviours ● Left side-lying reduces GOR ● Lifting ● Use elevated side-lying position for preterm, hypotonic or babies with chronic lung disease or neurological impairment when learning to bottle-feed ● May be appropriate for other medical conditions where increased risk of aspiration	● Provide back support. Gently curl back, flex hips and knees. Avoid excessive flexion which may impair respiration and digestion ● Position with feet against boundary to facilitate foot bracing ● Keep head in midline ● Keep upper shoulder slightly flexed to prevent baby falling backwards ● Support arms in midline, with hands close to face – use straps of nest/soft sheet. Give baby small soft toy/roll to 'cuddle' to support upper arm
Sitting	● Near term ready for more interaction/stimulation ● GOR ● Encourages midline position, chin tuck, eye/hand co-ordination	● Use reclining baby seat ● Maintain midline position – use blanket rolls to prevent slumping, asymmetry and plagiocephaly ● Keep hips in middle of seat ● Place padding behind back (from shoulder level) to allow head to rest in line with body ● Tuck rolls under shoulders to bring arms forward ● Avoid over-stimulation. Do not place objects too close to baby's face
Car seats (Information for parents)	● Small and preterm babies are at risk of breathing difficulties while travelling in car seats	● Fasten straps before tucking blankets around baby ● Use inserts only if recommended/approved by car seat manufacturer ● Advise parents to refer to RoSPa website www.rospa.org.uk/roadsafety before purchasing car seat ● Advise parents to keep time baby spends in car seat to a minimum and observe closely during journey

Comfort score

Observational tool to assess positioning as a guide to promote comfort and minimise postural deformity

		Least comfortable							Most comfortable
1	**Aah! Factor**	Baby looks uncomfortable (include facial expression and colour) – you feel you want to do something about it	0	1	2	3	4	5	Baby looks relaxed, comfortable, cosy, content
2	**Head and trunk**	Trunk arched/rotated or curved **with** a) Head extended **or** b) Chin on chest **or** c) Head flat to side with twisted neck	0	1	2	3	4	5	Head and trunk in line, with head in midline or three-quarters toward side of head (neck not fully twisted)
3	**Arms**	Flaccid or stiff, and stretched out **or**: a) 'W' position with shoulders retracted (pushed back) **or** b) Twisted/trapped under body **or** between body and bedding **or** immobilised	0	1	2	3	4	5	All the following: a) Shoulders forward b) Arms flexed or relaxed c) Possibility to reach mouth or face with ease
4	**Hands**	a) Fingers splayed **or** b) Hands tightly fisted **or** c) Immobilised or restricted by clothing	0	1	2	3	4	5	One or more of the following: a) Hands relaxed, open, or fingers softly folded b) Hands together or clasped c) Touching head/face/ mouth/own body d) Holding/grasping onto something
5	**Legs and feet**	a) Flaccid, with straight or 'frog-like' posture (abducted and externally rotated at hips) with feet pointing outwards **or** b) Stiff, straight legs with toes splayed or curled tight, and/or pushing hard on bedding, turning outwards	0	1	2	3	4	5	In all positions: a) Flexed legs with feet touching each other, or resting against other leg **and** b) Able to reach boundary to brace feet In prone position, knees should be tucked under body, feet angled towards each other (not turning out)
6	**Arousal**	a) Agitated, jerky, jittery movements **and/or** b) Fussing or crying c) Unconscious	0	1	2	3	4	5	a) Sleeping restfully or quietly awake b) Minimal or smooth movement
	Total								(Max score = 30)

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PROSTAGLANDIN INFUSION • 1/2

DOSAGE

- Ranges from 5–50 nanogram/kg/min (higher doses may be used on the recommendation of a tertiary specialist)
- Antenatal diagnosis of duct dependent lesion:
  - start at 5 nanogram/kg/min
- Cyanotic baby or with poorly palpable pulses who is otherwise well and non-acidotic:
  - start at 5–15 nanogram/kg/min
- Acidotic or unwell baby with suspected duct dependent lesion:
  - start at 10–20 nanogram/kg/min. If no response within first hour, consider an increase of up to 50 nanogram/kg/min

Desired response

- Suspected left-sided obstruction:
  - aim for palpable pulses, normal pH and normal lactate
- Suspected right-sided obstruction:
  - aim for SpO_2 75–85% and normal lactate
- Suspected or known transposition of the great arteries (TGA) or hypoplastic left or right heart syndrome with SpO_2 <70% or worsening lactates
  - liaise urgently with cardiology and/or intensive care/retrieval team (e.g. KIDS) as rapid assessment and atrial septostomy may be necessary

PREPARATIONS

Dinoprostone (Prostaglandin E_2) is the recommended prostaglandin*

Dinoprostone infusion	Other information
● Standard dinoprostone infusion: ● Make a solution of 500 microgram in 500 mL by adding 0.5 mL of dinoprostone 1 mg in 1 mL to a 500 mL bag of suitable diluent (glucose 5% or 10% or sodium chloride 0.45% and 0.9%) ● Transfer 50 mL of this solution into a 50 mL Luer lock syringe and label ● Discard the 500 mL bag immediately into clinical waste – single patient and single dose use only ● Infusion rate: 0.3 mL/kg/hr = 5 nanogram/kg/min	● **Stability:** ○ syringe stable for 24 hr ● **Compatibility:** ○ infuse dinoprostone via separate line ● **Flush:** ○ sodium chloride 0.9% at same rate as infusion ● **Administration:** ○ continuously (short half-life). Ensure 2 working points of IV access at all times ○ infusions can be given via long line, UVC or peripherally ○ extravasation can cause necrosis – use central access if available

* If IV Dinoprostone not available, use Alprostadil (Prostaglandin E_1) IV as alternative (see **Neonatal Formulary**)

Oral Dinoprostone (see Neonatal Formulary)

- Used temporarily on very rare occasions when IV access is extremely difficult
- Discuss with cardiac centre before using
- Use Dinoprostone injection orally
- May not be as effective as IV prostaglandin

SIDE EFFECTS

Common

- Apnoea – tends to occur in first hour after starting prostaglandin or when dose increased. Consider ventilation
- Hypotension – due to systemic vasodilatation. Consider sodium chloride 0.9% bolus 10 mL/kg
- Fever
- Tachycardia
- Hypoglycaemia

Uncommon

- Hypothermia
- Bradycardia
- Convulsions
- Cardiac arrest
- Diarrhoea
- Disseminated intravascular coagulation (DIC)
- Gastric outlet obstruction
- Cortical hyperostosis
- Gastric hyperplasia (prolonged use)

MONITOR

- Heart rate
- Blood pressure
- Respiratory rate
- Temperature
- Oxygen saturations
- Blood gases
- Blood glucose and lactate

TRANSFER OF BABY RECEIVING PROSTAGLANDIN INFUSION

- Contact local retrieval team for transport of babies to cardiac centre (e.g. for Birmingham Children's Hospital – contact KIDS team on 0300 200 1100)
- Keep baby nil-by-mouth for transfer
- For well babies on ≤10 nanogram/kg/min prostaglandin, risk of apnoea is low

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PULMONARY HAEMORRHAGE • 1/2

RECOGNITION AND ASSESSMENT

Definition

- Acute onset of bleeding from endotracheal tube (ETT) associated with cardiorespiratory deterioration and changes on chest X-ray
- Significant pulmonary haemorrhage is most likely to represent haemorrhagic pulmonary oedema. Differentiate from minor traumatic haemorrhage following endotracheal suction

Risk factors

- Preterm babies
- Respiratory distress syndrome (RDS)
- Large patent ductus arteriosus (PDA)
- Excessive use of volume (>20 mL/kg) in first 24–48 hr in babies ≤28 weeks' gestation
- Coagulopathy
- Sepsis
- IUGR
- Grade 3 hypoxic ischaemic encephalopathy (HIE)

Symptoms and signs

- Apnoeas, gasping respirations, desaturations
- Tachycardia >160/min, bradycardia, hypotension, shock, PDA, signs of heart failure
- Widespread crepitations, reduced air entry
- Pink/red frothy expectorate, or frank blood from oropharynx or ETT if intubated

Investigations

- Blood gas (expect hypoxia and hypercarbia with mixed acidosis)
- FBC, clotting
- Chest X-ray (usually shows classic white-out with only air bronchogram visible but may be less striking and resemble RDS)

IMMEDIATE TREATMENT

- Basic resuscitation

Respiratory

- Intubate and ventilate
- Sedate and give muscle relaxant
- PEEP 6–8 cm, even higher PEEP of 10–12 cm of water sometimes required to control haemorrhage
- PIP to be guided by chest expansion and blood gases
- Long inspiratory times (0.5 sec may be needed)
- Endotracheal suction (try to avoid but consider in extreme cases to reduce risk of ETT blockage)
- Ensure adequate humidification
- Avoid chest physiotherapy
- Establish arterial access

Fluid management

- If hypovolaemic, restore circulating volume over 30 min with 10 mL/kg sodium chloride 0.9% or O-negative packed cells if crystalloid bolus already given. Beware of overloading (added volume can be detrimental to LV failure)
- If not hypovolaemic and evidence of left ventricular failure, give furosemide 1 mg/kg IV
- Correct acidosis (see **Neonatal Formulary**)
- If PDA present, restrict fluids to 60–80 mL/kg/24 hr in acute phase
- Further blood transfusion, vitamin K administration and FFP to be guided by haemoglobin concentration, PT and APTT (see **Transfusion of red blood cells** guideline and **Coagulopathy** guideline)

Hypotension/cardiac dysfunction

- If still hypotensive or evidence of cardiac dysfunction after fluid resuscitation, treat hypotension with inotropes (see **Hypotension** guideline)

Infection

- If infection suspected, request septic screen and start antibiotics

SUBSEQUENT MANAGEMENT

Once baby stable

- Inform on-call consultant
- Speak to parents
- Document event in case notes
- Consider single extra dose of natural surfactant in babies with severe hypoxaemia or oxygenation index >20
- If PDA suspected, arrange echocardiogram (see **Patent ductus arteriosus** guideline)
- Perform cranial ultrasound scan to exclude intracranial haemorrhage as this may influence management – see **Cranial ultrasound scans** guideline

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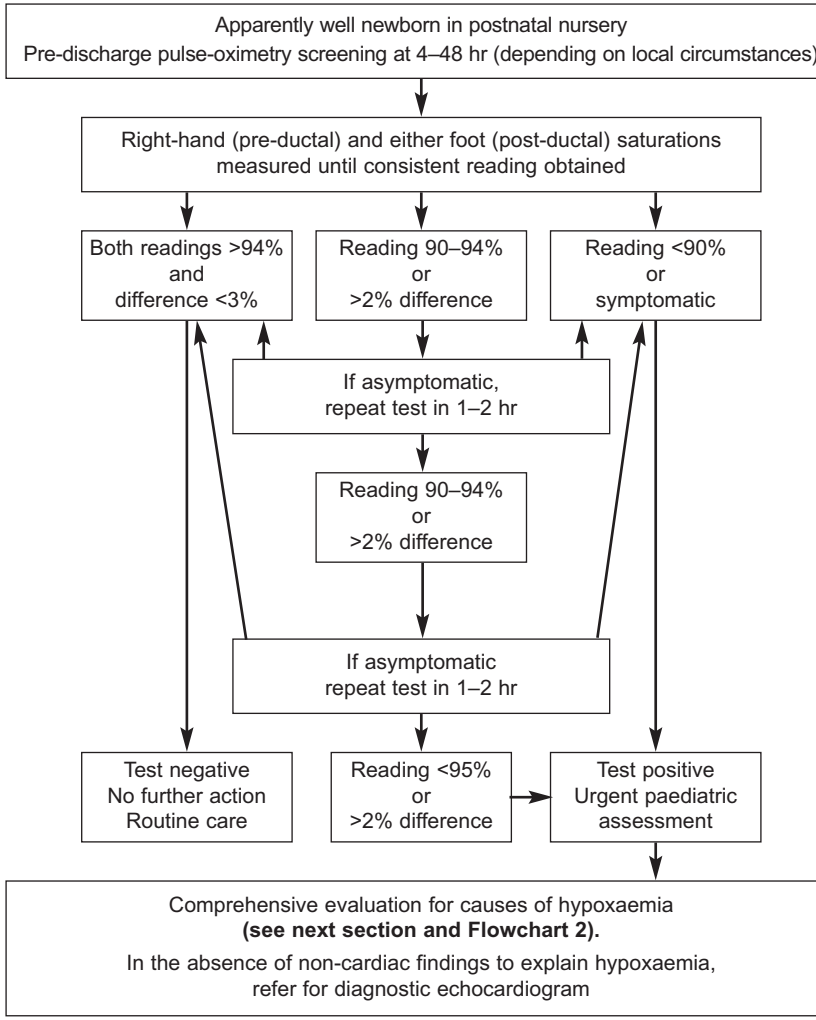
PULSE-OXIMETRY (UNIVERSAL) SCREENING • 1/3

INTRODUCTION

Used in some maternity units following results and recommendation of pulse-oximetry study to detect serious congenital heart disease for babies born ≥34 weeks' gestation along with clinical examination

Flowchart 1: Pulse-oximetry screening test



PULSE-OXIMETRY (UNIVERSAL) SCREENING • 2/3

POSITIVE PULSE-OXIMETRY SCREEN (ABNORMAL TEST)

Initial assessment of test-positive baby

Assess cardiac and respiratory systems

- Is baby symptomatic?
  - quiet, less responsive
  - temperature instability
  - tachypnoea with RR ≥60 min
  - respiratory distress
  - grunting respirations
  - nasal flaring
  - chest wall recession
  - apnoea

Examination

- Abnormal breath sounds
- Heart murmur
- Weak or absent femoral pulse
- Response to oxygen therapy

History

- Previous cardiac defect or congenital infection?
- Suspicion of congenital abnormality on antenatal scan?
- Maternal illness during pregnancy, including diabetes?
- Drug ingestion during pregnancy (anticonvulsants)?
- PROM
- Positive maternal culture
- Maternal fever or raised inflammatory markers
- Foul-smelling liquor
- Mode of delivery
- Need for resuscitation (Apgar score)

MANAGEMENT OF TEST-POSITIVE BABY

Any test-positive baby

- See **Flowchart 2**
- Seen by appropriately trained paediatric staff
- Seek advice from most experienced member of paediatric team

Admission

- Admit to NNU for assessment if:
  - abnormal examination findings **or**
  - pulse-oximetry screening positive on 3 occasions (see **Flowchart 2**)

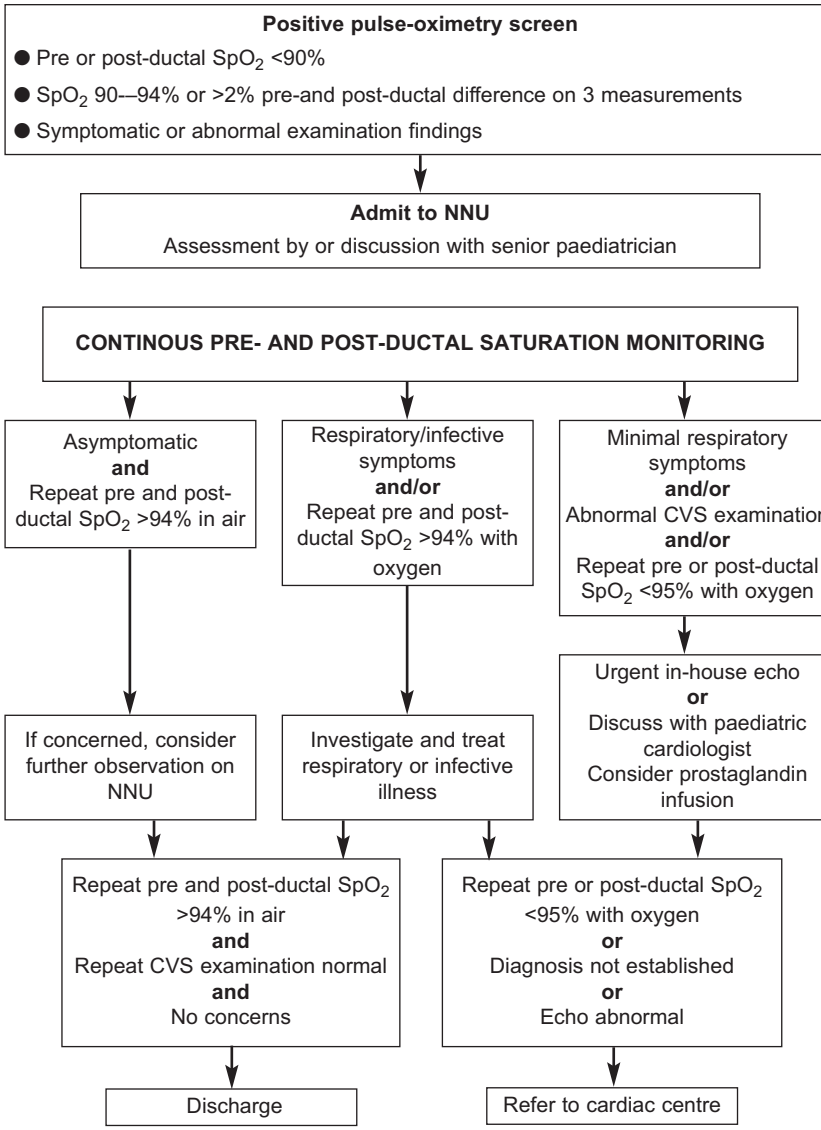
Investigations

- If respiratory/infective condition suspected from history/examination and saturations improve with oxygen
  - FBC/CRP/blood culture/chest X-ray as appropriate

Echocardiogram

- Indicated if any of the following:
  - CVS examination abnormal
  - no respiratory signs
  - no response to oxygen
  - low saturations persist
  - no satisfactory explanation
- If echo unavailable, contact senior regarding Prostaglandin E_2 infusion/paediatric cardiology input – see **Congenital heart disease** guideline and **Prostaglandin infusion** guideline

Flowchart 2: Positive pulse-oximetry screen (abnormal test)



RECTAL WASHOUT USING SYRINGE METHOD • 1/2

INDICATIONS

- Suspected or confirmed Hirschsprung's disease
- Suspected meconium plugs

BENEFITS

- Bowel decompression
- Establishment of feeding
- Weight gain
- Reduced risk of colitis

CONTRAINDICATIONS

- Rectal biopsies taken in preceding 24 hr
- Rectal bleeding (relative contraindication)
- Severe anal stenosis
- Anus not clearly identified
- Known surgical patient (without discussion with surgical team)

ADVERSE REACTIONS

- Bleeding from anus or rectum
- Perforation of bowel; this is very rare
- Electrolyte imbalance if inappropriate fluid used or retained
- Vomiting
- Hypothermia
- Distress to baby and parent

Consent

- Explain procedure to parents/carer and obtain verbal consent

Equipment

- Tube size 6–10 Fr (recommended: Conveen easicath pre-lubricated catheter)
- Lubricating gel (if catheter not lubricated)
- Bladder tip syringe **no smaller than 60 mL**
- Rectal washout solution (sodium chloride 0.9%) warmed to room temperature
- Plastic apron
- Gloves
- Protective sheet
- Receptacle to collect effluent
- Container for clean rectal washout solution
- Blanket to wrap baby

Preparation

- Place all equipment at cot side
- Sedation is not necessary
- Second person to comfort infant using dummy and breast milk/sucrose – see **Pain assessment and management** guideline
- Wash hands, put on gloves and apron
- Position baby supine with legs raised
- Keep baby warm

PROCEDURE

- Inspect and palpate abdomen – note distension or presence of lumps
- Draw up 60 mL solution into syringe and keep on one side
- Insert lubricated catheter into rectum [up to approximately 10 cm (in a term baby) or until resistance felt] noting any flatus or faecal fluid drained
- Massage abdomen in a clockwise direction to release flatus
- Attach syringe containing solution to tube in rectum and gently instil fluid:

Weight ≤2 kg	5–10 mL
Weight >2 kg	20 mL

- Disconnect syringe from tube and drain effluent into receptacle

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RECTAL WASHOUT USING SYRINGE METHOD • 2/2

- Repeat procedure until drained solution becomes clearer, up to a maximum of 3 times
- If solution does not drain out, manipulate tube in and out and massage abdomen
- If no faeces are passed or all the solution is retained, seek medical help
- Re-examine abdomen and note any differences
- Wash, dress and comfort baby

Preparation for discharge

- For discharge, baby should require no more than 2 rectal washouts a day
- Order equipment via paediatric community nurse
- Ward will supply 5 days' equipment
- Discharge letter for GP detailing equipment required
- Arrange home visit with clinical nurse specialist in stoma care if available locally
- Ensure parents competent to perform rectal washout and can describe signs of colitis
- complete rectal washout parent competency sheet if available locally

RE-CYCLING OF STOMA LOSSES VIA A MUCUS FISTULA • 1/2

INDICATIONS

- Stoma output >30 mL/kg/day term baby (>20 mL/kg/day for preterm baby)
- Discrepancy in proximal and distal bowel calibre
- Inability to absorb increasing enteral feeds
- Failure to thrive
- Developing cholestasis

BENEFITS

- Maximise nutrition for sustained weight gain and decrease in parenteral nutrition
- Stimulation of gut hormones and enzymes
- Increases absorption of water, electrolytes and nutrients by utilising distal bowel
- Digestive tract matures and increases in length and diameter with use
- Adaptation is driven by enteral feed in distal bowel
- Preparation of distal bowel for closure
- Baby can, in some circumstances, be managed at home

CONTRAINDICATIONS

- Diseased or compromised distal bowel
- Rectal bleeding (not absolute but discuss with surgical team)
- Anal stenosis or imperforate anus
- Signs of systemic infection
- Effluent too thick to infuse

ADVERSE REACTIONS

- Bleeding from distal stoma
- Perforation of bowel by catheter (rare)
- Leakage of stoma effluent onto peristomal skin may result in excoriation of the skin
- Distress to baby and parent
- Sepsis due to translocation

Before commencing

- **Discuss with surgical team** and confirm they agree with procedure
- whether a distal contrast study is required before re-cycling

Consent

- Explain procedure and potential adverse reactions to parents and obtain verbal consent

Equipment

- Tube (enteral or Foley catheter) size 6 or 8 Fr
- Lubricating gel (if catheter not lubricated)
- Enteral syringe (60 mL)
- Stoma pot to collect stoma effluent
- Extension tubing
- Syringe pump (enteral pump if available)
- Plastic apron and gloves
- Tape and dressing

Documentation

- Record name of surgeon requesting procedure in baby's notes (when commencing)
- Record condition of peri-stomal skin pre-procedure

Preparation

- Place all necessary equipment at cot side
- Wash hands and put on gloves and apron
- Position baby in supine position and keep warm

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RE-CYCLING OF STOMA LOSSES VIA A MUCUS FISTULA • 2/2

PROCEDURE

- Confirm which visible stoma is the mucus fistula – operation note or surgical team
- Pass lubricated catheter into mucus fistula up to 2 cm past end holes
- If using a Foley catheter put only 0.5 mL water into balloon
- Secure catheter to the abdomen with duoderm, tape and leave *in situ*
- Cover mucus fistula with paraffin gauze dressing (e.g. Jelonet)
- Collect stoma fluid from acting stoma into enteral syringe, connect to catheter via extension tube and start re-cycling using syringe pump
- Aim to infuse stoma loss over a few hours, but no more than 4 hr. Discard any effluent older than 4 hr
- If stoma loss <5 mL, re-cycle by syringe as a slow bolus over a few minutes
- Re-cycling should result in bowel actions per rectum of a consistency thicker than the stoma loss
- If bowel actions per rectum are watery and/or frequent, send samples for culture and sensitivity, virology and detection of fat globules and reducing substances. Discuss with surgical team
- If baby develops signs suggestive of sepsis, stop procedure and perform septic screen as per unit policy. Discuss with surgical team

Preparation for home

- Liaise with neonatal surgical nurse
- Teach parents the procedure
- Order equipment via paediatric community nurse
- Ward will supply 5 days' equipment
- Discharge letter for GP detailing equipment required
- Arrange home visit with clinical nurse specialist in stoma care if available locally
- Inform surgical team before discharge

DEFINITION

Failure of the kidneys to maintain metabolic stability in relation to fluid balance, electrolyte balance and excretion of nitrogenous waste

MAIN CAUSES

Congenital

- Usually affects term babies
- Often diagnosed antenatally with renal abnormality/hydrops
- Most commonly an obstructive uropathy
  - posterior urethral valves
  - bilateral pelvi-ureteric junction (PUJ) obstruction
- Non-obstructive cause
  - renal agenesis
  - polycystic kidneys (autosomal recessive)
  - secondary to congenital heart disease
  - hypoperfusion
  - severe acidosis

Asphyxia

- Occurs in severe hypoxic ischaemic encephalopathy
  - direct hypoxic effect or secondary to hypoperfusion
  - usually transient
  - poor prognosis for intact survival when severe

Prematurity

- Normally caused by poor renal perfusion secondary to:
  - hypovolaemia
  - hypotension
  - hypoxaemia
  - sepsis
- Inappropriate ADH in ventilated babies causes transient oliguria
  - will correct spontaneously as lung compliance improves

Other

- Renal vein thrombosis
- Renal artery thrombosis

DIAGNOSIS

- Renal abnormalities (prenatal)
- Risk factors (i.e. severe asphyxia/sepsis/hypotension/ congenital heart disease)
- Oliguria (<1 mL/kg/hr)
- Hypovolaemia
- Electrolyte disturbance (particularly raised potassium)
- Rising creatinine after 48 hr postpartum

PREVENTION

- This is the most important approach in the preterm baby
- Ensure adequate fluid intake particularly in very preterm babies with excessive transepidermal water loss (see **Fluid balance** below)
- Extra care required when using radiant heaters in contrast to high humidification in incubator (see **Hypothermia** guideline)
- Maintain a safe blood pressure (see **Hypotension** guideline)

INVESTIGATIONS

Monitor

- Weigh 12-hrly
- BP 12-hrly
- Cardiac monitor to detect arrhythmias

Urine

- Dipstick (proteinuria; sediment, such as blood, casts, tubular debris, indicate intrinsic problem; WBC and nitrites suggest infection)
- Microscopy and culture
- Electrolytes, urea, creatinine, osmolality

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Blood

- U&E, creatinine 8-hrly
- Blood gas, pH 4–8 hrly
- Blood cultures, CRP
- Glucose 4-hrly
- Calcium, phosphate, magnesium, albumin
- Blood count (film and platelets)

Typical biochemical changes in acute renal failure (ARF)

Increased urea, creatinine, K^+, PO_4^{2-}

Reduced Na^+, Ca^{2+}, HCO_3^-, pH

Imaging

- If umbilical artery catheter (UAC) in place, abdominal X-ray to check position
  - confirm UAC tip does not sit at L1
- Renal ultrasound scan
  - to detect congenital causes, post-renal causes, pyelonephritis and renal vein thrombosis

TREAMENT

Correct underlying cause

- Surgical approach to uropathy unless prognosis hopeless (e.g. Potter's syndrome)
- Correct hypovolaemia, but avoid over-hydration in established renal failure
  - sodium chloride 0.9% 10–20 mL/kg IV
  - if blood loss known or suspected, give 10–20 mL/kg packed red cells
- If hypotensive in absence of fluid depletion:
  - start inotrope infusion: (see **Hypotension** guideline)
- Open duct in duct-dependent circulation in congenital heart disease (see **Cardiovascular** guidelines)
- Antibiotics for sepsis
- Stop all nephrotoxic drugs (e.g. aminoglycosides, vancomycin, furosemide) if possible
- Consider trial of furosemide, if there are signs of fluid overload
- In the majority of cases the kidneys will recover in 24–48 hr

Supportive

- Assess fluid balance when problem recognised

Signs of depletion/hypovolaemia

- Cold peripheries
- Delayed capillary refill
- Tachycardic
- Oliguric (<1 mL/kg/hr) or anuric

Signs of overload

- Tachypnoeic
- Oedema
- Excessive weight gain
- Raised blood pressure
- Gallop rhythm
- Hepatomegaly

Fluid balance

- If baby hypovolaemic/hypotensive, it is important to correct this before instituting fluid restriction (see above)
- Strictly monitor all intake and output
- Restrict fluid intake to minimal maintenance fluids
- Calculate maintenance fluid:
  - maintenance fluid = insensible losses + urine output + GIT losses
  - insensible losses:
    <1500 g (at birth) = 50–80 mL/kg/day
    >1500 g (at birth) = 15–35 mL/kg/day
  - for babies in well-humidified incubator or receiving humidified respiratory support, use lower figure
- Replace maintenance fluid as glucose10–20% (electrolyte-free)
- Electrolytes will be required if electrolyte losses ongoing (e.g. diarrhoea, fistula)

- Weigh twice daily
  - best guide to change in hydration is change in body weight
  - stable weight indicates overhydration and need to reduce fluid intake further
  - aim to achieve 1% loss of body weight daily

Hyperkalaemia

- See **Hyperkalaemia** guideline

Acidosis

- Monitor pH 8-hrly
  - if metabolic acidosis is present with pH <7.2, give sodium bicarbonate

Hyponatraemia

- Low sodium is more likely to indicate fluid overload than a deficit in body sodium
- Unless evidence of dehydration, treatment should be fluid restriction with maintenance sodium intake of 2–3 mmol/kg/day
- If severe (Na <120 mmol/L) and associated with neurological symptoms, such as seizures:
  - can use hypertonic saline (sodium chloride 3%) 4 mL/kg over a minimum of 15 min; check serum sodium immediately after completion of infusion
- If baby still fitting, dose can be repeated **after** assessing serum sodium concentration
- During recovery phase, babies rarely become polyuric, when sodium chloride 0.45% is typically required, although this will depend on a measurement of urinary sodium concentration

Dialysis

- Hardly ever used in this population because of technical difficulty and poor prognosis
  - only applicable to term babies with a treatable renal problem

MONITORING

- Most useful variable is urine output
- In newborn renal failure, anuria/oliguria is the normal situation and increasing urine output indicates recovery
- Creatinine estimation is often misleading in first few days:
  - in utero, creatinine is cleared by the placenta
  - after delivery, creatinine production by muscles is not stable and can be influenced heavily by muscle damage resulting from delivery/hypoxia/sepsis
  - after 48–72 hr, it can be used, but the trend is much more valuable than the absolute concentration
- Urea estimation is misleading
  - it is influenced by tissue breakdown (e.g. bruises/swallowed blood)
  - conversely, little is produced when protein intake is compromised

CONCLUSION

In the newborn baby, the vast majority of cases of renal failure will recover if the underlying cause is addressed and supportive management provided to maintain fluid and electrolyte balance until recovery takes place, normally over 24–48 hr. If there is no improvement, discuss with paediatric nephrologist

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- Check equipment daily, and before resuscitation
- Follow Resuscitation Council UK Guidelines https://www.resus.org.uk/resuscitation-guidelines/

CORD CLAMPING

- Uncompromised term and preterm infants delay cord clamping for at least 1 min from complete delivery of baby
- Stripping (milking) of the cord is not recommended
- If immediate resuscitation is required, clamp cord as soon as possible

DRY AND COVER

- ≥32 weeks' gestation, dry baby, **remove wet towels** and cover baby with **dry towels**
- <32 weeks' gestation, do not dry body but place baby in plastic bag feet first, dry head only and put on hat
- Aim to maintain body temperature 36.5ºC–37.5ºC (unless decision taken to start therapeutic hypothermia)
- Preterm <32 weeks' gestation may require additional interventions to maintain target temperature:
  - warmed humidified respiratory gases
  - thermal mattress alone
  - increased room temperature (≥26ºC) plus plastic wrapping of head and body plus thermal mattress

ASSESS

- Assess **colour, tone, breathing and heart rate**

If baby very floppy and heart rate slow, assist breathing immediately

- Reassess heart rate, breathing and chest movement every 30 sec throughout resuscitation process
- If help required, request **immediately**

If baby not breathing adequately by 90 sec, assist breathing

CHECK AIRWAY

For baby to breathe effectively, airway must be open

- To open airway, place baby supine with head in **'neutral position'**
- If very floppy, give chin support or jaw thrust while maintaining the neutral position

IMMEDIATE TREATMENT

Airway

- Keep head in neutral position
- Use T-piece and soft round face mask, extending from nasal bridge to chin
- Give 5 inflation breaths, sustaining inflation pressure (**Table 1**) for 2–3 sec for each breath
- Give PEEP of 5 cm H_2O
- Inflation breaths:
  - term start in air
  - preterm use low oxygen concentration (≤30%)
- Look for chest movement

Table 1: Inflation pressure (avoid using pressure higher than recommended)

Term baby	30 cm of water
Preterm baby	20–25 cm of water

No chest movement

Ask yourself:

- Is head in neutral position?
- Is a jaw thrust required?
- Do you need a second person to help with airway to perform a jaw thrust?
- Is there an obstruction and do you need to look with a laryngoscope and suck with a large-bore device?

- Consider placing oropharyngeal (Guedel) airway under direct vision using laryngoscope
- Is inflation time long enough?
- if no chest movement occurs after alternative airway procedures above have been tried (volume given is a function of time and pressure), a larger volume can be delivered if necessary by inflating for a longer time (3–4 sec)
- Attach saturation monitor to right hand – see **Saturation monitoring** for guidance on SpO_2 targets

Endotracheal intubation

Nasal CPAP rather than routine intubation may be used to provide initial respiratory support of all spontaneously breathing preterm infants with respiratory distress

Indications

- Severe hypoxia (e.g. terminal apnoea or fresh stillbirth)
- Stabilisation of airway
- Congenital diaphragmatic hernia

Safe insertion of endotracheal tube requires skill and experience

If you cannot insert a tracheal tube within 30 sec, revert to mask ventilation

Capnography can help to assess endotracheal tube placement

Breathing

- Most babies have a good heart rate after birth and establish breathing by 90 sec
- if not breathing adequately give **5 inflation breaths,** preferably using air at pressures in **Table 1**
- Heart rate should rapidly increase as oxygenated blood reaches heart

Do not move onto ventilation breaths unless you have a heart rate response OR you have seen chest movement

Review assessment after inflation breaths

- Is there a rise in heart rate?
- Is there chest movement with the breaths you are giving?
- If no spontaneous breathing provided the heart rate has increased and chest movement has been obtained, perform 30 sec of **ventilation breaths,** given at a rate of 30 breaths/min (1 sec inspiration)
- If baby is floppy with slow heart rate and there is chest movement, start cardiac compressions with ventilation breaths immediately after inflation breaths
- Increase inspired oxygen concentration every 30 sec by 30% e.g. 30–60–90% depending on response – see **Saturation chart**

Chest compression

- Use if heart rate approximately <60 beats/min (do not try to count accurately as this will waste time)

Start chest compression only after successful inflation of lungs

Table 2: Outcome after 30 sec of ventilation breaths

Heart rate	Breathing	Action
Increases	Not started breathing	● Provide 30–40 breaths/min ● Where available, use PEEP at 5 cm water with T-piece system
<60	Obvious chest movement	● Start chest compressions (see overleaf)

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Figure 1

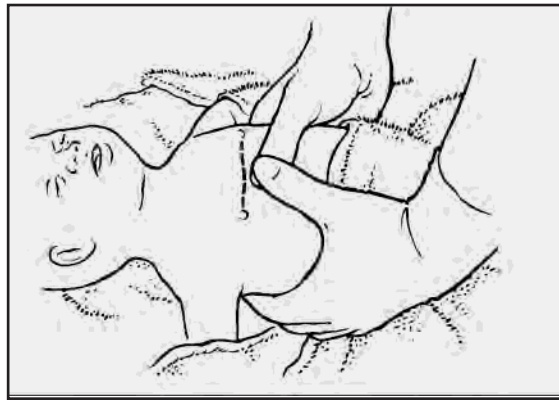
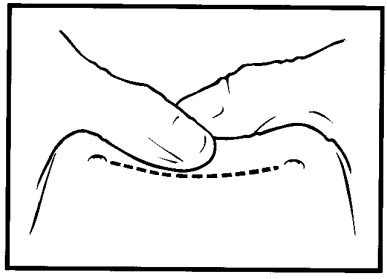
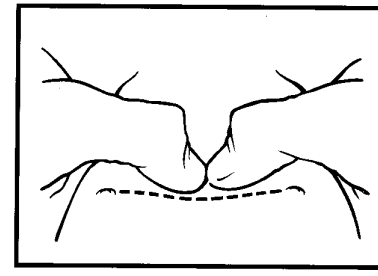


Figure 2





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Ideal hold (figure 1/figure 2)

- Circle chest with both hands so that thumbs can press on the sternum just below an imaginary line joining the nipples with fingers over baby's spine

Alternative hold (less effective)

- Compress lower sternum with fingers while supporting baby's back. The alternative hand position for cardiac compressions can be used when access to the umbilicus for UVC catheterisation is required, as hands around the chest may be awkward

Action

- Compress chest quickly and firmly to reduce the antero-posterior diameter of the chest by about one-third, followed by full re-expansion to allow ventricles to refill
- remember to relax grip on the chest during IPPV, and feel for chest movement during ventilation breaths, as it is easy to lose neutral position when cardiac compressions are started

Co-ordinate compression and ventilation to avoid competition. Aim for 3:1 ratio of compressions to ventilations and 90 compressions and 30 breaths (120 'events') per min

Blood

- If there is evidence of fetal haemorrhage and hypovolaemia, consider giving O negative emergency blood

Resuscitation drugs

- Always ask about drugs taken recently by, or given to mother
- Give drugs only if there is an undetectable or slow heartbeat despite effective lung inflation and effective chest compression
- Umbilical venous catheter (UVC) is the preferred route for urgent venous access
- Recommence cardiac compressions and ventilation breaths ratio 3:1 after each drug administration and re-assess after 30 sec
- If no heart rate increase, progress onto next drug

Adrenaline 1:10,000

- 0.1 mL/kg (10 microgram/kg) 1:10,000 IV
- Repeat dose 0.3 mL/kg (30 microgram/kg) 1:10,000 IV
- Administration via endotracheal tube use only when IV access not available; dose is 0.5–1.0 mL/kg (50–100 microgram/kg) 1:10,000

Sodium bicarbonate 4.2%

- 1–2 mmol/kg (2–4 mL/kg) IV (never give via ET tube)

Glucose 10%

- 2.5 mL/kg IV slowly over 5 min

Sodium chloride 0.9%

- 10 mL/kg IV

Naloxone

- Give only after ventilation by mask or ETT has been established with chest movement seen and heart beat >100 beats/min
- If mother has been given pethidine within 2–4 hr of delivery, give IM naloxone:
  - 100 microgram (0.25 mL) for small preterm babies
  - 200 microgram (0.5 mL) for all other babies

WHEN TO STOP

- If no sign of life after 10 min, outlook is poor with few survivors, majority will have cerebral palsy and learning difficulties

Continue resuscitation until a senior member of staff advises stopping

MONITORING

Saturation monitoring

- Oxygen monitoring is activated when paediatrician/2nd pair of hands arrives. In the meantime, the person initiating resuscitation carries out all the usual steps in resuscitation
- Do not stop resuscitation for a saturation probe to be attached
- Attach saturation probe to the right hand and connect to the monitor once 5 inflation breaths have been given
- SpO_2 should spontaneously improve as **Table 3**

Table 3

Time (min)	Acceptable pre-ductal SpO_2 (%)
2	60
3	70
4	80
5	85
10	90

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Heart rate monitoring

- Best by listening with stethoscope
- Pulse-oximetry
- ECG monitoring, if available, can give rapid accurate and continuous heart rate reading. However it does not indicate the presence of a cardiac output and should not be the sole means of monitoring

Air to oxygen

- If inflation breaths produce a response and SpO_2 monitoring is available with a reliable trace, target saturations as in **Table 3**
- If inflation breaths have been successful and chest movement seen but colour/SpO_2 (if available) not improved, increase oxygen to 30%
- If no response, increase by increments of 30% every 30 sec i.e.:

  Term air: 30–60–90/100%

  Preterm air: 30–60–90%
- If chest compressions are required following chest movement with inflation breaths, increase oxygen to 90%
- If SpO_2 above levels in **Table 3** or >95% at 10 min of life, reduce oxygen

Meconium deliveries

- Do not attempt to suction nose and mouth whilst head is on perineum
- If thick particulate meconium and baby not breathing inspect airway under direct vision before delivering inflation breaths but aim to inflate lungs within 1st min
- Only intubate if suspected tracheal obstruction, routine intubation is not necessary

Preterm deliveries

- Nasal CPAP rather than routine intubation may be used to provide initial respiratory support of all spontaneously breathing preterm babies with respiratory distress. Give PEEP at 5 cm H_20 via mask ventilation with oxygen supplementation as appropriate on the resuscitaire continuing PEEP support on transfer to NICU
- If respiratory effort is poor, at any point, or baby's condition deteriorates, intubate and ventilate

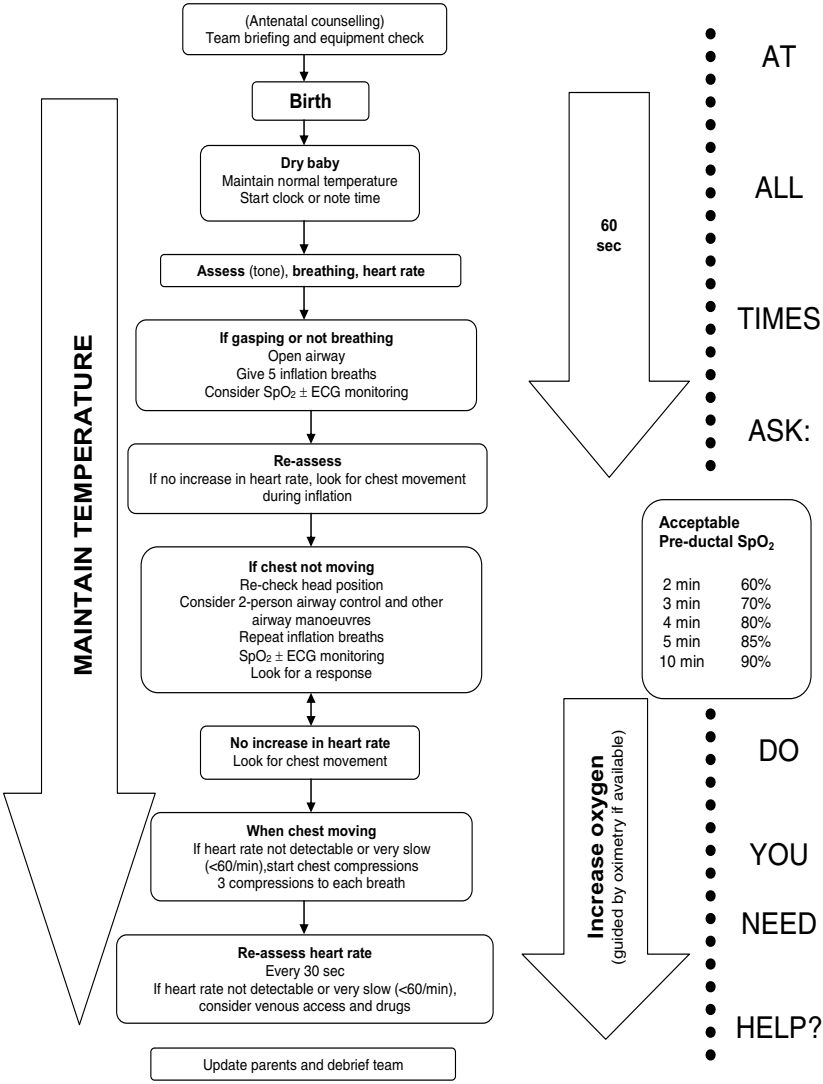
DOCUMENTATION

- Make accurate written record of facts (not opinions) as soon as possible after the event
- **Record:**
  - when you were called, by whom and why
  - condition of baby on arrival
  - what you did and when you did it
  - timing and detail of any response by baby
  - date and time of writing your entry
  - a legible signature

COMMUNICATION

- Inform parents what has happened (the facts)

Newborn life support algorithm



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RETINOPATHY OF PREMATURITY (ROP) • 1/2

INDICATIONS

- All babies either ≤1500 g birth weight or <32 completed weeks' gestation

PROCEDURE

When to screen

Indication	When to start screen
Born <27 weeks' gestation	30–31 weeks post-conceptual age
Born 27–32 weeks' gestation or ≤1500 g	4–5 weeks postnatal age

- If baby to be discharged before screening due, bring eye examination forward to be seen before discharge

How often to screen

- Determined by ophthalmologist but minimum recommendations are:
  - weekly for vessels ending in zone I or posterior zone II; or any plus or pre-plus disease; or any stage 3 disease in any zone
  - every 2 weeks in all other circumstances until criteria for discontinuing screening are met (see below)

When to stop screening

- In babies without ROP, when vascularisation has extended into zone III, usually after 36 completed weeks postnatal age
- In babies with ROP, when the following are seen on at least 2 separate occasions:
  - lack of increase in severity
  - partial resolution progressing toward complete resolution
  - change in colour of the ridge from salmon-pink to white
  - transgression of vessels through demarcation line
  - commencement of process of replacement of active ROP lesions by scar tissue

How to screen

- Arrange screening with ophthalmologist

Preparation for screening

- Prescribe eye drops for night before screening on drug chart
- Give cyclopentolate 0.5% and phenylephrine 2.5%
  - 1 drop into each eye. Give 2 doses, 15 min apart, 30 min before examination
  - if in any doubt whether drop has gone into eye, give another drop immediately (pupil must be fully dilated)
  - close eyelids after instillation of eye drops, wipe off any excess

Care during procedure

- A competent doctor/ANNP available during eye examinations
- Use comfort care techniques (nesting, swaddling +/- dummy)
- Consider oral sucrose – see **Pain assessment and management** guideline before examination (maximum 3 doses)
- If eyelid speculum or indentor to be used, topical anaesthesia (proxymetacaine 0.5% eye drops) administered before examination
- Avoid bright light and cover incubator/cot for 4–6 hr after examination

AFTERCARE

- Complete ad hoc ROP form in BadgerNet documentation
- Eye examination results and recommendations for further screening must be included in transfer letter, together with ophthalmological status, future recommendations for screening intervals and out-patient follow-up arrangements
- Subsequent examinations must be documented by ophthalmologist in baby's medical notes

Parent information

http://www.bliss.org.uk/factsheets

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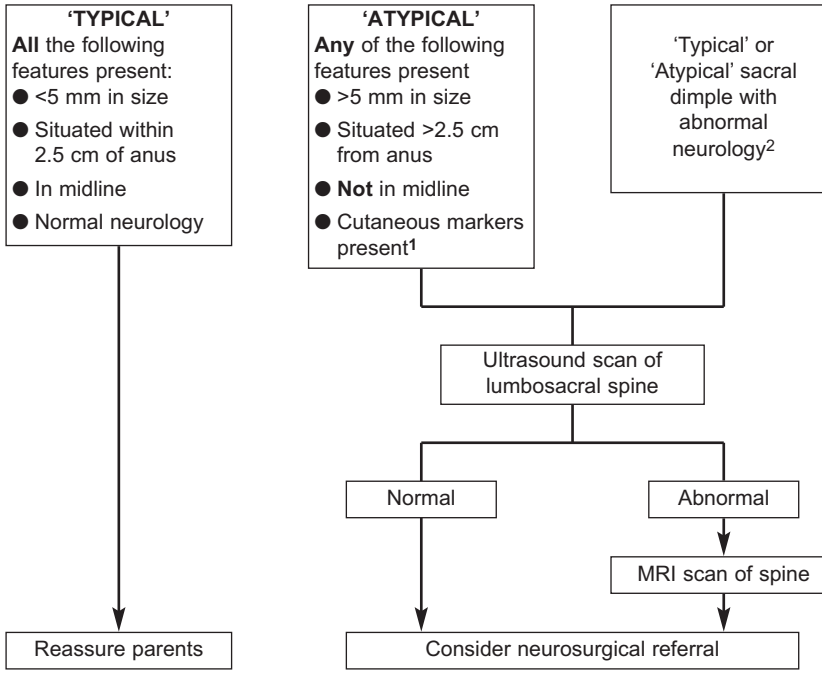

Notes

1. Cutaneous markers e.g. pigmentation, hairy patch, abnormal skin texture, lipoma, cyst, skin tag, haemangioma and swelling
2. Check for neurological signs in lower limbs – tone, deep tendon reflexes, presence of patulous anus etc.

Neonatal seizures are a manifestation of neurological dysfunction. Seizures occur in 1–3% of term newborn babies and in a greater proportion of preterm babies. They can be subtle, clonic, myoclonic or tonic

RECOGNITION AND ASSESSMENT

Physical signs

In addition to obvious convulsive movements, look for:

- Eyes: staring, blinking, horizontal deviation
- Oral: mouthing, chewing, sucking, tongue thrusting, lip smacking
- Limbs: boxing, cycling, pedalling
- Autonomic: apnoea, tachycardia, unstable blood pressure
- Focal (one extremity) or multifocal (several body parts)
- Perform a detailed physical examination and neurological assessment

Differential diagnosis

- Jitteriness: tremulous, jerky, stimulus-provoked and ceasing with passive flexion
- Benign sleep myoclonus: focal or generalised, myoclonic limb jerks that do not involve face, occurring when the child is going to or waking up from sleep; EEG normal; resolves by 4–6 months of age
- Differentiation between jitteriness and seizures

Sign	Jitteriness	Seizure
Stimulus provoked	Yes	No
Predominant movement	Rapid, oscillatory, tremor	Clonic, tonic
Movements cease when limb is held	Yes	No
Conscious state	Awake or asleep	Altered
Eye deviation	No	Yes

Investigations

First line

- Blood glucose
- Serum electrolytes including calcium, magnesium
- FBC coagulation (if stroke suspected, thrombophilia screen)
- Blood gas
- Blood culture
- CRP
- LFT
- Serum ammonia, amino acids
- Urine amino acids, organic acids
- Lumbar puncture (LP) – CSF microscopy and culture (bacterial and viral)
- Cranial ultrasound scan (to exclude intracranial haemorrhage)
- EEG (to identify electrographic seizures and to monitor response to therapy). Consider cerebral function monitor (CFM–aEEG)

Second line

- Congenital infection screen (TORCH screen)
- MRI scan
- Screen for maternal substance abuse
- Serum acylcarnitine, biotinidase, VLCFA, uric acid, sulphocysteine, total and free homocysteine
- CSF: lactate, glucose, glycine (paired with bloods, carried out before LP). Freeze spare sample

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- Trial of pyridoxine treatment, preferably during EEG monitoring, may be diagnostic as well as therapeutic
- Contact metabolic team for further advice

TREATMENT

- Ensure ABC
- Treat underlying cause (hypoglycaemia, electrolyte abnormalities, infection)
  - hypoglycaemia: give glucose 10% 2.5–5 mL/kg IV bolus, followed by maintenance infusion. Wherever possible, obtain 'hypoglycaemia screen' (see **Hypoglycaemia** guideline) before the administration of glucose bolus
  - hypocalcaemia (total Ca <1.7 mmol/L or ionized Ca <0.64 mmol/L): give calcium gluconate 10% 0.5 mL/kg IV over 5–10 min with ECG monitoring (risk of tissue damage if extravasation)
  - hypomagnesaemia (<0.68 mmol/L): give magnesium sulphate 100 mg/kg IV or deep IM (also use for refractory hypocalcaemic fit)
- Pyridoxine (50–100 mg IV) can be given to babies unresponsive to conventional anticonvulsants or seek neurologist opinion

Initiation of anticonvulsants (for immediate management follow Flowchart)

- Start anticonvulsant drugs when:
  - prolonged: >2–3 min
  - frequent: >2–3/hr
  - disruption of ventilation and/or blood pressure

Administration

- Intravenously to achieve rapid onset of action and predictable blood levels
- To maximum dosage before introducing a second drug

Maintenance and duration of treatment

- Keep duration of treatment as short as possible. This will depend on diagnosis and the likelihood of recurrence
- May not require maintenance therapy after loading dose
- If maintenance therapy is required:
  - monitor serum levels
  - develop emergency seizure management plan, including, if required, a plan for buccal/intranasal midazolam

Stopping treatment

- Consider:
  - seizures have ceased and neurological examination is normal **or**
  - abnormal neurological examination with normal EEG

DISCHARGE AND FOLLOW-UP

Discharge

- Ensure parents are provided with appropriate discharge documentation
  - seizure emergency management plan
  - copy of discharge summary, including: types of seizures, medications/anticonvulsants administered

Follow-up

- Follow-up will depend on cause of seizures and response to treatment
- Consider: specialist follow-up for babies discharged on anticonvulsant drugs or as per local unit guideline

Further information for patients

www.bcmj.org/sites/default/files/HN_Seizures-newborns.pdf

Anticonvulsant drug therapy schedule

Drug	Loading dose	Maintenance dose
Phenobarbital	● 20 mg/kg IV – administer over 20 min ● Optional additional doses of 10 mg/kg each until seizures cease or total dose of 40 mg/kg can be given	● 2.5–5 mg/kg IV or oral once daily beginning 12–24 hr after loading dose
Phenytoin	● 20 mg/kg IV – maximum infusion rate of 1 mg/kg/min ● Monitor cardiac rate and rhythm and blood pressure for hypotension	● 2.5–5 mg/kg IV or oral 12-hrly ● Measure trough levels 48 hr after IV loading dose
Midazolam (if no response to above drugs)	● Give 200 microgram/kg IV over 5 min followed by continuous infusion 60–300 microgram/kg/hr ● Reconstitution and dilution: Dilute 15 mg/kg of midazolam up to a total of 50 mL with sodium chloride 0.9%, glucose 5% or glucose 10% 0.1 mL/hr = 30 microgram/kg/hr ● may cause significant respiratory depression and hypotension if injected rapidly, or used in conjunction with narcotics	
Clonazepam (if midazolam not available)	● 100 microgram/kg IV push over 2 min ● repeat dose after 24 hr if necessary ● concurrent treatment with phenytoin reduces the half-life of clonazepam	
Lidocaine (if above medications ineffective)	● 2 mg/kg IV over 10 min, then commence infusion ● 6 mg/kg/hr for 6 hr, **then** 4 mg/kg/hr for 12 hr, **then** 2 mg/kg/hr for 12 hr	Exercise caution with phenytoin as concurrent intravenous infusion of both these drugs has a cardiac depressant action

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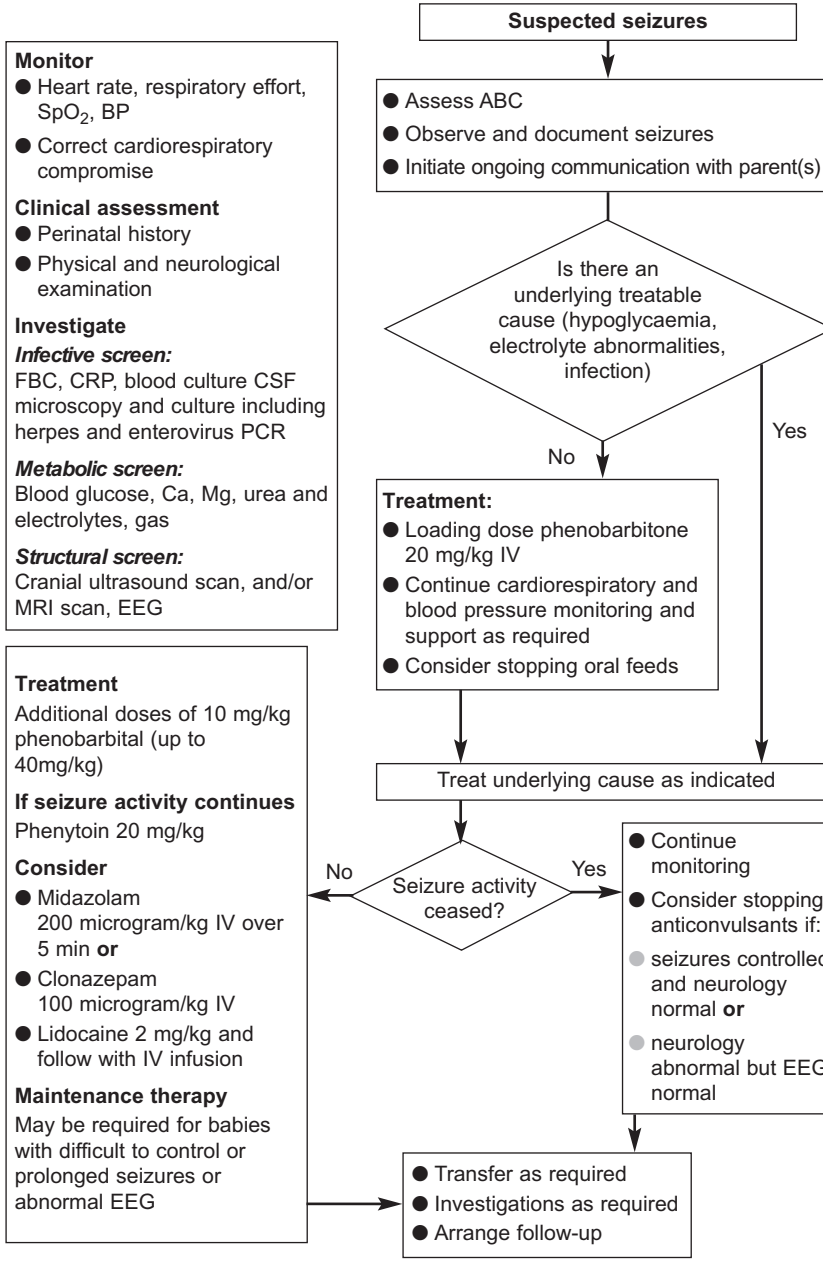
Flowchart: Immediate management



SKIN BIOPSY FOR INBORN ERRORS OF METABOLISM • 1/2

INDICATIONS

- Diagnosis of inherited metabolic disorders
- Wherever possible, discuss biopsy and arrangements with Department of Newborn Screening and Biochemical Genetics, Birmingham Children's Hospital 0121 333 9942
  - this should include discussion about which specimen bottles and transport medium to use
  - confirm instructions for storage and transport to laboratory with your local laboratory

Skin biopsy is often collected for histological analysis. Contact your local histopathology department for advice on sample handling

EQUIPMENT

- Forceps: fine non-bend watchmaker's or dissecting
- Cotton wool balls and gallipots
- Dressing towel
- Plastic apron
- Size 15 scalpel blade and no. 3 handle
- 25 gauge needle (orange top)
- 23 gauge needle (blue top)
- 21 gauge needle (green top) for drawing up lidocaine
- 2 mL syringe
- Cleaning solution as per unit policy
- Lidocaine 1%
- Bottles of culture medium
- Sterile gloves
- Steristrips
- Dressings:
  - 1 small transparent dressing (e.g. Tegaderm/Opsite)
  - gauze swabs
  - elasticated cotton or other bandage

SAMPLE REQUIREMENTS

- At least 1 mm x 1 mm of skin (ideally 2 mm x 2 mm) from preferred site (e.g. inner side of forearm or posterior aspect just above elbow)
  - choose site carefully as even a small scar on coloured skin will be very obvious
  - if post-mortem, take skin from over scapula as this leaves less obvious damage (see **Post-mortem specimens**)

PROCEDURE

Consent

- Inform parents of reason for biopsy, explain procedure and risks including:
  - healing and scarring
  - possibility of contamination
  - poor growth
- Obtain and record consent

Technique

Maintain strict asepsis using 'no touch' technique

- Wash hands and put on apron and sterile gloves
- Cleanse site
  - ensure cleaning fluid does not pool beneath baby
- Sedation if appropriate
- Inject lidocaine 1%, a little intradermally and remainder subcutaneously to anaesthetise an area 1.5 x 1 cm
- Wait 5 min to ensure site anaesthetised
- Cleanse again, wipe off and dry using sterile cotton wool or gauze swabs

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SKIN BIOPSY FOR INBORN ERRORS OF METABOLISM • 2/2

Method A

- Using fine forceps, grip a fold of skin between blades so that a length of skin 3 mm x 2 mm protrudes
- slice off in one stroke by running scalpel blade along upper edge of forceps blades
- if skin too thick or oedematous to grip, proceed to **Method B**

Method B

- Pierce skin with 23 or 21 gauge needle and lift to produce 'tenting'
- cut off tip of tent to produce a round 'O' shaped piece of skin approximately 2 mm
- Place into culture medium bottle immediately (lid of bottle removed by assistant for shortest possible time)
- Complete request form with:
- clinical details
- date and time of sampling

Dressing wound

- Although it may bleed freely, wound is usually partial thickness and should not require stitching
- apply pressure to stanch bleeding
- apply Steristrips and sterile dressing, bandage if necessary
- Remove bandage after a few hours, but leave dressing for several days
- Reassure parents that scar, when visible, will be seen as a fine line

Transport

- Once sample taken, send to Inherited Metabolic Diseases Laboratory as soon as possible
- if unable to arrange transport immediately, store sample at +4ºC for maximum of 12 hr before despatch, **do not freeze sample**

POST-MORTEM SPECIMENS

- In accordance with Human Tissue Act, post-mortem samples must be taken only on licensed premises (or satellites thereof). Check with your pathology laboratory manager

Specimens taken after death present a high risk of infection and possible failure of culture. Follow strict aseptic technique

- Take 2 biopsies from over scapula (as this leaves less obvious damage), as soon as possible after death, ideally before 48 hr have elapsed
- Send sample to Inherited Metabolic Disease Laboratory immediately, or store at +4ºC before dispatch for maximum of 12 hr, **do not freeze**
- Include clinical details, date and time of sampling, and date and time of death on request form

INTRODUCTION

Neonatal skin care is very important, especially if baby is premature and/or in a critical condition. Special emphasis is placed on skin barrier properties, transcutaneous absorption, transepidermal water loss and maintaining skin integrity

PURPOSE

- To maintain integrity of the skin
- Prevent/minimise skin damage
- Minimise water loss and heat loss
- Protect against absorption of toxic materials and drugs
- Treat skin damage
- Ensure optimal healing of wounds

RISK FACTORS

- Prematurity
- Birth weight <1000 g
- Oedema
- Immobility
- Congenital skin problems
- Invasive procedures

Birth weight <1250 g

Careful handling

- Most serious injuries can occur in first hours and days after birth when baby often requires intensive care monitoring

Frequent bathing changes skin pH, disrupts protective acid mantle and is not recommended

Preventing/minimising risk of skin injury/infection in all babies

- Ensure adequate hand hygiene to protect baby's skin from cutaneous infection e.g. *Staphylococcus aureus*
- Change baby's position 4–6 hrly as condition dictates and place intravenous lines and monitoring leads away from skin
- Check all substances that come into contact with baby's skin. Avoid using those with potential percutaneous absorption
- Protect areas of skin from friction injury with soft bedding and supporting blanket rolls
- Use pressure-relief mattresses (e.g. Spenco)
- Change nappy 4–6 hrly as condition dictates. Wash nappy area with warm water and dry well
- Nurse baby, especially extremely low birth weight, in humidity of 60–90% to protect skin, maintain body temperature and prevent water loss
- Do not use ECG leads on babies <26 weeks' gestation

Disinfectants

- Disinfect skin surfaces before invasive procedures such as intravenous cannulation, umbilical vessel catheterisation, chest drain insertion, intravenous puncture or heel pricks for laboratory samples
- Use disinfectant pre-injection as per unit policy

Adhesives

- In all newborns, use adhesives sparingly to secure life support, monitoring and other devices
- Wherever possible, use Duoderm under adhesive tape. Duoderm adheres to skin without the use of adhesive and will prevent epidermal stripping
- Remove adhesives carefully with warm water on a cotton wool ball. Alcohol is very drying, is easily absorbed and should be avoided

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CORD CARE

Immediate

- Clean cord and surrounding skin surface as needed with cleanser used for initial or routine bathing and rinse thoroughly or cleanse with sterile water
- Clean umbilical cord with warm water and cotton wool and keep dry

Ongoing

- Keep cord area clean and dry. If cord becomes soiled with urine or stool, cleanse area with water
- Educate staff and families about normal mechanism of cord healing
- Teach parents or care-givers to keep area clean and dry, avoid contamination with urine and stool, keep nappy folded away from area and wash hands before handling baby's umbilical cord area

NAPPY DERMATITIS

To maintain optimal skin environment

- Change nappy frequently
- Use nappy made from absorbent gel materials
- Use cotton wool and warm water. **Do not** use commercially available baby wipes
- Encourage/support breastfeeding throughout infancy

Prevention strategies for babies at risk

- Use petrolatum-based lubricants or barriers containing zinc oxide
- Avoid use of products not currently recommended for newborns (e.g. polymer barrier films)

Treat significant skin excoriation

- Identify and treat underlying cause
- Protect injured skin with thick application of barrier containing zinc oxide

Presence of red satellite lesions/culture indicates Candida albicans nappy rash

- Rash will become more intense if covered by occlusive ointments. Treatment includes antifungal ointments or cream and exposure to air and light
- Do not use powders in treatment of nappy dermatitis
- Avoid use of antibiotic ointments

TYPES OF STOMA

Split stoma and mucus fistula

- Bowel is divided and both ends brought out through abdominal wall separately
- Proximal end is the functioning stoma and the distal end is the mucus fistula
- Operation note should make it clear where the stoma and mucus fistula are situated on the abdomen
- Stoma and mucus fistula may sometimes be fashioned side-by-side without a skin bridge. The wound is closed with dissolvable sutures

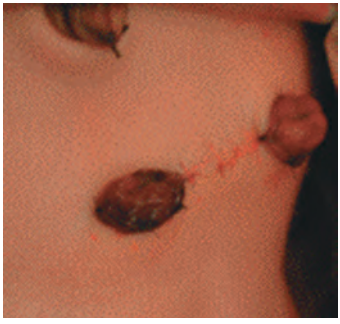

Fig. 1: Split stoma and mucus fistula

End stoma without mucus fistula

- Proximal bowel end is brought out through abdominal wall as stoma and distal end is closed and left within the abdominal cavity

Fig. 2: End stoma without mucus fistula

Loop stoma

- Formed by suturing a loop of bowel to the abdominal wall and making an opening into bowel, which remains in continuity

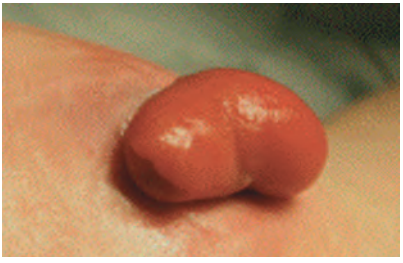

Fig. 3: Loop stoma (slightly prolapsed)

MANAGEMENT

Application of stoma bag

- Before stoma starts working, fit an appropriately sized stoma bag and empty 4–6 hrly
- In a split stoma and mucus fistula, fit the stoma bag on the proximal stoma only, where possible, and leave mucus fistula exposed and dressed with a paraffin gauze dressing (e.g. Jelonet) or Vaseline® and non-sterile gauze dressing
- Change bag every 1–3 days (maximum) or if it leaks
- Remove using a stoma adhesive remover wipe
- Clean skin around stoma with warm tap water and dry with non-sterile gauze

Monitoring

- Examine baby's abdomen and stoma daily
- Look for:
  - dehydration
  - abdominal distension
  - wound infection or breakdown
  - peri-stomal skin excoriation
  - granulation tissue formation
  - stomal bleeding

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- discolouration of stoma or mucus fistula
- stomal prolapse or retraction
- stoma bag leakage
- rectal discharge
- If stoma becomes dusky or black, call the surgical team
- If skin surrounding the stoma is excoriated, identify cause and treat

Weight

- Measure and record weight daily. Inadequate weight gain or weight loss may be secondary to:
- insufficient calorie intake
- malabsorption
- dehydration (high stoma output)
- electrolyte abnormalities (high stoma output)

Stoma effluent

- Maintain a regularly updated fluid balance chart and record:
- fluid intake and stoma losses
- colour and consistency of stoma effluent

Serum electrolytes

- Measure at least every 2 days in the first 7 post-operative days

Urinary electrolytes (sodium and potassium)

- Monitoring is extremely important for nutrition and growth
- Measure weekly
- Babies with stomata (especially small bowel stomata) are at risk of losing a significant amount of sodium into the effluent. They will often fail to gain weight if total body sodium is depleted. Serum sodium is an unreliable indicator of total body sodium
- Urinary sodium and Na^+:K^+ ratio are better indicators
- Sodium supplements usually required in babies with a small bowel stoma until the stoma closed
- If urinary sodium is <20 mmol/L or ratio of concentration of urinary sodium to potassium is <3:1, increase sodium intake

NUTRITION

Total parenteral nutrition and no enteral feeds

- Check surgical discharge letter and operation notes for instructions on starting enteral feeds
- Introduce enteral feeds slowly and increase gradually in accordance with local unit feeding regimen
- Useful indicators of potential feed intolerance are:
- vomiting and abdominal distension
- bile in nasogastric aspirates
- large nasogastric losses
- low stoma losses – indicating dysmotility/obstruction
- high stoma losses – indicating malabsorption
- reducing substances or fat globules in the stool/stoma effluent

Combination of parenteral nutrition and enteral feeds

- Increase enteral feeds gradually in accordance with local unit's feeding regimen
- It is not possible to predict how much enteral feed baby will be able to tolerate. As a general rule, the more distal the stoma, the better the absorption of feeds
- The amount of stoma effluent and presence/absence of reducing substances in the stoma effluent should guide the advancement of enteral feeds

Full enteral feeds

- Tolerance of enteral feeds can fluctuate with time and babies with stomata are at high risk of life-threatening dehydration and electrolyte abnormalities as a result of gastroenteritis. There should be a low threshold for readmission to hospital and appropriate resuscitation

COMPLICATIONS

High stoma output

- Daily output >20 mL/kg/day in premature or low-birth-weight babies and 30 mL/kg/day in term babies
- Measure serum and urinary electrolytes
- Replace stoma losses (when >20 mL/kg/day) mL-for-mL using sodium chloride 0.9% with potassium chloride 10 mmol in 500 mL IV
- Consider either reducing or stopping enteral feeds until losses decrease, liaison with surgical team is encouraged
- Test stoma effluent for reducing substances and fat globules
- If reducing substances are positive or fat globules present, consider reduction of enteral feed or changing type of enteral feed after consultation with a surgeon, specialist surgical outreach nurse or dietitian
- Perform blood gas; (stoma effluent may be rich in bicarbonate and metabolic acidosis may be present; consider sodium bicarbonate supplementation)

Mucus fistula

- If present, consider recycling of stoma effluent (see **Recycling stoma losses via a mucus fistula** guideline). Before recycling, consult surgical team to decide whether a contrast study through the mucus fistula is required
- If a contrast study advised, make arrangements with surgical unit and inform surgical team when the study will take place
- Surgical team will review and advise if recycling may start
- If baby not thriving, consider parenteral nutrition (see **Parenteral nutrition** guideline)

Increasing enteral feeds in a baby with poor weight gain and a high output stoma, will worsen the situation

- If none of the above measures are effective, stop enteral feeds, start parenteral nutrition and consult surgical team to discuss surgical options

Stomal stenosis

- May be present if:
  - stomal output reduces or stoma stops functioning
  - stoma effluent becomes watery
- Call surgical team for advice

Prolapse

- Call surgical team for advice. If stoma is discoloured, emergency action is required

STOMA CLOSURE

- Often aimed to be performed when baby is well and thriving, which may be after discharge from hospital
- Indications for early closure are:
  - failure to achieve full enteral feeds
  - recurrent stomal prolapse with or without stomal discolouration
  - stomal stenosis
  - high stoma output not responding to measures outlined above

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DISCHARGE PLANNING AND PARENTAL TEACHING

- Discharge when baby well, tolerating feeds and thriving
- It is the responsibility of the ward/unit nurse to teach parents stoma care
- When discharge planned, inform:
- secretary of surgical consultant who fashioned the stoma, to arrange out-patient follow-up
- stoma care specialist
- Bernadette Reda – surgical outreach service (if involved in care)

Who to call when you need help?

Surgical team

- Call team of consultant surgeon who performed the surgery
- In an emergency out-of-hours, contact on-call surgical registrar
- Stoma care specialist e.g. Gail Fitzpatrick at BCH (mobile 07557 001653) for management of stoma-related complications and parent and staff training
- Bernadette Reda, surgical outreach service will visit neonatal units and provide advice, support and training on surgical management

Useful information

- http://www.bch.nhs.uk/content/neonatal-surgery
- http://www.bch.nhs.uk/find-us/maps-directions

SUDDEN UNEXPECTED POSTNATAL COLLAPSE IN FIRST WEEK OF LIFE • 1/3

Based on recommendations from a Professional Group on Sudden Unexpected Postnatal Collapse March 2011 (British Association of Perinatal Medicine)

Sudden unexpected postnatal collapse (SUPC) in apparently well term babies, in the first week of life is rare

Summary of BAPM SUPC recommendations

- Increased risk of congenital anomaly or metabolic disease
- Need comprehensive investigation to determine underlying cause
- Involve interdisciplinary liaison to maximise diagnostic yield
- Senior doctor to obtain detailed family history and situational events
- Notify coroner of all babies who die from such collapse
- For all babies who die, post-mortem to be performed by a perinatal pathologist
- Safeguarding issues must be considered, if collapse happened after the baby left hospital
- Detailed multiprofessional case review should follow investigation of unexpected baby death

Information after the event

Collect the following as soon as possible after presentation

Parental medical history

- Full parental drug, alcohol and nicotine history
- Three-generation family tree noting egg donation, sperm donation (where available)

Obstetric history (from consultant obstetrician or senior trainee)

- Infection
- Fetal growth
- Suspected fetal anomalies
- Fetal movements
- Liquor volume

Labour and birth (from consultant obstetrician or senior trainee)

- Maternal medication
- Markers of fetal wellbeing
  - scalp pH
  - cord pH
  - electronic fetal monitoring (EFM)
  - passage of meconium
  - requirement for resuscitation

Health of baby until collapse

- Growth and feeding

Other information

- Circumstances surrounding collapse
  - who was present?
  - was baby feeding?
  - position of baby (from staff and family present at time of collapse)
- It is also important to collect information from other agencies who may have been involved with the family e.g. primary care, social care and police
- Full resuscitation details

Investigations whilst baby alive

- Carry out a full examination
- Liaison with local and regional laboratories is mandatory to ensure optimal collection and timing of samples. Use your judgment about which tests to prioritise to ensure optimal diagnostic yield with least intervention
- If baby sufficiently stable, consider transfer to a specialist unit for imaging

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SUDDEN UNEXPECTED POSTNATAL COLLAPSE IN FIRST WEEK OF LIFE • 2/3

Based on recommendations from a Professional group on sudden unexpected postnatal collapse March 2011 (British Association of Perinatal Medicine)

Neonatal blood	Cerebrospinal fluid	Surface swabs	Nasophyngeal aspirate	Urine	Imaging	Other investigations
● FBC ● Coagulation ● Blood gas ● Renal and liver biochemistry ● Glucose ● Lactate ● Calcium ● Magnesium ● Ammonia ● Beta-hydroxybutyrate ● Amino acids ● Insulin ● Free fatty acids ● Acyl carnitines profile ● Urates ● Uric acid ● Cortisol (3 samples at different times) ● Culture ● Viral titres ● Bloodspot for cardiolipin analysis ● Specific genetics: ● DNA ● chromosomes ● microarray ● retained bloodspot	● Biochemistry ● Glucose (paired with plasma glucose) ● Culture ● Virology ● Lactate ● Amino acids including glycine, storage	● Bacteriology	● Bacteriology and virology	● Bacteriology ● Virology ● Toxicology ● Organic acids including orotic acid ● Amino acids including urinary sulphocysteine ● Retain urine for storage	● Skeletal survey ● Cranial ultrasound scan ● MRI brain scan ● Renal/adrenal ultrasound scan ● Electrocardiogram ● Echocardiogram	● Ophthalmoscopy/ Retcam ● Skin biopsy for fibroblast culture ● If unable to exclude neuromuscular or mitochondrial disorder, muscle biopsy ● Electro-encephalogram ● Genetics assessment and clinical photographs

SUDDEN UNEXPECTED POSTNATAL COLLAPSE IN FIRST WEEK OF LIFE • 3/3

Based on recommendations from a Professional group on sudden unexpected postnatal collapse March 2011 (British Association of Perinatal Medicine)

- If there is suspicion that the event may have been due to unrecognised hypoventilation/apnoea, send DNA sample for phox2b gene abnormalities (commonly implicated in congenital central hypoventilation syndrome)
- Consider testing for mutations and copy number variation in mecp2 gene. This may present as newborn encephalopathy and/or apnoeas and respiratory collapse
- Array-based comparative genomic hybridisation is a useful investigation (will replace conventional karyotyping for detecting causative chromosomal deletions and duplications)

Investigations before post-mortem

- If it has not been possible to take samples during life, take samples (where feasible) while awaiting post-mortem to prevent degradation of material and loss of important diagnostic information. Where possible, discuss and agree baseline samples with a pathologist and, where indicated, a biochemist
- Throat and nose swabs for bacterial and viral culture
- Blood culture
- Blood and urine for metabolic studies
- glucose, acylcarnitine, organic and amino acids including orotic acid and sulphocysteine, freeze urine for storage
- Blood for DNA, chromosomes and dried bloodspots on several cards
- CSF obtained by lumbar puncture or ventricular tap – biochemistry
- glucose
- culture
- virology
- lactate
- amino acids including glycine, freeze and store
- Skin biopsy (if possible locally) for culture and storage of fibroblasts: 3 x 2 mm full thickness using aseptic technique into culture or viral transport medium or gauze soaked in sodium chloride 0.9%. Send promptly to cytogenetics laboratory (see **Skin biopsy** guideline)
- Muscle biopsy (if locally possible) for electron microscopy, histopathology and enzymology. Wrap in aluminium foil, snap freeze and store at -70ºC. Contact metabolic physician or pathologist before sample collection
- If difficulty in obtaining necessary kit for investigations, most labour wards have a 'still birth kit' which will contain much, if not all, of what is needed

Safeguarding issues

- Must be considered in all cases of out of hospital collapses
- The process of investigation for unexpected child deaths sometimes needs following even if the baby survives
- This involves the rapid response team from the district who need to undertake a home visit to gather additional information regarding the critical event

For documentation and investigation check list for SUPC, use appendices from full BAPM guidelines –
www.bapm.org/publications/documents/guidelines/SUPC_Booklet.pdf

- Early administration of natural surfactant decreases the risk of acute pulmonary injury and neonatal mortality
- Early CPAP and selective administration of surfactant is preferable to routine intubation and prophylactic surfactant
- Natural surfactant preparations are superior to protein-free synthetic preparations containing only phospholipids for reducing mortality and air leaks
- Poractant alfa at 200 mg/kg shows survival advantage compared to beractant or poractant alpha in a dose of 100 mg/kg
- Multiple rescue doses result in greater improvements in oxygenation and ventilatory requirements, a decreased risk of pneumothorax and a trend toward improved survival
- Use of INSURE (Intubate–Surfactant–Extubate to CPAP) technique for early surfactant administration reduces the need for ventilation and improves survival

INDICATIONS

Prophylaxis (administration within 15 min of birth)

Babies born <28 weeks' gestation

- **Routine intubation of these babies solely for the purpose of administration of surfactant is not necessary, and a policy of early CPAP with selective surfactant administration is preferred**
- If requiring intubation for respiratory support during resuscitation or whose mothers have not had antenatal steroids, give surfactant as prophylaxis
- Otherwise, institute early CPAP and administer surfactant selectively as per **Early rescue treatment**

Early rescue treatment

Babies born <26 weeks' gestation

If intubation for respiratory distress required and need FiO_2 >0.30, give surfactant

Babies born ≥26 weeks' gestation

If requiring intubation and needing FiO_2 >0.40, give surfactant

Other babies that can be considered for surfactant therapy (after discussion with consultant)

- Ventilated babies with meconium aspiration syndrome (may need repeat dose after 6–8 hr)
- Term babies with pneumonia and stiff lungs

EQUIPMENT

- Natural surfactant, Poractant alfa (Curosurf®) 200 mg/kg (2.5 mL/kg) round to the nearest whole vial (prophylaxis and rescue doses can differ, check dose with local policy) or beractant (Survanta®) 100 mg/kg (4 mL/kg)
- Sterile gloves
- TrachCare Mac catheter [do not cut nasogastric tube (NGT)]

PROCEDURE

Preparation

- Calculate dose of surfactant required and warm to room temperature
- Ensure correct endotracheal tube (ETT) position
  - check ETT length at lips
  - listen for bilateral air entry and look for chest movement
  - if in doubt, ensure ETT in trachea using laryngoscope and adjust to ensure bilateral equal air entry
  - chest X-ray not necessary before first dose

- Refer to manufacturer's guidelines and **Neonatal Formulary**
- Invert surfactant vial gently several times, without shaking, to re-suspend the material
- Draw up required dose
- Administer via TrachCare Mac device – **note:** it is no longer acceptable to administer surfactant via an NGT as this contravenes European conformity (CE marking) and NPSA guidance

Instillation

- With baby supine, instil prescribed dose down tracheal tube; administer beractant in 2–3 aliquots
- Wait for recovery of air entry/chest movement and oxygenation between boluses

Post-instillation care

- Do not suction ETT for 8 hr (suction is contraindicated in Surfactant-deficiency Disease for 48 hr)
- Be ready to adjust ventilator/oxygen settings in response to changes in chest movement, tidal volume and oxygen saturation. Use of volume-target ventilation can facilitate responsiveness to rapid changes in lung compliance following surfactant instillation. Be ready to reduce FiO_2 soon after administration of surfactant to avoid hyperoxia
- Take an arterial/capillary blood gas within 30 min

SUBSEQUENT MANAGEMENT

- If baby remains ventilated at FiO_2 >0.3 with a mean airway pressure of >7 cm H_2O, give further dose of surfactant 6–12 hr after the first dose
- Third dose should be given only at the request of the attending consultant

DOCUMENTATION

- For every dose given, document in case notes:
  - indication for surfactant use
  - time of administration
  - dose given
  - condition of baby pre-administration, including measurement of blood gas unless on labour ward when SpO_2 should be noted
  - response to surfactant, including measurement of post-administration blood gas and SpO_2
  - reasons why second dose not given, if applicable
  - reason(s) for giving third dose if administered
- Prescribe surfactant on drug chart

Information for parents

http://www.bliss.org.uk/factsheets

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INTRODUCTION

- If untreated, 40% of early syphilis will result in stillbirth/spontaneous abortion/perinatal loss. Risk is dependent upon maternal stage of infection and spirochete blood load
- Untreated babies >2 yr may present with:
  - CNS (VIII nerve deafness)
  - bone and joint (frontal bossing, saddle nose and Clutton joints)
  - teeth (Hutchinson incisors and mulberry molars)
  - eye (interstitial keratitis 5–20 yr) involvement

RECOGNITION AND ASSESSMENT

- Clarify maternal treatment and post-treatment titres if possible
- Discuss management plan with parents before birth if possible
- All parents are seen by specialist midwife antenatally to discuss management of baby
- Follow **Management flowchart**

CLINICAL FEATURES

Clinical evidence of early congenital syphilis

- Rash
- Infectious snuffles (copious nasal secretions)
- Haemorrhagic rhinitis
- Osteochondritis
- Periostitis
- Pseudo-paralysis
- Mucocutaneous patches
- Peri-oral fissures
- Hepatosplenomegaly
- Lymphadenopthy
- Oedema
- Glomerulonephritis
- Ocular or neurological involvement
- Haemolysis
- Thrombocytopenia

ASSESSMENT OF MATERNAL TREATMENT

- Maternal treatment is adequate if:
  - treated with full course of penicillin: 3 injections over 3 week **>4 week before delivery AND** there is a **documented** four-fold decrease in VDRL titres

INVESTIGATIONS

Diagnostic serology

Baby may have positive serology depending on timing of maternal infection, therefore mother **must be** screened simultaneously for titre comparison.
DO NOT USE CORD BLOOD

Non-treponemal tests

- Venereal disease research laboratory (VDRL) test:
  - 4 x decrease in titre = effective treatment
  - 4 x increase after treatment = relapse or re-infection
- May be **false negative** in babies who acquire congenital syphilis in late pregnancy or have extremely high antibody titres before dilution (prozone phenomenon)
- May be **false positive** in viral infections (Epstein-Barr, varicella zoster, hepatitis, measles), tuberculosis, endocarditis, malaria, lymphoma, connective tissue disease, pregnancy, intravenous drug use

Treponemal tests

- IgM
- *Treponema. pallidum* particle agglutination test (TPPA)
- *Treponema. pallidum* haemagglutination assay (TPHA)
- Fluorescent treponemal antibody

absorption test (FTA-ABS)

- Tests may also be **positive** in other spirochetal disease e.g. yaws, pinta, leptospirosis, and Lyme disease. There is poor correlation of titres with disease activity

Interpretation of syphilis serology of baby

- Syphilis serology is positive in baby if:
- anti-treponemal antibody IgM positive
- baby's TPPA is four-times greater than repeated maternal TPPA titre at delivery

Example of positive TPPA

- Maternal titres 1:1040
- Baby serology 1:4160 (i.e. baby four-times greater than mother)
- Baby's VDRL titre is four-times greater than repeated maternal VDRL titre at delivery

Example of positive VDRL

- Maternal titres 1:64
- Baby serology 1:256 (i.e. baby four-times greater than mother)

CSF

- CSF investigations require at least 0.5 mL of CSF. A CSF is classed as positive if:
- increased WCC and protein
- reactive TPPA and VDRL (a negative VDRL does not exclude neurosyphillis)
- Remember to suspect other causes of elevated values when evaluating baby for congenital syphilis

TREATMENT

- Possible congenital syphilis: benzylpenicillin 50 mg/kg IV 12-hrly for 7 days and 8-hrly for next 3 days
- If delay in results, offer single dose IM benzathine penicillin while awaiting results
- 50,000 units/kg as a single dose by IM injection within 24 hr of decision to treat. Reconstitute vial with the solvent provided (WFI) to produce a solution containing 300,000 units/mL
- **Example:** 2 kg baby: Dose = 50,000 units x 2 = 100,000 units – volume to inject = 100,000/300,000 = 0.33 mL. If >24 hr of therapy is missed, restart entire course

FOLLOW-UP

- If IgM test is negative, other tests are reactive with titres <four-fold higher than mother's with no signs of congenital syphilis, repeat reactive tests at 3, 6 and 12 months or until all tests (VDRL, TPPA and IgM) become negative (usually by 6 months)
- If baby's serum negative on screening, and no signs of congenital infection, no further testing is necessary
- If any doubt regarding test interpretation/follow-up, discuss with local expert in neonatal infection/microbiology
- If *Neurosyphilis*, CSF at 6 months

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BABIES BORN TO MOTHERS WITH POSITIVE SEROLOGY

Management flowchart: Baby born to mother with positive syphilis serology (IgM/VDRL or TPPA reactive)

- Clarify maternal treatment and post-treatment titres if possible
- Discuss management plan with parents before birth if possible

↓

- Clinical examination of baby
- Assess adequacy of maternal treatment (see **Assessment of maternal treatment**)
- Baby syphilis serology IgM, VDRL+TPPA (paired sample with mother **must** be taken and sent at same time)

↓

- Physical examination abnormal

OR

- Inadequate maternal treatment (including non-penicillin regimen)

OR

- Results from paired samples show positive baby serology (see associated text)

↓

Possible congenital syphilis

Evaluate:

- FBC and differential
- CSF cell count, protein, VDRL and TPPA
- Other tests as clinically indicated:
  - chest X-ray, X-ray femur
  - LFT
  - cranial ultrasound
  - ophthalmology review
  - auditory brain stem responses

↓

Treat

- Benzylpenicillin 50 mg/kg IV 12-hrly for 7 days and 8-hrly for next 3 days

↓

Follow-up

- Clinic review at 3, 6 and 12 months
- Repeat serology at 3, 6 and 12 months **or** until VDRL, TPPA and IgM all non-reactive
- If *Neurosyphilis*, CSF at 6 months

If examination is normal, mother has had adequate treatment but no documented reduction in titres post treatment

↓

- If results expected quickly, send child home and chase results of paired serology
- Warn parents baby may have to return for treatment if serology positive
- If delay in results, offer single dose IM benzathine penicillin* while awaiting results

↓

+ Serology (see associated text)

↓

Possible congenital syphilis

Evaluate:

- FBC and differential
- CSF cell count, protein, VDRL and TPPA
- Other tests as clinically indicated:
  - chest X-ray, X-ray femur
  - LFT
  - cranial ultrasound
  - ophthalmology review
  - auditory brain stem responses

↓

Treat

- Benzylpenicillin 50 mg/kg IV 12-hrly for 7 days and 8-hrly for next 3 days

↓

Follow-up

- Clinic review at 3, 6 and 12 months
- Repeat serology at 3, 6 and 12 months **or** until VDRL, TPPA and IgM all non-reactive
- If *Neurosyphilis*, CSF at 6 months

- Physical examination normal

AND

- Negative baby serology (VDRL, TPPA and IgM negative)

AND

- Adequate maternal treatment (including follow-up testing to confirm successful treatment)

↓

- (IgM negative, VDRL and/or TPPA <4 x paired maternal titres)

↓

Congenital syphilis unlikely

- No treatment

↓

Discharge

- If any uncertainty about completeness of antenatal follow-up or neonatal serology, further review with serology recommended at 3 and 6 months

---

***Benzathine penicillin:**

Dose: 50,000 units/kg as a single dose by IM injection within 24 hr of decision to treat

Reconstitution: reconstitute vial with the solvent provided (WFI) to produce a solution containing 300,000 units/mL

Example: 2 kg baby: Dose = 50,000 units x 2 = 100,000 units – volume to inject = 100,000/300,000 = 0.33 mL

THROMBOCYTOPENIA • 1/5

DEFINITION

- Platelet count <150 x 10^9/L
- mild (platelet count 100–150 x 10^9/L) and moderate (50–100 x 10^9/L) thrombocytopenia occur frequently in preterm babies who are ill, and in those born to women with pregnancy-induced hypertension (PIH)
- severe thrombocytopenia (<50 x 10^9/L) is uncommon, particularly in apparently healthy term babies and raises the possibility of neonatal allo-immune thrombocytopenia (NAIT; see below)
- ensure results are not spurious, if in doubt repeat venous sample

CAUSES

	WELL	ILL
Common	● Placental insufficiency ● Intrauterine growth retardation (IUGR) ● Maternal diabetes ● Immune mediated ● Allo-immune thrombocytopenia (NAIT) ● Auto-immune (maternal ITP, SLE) ● Trisomies (13, 18, 21)	● Infection ● Necrotising enterocolitis (NEC) ● Disseminated intravascular coagulation (DIC) ● Hypoxic Ischaemic Encephalopathy ● Congenital infections ● Thrombosis (renal, aortic) ● Congenital leukaemia or neuroblastoma
Rare	● Inherited disorders ● Thrombocytopenia Absent Radii (TAR) syndrome ● Congenital amegakaryocytic thrombocytopenia (CAMT) ● Cavernous haemangioma (Kasabach-Merritt syndrome)	● Metabolic disorders (propionic and methymalonic acidemia)

Severe thrombocytopenia in an otherwise healthy term newborn baby is NAIT until proved otherwise

INVESTIGATIONS

- Evaluation of early-onset (<72 hr after birth) thrombocytopenia (see **Flowchart**)
- in preterm babies with early-onset mild-to-moderate thrombocytopenia in whom there is good evidence of placental insufficiency, further investigations are not warranted unless platelet count does not recover within 10–14 days
- in preterm babies without placental insufficiency, investigate first for sepsis
- in term babies, investigate for sepsis and NAIT
- If severe thrombocytopenia, perform clotting screen
- Look for presence of active bleeding or visible petechiae
- If features suggestive of congenital infection (e.g. abnormal LFTs, rashes, maternal history etc.) or if persistent or unexplained thrombocytopenia, perform congenital infection i.e. CMV and toxoplasma serology; check maternal status for syphilis, rubella and HIV; herpes simplex and enteroviral screen
- Obstetric history, particularly maternal platelet count, drugs, pre-eclampsia. Family history of bleeding disorders
- Careful examination, include other associated features (e.g. trisomies and inherited syndromes)

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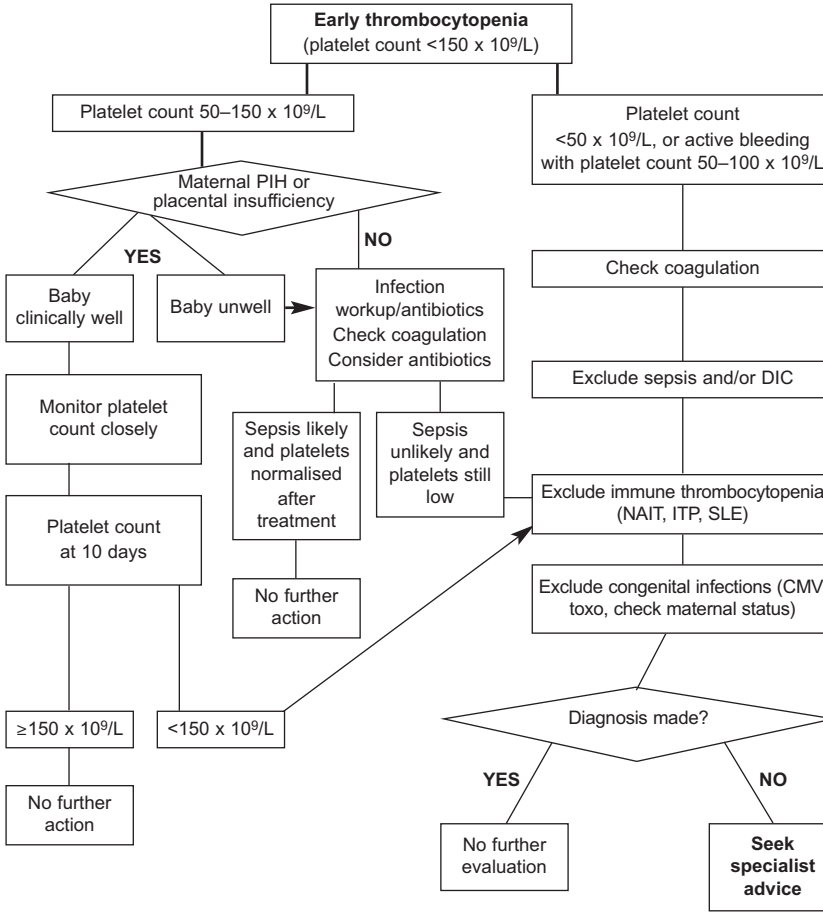
Flowchart



Evaluation of late onset thrombocytopenia

- Thrombocytopenia presenting in baby after first 3 days of life, presume underlying sepsis or NEC until proved otherwise
- these babies are at significant risk of haemorrhage, though the benefit of platelet transfusion is not clear-cut

MANAGEMENT

General

Avoid

- Heel prick and IM injections, use venepuncture and IV injections
- Invasive procedure (central line, lumbar puncture, chest drain etc). If any of above are unavoidable:
  - discuss with on-call consultant
  - give platelet transfusion if platelet count <50 x 10^9/L before the procedure (if semi-elective e.g. LP, central lines) **OR** during/soon after the procedure (if emergency like chest drain)
  - give particular attention to haemostasis

Platelet transfusion

Only available immediate and specific therapy for thrombocytopenia but carries a risk of transfusion-related infections and transfusion reactions and only after discussion with senior

Indications for platelet transfusion (term and preterm babies)

- Main objective is to prevent the consequences of severe thrombocytopenia, significant risk of acute intracerebral haemorrhage and neuromorbidity

Platelet count <30 x 10^9/L

- In otherwise well baby, including NAIT, if no evidence of bleeding and no family history of intracranial haemorrhage

Platelet count <50 x 10^9/L

- In baby with:
  - clinical instability
  - concurrent coagulopathy
  - birth weight <1000 g and age <1 week
  - previous major bleeding e.g. intraventricular haemorrhage (IVH)
  - current minor bleeding (e.g. petechiae, venepuncture oozing)
  - planned surgery, exchange transfusion or invasive procedure (central line insertion, lumbar puncture, chest drain, etc.)
  - platelet count falling and likely to fall below 30
  - NAIT if previously affected sibling with intracranial bleed
  - PDA treated with indomethacin or ibuprofen

Platelet count <100 x 10^9/L

- If major bleeding or major surgery (e.g. neurosurgery), give platelet transfusion

Type of platelets

- NAIT: HPA compatible platelets wherever possible
- All others: blood group-compatible cytomegalovirus (CMV) negative
- Irradiation of platelets is not routinely required but consider for babies with definite or suspected immunodeficiency or those who have undergone intrauterine transfusions

Volume of platelets

- 10–20 mL/kg (10 mL/kg usually raise platelet count by >50 x 10^9/L). Babies with suspected NAIT will require higher dose 20 mL/kg

ADMINISTRATION OF PLATELETS

Never administer platelets through an arterial line or UAC

- Use platelets as soon as they arrive on ward (ensure IV access before requesting platelets from blood bank)
- Keep platelets at room temperature
- To minimise loss, draw contents of pack into 50 mL syringe through a special platelet or fresh blood transfusion set with a 170–200 micrometre filter and infuse, using a narrow bore extension set linked to IV line, primed with sodium chloride 0.9%

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- Transfuse platelets over 30–60 min, mixing syringe from time to time to avoid platelets settling down
- There is no need for routine use of diuretic after platelet transfusion
- Check platelet count within 12 hr after transfusion

NEONATAL ALLO-IMMUNE THROMBOCYTOPENIA (NAIT)

- This is analogous to Rhesus haemolytic disease and is caused by transplacental passage of maternal alloantibodies directed against fetal platelet antigens, inherited from father but absent in mother
- Majority caused by antibodies against platelet antigens, HPA-1a (80%) and HPA-5b (10–15%)
- NAIT can affect first pregnancy and has a 10% risk of severe intracranial haemorrhage; 20% of survivors exhibit significant neuro-developmental sequelae

Recognition

- For HPA-1a antigen-negative women, complete a neonatal alert form
- Petechiae, purpura, excessive bleeding and severe thrombocytopenia in an otherwise healthy term newborn baby indicate NAIT until proved otherwise
- NAIT can also present with:
  - fetal intracranial haemorrhage or unexplained hydrocephalus
  - postnatal intracranial haemorrhage in term baby

If NAIT suspected, involve consultant neonatologist immediately

Assessment

- Check baby's platelet count daily until >100 x 10^9/L
- Check mother's platelet count (may already be in maternal healthcare record)
- Obtain blood from mother, baby and father for platelet typing and antibodies. Liaise with haematology department about appropriate samples
- Arrange cranial ultrasound scan (see **Cranial ultrasound scans** guideline)

Treatment

- In 30% of cases, maternal antibody may not be found and can be detected later
- Transfuse baby with suspected NAIT with accredited HPA-1 antigen-negative platelets if:
  - bleeding **or**
  - platelet count <30 x 10^9/L
- National Blood Transfusion Service has a pool of suitable donors, and platelets are available at short notice from blood bank
  - if accredited HPA-1a negative platelets not available, administer random donor platelets

Inform blood bank and consultant haematologist as soon as NAIT suspected.

Do not delay transfusion for investigations

- If thrombocytopenia severe (<50 x 10^9/L), or haemorrhage persists despite transfusion of antigen-negative platelets, administer intravenous human immunoglobulin (IVIG) 1 g/kg/day once daily (give one full 2.5 g vial maximum for babies ≥2.5 kg) for 1-3 days (may require additional doses 2–4 weeks later)
- Aim to keep platelet count >30 x 10^9/L for first week of life, or as long as active bleeding continues
- Report newly diagnosed babies with NAIT to fetal medicine consultant for counselling for future pregnancies

NEONATAL AUTO-IMMUNE THROMBOCYTOPENIA

Clinical features

- Caused by transplacental passage of autoantibodies in women with ITP or SLE, and affecting about 10% of babies born to such women
- Severity generally related to severity of maternal disease
- Risk of intracranial haemorrhage in baby <1%

Management

- Report all women with thrombocytopenia and those splenectomised through Neonatal Alert System, and instigate plan of management
- Send cord blood for platelet count
- Check baby's platelet count 24 hr later, irrespective of cord blood result
- If baby thrombocytopenic, check platelet count daily for first 3–4 days or until >100 x 10^9/L
- If platelet count <30 x 10^9/L, whether bleeding or not, treat with IVIG (dose as in NAIT) +/- steroids
- Discharge baby when platelet count >100 x 10^9/L
- For babies requiring IVIG, recheck platelet count 2 weeks later. A few may require another course of IVIG at this time because of persistence of maternal antibodies

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THYROID DISEASE (MANAGEMENT OF BABIES BORN TO MOTHERS WITH THYROID DISEASE) • 1/3

RECOGNITION AND ASSESSMENT

- Obstetric team should inform neonatal team after delivery of a baby with maternal history of hyperthyroidism (Graves' disease) or hypothyroidism

MATERNAL HYPERTHYROIDISM

Common

- Maternal Graves' disease (autoimmune hyperthyroidism)
- IgG thyroid stimulating antibodies cross from mother with Graves' disease to fetus towards the end of 12.5% of pregnancies
- half-life of thyroid stimulating antibodies is approximately 12 days and resolution of fetal thyrotoxicosis corresponds to their degradation over 3–12 weeks

Rare

- Maternal Hashimoto's thyroiditis producing thyroid stimulating antibodies
- Activating mutations of TSH receptor (family history of hyperthyroidism in first degree relatives)

Babies at high risk

- Mother has high levels of thyroid antibodies (Thyroid Stimulating Immunoglobulin, TSI or Thyroid Receptor Antibody, TRAb) – refer to maternal healthcare record
- Maternal thyroid antibody status unknown
- Mother clinically hyperthyroid or receiving antithyroid drugs in third trimester
- Mother previously treated with radioactive iodine or surgery or with previously affected infants
- Evidence of fetal hyperthyroidism
- Family history of TSH receptor mutation

Clinical features of fetal hyperthyroidism

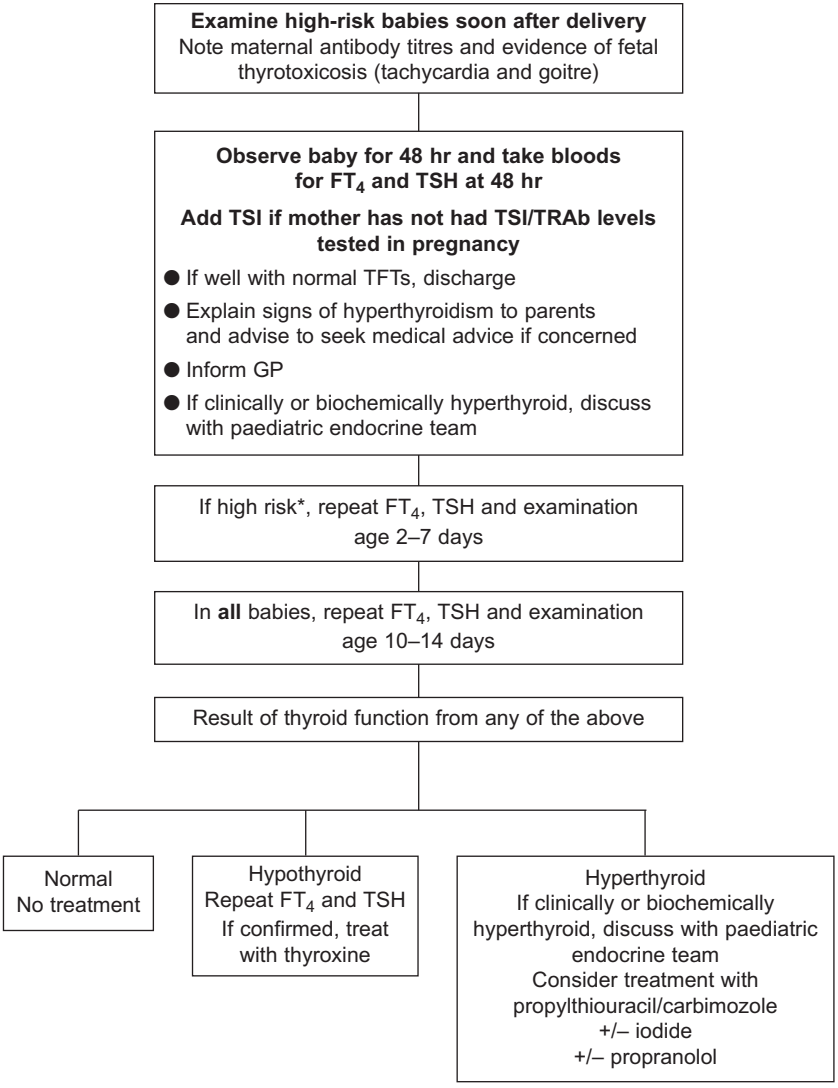
- Usually present by 24–48 hr of age but can be delayed up to 10 days. Disorder is self-limiting over 3–12 weeks
- **Head and neck**
  - goitre, periorbital oedema, exophthalmos
- **Central nervous system (CNS)**
  - irritability, jitteriness, poor sleeping, microcephaly
- **Cardiovascular system (CVS)**
  - tachycardia, arrhythmias, flushing, sweating, hypertension
- **Gastrointestinal (GI)**
  - diarrhoea, vomiting, excess weight loss, hepatosplenomegaly
- **Others**
  - bruising, petechiae due to thrombocytopenia, jaundice

It is not sufficient to judge risk based on current maternal thyroid function as mothers on antithyroid medication or who have received thyroid ablative therapy (surgery or radioactive iodine) may be euthyroid or hypothyroid yet still have high thyroid antibody titres

Management

- Follow **Management flowchart**
- Examine high risk babies after delivery
  - note maternal antibody titres and evidence of fetal thyrotoxicosis (tachycardia and goitre)
- Observe baby for 48 hr and take bloods for FT_4 and TSH at 48 hr
  - if well with normal TFTs, (see **Hypothyroidism** guideline for normal values) discharge
- Explain signs of hyperthyroidism to parents and advise to seek medical advice if concerned
- Arrange review at 10–14 days to repeat TFTs and clinical assessment
  - if clinically or biochemically hyperthyroid, discuss with paediatric endocrine team

Flowchart: Management of babies at risk for congenital hyperthyroidism



* see text

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THYROID DISEASE (MANAGEMENT OF BABIES BORN TO MOTHERS WITH THYROID DISEASE) • 3/3

MATERNAL HYPOTHYROIDISM

Physiology

- After onset of fetal thyroid secretion at mid-gestation, maternal transfer of T4 continues to contribute to fetal serum T4, protecting neurodevelopment until birth. Prompt treatment of maternal hypothyroidism should mitigate negative effects on baby's neurodevelopment

Risks associated with maternal hypothyroidism

- Preterm delivery
- Intrauterine growth restriction (IUGR)
- Postpartum bleeding
- Untreated severe hypothyroidism in mother can lead to impaired brain development in baby

Management

- Hashimoto's thyroiditis (autoimmune) occurs in approximately 2.5% of women and is associated with thyroid inhibiting or, rarely, thyroid stimulating antibodies. Baby may develop transient hypo or, rarely, hyperthyroidism. These babies should be reviewed at 10-14 days and have their T4/TSH checked
- Babies born to mothers with congenital hypothyroidism (aplasia/hypoplasia) and treated with levothyroxine do not require routine thyroid function testing
- Mothers who have been treated for Grave's disease (surgery or radioactive iodine) may be euthyroid or hypothyroid but may still have high thyroid antibody. Treat as high risk for neonatal hyperthyroidism and follow guideline for maternal hyperthyroidism

Breastfeeding

- Encourage for all babies even if mother currently taking carbimazole, propylthiouracil or levothyroxine

Contraindication

- Radioactive iodine treatment

TRANSCUTANEOUS CO_2 AND O_2 • 1/3

(Adapted with permission, Guy's and St Thomas' NHS Trust nursing guideline)

INTRODUCTION

- In babies requiring assisted ventilation, it is essential to monitor arterial partial pressure of oxygen (PaO_2) and carbon dioxide ($PaCO_2$) to ensure adequate gas exchange
- Transcutaneous monitoring allows continuous measurement ($TcCO_2$ and TcO_2)
- Use this guideline to set up and safely use transcutaneous monitoring equipment

Clinical indications

- Monitoring adequacy of arterial oxygenation and/or ventilation
- Nursing critically ill or unstable baby

Advantages

- Reduction in number of blood gas measurements
- Immediate recognition of need for ventilation adjustment

Potential problems

- Tissue injury (e.g. erythema, blisters, burns, and skin tears) as a result of failure to change site frequently enough (2–3 hrly) according to local protocol
- Inadequate measurement resulting from incorrect set-up

EQUIPMENT

- Transducer: insert at end position of rack for easy accessibility
- Membranes
- Electrolyte solution
- Adhesive fixation rings
- Recalibration machine

Probe placement and application of fixation rings

- Preferred sites:
  - if baby nursed prone: the back
  - if baby nursed supine: the chest
- Avoid bony surfaces: use soft tissues (e.g. abdomen, buttock, thigh) and avoid placing over liver as this can prevent accurate clinical assessment of liver size
- Ensure chosen site is clean and dry
- Peel adhesive protection layer off ring
- Place ring on chosen site pressing gently on centre of ring before running finger around outside. Ensure effective seal as this will affect accuracy of measurement
- Place three drops of contact fluid in centre of ring
- Remove transducer from module into ring and turn one-quarter clockwise to secure

CARE AND MONITORING

Temperature setting

- Keep transducer setting at 44ºC for all babies. There is good correlation of TcO_2 with heat settings of 44ºC but lower settings will result with under-reading of TcO_2 and difference is larger with increasing TcO_2

Alarm settings

PPHN

- Exact limits will depend on specific pathology but, for guidance, in term babies with PPHN:
  - TcO_2 upper 10.0 lower 5.5
  - $TcCO_2$ upper 7.0 lower 5.0

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Blood gas sampling

- Take blood gas 20 min after commencing transcutaneous monitoring to allow comparison between transcutaneous values and arterial partial pressures of O_2 and CO_2 levels, as discrepancy can occur
- If transcutaneous monitoring values change suddenly, check contact is in place before making ventilator changes. If any doubt about accuracy of values, check blood gas before making ventilator changes

Changing measurement site

- Babies <29 weeks: change 2-hrly
- Babies ≥29 weeks: change 3-hrly
- Unscrew transducer before removing fixation rings
- Remove fixation rings when repositioning baby from supine to prone and vice-versa to avoid pressure sore from lying on rings
- Remove rings 12-hrly on babies <29 weeks and 24-hrly on babies ≥29 weeks

Calibration of membrane

- See **Figure 1–5**

Indications

- Transducer membrane has been replaced
- Monitor displays 'calibration required'
- Measurement values in doubt
- Applying to a new baby
- Changing measurement site

Ensure calibrator is turned off after use. Do not dispose of connecting tube.
Contact technicians when calibrating gas empty

Changing transducer membranes – see Figure 6–10

- All staff responsible for ventilated babies can change transducer membranes

Indications

- When using a new transducer or if transducer has dried out
- For each new baby
- When membrane crinkled, scratched or damaged
- After 5 days continuous use

Procedure

- Wash and dry hands
- To remove O-rings, unscrew protective cap from transducer and hook O-ring remover under them
- Remove both clear plastic membranes with your fingers
- To ensure correct values, clean transducer head, including grove and rim, with absorbent paper to remove all old electrolyte solution
- Apply approximately two drops of electrolyte solution to transducer head
- Press transducer head downward into an unused membrane replacer until replacer reacts as far as it can and a click is heard

Figure: 1–5:
Calibration of membrane;

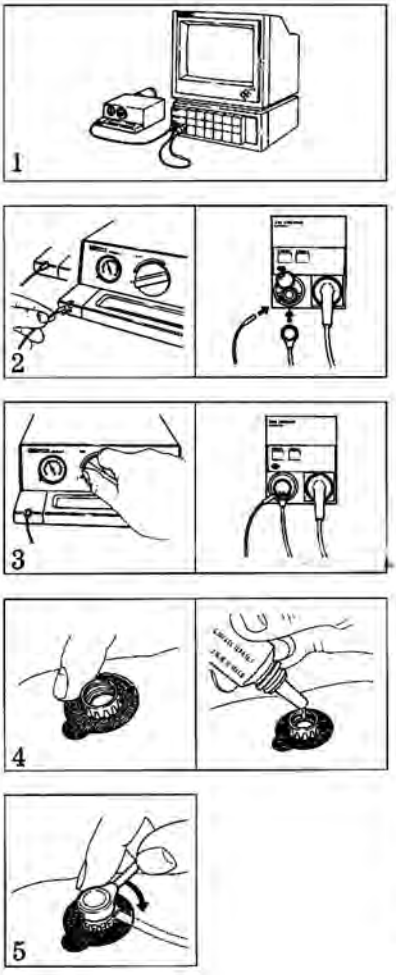
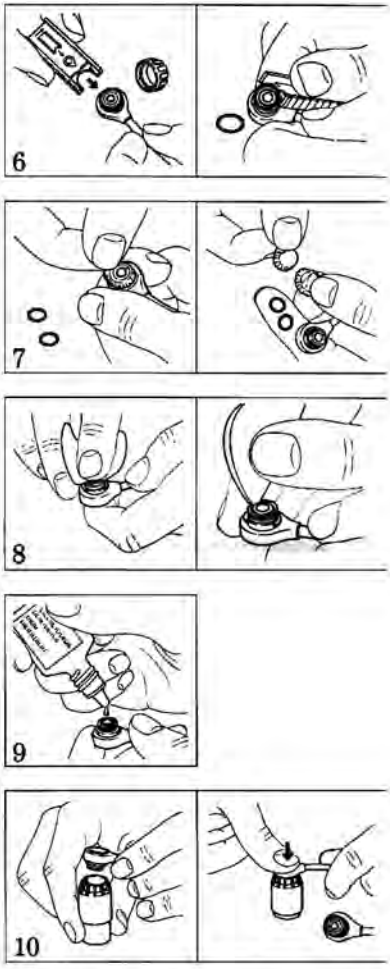


Figure: 6–10
Changing transducer membranes



CE This product complies with the requirements of the Council Directive 93/42/EEC June 1993 (Medical Device Directive).

For USA
United States law restricts this device to sale by or on the order of a physician.

TRANSFUSION OF RED BLOOD CELLS • 1/3

INDICATIONS

- **Acute blood loss** with haemodynamic compromise or ≥10% blood volume loss (e.g. significant feto-maternal transfusion or pulmonary haemorrhage)
  - in emergency, use O negative blood
  - transfuse 10 mL/kg over 30 min
  - further transfusion based on haemoglobin (Hb)
- Top-up blood transfusion, if Hb below threshold levels quoted in the following situations

Postnatal age	Suggested transfusion threshold Hb (g/L)		
	Ventilated	Other respiratory support (CPAP/ BIPAP HFNC/O_2)	No respiratory support
Week 1 (days 1–7)	<120	<100	
Week 2 (days 8–14)	<100	<95	<85 if symptoms of anaemia (e.g. poor weight gain or significant apnoeas) or poor reticulocyte response (<4% or count <100 x 10^9/L)
≥Week 3 (day 15 onwards)		<85	<75 if asymptomatic and good reticulocyte response (≥4% or reticulocyte count ≥100 x 10^9/L)

Adapted from British Committee for Standards in Haematology recommendations

PRE-TRANSFUSION

Communication

- If clinical condition permits before transfusion, inform parents that baby will receive blood transfusion
  - document discussion
- If parents refuse transfusion (e.g. Jehovah's Witness) follow local policy

Crossmatch

- For top-up transfusions in well baby, arrange with blood bank during normal working hours
- Crossmatch against maternal serum (or neonatal serum if maternal serum not available)
- For first transfusion, send samples of baby's and mother's blood

Direct Coombs' testing

- The laboratory will perform Direct Coombs' test (DCT) on maternal serum for any atypical antibodies
- If maternal DCT negative, blood issued will be crossmatched **once** against maternal serum. No further maternal blood samples are necessary for repeat top-up transfusions
- If maternal DCT positive, crossmatching of donor red blood cells against maternal serum is required **every time**

Multiple transfusions

- In babies <29 weeks who may need multiple transfusions, use paediatric satellite packs ('Paedipacks') from one donor (if available) to reduce multiple donor exposure

When to use irradiated blood

- It is preferred practice for all blood given to babies to be irradiated. However, irradiated blood **MUST** always be given for those:
  - who have received intra-uterine transfusion
  - with suspected or proven immunodeficiency
  - receiving blood from a first- or second-degree relative, or an HLA-selected donor

When to use CMV-free blood

- As CMV seronegativity cannot be guaranteed in untested blood, **use only CMV-seronegative blood for neonatal transfusions**
- Blood products in use in the UK are leuco-depleted to <5 x 10^6 leucocytes/unit at point of manufacture

Special considerations

Iron supplements

- Premature babies receiving breast milk or with Hb <100 g/L, commence oral iron supplementation at 4 weeks of age – see **Nutrition and enteral feeding** guideline

Withholding feeds during transfusion

- Some units withhold enteral feeds during the 3–4 hr duration of transfusion

Babies with necrotising enterocolitis (NEC)

- Transfuse using red cells in sodium chloride 0.9%, adenine, glucose and mannitol (SAG-M), preferably, as it is relatively plasma-free. This may not be available in all units. Investigate any unexpected haemolysis associated with transfusion in a baby with NEC for T-cell activation in consultation with local haematology department and with close involvement of consultant neonatologist

Exchange transfusion

- See **Exchange transfusion** guideline

TRANSFUSION

Volume of transfusion

- Give 15–20 mL/kg of red cell transfusion irrespective of pre-transfusion Hb

A paediatric pack contains approximately 50 mL blood. Use one pack if possible

Rate of administration

- Administer blood at 15 mL/kg over 3 hr or 20 mL/kg over 4 hr (5 mL/kg/hr)
- Increase rate in presence of active haemorrhage with shock
- Via peripheral venous or umbilical venous line (**not** via long line or arterial line)

Use of furosemide

- Routine use **not** recommended
- Consider soon after blood transfusion for babies:
  - with chronic lung disease
  - with haemodynamically significant PDA
  - in heart failure
  - with oedema or fluid overload

DOCUMENTATION AND GOOD PRACTICE

- Clearly document indication for transfusion
- After transfusion, record benefit (or lack thereof)
- Document pre- and post-transfusion Hb levels
- Ensure blood transfusion volume and rate is prescribed in appropriate infusion chart
- Observations, including:
  - continuous ECG
  - SpO_2
  - hourly temperature and BP (recorded before, during and after transfusion)

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- Ensure positive identification of baby using accessible identification
- Appropriate labelling of syringes to ensure compliance with current best practice
- Unless clinically urgent, avoid transfusion out-of-hours
- To reduce need for blood transfusion, minimise blood sampling in babies (micro-techniques, non-invasive monitoring) and avoid unnecessary testing
- Ensure donor exposure is minimised by using satellite packs from same donor

Hazards of transfusion

- Most important are:
  - infections – bacterial or viral
  - hypocalcaemia
  - volume overload
  - citrate toxicity
  - rebound hypoglycaemia (following high glucose levels in additive solutions)
  - thrombocytopenia after exchange transfusion

TRANSILLUMINATION OF THE CHEST • 1/1

INDICATION

- Suspected pneumothorax (e.g. any deterioration in clinical condition, particularly if ventilated)

EQUIPMENT

- Cold light source
- Black drapes to cover incubator

PROCEDURE

- Dim lights
- Expose baby's chest and abdomen
- Remove all non-essential monitoring leads
- Cover outside of incubator with black drapes
- Place cold light tip perpendicular to and touching baby's skin
- Shine light from the side, in the 5 positions shown in diagram, comparing right side with left (5th position shines through the liver and is used as a control)
- Clean cold light tip with an alcohol wipe after use

DIAGNOSIS

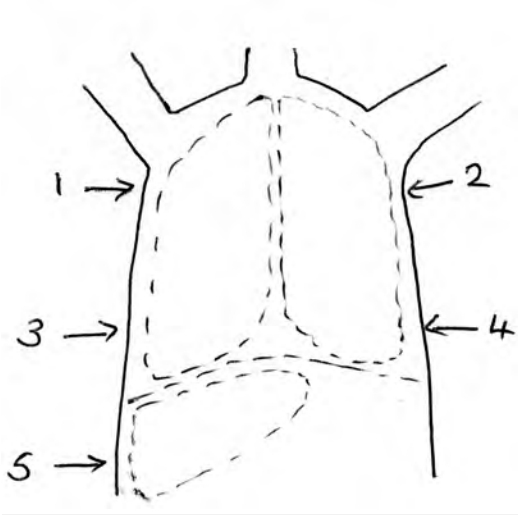
- Pneumothorax confirmed if chest fluoresces bright red
- Compare both sides of chest (babies can have bilateral pneumothoraces)
- Compare degree of fluorescence with that seen over liver
- liver and lung without pneumothorax, shine dull dark red

Caution – false positive diagnoses may be made in extremely preterm babies and those with pulmonary interstitial emphysema

Transillumination may be unreliable in babies with increased thickness of the chest wall (macrosomic term infants and those with chest wall oedema)

ACTION

- Once pneumothorax is confirmed in a ventilated or unstable baby, perform immediate needle thoracocentesis in 2nd intercostal space, mid-clavicular line on the side of the chest that fluoresced brightly. Do **not** wait for a chest X-ray



1. Right side just below axilla
2. Left side just below axilla
3. Right side approximately 5th/6th intercostal space
4. Left side approximately 5th/6th intercostal space
5. Right side just below diaphragm (liver)

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INTRODUCTION

The aim of a safe transfer policy is to ensure the highest standard, streamlined care. In the majority of cases, transfer will be performed by a dedicated transfer team but, in certain cases, the referring team may perform the transfer. In all cases, the ACCEPT model (**Table 1**) can be used

INDICATIONS FOR TRANSFER

- Uplift for services not provided at referring unit (including diagnostic and drive-through transfers)
- Repatriation
- Resources/capacity

Table 1: ACCEPT model

A	**A**ssessment
C	**C**ontrol
C	**C**ommunication
E	**E**valuation
P	**P**reparation and packaging
T	**T**ransportation

ASSESSMENT

Referring team decides on urgency of transfer and who will perform it

- Key questions are:
  - what is the problem?
  - what is being done?
  - what effect is it having?
  - what is needed now?

Control

- Following initial assessment control the situation:
  - who is the team leader?
  - what tasks need to be done (clinical care/equipment and resources)?
  - who will do them (allocated by team leader)?
  - who will transfer the baby (if relevant)?

Clinical care

- Preparation for transport begins as soon as decision is made to transfer the baby

Airway/breathing

- If baby unstable or on CPAP with FiO_2 >0.4, intubate and ventilate (intermittent mandatory ventilation modality most used in transport ventilators)
- Adjust ETT and lines depending on chest X-ray position; document all positions and adjustments
- If indicated, give surfactant (see **Surfactant replacement therapy** guideline)
- If present, connect chest drains to a flutter valve device
- Check appropriate type of ventilator support is available for transfer (e.g. high-flow/BiPAP/SiPAP may not be provided in transport)

Circulation

- If baby dependent on drug infusions (e.g. inotropes, prostaglandin), two reliable points of venous access must be inserted
- **Check whether receiving unit will accept central lines**
  - if ventilated with FiO_2 >0.4, UVC and umbilical artery catheter (UAC) necessary, decide whether a double lumen UVC is required
  - ensure catheters are secured with suture and tape
  - check all access is patent and visible
  - optimise blood pressure (see **Hypotension** guideline)

Drugs

- Antibiotics – see **Infection in first 72 hr of life** guideline and **Infection (late onset)** guideline
- Decide whether infusions need to be concentrated
- Check IM vitamin K has been given
- Decide whether sedation needed for transfer

Environment

- Monitor temperature throughout stabilisation – in the extreme preterm baby, chemical gel mattress may be required
- Cooling babies – see **Cooling in non-cooling centres (referral and preparation of babies eligible for active cooling)** guideline

Fluids

- Ensure all fluids and infusions are in 50 mL syringes and are labelled
- Volume as per **IV fluid therapy** guideline
- Monitor intake and output

Parents

- Update with plan of care
- Establish how parents will get to unit; if mother is an inpatient, check with maternity liaison
- Clarify method of feeding

COMMUNICATION

Referring centre

- Make decision to transfer with parents' agreement
- Locate neonatal intensive care unit (NICU)/paediatric intensive care unit (PICU)/speciality bed
  - for BCH PICU bed, call KIDS on 0300 200 1100
  - for speciality or other PICU bed, call receiving clinician
  - for neonatal cot, call cot locator (0121 626 4571) during office hours (0900–1700 hr) or contact units directly out-of-hours (use cot availability chart on website)
- Once cot is available (and KIDS not co-ordinating) contact WMNTS:
  - 07929 053730 (mobile). If your call is not answered, leave a message
  - state type of, and time limit for, transfer
  - provide clinical details to transfer team
    - name, weight and gestation
    - history and clinical details
    - interventions, investigations and results
    - medications
- Document advice given/received
- Prepare transfer information/discharge summary and arrange for images to be reviewed at receiving hospital
- Obtain a sample of mother's blood (if required)
- Identify whether a parent is suitable for transfer with baby (see WMNTS policy for details)

Receiving centre

- Ensure consultant and nurse co-ordinator accept referral and agree with advice given

EVALUATION

- Referring clinician, transfer team and receiving team evaluate urgency of the transfer and decide who will do it
- Neonatal transfers are classified as:
  - time critical (e.g. gastroschisis, ventilated tracheoesophageal fistula, intestinal perforation, duct-dependent cardiac lesion not responding to prostaglandin infusion and other unstable conditions)
  - to be performed within 1 hr
  - to be performed within 24 hr
  - to be performed after 24 hr
- In the event of a transfer team being unable to respond within an appropriate time period, referring unit may decide to perform the transfer themselves in the best interests of the baby

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PREPARATION AND PACKAGING

- Three components:
  - clinical care (see above)
  - location and checking of equipment
  - allocation of team
- Transport equipment must not be used for any other purpose
- Team undertaking the transfer must be trained in use of all equipment and drugs and be competent to perform any necessary procedures en-route
- Ensure air and oxygen cylinders are full before departure
- ETT and lines must be secured before transferring baby to the transport incubator
- Baby must be secured in the transport incubator

TRANSPORT

Before leaving the referring unit

- Change to transport incubator gases (check cylinders are full)
- Check blood gas 10 min after changing to transport ventilator. Make any necessary changes
- Check lines and tubes are not tangled; check infusions are running
- Record vital signs
- Allow parents to see baby
- Contact receiving hospital to confirm cot is still available

Only leave referring unit when team leader is confident that baby is stable for transfer

On arrival at ambulance

- Ensure incubator and equipment are securely fastened/stowed in accordance with CEN standards
- Plug in gases and electrical connections
- Ensure temperature in ambulance is suitable
- Check all staff are aware of destination
- Discuss mode of progression to hospital (e.g. blue lights)
- Ensure all staff are wearing seatbelts before vehicle moves

During road transit

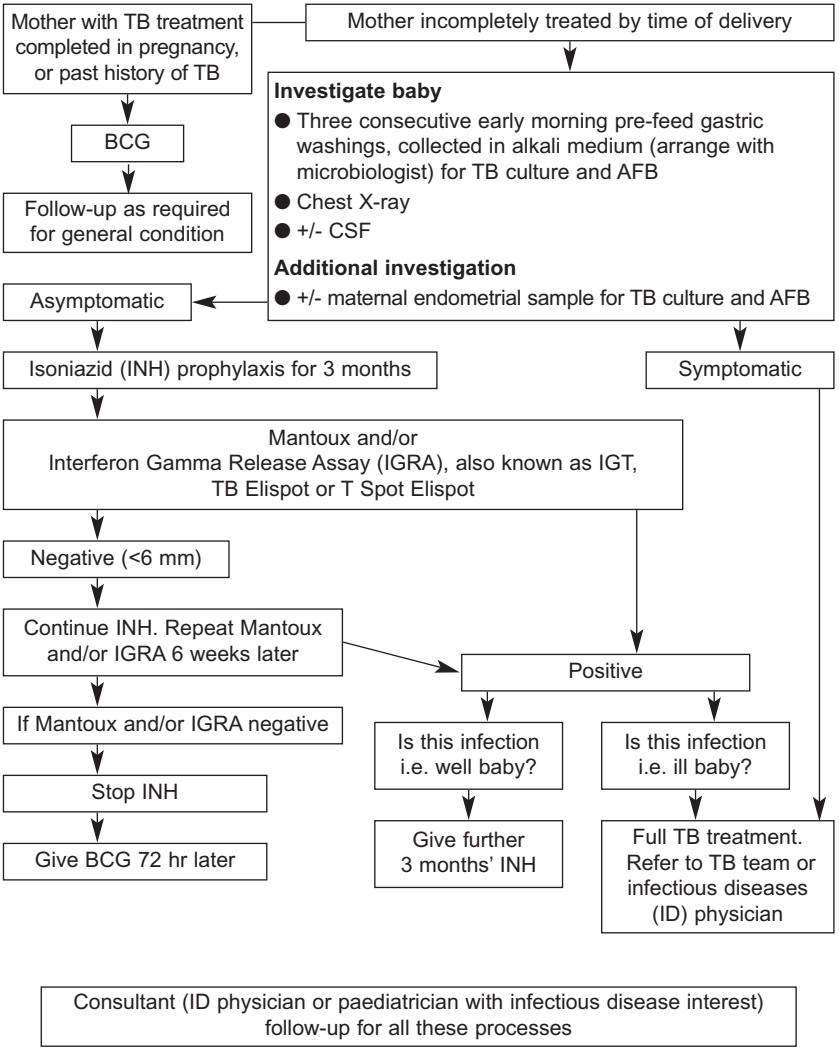
- Record vital signs
- If baby requires clinical intervention, stop ambulance in a safe place before staff leave their seats
- Make receiving team aware of any major changes in clinical condition

On arrival at receiving hospital

- Follow the ACCEPT structure
- Handover to receiving team then transfer baby to the unit's equipment
  - transfer and receiving teams to agree order in which transfer happens
- After transfer, dispose of any partially used drugs and infusions before returning to ambulance

TUBERCULOSIS (INVESTIGATION AND MANAGEMENT FOLLOWING EXPOSURE IN PREGNANCY) • 1/2

- Usually the result of:
  - maternal history of TB in pregnancy
  - baby exposed to a close (usually household) contact with sputum positive TB



Consultant (ID physician or paediatrician with infectious disease interest) follow-up for all these processes

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Important points to consider

- As clearance of mycobacteria from pregnant mother's sputum is not clearly defined, treat newborns of any incompletely treated mother as at risk for acquiring TB infection/disease
- Baby may acquire mycobacteria from an incompletely treated mother either in-utero, intrapartum or postpartum. Gastric washing samples taken pre-feed (usually early morning) are useful, as any potential mycobacteria caught by baby's innate mucociliary escalator will be washed into trachea, bronchi and upwards, swallowed and present in the relatively less acidic neonatal stomach. Using an alkali solution as the transport medium for the gastric aspirate keeps the mycobacteria alive until plated in the laboratory
- IGRA and Mantoux skin tests define infection but cannot distinguish between infection and disease
- If IGRA (also known as IGT, TB Elispot or T Spot) not available, Mantoux skin test is sufficient provided baby has not had BCG. IGRA takes 72 hr to be completed and cannot be carried out at weekend. This must be arranged with microbiology/immunology laboratory

UMBILICAL ARTERY CATHETERISATION AND REMOVAL • 1/4

Do not attempt to carry out this procedure unsupervised unless you have been trained to do so and have demonstrated your competence

INDICATIONS

- Frequent blood gas analysis:
  - ventilated babies (most babies treated with CPAP can be managed with capillary gases)
- Continuous monitoring of arterial blood pressure (if poor circulation or need for accurate BP)
- Exchange transfusion

CONTRAINDICATIONS

- Umbilical sepsis
- Necrotising enterocolitis (NEC)
- Evidence of vascular compromise in legs or buttocks
- Congenital abnormality of the umbilicus (e.g. exomphalos or gastroschisis)

EQUIPMENT

- Umbilical artery catheterisation pack
- Umbilical catheter (<2 kg use size 3.5 FG, >2 kg use size up to 5 FG)
- 3-way tap
- Sterile gown, gloves and drape
- Infusion pump
- Sodium chloride 0.9% or 0.45% infusion containing heparin 1 unit/mL
- Umbilical tape
- Cleaning solution as per unit policy
- Zinc oxide tape or Elastoplast®

PROCEDURE

Consent

- Wherever possible inform parents of need and associated risks before procedure; if an emergency, delay explanation until after insertion
- Risks include sepsis and thrombosis
- See **Consent** guideline

Non-sterile preparation

- Monitor baby's vital signs during procedure
- Estimate length of catheter to be inserted using formula: (weight in kg x 3) + 9 cm
  - alternative method for UAC length is twice distance from umbilicus to mid-inguinal point, plus distance from umbilicus to xiphisternum
  - add length of cord stump to give final length
  - prefer high catheter position i.e. tip above diaphragm (T6–T10 vertebral bodies)
- Inspect lower limbs and buttocks for discolouration
- Tie an umbilical tape loosely around base of cord

Sterile preparation

- Scrub up, put on gown and gloves using aseptic technique
- Ask assistant (if available) to gently hold baby's legs and arms away from umbilical site
- Clean cord stump and surrounding skin with cleaning solution
- Attach 3-way tap to catheter and flush all parts with sodium chloride 0.9% leaving syringe attached
- Place all equipment to be used on a sterile towel covering a sterile trolley
- Place sterile drape with a hole in the centre over the umbilical stump. Pull the stump through the hole ready for catheter insertion

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Insertion of arterial catheter

- Clamp across cord with artery forceps
- Apply gentle upward traction
- Cut along underside of forceps with a scalpel blade to reveal either the cut surface of the whole cord, or use a side-on approach cut part way through the artery at a 45º angle
- Leave a 2–3 cm stump; remember to measure length of cord stump and add to calculated placement to give final advancement distance
- Identify vessels, single thin-walled vein and two small thick-walled arteries that can protrude from the cut surface
- Support cord with artery forceps placed near to chosen artery
- Dilate lumen using either dilator or fine forceps
- Insert catheter with 3-way tap closed to catheter. If resistance felt, apply gentle steady pressure for 30–60 sec
- Advance catheter to the calculated distance
- Open 3-way tap to check for easy withdrawal of blood and for pulsation of blood in the catheter

If catheter will not advance beyond 4–5 cm and blood cannot be withdrawn, it is likely that a false passage has been created. Remove catheter and seek advice from a more experienced person

Securing catheter

- If an umbilical venous catheter (UVC) is also to be inserted, site both catheters before securing either. Secure each catheter separately as below to allow independent removal
- Place 2 sutures into cord, one on either side of catheter, allowing suture ends to be at least 5 cm long beyond cut surface of the cord. Sandwich catheter and ends of the 2 sutures between zinc oxide or Elastoplast® tape as close to cord as possible without touching cord (like a flag). The sutures should be separate from the catheter on either side as this allows easy adjustment of catheter length, should this be necessary. Top edge of sutures can be tied together above flag for extra security after confirming X-ray position
- If catheter requires adjustment, cut zinc oxide or Elastoplast® tape between catheter and the 2 suture ends, pull back catheter to desired length and retape; **never** advance once tape applied as this is not sterile
- Connect catheter to infusion of heparinised sodium chloride 0.9% or 0.45% at 0.5 mL/hr
- Confirm position of catheter by X-ray: unlike a UVC, a UAC will go down before it goes up
  - a high position tip (above diaphragm but below T6) is preferred
  - if catheter below the diaphragm resite at L3–L4 (low position)
  - if catheter position too high, withdraw to appropriate length
  - if catheter length adjusted, repeat X-ray

Acceptable UAC tip positions

Tip position	Acceptable or unacceptable	Precautions/adjustments
T6–T10 vertebra	Acceptable	Ideal high UAC position
L3–L4	Acceptable	Low UAC position
T11	Can be used with caution	Monitor blood sugar
L5	Can be used with caution	Monitor leg perfusion
T12–L2	Not acceptable	Risk of bowel or renal ischemia, pull back to L3–L4
Above T6	Not acceptable	Pull back to T6–T10
Femoral artery	Not acceptable	Risk of leg ischemia, replace with new UAC

Avoid L1, the origin of the renal arteries

Never attempt to advance a catheter after it has been secured; either withdraw it to the low position or remove it and insert a new one

DOCUMENTATION

- Record details of procedure in baby's notes, including catheter position on X-ray and whether any adjustments were made
- Always label umbilical arterial and venous catheters using the appropriately coloured and labelled stickers
- Place traceability sticker from catheter/insertion pack into notes

AFTERCARE

- Nurse baby in a position where UAC can be observed
- Monitor circulation in lower limbs and buttocks while catheter is *in situ*
- Leave cord stump exposed to air
- Infuse heparinised sodium chloride 0.9% or 0.45% 0.5 mL/hr heparin/mL
- Do not infuse any other solution through UAC. Glucose or drugs may be administered through UAC only in exceptional situations, on the authority of a consultant

COMPLICATIONS

- Bleeding following accidental disconnection
- Vasospasm: if blanching of the lower limb occurs and does not resolve, remove catheter
- Embolisation from blood clot or air in the infusion system
- Thrombosis involving:
  - femoral artery, resulting in limb ischaemia
  - renal artery, resulting in haematuria, renal failure and hypertension
  - mesenteric artery, resulting in necrotising enterocolitis (NEC)
- Infection: prophylactic antibiotics are not required

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REMOVAL

Do not attempt to carry out this procedure unsupervised unless you have been trained to do so and have demonstrated your competence

INDICATIONS

- Catheter no longer required
- No longer patent
- Suspected infection
- Complications (e.g. NEC, vascular compromise to the lower limbs)

EQUIPMENT

- Sterile stitch cutter
- Sterile blade
- Umbilical tape
- Cleaning solution as per unit policy

PROCEDURE

- Wash hands and put on sterile gloves
- Clean cord stump with cleaning solution
- if umbilical tissue adherent to catheter, loosen by soaking cord stump with gauze swab soaked in sodium chloride 0.9%
- Ensure an umbilical tape is loosely secured around base of umbilicus
- Turn infusion pump off and clamp infusion line
- Withdraw catheter slowly over 2–3 min taking particular care with last 2–3 cm
- If bleeding noted, tighten umbilical tape
- Do not cover umbilicus with large absorbent pad, a small piece of cotton gauze should suffice
- Confirm catheter is intact

AFTERCARE

- Nurse baby supine for 4 hr following removal, and observe for bleeding

COMPLICATIONS

- Bleeding
- Catheter tip inadvertently left in blood vessel

UMBILICAL VENOUS CATHETERISATION AND REMOVAL • 1/3

Do not attempt to carry out this procedure unsupervised unless you have been trained to do so and have demonstrated your competence under appropriate supervision

INDICATIONS

- All babies <1000 g
- Babies >1000 g ventilated or unwell (e.g. HIE) (a double lumen catheter may be indicated if baby requires significant support)
- Exchange transfusion
- Administration of hypertonic solutions (e.g. glucose >12.5%, parenteral nutrition or inotropes)

CONTRAINDICATIONS

- Umbilical sepsis
- Necrotising enterocolitis (NEC)
- Gastroschisis/exomphalos

EQUIPMENT

- Umbilical vein catheterisation pack
- Umbilical venous catheter
- 3-way tap
- Gown and gloves
- Sterile drape
- Infusion pump
- Sodium chloride 0.9% infusion
- Umbilical tape
- Cleaning solution as per unit policy
- Zinc oxide tape or Elastoplast®

PROCEDURE

Consent

- Wherever possible inform parents of need and associated risks before procedure; if an emergency, delay explanation until after insertion
- Risks include sepsis and thrombosis
- See **Consent** guideline

Non-sterile preparation

- Monitor all vital signs during procedure
- Estimate length of catheter to be inserted: use formula (weight in kg x 1.5) + 5.5 cm but note that this formula aims to site the catheter in the right atrium which is now considered potentially unsafe
- Alternatively, measure distance from umbilicus to xiphisternum for length of UVC
- high catheter placement preferred: at T8–9 but not in heart
- if tip in liver, pull back to lower border of liver (acceptable lower position) and check whether catheter is still sampling freely before use
- Remember to add length of cord stump to give final distance catheter needs to be advanced
- Tie umbilical tape loosely around base of cord

Sterile preparation

- Scrub up, and put on gown and gloves
- Use sterile technique
- Clean cord stump and surrounding skin with cleaning solution
- Attach 3-way tap to catheter and flush all parts with sodium chloride 0.9%. Leave syringe attached
- Place all equipment to be used on sterile towel covering sterile trolley
- Drape umbilical stump with sterile towels
- Place sterile sheet with a hole in the centre over the cord. Pull the cord through the hole

Insertion of umbilical catheter

- Clamp across cord with artery forceps
- Apply gentle upward traction
- Cut along underside of forceps with scalpel blade cleanly to leave 2–3 cm stump or, if also placing an umbilical arterial catheter (UAC) and you have been trained in this procedure, consider using side-on technique (see **Umbilical artery catheterisation** guideline)

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Remember to measure length of cord stump and add to calculated placement distance to give final length catheter needs to be advanced

- Identify vessels:
  - single thin-walled vein
  - 2 small thick-walled arteries that can protrude from cut surface
- Support cord with artery forceps placed near to vein
- Locate lumen of vein using either a dilator or fine forceps
- Insert catheter (3.5 F for babies with birth weight <1500 g and 5 F for those >1500 g) with 3-way tap closed to catheter; if resistance felt, apply gentle steady pressure for 30–60 sec
- Advance catheter to desired distance, and open 3-way tap to check for easy withdrawal of blood

If catheter will not advance beyond 4–5 cm and blood cannot be withdrawn, it is likely that a false passage has been created. Remove catheter and seek advice from a more experienced senior person

Securing catheter

- If a UAC is also to be inserted, site both catheters before securing either. Secure each catheter separately as below to allow independent removal
- Place 2 sutures into cord, one on either side of the catheter, allowing suture ends to be at least 5 cm long beyond cut surface of cord. Bend the catheter in a loop then sandwich it and ends of the 2 sutures between zinc oxide or Elastoplast® tape as close to the cord as possible without touching cord (like a flag). The sutures should be separate from the catheter on either side as this allows easy adjustment of catheter length, should this be necessary. Top edge of sutures can be tied together above flag for extra security after confirming X-ray position
- If catheter requires adjustment, cut zinc oxide or Elastoplast® tape between catheter and 2 suture ends, pull back catheter to desired length and retape; never advance once tape has been applied as it is not sterile
- Connect catheter to infusion
- Confirm position of catheter in IVC by X-ray. A UVC goes straight up
  - if catheter found to be in right atrium, withdraw it to avoid risk of cardiac tamponade or cardiac arrhythmia
  - if catheter in liver, withdraw it to lower border of liver so that it lies in IVC, or remove it and insert replacement
  - if catheter length adjusted, repeat X-ray

Acceptable UVC tip positions

- High position – at T8–9 but not within cardiac shadow on X-ray
- Low position – at the lower border of liver and not inside the liver shadow (short-term use only)

DOCUMENTATION

- Record in notes details of procedure, including catheter position on X-ray and whether any adjustments were made
- Always label umbilical arterial and venous catheters, using the appropriately coloured and labelled stickers
- Place traceability sticker from catheter/insertion pack into notes

AFTERCARE

- Monitor circulation in lower limbs and buttocks whilst catheter is *in situ*
- Leave cord stump exposed to air
- The catheter may remain in place for up to 7–10 days (longer at consultant request). There is a risk of infection if left longer than 7 days
- Any infusions must be connected to UVC using aseptic technique

- Catheters below T10 have increased risk of extravasation. They can be used in the short term but should be replaced at the earliest opportunity

COMPLICATIONS

- Air embolism
- Bleeding resulting from accidental disconnection
- Refractory hypoglycaemia due to malpositioning of catheter
- Infection: prophylactic antibiotics not required
- Thrombus formation
- Cardiac tamponade (see below)
- Any deterioration in a baby in whom a central venous catheter is present should raise the question of catheter related complications; particularly infection, extravasation and tamponade

Cardiac tamponade

- Suspect in presence of:
  - tachycardia
  - poor perfusion
  - soft heart sounds
  - increasing cardiomegaly
  - decreasing oxygen saturation
  - arrhythmias
- Confirm diagnosis by:
  - chest X-ray: widened mediastinum and enlarged cardiac shadow
  - echocardiogram (if available)
- If there is cardiovascular compromise, consider drainage (see **Pericardiocentesis** guideline)

REMOVAL

Do not attempt to carry out this procedure unsupervised unless you have been trained to do so and have demonstrated your competence under appropriate supervision

INDICATIONS

- Central venous access no longer required
- Concerns regarding sepsis
- Remove after a maximum of 10 days

EQUIPMENT

- Sterile stitch cutter
- Sterile blade
- Cleaning solution as per unit policy
- Gown and gloves

PROCEDURE

- Wash hands and put on gown and gloves
- Clean cord stump with cleaning solution
- Turn infusion pump off and clamp infusion line
- Ensure umbilical tape secured loosely around base of umbilicus
- Withdraw catheter slowly
- If any bleeding noted, tighten umbilical tape
- Confirm catheter is intact

AFTERCARE

- Nurse baby supine for 4 hr following removal and observe for bleeding

COMPLICATIONS

- Bleeding
- Loss of UVC tip
- Infection

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UPPER LIMB BIRTH INJURIES INCLUDING BRACHIAL PLEXUS PALSY • 1/1

DEFINITION

- Brachial plexus palsy may be congenital occurring in-utero or acquired due to injury to brachial plexus nerves sustained due to stretching of nerves during delivery
- Fractures to humerus or clavicle
- Isolated radial nerve palsy of the newborn

ASSESSMENT OF ALL BABIES WITH REDUCED UPPER LIMB MOVEMENT

- Examine the arm and neck for swelling, bruising, tone, posture and degree of movement
- Assess for breathing difficulties and Horner's syndrome
- Document findings clearly in case notes
- Explain to parents that recovery probable but may not be complete
- Inform consultant obstetrician and paediatrician

MANAGEMENT

- X-ray humerus/clavicle to exclude fracture
- if fracture of clavicle clearly seen, reassure parents and review baby at 3 weeks when movement should be returning
- if fracture of humerus is clearly seen, offer strapping of arm to chest for comfort and review baby at 3 weeks when movement should be returning and baby becoming more comfortable
- if uncertain, refer to Children's Hand and Upper Limb Service at BCH
- Classical 'Waiter's tip position' –
- refer to Children's Hand and Upper Limb Service at BCH as soon as possible
- initiate referral to local physiotherapists
- Paralysis of the arm, which is **completely** resolved within a few days does not need to be referred but if there is any doubt, **all** babies will be seen in the regular **weekly hand trauma clinic** so that a specialist assessment can be made and the parents can be given appropriate information

BIRMINGHAM CHILDREN'S HAND and UPPER LIMB SERVICE:

- Fax referral proforma to: 0121 333 8131. Form available for download from http://www.networks.nhs.uk/nhs-networks/staffordshire-shropshire-and-black-country-newborn/neonatal-guidelines/neurology-1
- Email secretary: Brenda Riley or Parvinder.Sahota2@bch.nhs.uk
- Tel: 0121 333 8136/8285
- Email for advice: andrea.jester@bch.nhs.uk
- Write to Mrs Jester, Consultant Plastic/Hand Surgeon, Birmingham Children's Hand and Upper Limb Service, Birmingham Children's Hospital, Steelhouse Lane Birmingham B4 6NH

URINARY TRACT ABNORMALITIES IN ANTENATAL SCANS • 1/3

ANTENATAL ASSESSMENT

Fetal diagnostic scans are undertaken at 18–20 weeks and may be repeated at 32–34 weeks

18–20 week scan

Possible urinary tract abnormalities include:

Kidneys

- Renal agenesis +/- oligohydramnios – Potter sequence
- Multi-cystic dysplastic kidney (MCDK), check other kidney for normal appearance
- Solitary kidney
- Abnormal position (e.g. pelvic) or shape (e.g. horseshoe)
- Kidneys with echo-bright parenchyma (suspect cystic diseases)

Collecting system/tubes

- Unilateral or bilateral renal pelvic dilatation (RPD)/pelviectasis
- Measured in antero-posterior diameter (APD)
  - mild: RPD 5–9 mm
  - moderate: RPD 10–14 mm
  - severe: RPD ≥15 mm
- Unilateral or bilateral dilated calyces or ureter

Bladder (dilated or thick-walled; ureterocoele in bladder)

32–34 week scan

- To clarify urinary tract abnormalities found in early fetal scans
- Assess severity of RPD/pelviectasis:
  - normal: RPD <7 mm
  - mild: RPD 7–9 mm
  - moderate: RPD 10–14 mm. If bilateral, suspect critical obstruction
  - severe: RPD ≥15 mm. Suspect critical obstruction
  - calyceal dilatation: often indicates severity; may suggest obstruction
- Unilateral/bilateral dilated ureter(s) – suspect obstruction or vesico-ureteric reflux (VUR)
- Thick-walled bladder, suspect outlet obstruction
- Dilated bladder, suspect poor emptying
- Ureterocoele, suspect duplex system on that side

Communication

- Provide mother with an information leaflet, if available in your hospital, about this antenatal anomaly and proposed plan of management after birth

POSTNATAL MANAGEMENT

Indications for intervention

Urgent

- Bilateral RPD ≥10 mm +/- thick-walled bladder: suspect posterior urethral valve (boys)
- Unilateral RPD ≥15 mm, suspect pelvi-ureteric junction (PUJ) obstruction
- Significant abnormalities of kidney(s)/urinary tract – if risk of renal insufficiency
  - check serum potassium, blood gas for metabolic acidosis and serum creatinine

Non-urgent

- All other abnormalities of urinary tract in the antenatal scan

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URINARY TRACT ABNORMALITIES ON ANTENATAL SCAN • 2/3

IMMEDIATE MANAGEMENT

For urgent indications

- If posterior urethral valve (PUV)/PUJ obstruction suspected, check urine output/stream and monitor weight trend
- Arrange **urgent KUB ultrasound scan** within 24–48 hr (minimal milk intake may underestimate the size of renal pelvis, **but do not delay** if there is gross dilatation)
- If postnatal scan raises suspicion of posterior urethral valve (dilated ureters + thick walled bladder)
  - check serum creatinine
  - arrange urgent micturating cysto-urethrogram (MCUG)
  - after confirmation by MCUG, refer baby **urgently** to paediatric urologist
- If unilateral RPD ≥20 mm (suggestive of PUJ obstruction) discuss with urologist and arrange MAG3 renogram as soon as possible/as advised by the urologist
- Significant abnormalities of kidney(s)/urinary tract – if risk of renal insufficiency:
  - check serum potassium, blood gas for metabolic acidosis and serum creatinine
  - start trimethoprim 2 mg/kg as single night-time dose
- Discuss with consultant before discharge

For non-urgent indications

- Renal ultrasound scan at 2–6 weeks of age
- Consultant review with results

Antibiotic prophylaxis

- For RPD ≥10 mm, give trimethoprim 2 mg/kg as single night-time dose until criteria for stopping are met (see below)

SUBSEQUENT MANAGEMENT

- Subsequent management depends on findings of ultrasound scan at 2–6 weeks

Severe pelviectasis (RPD ≥15 mm)

- Arrange MAG3 scan – timing depends on severity of obstruction – as soon as possible if RPD ≥20 mm
  - if MAG 3 scan shows obstructed pattern, discuss with paediatric urologist
- Repeat ultrasound scan at 3–6 months of age (depending on cause of dilatation, a complete obstruction requires closer monitoring)
- Continue antibiotic prophylaxis until advised otherwise by urologist

Moderate unilateral pelviectasis (RPD 10–14 mm) and/or ureteric dilatation

- Presumed mild obstruction or VUR
- If RPD increases beyond 15 mm, arrange MAG3 scan
- Continue prophylaxis for VUR ≥grade 4 (marked dilatation of ureter and calyces) until child is continent (out of nappies)
- Repeat scan every 6 months until RPD <10 mm, then follow advice below

Normal or mild isolated pelviectasis (RPD <10 mm)

- Stop antibiotic prophylaxis
- Repeat scan after 6 months
  - if 6 month scan normal or shows no change and there have been no urinary tract infections (UTIs), discharge
- If unwell, especially pyrexial without obvious cause, advise urine collection

Multi-cystic dysplastic kidney (MCDK)

- DMSA to clarify nil function of MCDK and normal uptake pattern of other kidney
- Repeat ultrasound scan 6–12 monthly to observe involution of kidney (may take several years)
- Beware of 20% risk of vesico-ureteric reflux (VUR) in 'normal' kidney, advise parents to recognise UTI/pyelonephritis (especially if fever is without obvious focus)
- MCUG or prophylaxis until continent **ONLY** if dilated pelvis or ureter in good kidney
- Annual blood pressure check until kidney involuted
- If cysts persist > 5 yrs, enlarging or hypertension, refer to urology

Ureterocoele (often occurs with duplex kidney)

- MCUG (if VUR or PUV suspected)
- MAG3 to check function and drainage from both moieties of the duplex system
- Prophylaxis until problem resolved
- Urology referral – sooner if obstruction suspected

Solitary kidney/unilateral renal agenesis

- Kidney ultrasound at 6 weeks to confirm antenatal findings and rule out other urogenital structure abnormalities
- DMSA to confirm absence of one kidney + normal uptake pattern by the single kidney

Renal parenchymal problem requiring nephrology review

- Bright kidneys
- Multiple cysts

Other conditions

- Single renal artery in cord
- increased risk of renal abnormality but postnatal ultrasound scan only if antenatal scan missed or abnormal
- Ear abnormalities: ultrasound examination only if associated with:
- syndrome
- other malformations
- maternal/gestational diabetes
- family history of deafness

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RECOGNITION AND ASSESSMENT

Definition

- There are 2 separate presentations depending on timing of infection:
  - fetal varicella syndrome: maternal chickenpox infection before 20 weeks' gestation
  - neonatal varicella: maternal infection in perinatal period or close contact with chickenpox or shingles in first 7 days after birth

FETAL VARICELLA SYNDROME (FVS)

Symptoms and signs

- Limb hypoplasia
- Scarring of skin in a dermatomal distribution
- Cortical atrophy, microcephaly, bowel and bladder sphincter dysfunction, vocal cord paralysis
- Chorioretinitis, cataracts and microphthalmia
- Intra-uterine growth restriction (IUGR)

Investigations

Maternal

- If no history of chickenpox, check maternal VZ IgG at time of contact
- If mother develops chickenpox rash, send a swab from the base of the vesicle in viral transport media for varicella zoster PCR

Neonatal

- ≤7 days VZ IgM (can be done on cord blood), **or**
- >7 days VZ IgG (even if VZ IgM negative at birth)
- If vesicles are present send a swab from the base of the vesicle in viral transport media for varicella zoster PCR

Management

- Management is supportive and requires long-term multidisciplinary follow-up. Varicella zoster immunoglobulin (VZIG) or aciclovir have no role in the management of these babies

NEONATAL VARICELLA (NV)

Neonatal varicella is a serious illness with high mortality (approximately 30%). It most commonly occurs in babies born to mothers with chickenpox or close contact with chickenpox or zoster within 7 days of birth

Management of exposure to chickenpox/zoster

- Requires VZIG
  - obtain VZIG from microbiology department

Management of baby born to mother who develops chickenpox rash (but not zoster) within 7 days before birth, or 7 days after birth

- Give VZIG 250 mg (1 vial approx. 1.7 mL) IM (**not** IV)
  - antenatal chickenpox: give as soon as possible after delivery (must be within 72 hr)
  - postnatal chickenpox: give as soon as possible and within 10 days after initial exposure
  - consider giving in different sites in small babies
  - can be given without antibody testing of baby
  - of no benefit once neonatal chickenpox has developed
  - not needed for babies born after 7 days of appearance of maternal chickenpox, or where mother has zoster, as these babies should have transplacental antibodies
  - may not prevent neonatal varicella, but can make the illness milder

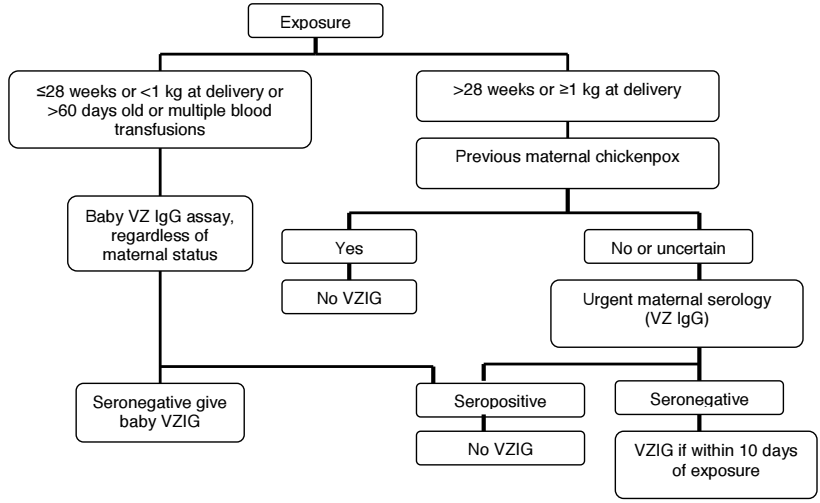
- If VZIG not available or IM injection contraindicated, give IVIG 0.2 g/kg (less effective)

Management of baby exposed after birth to chickenpox from non-maternal source (see Decision pathway)

- Significant exposure: household, face-to-face for 5 min, in same room for >15 min
- a case of chickenpox or disseminated zoster is infectious between 48 hr before onset of rash until crusting of lesions

- **Give VZIG** in the following cases of postnatal exposure to varicella:
- varicella antibody-negative babies (this can be determined by testing mother for varicella antibodies) exposed to chickenpox or herpes zoster from any other contact other than mother, in first 7 days of life (see **Decision pathway**)
- VZ antibody-negative babies of any age, exposed to chickenpox or herpes zoster while still requiring intensive or prolonged special care nursing
- for babies exposed postnatally, regardless of maternal chickenpox history, who:
  - weighed <1 kg at birth, **or**
  - were ≤28 weeks' gestation at birth, **or**
  - are >60 days old, **or**
  - have had repeated blood sampling with replacement by packed cell infusions perform VZ IgG assay and, if negative, give VZIG (because they are at risk of not having received or retained sufficient maternal VZ IgG)

Decision pathway for VZV contact



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Symptoms and signs of neonatal varicella

- Mild: vesicular rash
- Severe: pneumonitis, pulmonary necrosis, fulminant hepatitis
- mortality 30% without varicella-zoster immunoglobulin (VZIG)

TREATMENT

Aciclovir

Indications

- Babies with signs and symptoms of neonatal varicella
- Babies with postnatal exposure for whom VZIG was indicated (as above) but not given within 24 hr of exposure
- Chickenpox in baby currently treated with corticosteroids or born prematurely or immunocompromised

Dosage

- 20 mg/kg IV (over 1 hr) 8-hrly, diluted to 5 mg/mL
- For renal impairment, refer to **Neonatal Formulary**
- Treat for at least 7 days, up to 21 days if severe

SUBSEQUENT MANAGEMENT

Where

- On postnatal ward, unless baby requires neonatal intensive care support:
- isolate mother and baby together in separate room until 5 days after onset of rash and all lesions crusted over
- if baby already exposed, breastfeeding can continue but explain to mother possible risk of transmission

Staff

- Exposed staff with no history of chickenpox, VZ vaccination or of unknown VZ IgG status should have VZ IgG measured by occupational health
- if VZ IgG negative, immunise with varicella vaccine
- remove from clinical duties during days 7–21 following exposure
- if in high risk group for complications (immunocompromised), offer VZIG

MONITORING TREATMENT

- Aciclovir
- ensure good hydration
- stop once clinical improvement occurs or when all lesions crusted

DISCHARGE AND FOLLOW-UP

Maternal infection

- After baby has had VZIG, discharge
- Monitor baby for signs of infection, especially if onset of maternal chickenpox occurred 4 days before to 2 days after delivery
- Advise mother to seek medical help if baby develops chickenpox, preferably via an open-access policy where available
- Advise GP and midwife to recommend admission to isolation cubicle if rash develops

Fetal infection

- Diagnosed with positive VZ IgM or positive VZV PCR
- ophthalmic examination
- cranial ultrasound
- developmental follow-up

Vascular spasm

Blanching or cyanosis of extremity following insertion or manipulation of peripheral or umbilical arterial catheter (UAC)

- **Remove catheter**
  - unless absolutely essential
- **Elicit reflex vasodilation**
  - reflex vasospasm on insertion of UAC can occasionally be corrected by reflex vasodilation by warming contralateral limb
- **Volume expansion**
  - if appropriate, give 10 mL/kg sodium chloride 0.9% as volume expander
- **GTN patch**
  - use can be considered to improve perfusion but not trialled or licensed for use in babies. Discuss with consultant
- Liaise with plastic surgeons, haematologists and other specialists as needed

Management of thromboembolism

- Controversial
- Inadequate controlled trials
- Inform consultant
- Liaise with plastic surgeons, haematologists and other specialists as needed

Treatment options

Conservative

- Observe closely with no intervention e.g. unilateral renal vein thrombosis

Anticoagulation and thrombolysis

- No controlled neonatal trials
- Use only under guidance from haematologist and/or plastic surgeon

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Vascular thrombosis

Clinical features suggesting vascular thrombosis

Site	Clinical signs	Diagnostic imaging
Peripheral or central (aorta or iliac) arterial thrombosis	● Pallor ● Cold arm/foot ● Weak or absent peripheral pulse ● Discolouration ● Gangrene ● Difficulty establishing a proper pulse oximetry trace ● Delayed capillary refill time on affected limb	● Doppler scan for large vessel thrombus (sensitivity and specificity uncertain in the neonatal period) ● Real-time two-dimensional ultrasound ● CT scan with contrast ● Contrast angiography (at specialised centre)
Renal artery/aortic thrombosis	● Systemic hypertension ● Haematuria ● Oliguria ● Renal failure	
Renal vein thrombosis	● Flank mass ● Haematuria ● Hypertension ● Thrombocytopenia	
Inferior vena cava thrombosis	● Cool lower limbs ● Cyanosis ● Oedema	
Superior vena cava thrombosis	● Swelling of upper limbs and head ● Chylothorax	
Central venous line thrombus	● High pressures on long line ● SVC obstruction ● Chylothorax ● Swelling ● Discolouration of extremity	
Right atrial thrombus	● Heart failure ● Embolic phenomenon	● Echo
Pulmonary thromboembolism	● Respiratory failure	● Lung perfusion scan (at specialised centre)

VENEPUNCTURE • 1/1

INDICATIONS

- Blood sampling in a baby without indwelling arterial line, or when sampling from arterial line or capillary sampling is inappropriate

EQUIPMENT

- Cleaning solution or cleaning swab – follow local infection control policy
- Appropriately labelled blood bottles and request cards
- Non-sterile gloves
- 23 gauge blood sampling needle or needle-safe cannula
- **Do not use a broken needle**
- Sterile gauze/cotton wool to apply to wound post-procedure

PROCEDURE

Preparation

- Wash hands and wear gloves
- Second person employs containment holding and gives sucrose – see **Pain assessment and management** guideline
- Identify suitable vein (typically back of hand or foot)
- **Avoid sampling from potential IV infusion site or long-line vein (e.g. cubital fossa or long saphenous) whenever possible**
- Place paper towels under limb to avoid blood dripping onto bed linen

Insertion and sampling

- Apply hand pressure around limb to distend vein
- Clean the puncture site then do not touch again
- Place thumb on skin slightly distal to proposed puncture site
- Hold needle at a 10–20º angle and puncture skin
- Advance needle toward vein. Resistance may diminish slightly as needle enters vein and blood will be seen to flow
- Collect required volume taking care to mix but not shake blood
- When sampling complete, place gauze/cotton wool over insertion point and withdraw needle
- Maintain pressure on site until bleeding ceases
- Keep track of all needles used and dispose of them in sharps container
- Label all samples and investigation forms at cot side
- Arrange for transfer of samples to laboratory

DIFFICULT VENEPUNCTURE

- If small quantities of blood required (<1 mL), use heel prick, but remember that squeezing can cause haemolysis and elevate serum potassium
- Defer to a more experienced operator
- Transillumination of limb can help identify suitable vein

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INTRODUCTION

Oxygenation

- Increase oxygenation by increasing:
  - FiO_2
  - peak end expiratory pressure (PEEP)
  - peak inspiratory pressure (PIP)
  - inspiratory time (T_{insp})

CO_2

- Reduced by:
  - increased PIP
  - increased rate
  - occasionally by reducing excessive PEEP (beware of effect on oxygenation)

VENTILATOR PARAMETERS

Peak inspiratory pressure (PIP)

- Use lowest possible PIP to achieve visible chest expansion and adequate gas exchange on blood gas analysis
- To minimise lung injury from barotrauma and inadvertent over-distension, avoid excessive PIP
- Need for higher pressures [e.g. mean airway pressure (MAP) >12 cm] should lead to consideration of high frequency oscillatory ventilation (HFOV) – see **High frequency oscillatory ventilation** guideline

Peak end expiratory pressure (PEEP)

- Use a PEEP of at least 3 cm and increase incrementally up to 8 cm for improving oxygenation but
  - when PEEP >6 cm is necessary, take senior advice

Inspiratory time (T_{insp})

- Usually between 0.3–0.4 sec
- Avoid T_{insp} >0.5 sec except in term babies with parenchymal lung disease where a T_{insp} up to 1 sec may be used

Rate

- Fast-rate (≥60/min) ventilation is associated with fewer air leaks and asynchrony compared to slow (20–40/min) rates
- If rate >70/min required, HFOV may be a more appropriate option – see **High frequency oscillatory ventilation** guideline

Flow

- Flow of 5–8 L/min is generally sufficient
- Consider higher flows at faster ventilatory rates or shorter inspiratory times
- SLE ventilator has a fixed flow (5 L/min) that cannot be altered

Tidal volume (V_t)

- Target is 4–6 mL/kg

SETTING UP VENTILATOR

- Switch on humidifier and follow manufacturer's recommended settings for optimum temperature and humidity

Setting 1

- When an admission of a preterm baby requiring ventilatory support (for recurrent apnoea, see **Setting 2**)
  - rate 60/min
  - PIP 16–18 cmH_2O
  - PEEP 4 cmH_2O
  - T_{insp} 0.3–0.4 sec
  - FiO_2 0.4–0.6
  - flow 6–8 L/min (not applicable to SLE)
- Adjust ventilatory settings depending on chest movement, SpO_2, and measured V_t
- Sample blood gas within 30 min of commencing ventilatory support

Setting 2

- For babies with **normal** lungs requiring supportive ventilation such as term babies with respiratory depression (asphyxia or drugs), babies with neuromuscular disorders or, in the post-operative period, and preterm babies with recurrent apnoea, set ventilator at following settings:
  - rate 20–40/min
  - PIP/PEEP 10–12/3 cmH_2O
  - T_{insp} 0.35–0.4 sec
  - FiO_2 0.21–0.3

ADJUSTING VENTILATORY SETTINGS

Adjusting FiO_2

- Oxygen is a drug and should be prescribed as with other medications. This should be done by specifying the intended target range of SpO_2 on baby's drug chart
- Suggested target SpO_2 ranges (see **Oxygen saturation** guideline)
  - preterm babies: 91–95%
  - term babies with PPHN: 96–100%

Altering ventilatory settings according to blood gases

If blood gases are outside the targets, first check the following:

- **Reliability of blood gas:**
  - is the blood gas result reliable?
  - has there been a sudden unexpected change from previous blood gas values?
  - did sample contain an air bubble?
  - was it obtained from a poorly perfused site?
- **Baby's status:**
  - is baby's chest moving adequately?
  - how is the air entry?
- **Ventilator and tubing**
  - is there an air leak? (transilluminate to exclude – see **Transillumination of the chest** guideline)
  - what is the V_t?
  - are the measured ventilatory values markedly different to the set ones?
  - is there a large (>40%) endotracheal tube (ETT) leak?

> ***Remember to exclude airway problems (blocked/displaced ETT) and air leaks in case of deterioration of blood gases. If available, use pedi-cap or end-tidal CO_2 monitoring to exclude ETT malposition***

- Small frequent changes are more appropriate than large infrequent ones

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Blood gas scenario	Recommended action *in order of preference*
Low PaO_2/SpO_2	● Exclude airleak/displaced ETT/overinflation ● Increase FiO_2 ● Increase PEEP ● Increase PIP (but be aware of effect on $PaCO_2$) ● Increase T_{insp} (but ensure adequate T_{exp}, especially at fast rates) ● Consider further surfactant (see **Surfactant replacement** guideline) ● If above measures unsuccessful, discuss with consultant (may need HFOV/iNO)
High PaO_2	● Decrease FiO_2 (unless already in air) ● Decrease PEEP (if >5 cm) ● Decrease PIP (especially if $PaCO_2$ is also low)
High $PaCO_2$	● Exclude airleak/displaced or blocked ETT ● Increase PIP ● Increase rate ● Decrease PEEP (only if oxygenation adequate and PEEP >6 cm) after taking senior advice
Low $PaCO_2$	● Decrease PIP ● Decrease rate
Low PaO_2/SpO_2 and high $PaCO_2$	● Exclude displaced/blocked ETT ● Exclude air leak ● Increase PIP ● Consider further surfactant ● If no response, consider HFOV – see **High frequency oscillatory ventilation** guideline

All ventilator changes must be prescribed and signed for on the intensive care chart

Load all babies <30 weeks' gestation with caffeine on day 0 with maintenance doses thereafter. Do not delay loading until the weaning stage

WEANING

- While weaning baby off ventilator:
- reduce PIP (usually by 1–2 cm) until MAP of ≤7 cm reached
- thereafter, reduce rate to 20/min, usually in decrements of 5–10 breaths/min

Extubation

- Extubate babies of <30 weeks' gestation onto nasal CPAP – for mode, see **CPAP** guideline
- more mature babies with no significant chest recessions can be extubated directly into incubator oxygen

BABIES FIGHTING VENTILATOR

If baby in asynchrony with the ventilator (fighting)

- Ensure baby is not hypoxic or under-ventilated
- Exclude blocked ETT
- Look for obvious pain e.g. necrotising enterocolitis (NEC)
- If possible, change to synchronised form of ventilation (SIPPV/PTV/Assist Control/SIMV) – see **Ventilation: synchronous positive pressure** guideline
- Ensure adequate sedation. Usually intravenous infusion of morphine (10–20 microgram/kg/hr). Muscle relaxation is seldom necessary and used only if morphine infusion has already commenced

CARE OF VENTILATED BABY

Ventilated babies should have:

- Continuous electronic monitoring of heart rate, ECG, respiratory rate, SpO_2 and temperature
- Blood pressure
- continuous measurement of arterial blood pressure in babies ≤28 weeks' gestation, and those >28 weeks needing FiO_2 >0.6
- cuff measurement 4-hrly in acute phase
- At least 6-hrly blood gas (arterial or capillary) measurement during acute phase of disease
- Hourly measurement of colour, and measured ventilatory parameters. If sudden drop in V_t, check air entry
- Daily monitoring of intake, output and weight

Parent information

Offer parents the following information, available from:

http://www.bliss.org.uk/ventilation

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VENTILATION: HIGH FREQUENCY OSCILLATORY (HFOV) • 1/3

Decision to initiate HFOV must be made by a consultant. Do not start HFOV unless you have been trained to do so and have demonstrated your competence

INDICATIONS

- Rescue following failure of conventional ventilation (e.g. PPHN, MAS)
- To reduce barotrauma when conventional ventilator settings are high
- Airleak (pneumothorax, PIE)

Less effective in non-homogenous lung disease

Terminology

Frequency	High frequency ventilation rate (Hz, cycles per second)
MAP	Mean airway pressure (cmH_2O)
Amplitude	Delta P or power is the variation around the MAP

Mechanism

Oxygenation and CO_2 elimination are independent

Oxygenation is dependent on MAP and FiO_2	MAP provides constant distending pressure equivalent to CPAP, inflating the lung to constant and optimal lung volume, maximising area for gas exchange and preventing alveolar collapse in the expiratory phase
Ventilation (CO_2 removal) dependent on amplitude	The wobble superimposed around the MAP achieves alveolar ventilation and CO_2 removal

MANAGEMENT

Preparation for HFOV

- If there is significant leakage around the ET tube (ETT), insert a larger one
- Optimise blood pressure and perfusion, complete any necessary volume replacement and start inotropes, if necessary, before starting HFOV
- Invasive blood pressure monitoring if possible
- Correct metabolic acidosis
- Ensure adequate sedation
- Muscle relaxants are not necessary unless already in use

Initial settings on HFOV

MAP

Optimal (high) lung volume strategy (aim to maximise recruitment of alveoli)	• If changing from conventional ventilation, set MAP 2–4 cmH_2O above MAP on conventional ventilation • If starting immediately on HFOV, start with MAP of 8 cmH_2O and increase in 1–2 cmH_2O increments until optimal SpO_2 achieved • Set frequency to 10 Hz
Low volume strategy (aim to minimise lung trauma)	• Set MAP equal to MAP on conventional ventilation • Set frequency to 10 Hz

- Optimal (high) volume strategy preferred but consider low volume strategy when air leaks are present

VENTILATION: HIGH FREQUENCY OSCILLATORY (HFOV) • 2/3

Amplitude (delta P on SLE ventilator)

- Gradually increase amplitude until chest seen to wobble well
- Obtain early blood gas (within 20 min) and adjust settings as appropriate
- **Change frequency only after discussion with consultant**

Making adjustments once HFOV established

	Poor oxygenation	Over-oxygenation	Under-ventilation	Over-ventilation
Either	Adjust MAP (+/- 1–2 cmH_2O)*	Decrease MAP (1–2 cmH_2O) when FiO_2 <0.4	Increase amplitude	Decrease amplitude
Or	Increase FiO_2	Decrease FiO_2		

* both over and under inflation can result in hypoxia. If in doubt, perform chest X-ray

MONITORING

- Amplitude maximal when chest 'wobbling', minimal when movement imperceptible
- Frequent blood gas monitoring (every 30–60 min) in early stages of treatment as PaO_2 and $PaCO_2$ can change rapidly
- If available, transcutaneous $TcPCO_2$

Chest X-ray

- Within 1 hr to determine baseline lung volume on HFOV (aim for 8 ribs at midclavicular line)
- if condition changes acutely and/or daily to assess expansion/ETT position, repeat chest X-ray

TROUBLESHOOTING ON HFOV

Chest wall movement

- Suction indicated for diminished chest wall movement indicating airway or ETT obstruction
- Always use an in-line suction device to maintain PEEP
- increase FiO_2 following suctioning procedure
- MAP can be temporarily increased by 2–3 cmH_2O until oxygenation improves

Low PaO_2

- Suboptimal lung recruitment
- increase MAP
- consider chest X-ray
- Over-inflated lung
- reduce MAP: does oxygenation improve? Check blood pressure
- consider chest X-ray
- ETT patency
- check head position and exclude kinks in tube
- check for chest movement and breath sounds
- check there is no water in ETT/T piece
- Air leak/pneumothorax
- transillumination – see **Transillumination of the chest** guideline
- urgent chest X-ray

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VENTILATION: HIGH FREQUENCY OSCILLATORY (HFOV) • 3/3

High $PaCO_2$

- ETT patency and air leaks (as above)
- Increase amplitude, does chest wall movement increase?
- Increased airway resistance (MAS or BPD) or non-homogenous lung disease, is HFOV appropriate?

Persisting acidosis/hypotension

- Over-distension
- Exclude air leaks; consider chest X-ray
- reduce MAP: does oxygenation improve?

Spontaneous breathing

- Usually not a problem but can indicate suboptimal ventilation (e.g. kinking of ETT, build-up of secretions) or metabolic acidosis

WEANING

- Reduce FiO_2 to <0.4 before weaning MAP (except when over-inflation evident)
- When chest X-ray shows evidence of over-inflation (>9 ribs), reduce MAP
- Reduce MAP in 1–2 cm decrements to 8–9 cm 1–2 hrly or as tolerated
- If oxygenation lost during weaning, increase MAP by 3–4 cm and begin weaning again more gradually. When MAP is very low, amplitude may need increasing
- In air leak syndromes (using low volume strategy), reducing MAP takes priority over weaning the FiO_2
- Wean the amplitude in small increments (5–15%) depending upon PCO_2

Do not wean the frequency

- When MAP <8 cmH_2O, amplitude 20–25 and blood gases satisfactory, consider switching to conventional ventilation or extubation to CPAP

VENTILATION: SYNCHRONOUS POSITIVE PRESSURE (SIPPV) • 1/3

DEFINITION

A form of synchronous ventilation in which baby triggers/initiates the breath while ventilator does the work of breathing. In other words, rate of ventilation is determined by baby while pressures are determined by operator via ventilator

SETTING UP TRIGGER VENTILATION

- Set humidifier temperature at 39ºC (negative 2) to achieve airway temperature of 37ºC

Set up Babylog (Drager)

- Flow 6–10 L/min
- Select SIPPV mode
- Select highest trigger sensitivity (1: bar is all unshaded)
- Select T_{insp} (inspiratory time) between 0.3–0.4 sec
- Adjust T_{exp} (expiratory time) to achieve back-up rate of 35–40/min
- Peak inspiratory pressure (PIP) 16–18 cm H_2O
- Peak end expiratory pressure (PEEP) 5 cm H_2O
- FiO_2: 0.4–0.6

Set up SLE 5000 using version 4.3 software upgrade

- Flow is fixed in SLE at 5 L/min
- Select PTV (patient triggered ventilation) mode
- Select highest trigger sensitivity (0.4 L/min for ≤28 weeks' gestation, 0.6–0.8 L/min for >28 weeks' gestation). Look at baby to confirm triggering adequately by observing baby generated breaths are triggering ventilator support
- Select Ti (inspiratory time) for back-up breaths between 0.3–0.4 sec
- Set back-up rate of 35–40/min
- Peak inspiratory pressure (PIP) 16–18 cm H_2O
- Peak end expiratory pressure (PEEP) 5 cm H_2O
- FiO_2: 0.4–0.6
- Software allows compensation for a leak of 10–50%
- Observe tidal volume settings to confirm between 4–6 mL/kg

Baby

- If gestation <34 weeks, load baby with caffeine citrate (20 mg/kg) IV if not already started
- Discontinue sedation

INITIATING TRIGGER VENTILATION

- Once baby connected to ventilator:
  - check SpO_2 (see **Oxygen saturation targets** guideline) and adjust FiO_2 accordingly
  - check baby's chest moving adequately, and measured tidal volume (Vt). Chest expansion should be just visible, and Vt should be between 4–6 mL/kg. If not, adjust PIP/PEEP to maintain adequate oxygenation and ventilation
  - check ventilator triggering in synchrony with baby. Assess by **listening** to ventilator while **watching** baby's respiratory effort

Most likely cause of baby 'fighting' ventilator is asynchrony (see Management of asynchrony)

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SUBSEQUENT ADJUSTMENTS ON SIPPV

- Check blood gas within 30 min of initiation of SIPPV
- Aim for PaO_2 between 6–10 kPa, $PaCO_2$ between 5–7 kPa and pH >7.25

To improve oxygenation

- Increase FiO_2
- Rule out pneumothorax
- Increase PIP and/or PEEP
- Increase T_{insp} (not more than 0.4 sec)

To decrease $PaCO_2$

- Rule out pneumothorax
- Increase PIP
- Check if baby triggering adequately. If not, try shortening T_{insp}, or increasing back-up rate

Low $PaCO_2$

- Decrease PIP
- Decrease back-up rate if >35/min
- In a vigorous hypocapnic baby, transfer to SIMV (synchronised intermittent mandatory ventilation) at a rate of at least 20/min

GENERAL SUPPORT

- Monitor SpO_2 continuously
- Check arterial blood gases at least 4–6 hrly depending on stage of disease
- In babies successfully ventilated in SIPPV mode, sedation is unnecessary
- Remember, most common cause of baby fighting ventilator is **asynchrony**. Always carry out checks and adjustments (see **Management of asynchrony**)

Do not use muscle relaxants at any stage unless, despite carrying out above checks, baby cannot be ventilated.

If muscle relaxants necessary, revert to conventional ventilation (see* Ventilation - conventional *guideline)

NURSING OBSERVATIONS

While baby on SIPPV, hourly observations

- Back-up rate set
- Baby's own respiratory rate
- Tidal volume (Vt in mL)
- Minute ventilation (MV in 1/min)

If alarm goes off, check

- Synchrony between baby and ventilator
- Excessive water droplets in ventilator tubing
- Flow graph for evidence of blocked tube or excessive T_{insp}
- Disconnection

MANAGEMENT OF ASYNCHRONY

Checklist

- Is endotracheal tube (ETT) patent (look at flow graph and Vt)
- Is T_{insp} too long? (is baby exhaling against ventilator?), if so shorten T_{insp} to 0.24–0.3 sec
- Is back-up rate too high? If so, consider dropping to 30–35 breaths/min
- Is there water condensation in ventilator tubing?
- If all above fails, consider morphine bolus (100 microgram/kg) over 3–5 min
- If baby still continues to 'fight' ventilator, use continuous sedation and revert to SIMV (see **Ventilation - conventional** guideline)

VENTILATION: SYNCHRONOUS POSITIVE PRESSURE (SIPPV) • 3/3

AUTOCYCLING (FALSE TRIGGERING)

- False triggering occurs when ventilator delivers a mechanical breath artifactually when baby not actually initiating a spontaneous respiration
- Usually results from presence of water droplets in ventilatory circuit, or an excessive ETT leak
- If baby's trigger rate appears to be in excess of 80/min, ensure this is actual rate by observing baby's own respiratory movements. If not:
  - check ventilatory circuit for excessive water condensation and empty if necessary
  - decrease trigger sensitivity
  - look for amount of ETT leak on Babylog display. If in excess of 50%, consider changing to slightly wider ETT

WEANING FROM SIPPV

- Once baby stable (triggering above set rate, saturating in FiO_2 <0.3), wean by:
  - decreasing PIP by 1–2 cm H_2O each time (in SIPPV/PTV mode, weaning rate in a baby who is already triggering above it is useless)
  - check baby breathing regularly and effortlessly (no chest recessions), and blood gases and oximetry are acceptable
  - once PIP between 14–16 cm H_2O (depending on size of baby), consider extubation
  - assess need for nasal CPAP by checking for chest recessions, spontaneous minute ventilation, and regularity of breathing
- During weaning $PaCO_2$ can rise above 7 kPa and Vt may fall below 4 mL/kg
  - provided baby triggering well, is not visibly tired, and pH >7.25, no action required
  - if poor triggering, visibly tired or abnormal pH, increase PIP, and later back-up rate

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VENTILATION - VOLUME TARGETED
(Volume guarantee/targeted tidal volume) • 1/1

DEFINITION

In volume-targeted ventilation (VTV) primary gas delivery target is tidal volume (Vt) while the peak inspiratory pressure may vary depending on underlying lung compliance. Available as volume guarantee (VG) on Draeger babylog and targeted tidal volume (TTV) on SLE 5000

Benefits

- Compared with pressure-controlled ventilation, VTV can reduce:
  - mortality
  - bronchopulmonary dysplasia
  - pneumothorax
  - hypocarbia
  - severe cranial ultrasound abnormalities

INDICATION

- Primarily used in preterm babies with surfactant-deficient lung disease requiring ventilation
- May be useful in other situations requiring ventilation

TIDAL VOLUMES TO USE

- Expired tidal volume (Vte) used as less influenced by ETT leaks
- V_t 4–6 mL/kg
- V_t >8 mL/kg associated with volutrauma
- 5 mL/kg reasonable starting volume
- Adjustments can be made in steps of 0.5 mL/kg
- Avoid V_t <3.5 mL/kg

MODE

- VG/TTV combined with assist control (PTV) or pressure-support ventilation (PSV) preferred – these modes support all spontaneous breaths
- If used in SIMV mode, need a set rate of at least 40/min
- PSV has the additional advantage of synchronising expiration

PEAK PRESSURES

- Start PIP limit (Pmax) of ~25–30 cm H_2O
- Adjust Pmax to 5–6 cm H_2O above average PIP needed to deliver set tidal volume
- If PIP progressively increases or is persistently high or if set V_t not delivered, re-assess baby
- PEEP set at 4–6 cm water

VENTILATOR RATE

- In baby with poor respiratory drive, use rates of 50–60 bpm
- Lower back-up rates of 30–40 bpm can be used with good respiratory drive
- Use Ti (inspiratory time) of 0.3–0.4 sec; in PSV mode, set maximum Ti at 0.5–0.6 sec – actual Ti is adjusted by the ventilator

WEANING

- In assist-control or PSV, wean by reducing V_t in steps of 0.5 mL/kg
- Pressure weans automatically as lung compliance improves
- Avoid tidal volumes <3.5 mL/kg
- In SIMV, rate reduced as well as V_t
- Attempt extubation when:
  - MAP falls consistently <8 cm
  - baby has good respiratory drive and satisfactory gases

INDICATIONS

Prophylaxis

- Babies are relatively deficient in vitamin K (phytomenadione) and those who do not receive supplements are at risk of bleeding (vitamin K deficiency bleeding, formerly known as haemorrhagic disease of the newborn)
- All babies should be given vitamin K with parental consent

Therapy

- After blood has been taken for clotting studies, vitamin K can also be used to treat any baby with active bleeding that might have resulted from vitamin K deficiency
- a prolonged prothrombin time (INR ≥3.5) that falls within 1 hr of treatment, with normal platelet count and fibrinogen concentration suggest the diagnosis. However, as INR is a poor indicator of vitamin K deficiency, PIVKAII is a better investigation if available

ADMINISTRATION

Prophylaxis

- Vitamin K (Konakion MM Paediatric) as a single IM dose (see **Table** below for dosage schedule)
- avoid IV administration for prophylaxis as it does not provide the same sustained protection as IM
- Give in accordance with manufacturer's instructions in order to ensure clinical effectiveness
- If parents decline IM route, offer oral vitamin K as second line option (safety fears of parenteral vitamin K appear to be unfounded)
- Two doses of oral vitamin K 2 mg should be given in the first week, the first at birth and the second at 4–7 days. For exclusively breastfed babies, a third dose of 2 mg is given at 1 month of age; the third dose is omitted in formula-fed babies because formula feeds contain adequate vitamin K
- If parents refuse prophylaxis, ask senior neonatologist to see and record discussion in notes

IM use

- Do not dilute or mix with other parenteral injections

Oral use

- Break open ampoule and withdraw 0.2 mL (2 mg) into the oral dispenser provided. Drop contents directly into baby's mouth by pressing plunger

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Prophylaxis dosage	Konakion MM Paediatric
Healthy babies of ≥36 weeks	**First line** ● 1 mg IM at birth or soon after **Second line** ● 2 mg oral at birth, then ● 2 mg oral at 4–7 days, then ● 2 mg oral at 1 month if exclusively breastfed
Term babies at special risk ● Instrumental delivery, caesarean section ● Maternal treatment with enzyme-inducing anticonvulsants (carbamazepine, phenobarbital, phenytoin), rifampicin or warfarin ● Requiring admission to neonatal unit ● Babies with cholestatic disease where oral absorption likely to be impaired	1 mg IM at birth or soon after **Do not** offer oral vitamin K
Preterm babies <36 weeks but ≥2500 g	1 mg IM at birth or soon after
All babies <2500 g	400 microgram/kg (0.04 mL/kg) IM shortly after birth (maximum dose 1 mg) Do not exceed this parenteral dose The frequency of further doses should depend on coagulation status
Babies who have or may have Factor VIII or Factor IX deficiency or other coagulation deficiency	Unless results of Factor assays normal, give orally – consult with local haematologist

For babies with birth weight ≥2500 g

- Administer Konakion MM Paediatric 1 mg (0.1 mL) IM
- this is approximately **half** of the ampoule volume and should be drawn up using the syringe supplied with the ampoule

For babies with birth weight <2500 g

- Administer 400 microgram/kg (0.04 mL) with a maximum of 1 mg (0.1 mL) of Konakion MM Paediatric IM
- round up the dose to nearest hundredth [e.g. 300 microgram (0.03 mL), 500 microgram (0.05 mL) etc.]
- draw up the dose using the syringe supplied with the ampoule

Therapy dosage

- If not already given IM, give vitamin K 100 microgram/kg IV up to 1 mg maximum dose
- Further doses as required, depending on clinical picture and coagulation status
- may need to be accompanied by a more immediately effective treatment such as transfusion of fresh frozen plasma

IV administration

- If necessary, dilute. For IV administration, dilution in glucose is not recommended due to reactions with syringes but the drug can be added to a lower port of a syringe giving set administering glucose 5% at rate not less than 0.7 mL/hr

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Neonatal Guidelines 2015-17

This book has been compiled as an aide-memoire for all staff concerned with the management of neonates, towards a more uniform standard of care across the Staffordshire, Shropshire and Black Country Newborn and Maternity Network hospitals and Southern West Midlands Maternity and Newborn Network hospitals.

These guidelines are advisory, not mandatory

Every effort has been made to ensure accuracy

The authors cannot accept any responsibility for adverse outcomes

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