CHAPTER 19

PREMATURITY AND NEONATAL CONDITIONS

Note: Always assess gestational age as accurately as possible.
Use Ballard Scoring Assessment (below).

Neuromuscular Maturity

Score	-1	0	1	2	3	4	5
Posture							
Square window (wrist)	 >90°	 90°	 60°	 45°	 30°	 0°	
Arm recoil		 180°	 140°–180°	 110°–140°	 90°–110°	 <90°	
Popliteal angle	 180°	 160°	 140°	 120°	 100°	 90°	 <90°
Scarf sign							
Heel to ear							

Physical Maturity

Skin	Sticky, friable, transparent	Gelatinous, red, translucent	Smooth, pink; visible veins	Superficial peeling and/or rash; few veins	Cracking, pale areas; rare veins	Parchment, deep cracking; no vessels	Leathery, cracked wrinkled
Lanugo	None	Sparse	Abundant	Thinning	Bald areas	Mostly bald	
Plantar surface	Heel-toe 40-50 mm: –1 <40 mm: –2	>50 mm, no crease	Faint red marks	Anterior transverse crease only	Creases anterior ⅔	Creases over entire sole	
Breast	Imperceptible	Barely perceptible	Flat areola, no bud	Stippled areola, 1–2 mm bud	Raised areola, 3–4 mm bud	Full areola, 5–10 mm bud	
Eye/Ear	Lids fused loosely: –1 tightly: –2	Lids open; pinna flat; stays folded	Slightly curved pinna; soft; slow recoil	Well curved pinna; soft but ready recoil	Formed and firm, instant recoil	Thick cartilage, ear stiff	
Genitals (male)	Scrotum flat, smooth	Scrotum empty, faint rugae	Testes in upper canal, rare rugae	Testes descending, few rugae	Testes down, good rugae	Testes pendulous, deep rugae	
Genitals (female)	Clitoris prominent, labia flat	Clitoris prominent, small labia minora	Clitoris prominent, enlarging minora	Majora and minora equally prominent	Majora large, minora small	Majora cover clitoris and minora	

Maturity Rating

Score	Weeks
-10	20
-5	22
0	24
5	26
10	28
15	30
20	32
25	34
30	36
35	38
40	40
45	42
50	44

https://epomedicine.com/clinical-medicine/new-ballard-score-how-to-use-it-correctly/

19.1 RESUSCITATION OF THE NEWBORN

Be prepared!
Be at the delivery!
Check the equipment and emergency medicines!

Ask 3 questions to evaluate the infant:

1. Is there good tone?
2. Is the infant breathing adequately and not just gasping?
3. Is the heart rate above 100 beats per minute?

If the answer to all three questions is 'yes', the newborn does not need resuscitation.
If the answer to any of the three questions is 'no', the newborn needs resuscitation.

Assess the infant using the above 3 questions every 30 seconds during resuscitation. If the newborn is improving, then the intervention, e.g. bag-mask ventilation can be stopped. Only if the baby is not responding or getting worse, is further intervention needed, e.g. chest compressions (see algorithm).

Check that each step has been effectively applied before proceeding to the next step. The algorithm follows the assumption that the previous step was unsuccessful and the newborn is deteriorating.

Use the lowest inspiratory oxygen concentration to alleviate central cyanosis and restore a heart rate to above 100 beats per minute. There is evidence that resuscitation with 100% oxygen may be harmful to the baby.

- Oxygen resuscitation of newborns:
  - ≥ 32 weeks gestation: begin with 21%.
  - 28–31 weeks gestation: begin with 21–30%.
  - < 28 weeks gestation: begin with 30%.

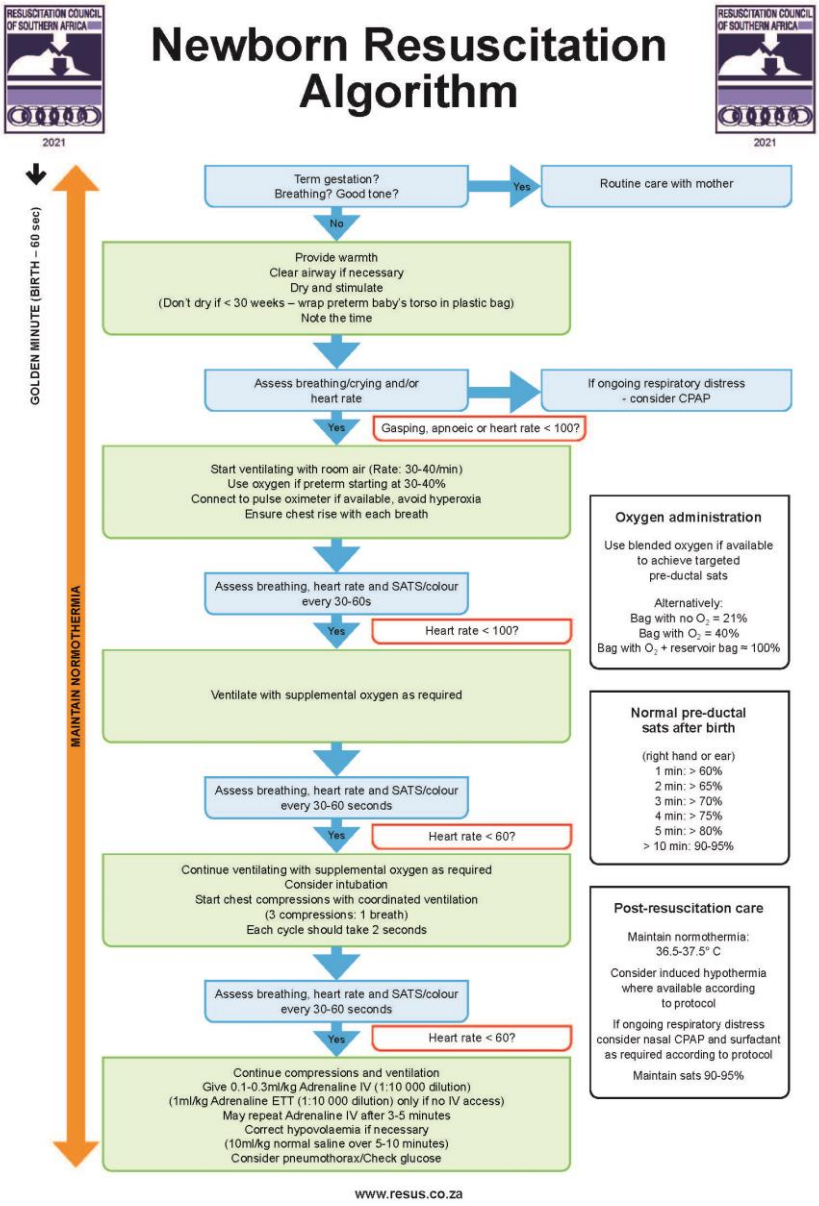
If baby is breathing but oxygen saturation is not within target range: free-flow oxygen administration may begin at 30%.
An unsatisfactory response to resuscitation includes:

» A sustained slow heart rate, usually ≤ 60/minute or a progressive decrease in heart rate until cardiac arrest occurs.
» Episodes of cardiac arrest, with a progressively weaker response to chest compressions, positive pressure ventilation and medicines.
» A decreasing blood pressure, increasing acidosis, severe hypotonia with central cyanosis or intense pallor.
» Apnoea or weak, irregular and inefficient respiratory efforts.
» Consider discontinuation of resuscitation if the unsatisfactory response to resuscitation persists for > 20 minutes and underlying conditions, e.g. pneumothorax, diaphragmatic hernia have been excluded or > 10 minutes of unresponsive cardiac arrest (asystole) and/or > 20 minutes of unsustainable respiration.

» Admit newborns with a favourable response to resuscitation to a neonatal high or intensive care unit, if available, for post-resuscitation care – see section 19.6.1: Hypoxia/Ischaemia of the newborn.
» Include analgesia for babies likely to be in pain. (See Chapter 20: Pain controlo9.)

MEDICINES USED DURING NEONATAL RESUSCITATION

Medicine	Indications	Dosage	Effect
Adrenaline (epinephrine)	Asystole Heart rate < 60/min.	IV, 0.1 mL/kg of a 1:10 000 dilution, which may be repeated up to three times. ET, 1 mL/kg of a 1:10 000 solution.	↑Heart rate ↑Myocardial contractility. ↑Arterial pressure.
Naloxone	Maternal administration of opiates + apnoeic infant.	ET/IV/SC/IM, 0.1 mg/kg.	Corrects apnoea and/or hypoventilation.
Fluids: sodium chloride 0.9%	Hypovolaemia	Slow IV, (5–10 min) 10–20 mL/kg.	↑Blood pressure and improves tissue perfusion.
Dextrose	Hypoglycaemia	IV, 250–500 mg/kg (2.5–5 mL/kg of 10% dextrose water).	Corrects hypoglycaemia.



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19.2 NEWBORN

19.2.1 JAUNDICE, NEONATAL

P58

DESCRIPTION

Yellow discolouration of the skin and mucous membranes due to hyperbilirubinaemia. Bilirubin is formed mainly from haem catabolism. Jaundice develops when there is an overproduction of bilirubin, defective bilirubin metabolism and/or defective excretion of bilirubin from the body.

DIAGNOSTIC CRITERIA

Jaundice may be physiological or pathological.

Physiological jaundice

» Seldom appears before 24–36 hours after birth.
» Rarely lasts more than 10 days in the full term infant and 14 days in the preterm infant.
» Only the unconjugated bilirubin fraction is increased.
» Total peak serum bilirubin concentration is usually below 275 µmol/L in the term infant.
» Total bilirubin concentration does not rise by more than 85 µmol/L/24 hours or 17 µmol/L/hour.
» The baby thrives and shows no signs of illness or anaemia.
» Treatment is unnecessary.

Pathological jaundice

» May appear within the first 24 hours of birth, but can occur at any time after birth.
» Persists for longer than 14 days in the full term infant or 21 days in the preterm infant.
» The unconjugated and/or conjugated fractions of bilirubin are increased.
» The conjugated bilirubin level exceeds 20% of the total bilirubin value, or the conjugated bilirubin fraction is 30 µmol/L or more.
» Total bilirubin concentration rises by more than 85 µmol/L/24 hours or 17 µmol/L/hour and the total serum bilirubin level is above physiological level.
» There are signs and symptoms of illness in the baby.
» Stools are pale in obstructive jaundice.

BREASTFEEDING ASSOCIATED JAUNDICE

Increased unconjugated bilirubin levels during the first week of life in breastfed babies is due to calorie and fluid deprivation and delayed passage of stools. It improves with increased frequency of breastfeeding.

19.2.1.1 HYPERBILIRUBINAEMIA, UNCONJUGATED

Excessive haemolysis	Defective conjugation
» ABO incompatibility	» prematurity
» rhesus disease	» infection
» enclosed haemorrhages	» hypoxia
» polycythaemia	» hypoglycaemia
» infections*	» hypothyroidism*
» spherocytosis	» breast milk jaundice*
» G6PD deficiency	

*May cause prolonged neonatal jaundice.

GENERAL AND SUPPORTIVE MEASURES

» Treat the underlying cause.
» Monitor the infant's body temperature and maintain within thermoneutral range.
» Maintain adequate nutrition and hydration.
» Correct factors known to increase the risk of brain damage in babies with jaundice, e.g.:
  > hypoxia,
  > hypoglycaemia,
  > acidosis,
  > haemolysis.
  > prematurity,
  > hypothermia,
  > hypoalbuminaemia, and

PHOTOTHERAPY

Guideline for initiating and terminating phototherapy:

» Commence phototherapy based on total serum bilirubin measurements, correlated with phototherapy graph attached. The need for phototherapy is determined by the level according to hours of life and gestation or weight.
» The skin colour of a baby receiving phototherapy does not reflect the degree of jaundice (bilirubin blood level) or the efficacy of the phototherapy.
» Undress the baby and cover the eyes with gauze pads or commercially available eye covers.
» Position the phototherapy unit (fluorescent light bulbs of 400–500 nm wavelength) not higher than 45 cm above the baby.
» Check spectral irradiance of the fluorescent lights using a radiometer after every 200–300 hours of use to ensure that they are effective.
» The spectral irradiance should be above 10 µwatt/cm^2/nm of wavelength. If spectral irradiance cannot be checked regularly, replace fluorescent light bulbs after 1 000 hours of continuous use.
» A quartz halogen light source (400–500 nm wavelength) can also be used for phototherapy.
» Phototherapy units with diodes emitting light in the blue spectrum or fibre-optic phototherapy units can be used instead of the fluorescent/quartz halogen units.
» Terminate phototherapy when the total serum bilirubin level is more than 50 µmol/L below the recommended phototherapy initiating level, and the cause of the jaundice has been determined and adequately addressed.
» A rebound increase in bilirubin may follow termination of phototherapy.

» Monitor bilirubin levels approximately 6 hourly after phototherapy has been stopped.

Guideline for exchange transfusion (see also the graphs below):

» Exchange transfusion is indicated when the risk of bilirubin encephalopathy and kernicterus is significant. Referral for exchange transfusion may be needed.

MEDICINE TREATMENT

Rh incompatibility (i.e. mother Rh-negative, baby Rh-positive).
ABO incompatibility (i.e. mother = O, baby = A, B or AB).
Once the diagnosis of Rh- or ABO-related haemolysis is confirmed, together with a positive direct Coombs test; and the serum bilirubin is rising rapidly (> 17 µmol/L/hour with intensive phototherapy) or is approaching exchange transfusion level, then administer (**in consultation with a specialist**):

- Immunoglobulin, IV, 500 mg/kg over 1 hour.
  - Can be repeated once after 6–8 hours.

Mothers of babies with Rh incompatibility should receive:

- Anti-D immunoglobulin, IM, 100 mcg as soon as possible after birth but within 72 hours of birth.

PHOTOTHERAPY

South African Neonatal Academic Hospital Guidelines: 2006

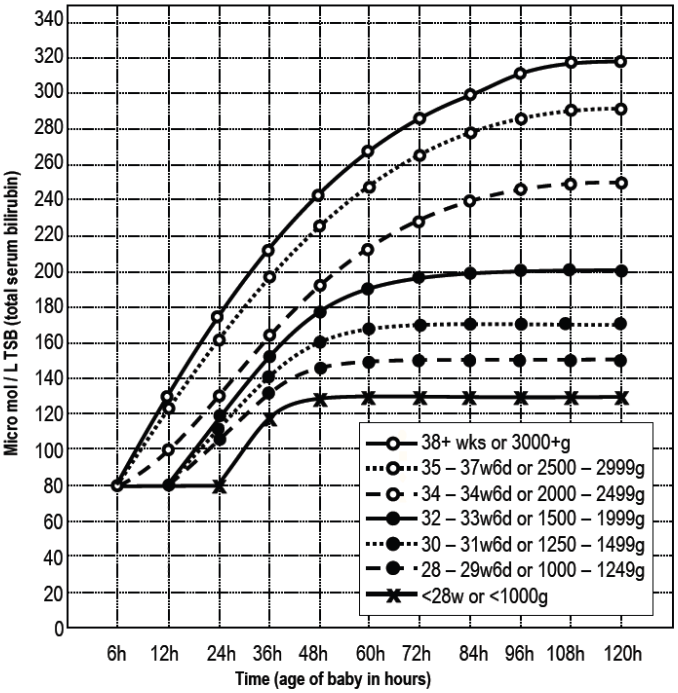
In presence of risk factors use one line lower (the gestation below) until <1000g.

If gestational age is accurate, rather use gestational age (weeks) instead of body weight

Infants > 12 hours old with TSB level below threshold, repeat TSB level as follows:
1- 20µmol/L below line:repeat TSB in 6hrs or start phototherapy and rept TSB in 12- 24hrs,
21 - 50 µmol/L below line: repeat TSB in 12 – 24hrs,
>50 µmol/L below line: rept TSB until it is falling and/or until jaundice is clinically resolving

Infants under phototherapy :
Check the TSB 12 – 24 hly but if TSB >30 µmol/L above the line , check TSB 4 – 6hly.

STOP phototherapy :
If TSB > 50 µmol/L below the line. Recheck TSB in 12 – 24hr.



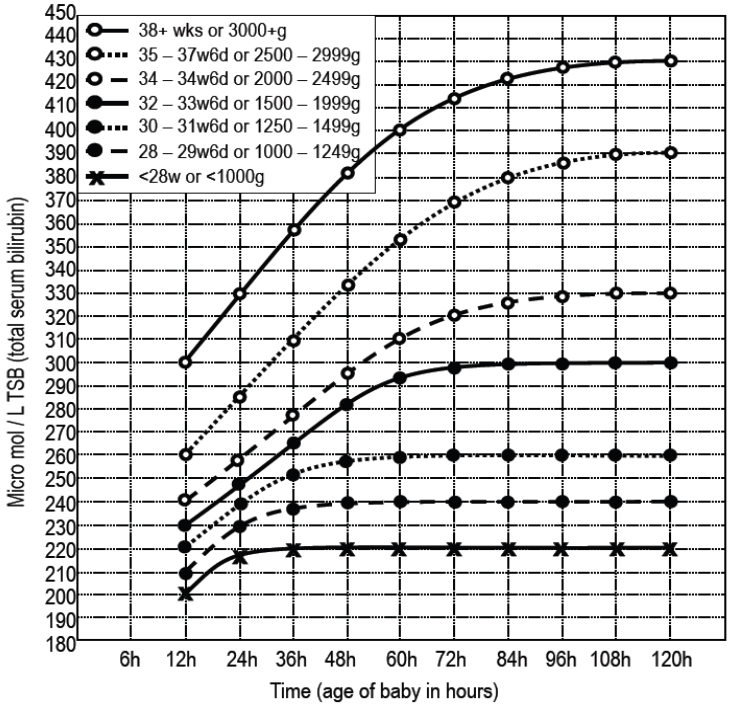
Start intensive phototherapy when the TSB is ≥ the line according to gestation or weight.
Published with permission from A Horn, P Henning, G Kirsten and SAMJ.
(SAMJ 2006;96:819-824)

EXCHANGE TRANSFUSION

South African Neonatal Academic Hospital Guidelines: 2006

In presence of sepsis, haemolysis, acidosis, or asphyxia,
use one line lower (gestation below) until <1000g
If gestational age is accurate, rather use gestational age (weeks) than body weight

Note: 1. Infants who present with TSB above threshold should have Exchange done if the TSB is not expected to be below the threshold after 6 hrs of intensive phototherapy.
2. Immediate Exchange is recommended if signs of bilirubin encephalopathy and usually also if TSB is >85 µmol/L above threshold at presentation
3. Exchange if TSB continues to rise >17 µmol/L/hour with intensive phototherapy

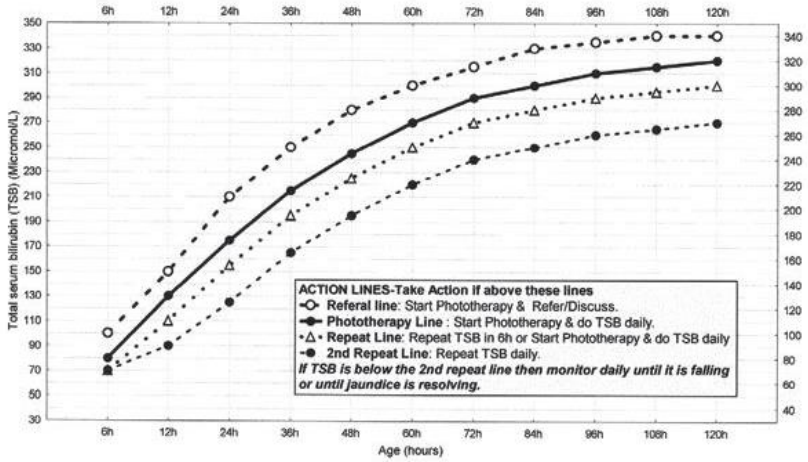


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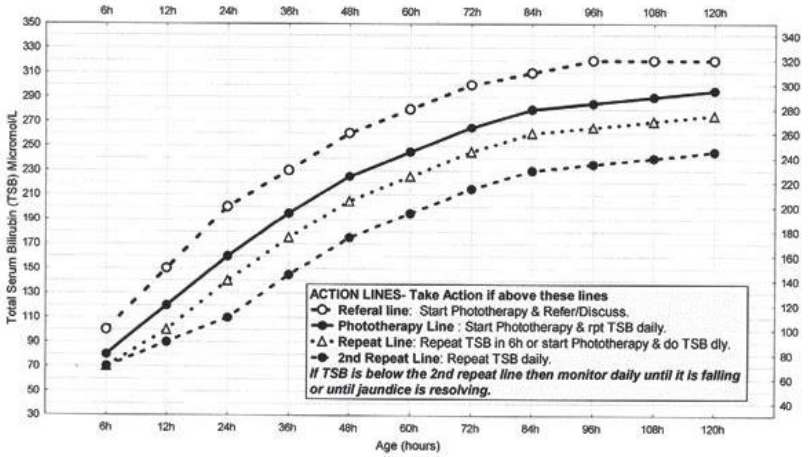
PHOTOTHERAPY AND TOTAL SERUM BILIRUBIN (TSB) MONITORING IN THE FIRST WEEK OF LIFE AT PRIMARY CARE
(South African Neonatal Academic Hospitals 2006)

- Refer/Discuss all jaundiced infants who are: < 2Kg or < 35wks gestation.
- Refer all infants of mothers who have Rhesus antibodies on antenatal screening.
- Discuss ALL infants receiving phototherapy, daily, with MOU doctor (day) or referral hospital (night)
- Stop phototherapy when TSB > 50µmol/L below phototherapy line.
- If TSB continues to fall after phototherapy has been stopped, then no more TSB measurements are needed.

WELLTERM INFANTS > 3kg



WELL INFANTS 2 - 3kg *and* > 35wks



Horn et.al. SAMJ, 2006, 96 (9): 819-824

19.2.1.2 HYPERBILIRUBINAEMIA, CONJUGATED

Hepatocellular disease	Bile duct obstruction
» hepatitis*	» bile duct hypoplasia/atresia*
» total parenteral nutrition*	» choledochal cyst
» syphilis	» cystic fibrosis
» other congenital infections	
» galactosaemia*	

*May cause prolonged neonatal jaundice.

Conjugated hyperbilirubinaemia is due to intra/extrahepatic obstruction of bile ducts (cholestasis) and usually presents in the second week of life or later.
The baby has a green-yellow skin discolouration, dark bile stained urine and pale acholic stools. Hepatomegaly is commonly present and the infant often fails to thrive.

Neonatal hepatitis, prolonged TPN and biliary atresia or hypoplasia accounts for the majority of cases of conjugated hyperbilirubinaemia.

GENERAL AND SUPPORTIVE MEASURES

» Treat the underlying cause.
» Dietary modifications to counteract the malabsorption of fat and fat-soluble vitamins (A, D, E and K) that may occur in patients with a prolonged conjugated hyperbilirubinaemia.
» When galactosaemia is suspected, avoid lactose-containing feeds, i.e. breast milk and lactose-containing formula.

MEDICINE TREATMENT

All premature babies, day 15 to 1 year:

- Multivitamin drops, oral, 0.6 mL daily.

SURGICAL TREATMENT

Conditions amenable to surgery, e.g. biliary atresia.
Hepatoporto-enterostomy for biliary atresia should be done before 60 days of age for optimal outcome.

REFERRAL

» All cases of jaundice persisting more than 2 weeks with conjugated bilirubin level > 20% of total bilirubin, for diagnosis and initiation of treatment.

19.2.1.3 JAUNDICE, NEONATAL, PROLONGED

DESCRIPTION

Jaundice (static or a rising bilirubin) present for more than 14 days in a term infant and 21 days in a preterm infant. The usual causes are:
» breast milk jaundice,

» hypothyroidism,
» hepatitis,
» galactosaemia, and
» infections, e.g. UTIs.

Breast milk jaundice may be confirmed by substituting breastfeeding with formula feeds for 24–48 hours. The bilirubin level will always drop to a lower level and increase again when breastfeeding is resumed. However, the level will not rise to the original high level. Breast milk jaundice is an unconjugated hyperbilirubinaemia and the infant is always well and thriving.

Abnormal thyroid function, increased TSH and decreased T_3 and T_4, indicates hypothyroidism. The unconjugated bilirubin fraction is raised and the infant may have clinical signs of hypothyroidism, e.g.:

» lethargy,
» feeding difficulties,
» poor cry,
» nasal obstruction,
» bradycardia.
» constipation,
» hypotonia,
» umbilical hernia,
» hypothermia, and

Infants with galactosaemia usually present with:

» a conjugated hyperbilirubinaemia,
» refusal to feed,
» failure to thrive,
» encephalopathy, and
» vomiting,
» hepatomegaly,
» hypoglycaemia,
» cataracts (later).

DIAGNOSTIC CRITERIA

» Hepatitis may be confirmed by abnormal liver function tests, i.e. raised values of:
  > AST,
  > ALT,
  > GGT.
  > ALP,
  > bilirubin, mainly the conjugated fraction, and
» Hepatomegaly or hepatosplenomegaly.
» If conjugated hyperbilirubinaemia – see above.

Investigations

» Syphilis. See section 19.5.4: Syphilis, early congenital.
» Thyroid function (see Chapter 7: Endocrine System, section 7.12: Hypothyroidism, congenital).
» Urine for MCS (see Chapter 6: Nephrological/Urological Disorders, section 6.2: Urinary tract infections).
» Suspect galactosaemia if urine is positive for reducing substances but negative for glucose in a baby receiving lactose-containing feeds. A galactose-1-phosphate uridyl transferase assay will confirm the diagnosis.

GENERAL AND SUPPORTIVE MEASURES

» Monitor bilirubin levels.
» Treat the underlying cause.

» Dietary adjustment for prolonged conjugated hyperbilirubinaemia to counteract the malabsorption of fat and fat-soluble vitamins (A, D, E and K).
» Avoid lactose-containing feeds, i.e. breast milk and lactose-containing formulae, when galactosaemia is suspected.
» Regular follow-up until the underlying condition has been resolved.

MEDICINE TREATMENT

All premature babies, day 15 to 1 year:

- Multivitamin drops, oral, 0.6 mL daily.

REFERRAL

» Pathological jaundice, unconjugated and/or conjugated, where the underlying cause cannot be identified.
» Serum unconjugated bilirubin at exchange transfusion level.
» Jaundice, unconjugated and/or conjugated, not improving on adequate treatment.
» Conjugated hyperbilirubinaemia due to conditions requiring surgical intervention, e.g. biliary atresia.
» Prolonged neonatal jaundice, excluding breast milk jaundice.

19.2.2 RESPIRATORY DISTRESS IN THE NEWBORN

P22.9

DESCRIPTION

Newborn experiencing difficulty with breathing.

Causes of respiratory distress include:

Pulmonary causes	Extrapulmonary causes
» respiratory distress syndrome (surfactant deficiency), » meconium aspiration, » pneumonia, » pneumothorax, » transient tachypnoea of newborn » pulmonary haemorrhage, » pulmonary hypertension, » hypoplastic lungs, and » diaphragmatic hernia.	» sepsis, » cardiac failure irrespective of cause, » hypothermia/hyperthermia, » hypoglycaemia, » anaemia, » polycythaemia, » hypovolaemic shock, and » perinatal hypoxia.

Respiratory distress syndrome (RDS), meconium aspiration syndrome (MAS) congenital pneumonia and transient tachypnoea of the newborn (TTN) are the most common causes of respiratory distress in newborns.

DIAGNOSTIC CRITERIA

Clinical

» Pulmonary and/or extrapulmonary disorders presenting with two or more of the following signs in a newborn baby:
  > tachypnoea (≥ 60 breaths/minute),
  > expiratory grunting,
  > intercostal and sternal retractions (recession), and
  > central cyanosis while breathing room air.

Investigations

» Chest X-ray to determine the underlying pathology.
» Echocardiography, if available, to exclude cardiac causes of respiratory distress.
» Haematocrit, blood glucose and temperature.

GENERAL AND SUPPORTIVE MEASURES

» Identify and treat the underlying cause, e.g.:
  > Chest tube and underwater drainage of a pneumothorax.
» Admit to a neonatal high care/intensive care facility, if available.
» Handle the neonate as little as possible.
» Nurse a non-intubated infant in the prone position.
» Keep in a neutral thermal environment (incubator or infant crib with overhead heater). Keep the room temperature at 26–28°C, and anterior abdominal wall skin temperature at 36.5–37.5°C.
» Monitor:
  > blood pressure,
  > peripheral perfusion,
  > haematocrit,
  > blood glucose,
  > blood gases,
  > minerals and electrolytes,
  > respiratory rate,
  > heart/pulse rate,
  > acid-base status,
  > body temperature,
  > S_aO_2,
  > fluid balance.
» Nutrition:
  > Provide adequate IV dextrose to maintain blood glucose ≥ 2.6 mmol/L.
  > Commence oro/nasogastric feeding as soon as possible after birth.
  > If enteral feeding is not possible 24 hours after birth, start IV hyperalimentation.
» Ventilation (non-invasive or invasive) is needed if:
  > An oxygen saturation of at least 90% or P_aO_2 of at least 60 mmHg (8 kPA) cannot be maintained with an inspiratory oxygen concentration of ≥ 60% with or without nasal CPAP.
  > The P_aCO_2 rises to > 55 mmHg (7.5 kPa) with uncompensated respiratory acidosis (pH ≤ 7.20), irrespective of oxygen saturation or P_aO_2.

(1 kPa = 7.5 mmHg; 1 mmHg x 0.133 = 1 kPa)

MEDICINE TREATMENT

To eliminate central cyanosis and to maintain oxygen saturation of haemoglobin 90–95%:

- Oxygen, warmed and humidified via nasal cannula.

- If a pulse oximeter or facility for blood gas analysis is available, oxygen, humidified via nasal cannula to maintain oxygen tension in the blood at 60–80 mmHg.
- If a pulse oximeter or facility for blood gas analysis is not available, regulate the inspired oxygen concentration in such a way that the least amount of oxygen that will prevent central cyanosis is used.
- Keep P_aO_2 at 60–80 mmHg (8 - 10.5 kPa) and P_aCO_2 at 35–45 mmHg (4.5 – 5.5 kPa) (arterial blood gas analysis).

Nasal CPAP is needed if the neonate has a good respiratory drive with a PCO_2 of ≤ 55 mmHg but unable to maintain a S_aO_2 of 90–95% on an inspiratory oxygen concentration of ≥ 60% (F_iO_2) and pneumothorax has been excluded.
Administer nasal CPAP at 4–6 cmH_2O and monitor S_aO_2, blood gas and acid-base status.

OR

- Oxygen/air mixture, high-flow, warmed and humidified via nasal prongs. (Under specialist supervision.)
  - Do not exceed 6 L/minute. The flow/minute (L/min) approximates the pressure generated in cm of water.

Stabilise circulation and blood pressure

- Neonatal maintenance solution, IV infusion, 60–80 mL/kg/24 hours (day 1 of life) and adapt to daily maintenance requirements.

AND/OR

- Sodium chloride 0.9%, 10–20 mL/kg over 1–2 hours.
  - For preterm infants restrict to 10 mL/kg.

AND/OR

- Fresh frozen plasma, 10–20 mL/kg over 1–2 hours.

OR

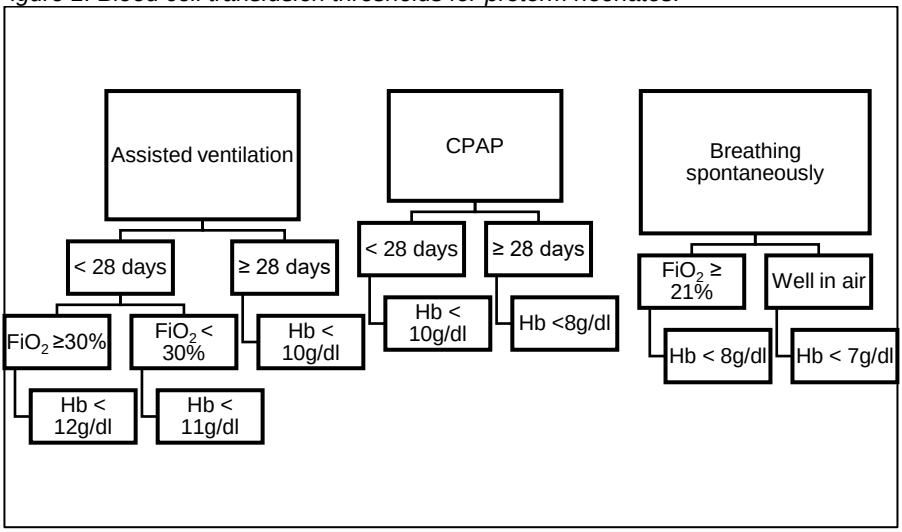
- Lyophilised plasma, 10–20 mL/kg over 1–2 hours.

Inotropic support

- Dopamine, IV, 5–15 µg/kg/minute, continued until blood pressure has stabilised.
  - Response to inotropic support will be unsatisfactory if the circulating blood volume is not corrected.

Anaemia

Figure 1: Blood cell transfusion thresholds for preterm neonates.



**Thresholds from Harrison et.al. Resource implications of adopting a restrictive neonatal blood transfusion policy, SAMJ, 2013.*

- If anaemia is present according to thresholds in figure 1 above: Packed red cells, IV, 10–15 mL/kg over 3-4 hours in haemodynamically stable patients. More rapid transfusions may be appropriate in bleeding and haemodynamically unstable patients.

Metabolic acidosis

If pH ≤ 7.0 and the metabolic acidosis does not respond to normalisation of P_aO_2, P_aCO_2, blood pressure, volume expansion (hydration) and correction of anaemia:

- Sodium bicarbonate, 4.2%, IV, administered slowly.
  - 1 mmol = 2 mL
  - HCO_3 needed (mmol) = base excess x 0.3 x body mass (kg).
  - (½ correct base deficit initially.)

CAUTION
Do not administer Ca^{++} containing infusions with sodium bicarbonate solution.

Respiratory distress syndrome (Surfactant deficiency)

In consultation with a paediatrician.

If surfactant deficiency is suspected or present, provide respiratory support.

» Mild surfactant deficiency: nasal CPAP 4–6 cmH_2O.

» Moderate surfactant deficiency: 'in-out' surfactant followed by nasal CPAP 4–6 cmH_2O. Intubate infant and administer surfactant via naso- or orotracheal tube.

Ventilate for a few minutes with a T-Piece resuscitation device or resuscitation bag with a CPAP generating device. Extubate baby and put on nasal CPAP 4–6 cmH_2O. Babies may be put on nasal CPAP directly after 'in-out' surfactant administration, omitting the ventilation step following 'in-out' surfactant.

» The LISA (Less Invasive Surfactant Administration) method may be used if the doctor is competent in the procedure. Baby is intubated with a size 8 feeding tube whilst on CPAP. The surfactant is administered through the feeding tube slowly over 5 minutes.

» Severe surfactant deficiency: intubate baby and ventilate with a ventilator. Administer surfactant via the naso- or orotracheal tube. If a ventilator is not available, then 'in-out' surfactant followed by nasal CPAP can be used.

Short-term intubation ('In-out' endotracheal surfactant administration)

» Nasal CPAP as required.

» If inadequate oxygenation on nasal CPAP, pre-oxygenate with bag-mask or T-piece ventilation to maintain preductal saturation between 90–95%.

» Intubate orally, give surfactant and follow with gentle manual ventilation or CPAP, as required, for 5 minutes:
- Surfactant, 100 mg/kg.

» Extubate and recommence nasal CPAP.

Infection

» If infection, e.g. bronchopneumonia, is present or suspected, give antibiotics after blood cultures have been taken.

» Consider the antibiotic sensitivity profile of micro-organisms in a particular hospital when prescribing antibiotics.

- Aminoglycoside, e.g.:
  - Gentamicin, IV, for 5–7 days in the first week of life.
    - If < 32 weeks gestation of age: 5 mg/kg/36 hours.
    - ≥ 32 weeks gestation of age: 5 mg/kg/24 hours.
    - After first week, 5 mg/kg/24 hours for all gestations.

  PLUS

  - Ampicillin, IV, for 5–7 days.

Gestational Age	Postnatal Age	Dose
≤ 34 weeks	≤ 7 days	50 mg/kg/dose every 12 hours
	8 to 28 days	75 mg/kg/dose every 12 hours
>34 weeks	≤ 28 days	50mg/kg/dose every 8 hours

Review after 48 hours. If infection is confirmed, or very strongly suspected, continue for 5–7 days.

Where available, gentamicin doses should be adjusted on the basis of therapeutic drug levels.

- Trough levels (taken immediately prior to next dose), target plasma level < 1 mg/L.

- Peak levels (measured 1 hour after commencement of IV infusion or IM/IV bolus dose), target plasma level > 8 mg/L.

REFERRAL
» No improvement or deterioration despite adequate treatment.
» Development of respiratory failure and need for ventilatory support.

19.3 PREMATURITY/PRETERM NEONATE
P07.3

DESCRIPTION
Neonate born before 37 completed weeks of pregnancy.

GENERAL AND SUPPORTIVE MEASURES
» Admit unwell/unstable infants to a neonatal high/intensive care facility.
» Temperature control:
  > Kangaroo mother care: Initiate if baby is well and vital signs are stable.
  > Provide a neutral thermal environment (incubator or infant crib with overhead heater) and keep ambient temperature at 26–28°C.
  > Keep infant's temperature, axilla or skin of anterior abdominal wall, at 36.5–37.5°C.

Table for neutral thermal environment for age and body mass

Neutral Thermal Environment				
Age	**Temperature for body mass range**			
	< 1200 g **± 0.5°C**	**≥ 1200–1500 g** **± 0.5°C**	**≥ 1500–2500 g** **± 1°C**	**≥ 2500 g** **± 1.5°C**
0–12 hours	35.0	34.0	33.3	32.8
12–24 hours	34.5	33.8	32.8	32.4
2–4 days	34.5	33.5	32.3	32.0
4–14 days	33.5	32.1	32.0	
2–3 weeks	33.1	31.7	30.0	
3–4 weeks	32.6	31.4		
4–5 weeks	32.0	30.9		
5–6 weeks	31.4	30.4		

» Monitor:
  > respiratory rate,
  > blood pressure,
  > blood gas,
  > acid-base status,
  > calcium, magnesium,
  > growth parameters.
  > haematocrit,
  > bilirubin,
  > blood glucose,
  > electrolytes,
  > hydration status, and

» Nutritional support:
  > Give oro/nasogastric tube feedings to infants with audible bowel sounds and no complications of prematurity.
  > Preferably use own mother's expressed breast milk, pasteurised donor breast milk or preterm formula. Give small frequent bolus feeds, 3 hourly or continuous oro/nasogastric tube feeds (alternatives: cup, dropper, spoon, syringe). Refer, if there is intolerance.
  > Monitor gastric emptying by aspirating the stomach before each feed.
  > Consider stopping enteral feeding if:
    - vomiting,
    - abdominal distension,
    - diarrhoea,
    - haematochezia, or
    - ileus.
  > IV alimentation if enteral feeds are contraindicated or not tolerated.
» IV fluids to ensure adequate hydration, electrolyte and mineral intake, and normoglycaemia (blood glucose ≥ 2.6 mmol/L) until enteral (tube or oral) intake is satisfactory.
  > Discontinue IV fluids gradually to avoid reactive hypoglycaemia.
  > Discontinue the infusion when several oral feedings have been retained.
  > If renal function is compromised, use potassium-free solution.

Fluid requirements for a healthy preterm infant	
Day of life	**mL/kg/24 hours**
1	70
2	90
3	110
4	130
5 and onwards	150

Some infants may require fluid volumes up to 180 mL/kg/24 hours after day 6.

» Hospital discharge if:
  > clinically well,
  > able to breastfeed or formula feed,
  > able to maintain body temperature, and
  > usually > 1.8 kg.
» Follow-up visits to assess growth parameters, neurodevelopment, hearing and vision.

MEDICINE TREATMENT

See figure 1: Blood cell transfusion thresholds for preterm neonates.

If anaemia is present according to thresholds in figure 1

- Packed red cells, IV, 10 mL/kg over 3 – 4 hours in haemodynamically stable patients. More rapid transfusions may be appropriate in bleeding and haemodynamically unstable patients.

To maintain oxygen tension in the blood at 60–80 mmHg:

- Oxygen, humidified via nasal cannula.
  - Oxygen therapy should be utilised to maintain oxygen saturation of haemoglobin at of 90–95%; use a pulse oximeter.

At birth

- Vitamin K, IM, 0.5–1 mg.
- Immunise according to EPI schedule according to chronological age.
- Iron and multivitamin supplementation from the third week of life.

Prophylaxis

- Iron (elemental), oral, 2–4 mg/kg/24/hours.
  - Ferrous lactate 1 mL = 25 mg elemental iron.
  - Multivitamin, oral, providing at least vitamin D, 400–800 IU and vitamin A, 1250–5000 IU per 24 hours.

Continue with iron and vitamin supplementation until the infant is on a balanced diet.

REFERRAL

Presence of one or more of the following complications that cannot be managed at the facility:

» Respiratory distress and/or apnoea attacks requiring ventilatory support.
» PDA with cardiac failure not responding to medical management.
» Necrotising enterocolitis requiring surgical intervention.
» Jaundice with serum unconjugated bilirubin level in the exchange transfusion zone.
» Septicaemic infants or infants with infections not responding to therapy.
» Pulmonary and/or intraventricular haemorrhage.
» Feeding difficulties where the underlying cause is unclear.
» Infants requiring hyperalimentation if parenteral nutrition is not available at the hospital.
» Convulsions not responding to treatment.
» Congenital abnormalities requiring surgical intervention.
» Hypoglycaemia not responding to treatment.
» For eye examination/hearing screening:
  > infants < 1.5 kg,
  > infants < 32 weeks gestation,
  > infants who received prolonged respiratory support/oxygen,
  > infants with recurrent apnoea, and
  > infants with an unstable clinical course.

19.3.1 ENTEROCOLITIS, NECROTISING (NEC)

P77

DESCRIPTION

Neonate presenting with the consequences of bowel wall injury or necrosis.

Risk factors include:

- » prematurity,
- » sepsis,
- » early formula feedings,
- » patent ductus arteriosus, and
- » hypotension/shock,
- » high feeding volumes,
- » perinatal asphyxia (hypoxia),
- » polycythaemia.

DIAGNOSTIC CRITERIA

- » Early signs are often non-specific, i.e.:
  - > feeding intolerance,
  - > significant gastric aspirates,
  - > vomiting,
  - > body temperature instability,
  - > apnoea and lethargy.
- » Non-specific signs may progress to more specific signs, including:
  - > abdominal distention with ileus,
  - > bloody stools,
  - > peritonitis,
  - > red-purple discolouration of the abdominal wall with abdominal wall cellulitis, and
  - > bowel perforation.
- » X-ray of abdomen may show:
  - > distended loops of intestines,
  - > bowel-wall thickening (oedema),
  - > pneumatosis intestinalis,
  - > hepatic portal venous gas, and
  - > free intraperitoneal air due to perforation.
- » Blood samples for culture and sensitivity testing before starting antibiotic therapy.

Modified Bell's Criteria for NEC

Stage	Systemic signs	Abdominal signs	Radiographic signs
1A Suspected	Temperature instability, apnoea, bradycardia, lethargy.	Gastric retention, abdominal distension, emesis, haeme-positive stool.	Normal or intestinal dilation, mild ileus.
1B Suspected	Same as above.	Grossly bloody stool.	Same as above.
2A Definite, mildly ill	Same as above.	Same as above, plus absent bowel sounds with or without abdominal tenderness.	Intestinal dilation, ileus, pneumatosis intestinalis.
2B Definite, moderately ill	Same as above, plus mild metabolic acidosis and thrombocytopenia.	Same as above, plus absent bowel sounds, definite tenderness, with or without abdominal cellulitis or right lower quadrant mass.	Same as above, plus ascites.

3A Advanced, severely ill, intact bowel	Same as 2B, plus hypotension, bradycardia, severe apnea, combined respiratory and metabolic acidosis, DIC, and neutropenia.	Same as above, plus signs of peritonitis, marked tenderness, and abdominal distension.	Same as 2A, plus ascites.
3B Advanced, severely ill, perforated bowel	Same as 3A.	Same as 3A.	Same as above, plus pneumoperitoneum.

https://www.researchgate.net/figure/Modified-Bell-s-Staging-Criteria-for-Necrotizing-Enterocolitis-NEC_tbl1_273870645

GENERAL AND SUPPORTIVE MEASURES

» Admit to a neonatal high-care unit or intensive care unit.
» Nurse in a neutral thermal environment.
» Insert an oro/nasogastric tube and apply free drainage.
  > Suspected cases should be nil-per-mouth for 72 hours.
  > Confirmed cases should be nil-per-mouth for at least 7 days.
» Provide adequate parenteral nutrition as soon as diagnosis is confirmed.
» Provide cardiovascular and ventilatory support, if necessary.

MEDICINE TREATMENT

Depending on age, weight and hydration status:

- Neonatal maintenance solution, IV.
  Add volume of gastric aspirates to daily maintenance fluid volume.

If coagulopathy or septic shock:

- Plasma (lyophilised or fresh frozen), IV, 20 mL/kg over 2 hours.

See figure 1: Blood cell transfusion thresholds for preterm neonates.
If anaemia is present according to thresholds in figure 1

- Packed red cells, IV, 10 mL/kg over 3 – 4 hours in haemodynamically stable patients. More rapid transfusions may be appropriate in bleeding and haemodynamically unstable patients.

Until blood pressure is stabilised:

- Dopamine, IV, 5–15 µg/kg/minute.

Empiric antibiotic therapy

- Ampicillin, IV, 50 mg/kg/dose for 7 days.

Gestational Age	Postnatal Age	Dose
≤ 34 weeks	≤ 7 days	50 mg/kg/dose every 12 hours
	8 to 28 days	75 mg/kg/dose every 12 hours
>34 weeks	≤ 28 days	50mg/kg/dose every 8 hours

PLUS

- Gentamicin, IV, 5 mg/kg once daily for 7 days.

Where available, gentamicin doses should be adjusted on the basis of therapeutic drug levels.

- Trough levels (taken immediately prior to next dose), target plasma level < 1 mg/L.
- Peak levels (measured 1 hour after commencement of IV infusion or IM/IV bolus dose), target plasma level > 8 mg/L.

PLUS

- Metronidazole, IV, for 7 days.
  - Loading dose: 15 mg/kg over 60 minutes.
  - Postnatal age < 4 weeks: 7.5 mg/kg/dose 12 hourly.
  - Postnatal age ≥ 4 weeks: 7.5 mg/kg/dose 8 hourly.

Reassess choice of antibiotics when the culture and sensitivity results become available.

Adjust antibiotic regimen according to local susceptibility patterns and suspicion of nosocomial infection, where possible in consultation with a microbiologist or infectious diseases specialist.

SURGICAL TREATMENT

Surgical intervention is required when there is progressive deterioration of the clinical condition despite maximal medical support and/or bowel necrosis with/without bowel perforation.

» Prior to transport to a tertiary hospital for definitive surgery, insert/place a peritoneal drain in babies presenting with severe abdominal distension, due to free air and/or fluid in the peritoneal cavity, compromising respiration and/or blood pressure.
» Perform the procedure in a theatre, intensive care or high care unit where facilities for monitoring vital signs, resuscitation, ventilation and temperature control of the environment are available.
» Obtain consent to perform the surgical procedure.

Method of inserting/placing a peritoneal drain

» The procedure is sterile; the doctor should be gowned and gloved.
» Clean and drape the abdomen.
» Administer an appropriate analgesic (e.g. ketamine, IV) immediately before the start of the procedure.
» Identify a site in either one of the fossae iliaca, ensuring that it is lateral to the inferior epigastric artery.
» At the intended surgical incision site, inject:
  - Lidocaine (lignocaine) 1%, SC, 0.5 mL.
» Make a small skin incision over the ‘bubble’ of lidocaine (lignocaine) (no. 11 blade).

» Use a mosquito forceps or clamp to dissect down to the peritoneum, pierce the latter with a gentle stab using the closed forceps and slightly stretch the peritoneal puncture site with the forceps.
» Note what drains from the peritoneal cavity and send a sample for microscopy and culture.
» Insert a pencil drain of ~5 mm width with the mosquito clamps or forceps into the peritoneal cavity through the peritoneal stab wound. About 1.5–2 cm of the pencil drain should be inside the peritoneal cavity.
» Fix the drain to the skin with a size 4–0 stitch (e.g. PDS).
» Cover the drain with a gauze pad or urine collecting bag.

REFERRAL
» All confirmed cases for specialist care.
» Deterioration of clinical condition, despite adequate treatment.
» Signs and symptoms of intestinal perforation and peritonitis requiring surgical intervention.
» Recurrent apnoea episodes and/or signs of respiratory failure, requiring respiratory support.

19.3.2 PATENT DUCTUS ARTERIOSUS (PDA) IN THE NEWBORN
Q25.0

DESCRIPTION
Patent ductus arteriosus (PDA) is the extra-uterine persistence of the normal foetal vessel that joins the pulmonary artery to the aorta.

DIAGNOSTIC CRITERIA
Clinical
Depending on the size of the PDA:
» A systolic or continuous murmur at the upper left sternal border.
» Hyperactive precordium with easily palpable bounding peripheral pulses.

Investigations
» Echocardiography should be done to confirm the diagnosis in all symptomatic children with a heart murmur.
» Observe and follow-up all asymptomatic patients.

Risk factors include:
» prematurity,
» hypoxia,
» fluid overload,
» anaemia, and
» pulmonary hypertension,
» sepsis,
» lung disease,
» congenital cardiac abnormalities.

Complications include cardiac failure, systemic hypotension, pulmonary haemorrhage and steal phenomena, such as a decrease in mesenteric blood flow.

GENERAL AND SUPPORTIVE MEASURES

Preterm Infants

» Identify and treat underlying risk factors.
» Restrict fluid intake to 80% of maintenance. Individualise volume to avoid over restriction of fluid and poor weight gain.
» Maintain haematocrit at ≥ 40% and Hb ≥ 13 g/dL.
» Monitor cardiac function, renal function and urinary output.
» Provide adequate nutrition.
» Nurse in a neutral thermal environment.

MEDICINE TREATMENT

In confirmed cases (in consultation with specialist):

Cardiac failure

Diuretics

- Furosemide, IV/oral, 1 mg/kg/24 hours.

Closure of PDA in preterm infants less than 14 days of age

- Ibuprofen, oral.
  First dose: 10 mg/kg. After 24 hours, follow with 2 doses of 5 mg/kg 24 hours apart.
  Contraindications to ibuprofen therapy:
  - Thrombocytopenia (< 50 000/mm^3).
  - Bleeding disorders.
  - Impaired renal function.
  - Jaundice approaching exchange transfusion levels.
  - Duct-dependant cyanotic heart disease

OR

- Paracetamol, oral.
  - Can be used when there are contraindications to Ibuprofen.
  - Dosage: 15 mg/kg every 6 hours for 5 days.
  - Contraindications to paracetamol: Liver failure.

SURGICAL TREATMENT

Consider if medicine treatment is contraindicated or fails.

REFERRAL

» Patients with complications, e.g. cardiac failure, pulmonary haemorrhage, ventilator dependence.
» PDA which remained patent despite adequate treatment.
» Term babies with symptomatic or persistent PDA.

19.3.3 RETINOPATHY OF PREMATURITY

H35.1

See Chapter 16: Eye Conditions, section 16.8: Retinopathy of Prematurity (ROP).

19.3.4 APNOEA, NEONATAL

P28.3

DESCRIPTION

A neonate presenting with episodes of cessation of breathing.
Apnoea episodes in a previously asymptomatic well neonate may be the first indication of a serious underlying disease.
Apnoea episodes in an already unwell neonate indicate deterioration in the condition of the neonate.

DIAGNOSTIC CRITERIA

» Cessation of respiration for longer than 20 seconds, with/without cyanosis, pallor or bradycardia.
» Cessation of respiration for less than 20 seconds with cyanosis, pallor and/or bradycardia (heart rate < 100 bpm).

Central apnoea

Causes include:

» *IRDS,*
» *prematurity,*
» *hypoxia/hypercarbia,*
» *sepsis,*
» *acidosis,*
» *meningitis,*
» *temperature disturbances,*
» *hypotension,*
» *pneumonia,*
» *intraventricular haemorrhage,*
» *patent ductus arteriosus,*
» *hypoglycaemia,*
» *hypermagnesaemia,*
» *atypical convulsions,*
» *anaemia,*
» *rough or excessive handling, and*
» *medicines (sedatives, anticonvulsants, analgesics).*

Obstructive apnoea

Neonates are obligatory ‘nose breathers’. Obstruction of the nares makes neonates prone to apnoea.
Causes of obstructive apnoea include:

» choanal atresia,
» micrognathia,
» gastro-oesophageal reflux,
» macroglossia,
» secretions (milk, meconium, blood, mucous) lodged in the upper airway, and,
» neck flexion or extension.

Reflex apnoea or vagally mediated apnoea

Is due to:

» endotracheal intubation,
» gastro-oesophageal reflux,
» suction of the pharynx or stomach.
» passage of a nasogastric tube,
» overfeeding, and

Mixed apnoea
Apnoea caused by a combination of the above causes.

GENERAL AND SUPPORTIVE MEASURES

For all forms of neonatal apnoea:
» Identify and treat the underlying cause.
» Frequent gentle physical stimulation, e.g. rubbing of soles of feet.
» Nurse preterm neonates in the prone position.
» Maintain ambient temperature at the lower range of neutral thermal environment.
» Maintain axillary temperature or anterior abdominal wall skin temperature at 36.2–36.8°C.
» Maintain haematocrit at 30%.
» Maintain nasal CPAP of 4–6 cmH_2O. (Nasal CPAP – not for central apnoea except for apnoea of prematurity.)
» Monitor vital signs and parameters relating to the underlying cause.

MEDICINE TREATMENT

To maintain oxygen/haemoglobin saturation of 90–95% or an oxygen tension in the blood at 60–80 mmHg:

- Oxygen via nasal cannula or mask.

Only for apnoea of prematurity (not term infants):

- Caffeine citrate, oral/IV:
  - Oral route strongly recommended (formulation can be extemporaneously compounded).
  - Loading dose: 20 mg/kg.
  - Maintenance dose: 5 mg/kg/24 hours. Start maintenance dose 24 hours after the loading dose.
    (Caffeine citrate 20 mg = caffeine base 10 mg.)

OR
(if caffeine not available)

- Aminophylline, IV/oral:
  - Loading dose: 8 mg/kg. (If IV infusion, administer over 30 minutes.)
  - Maintenance dose: 1.5–3 mg/kg/dose 8 hourly. Start maintenance dose 8 hours after loading dose.

Maintain aminophylline blood levels at 10–12 µg/mL.
If neonate responds favourably to caffeine/aminophylline, continue until neonate is apnoea free for 7 days.

REFERRAL

» Recurrent life-threatening episodes of apnoea, not responding to adequate treatment and requiring ventilation.

19.4 CARDIOVASCULAR

19.4.1 HEART FAILURE IN NEONATES

P29.0

DESCRIPTION

Clinical syndrome reflecting the inability of the myocardium to meet the oxygen, nutritional or metabolic requirements of the body. Heart failure may be acute or chronic.

The main causes of heart failure are:

» Congenital heart abnormalities:
  > Left-sided outflow obstruction, e.g. interrupted aortic arch, coarctation of the aorta and aortic valve stenosis.
  > Left to right shunts, VSD and PDA.
  > Hypoplastic left heart.
  > Complex congenital heart lesions.
» Acquired conditions:
  > fluid overload,
  > hypoglycaemia,
  > acidosis,
  > arrhythmias,
  > pneumopericardium,
  > hypertension.
  > sepsis,
  > hypoxia,
  > severe anaemia,
  > cardiomyopathy,
  > hyperthyroidism,

DIAGNOSTIC CRITERIA

Diagnosis relies on history, physical examination and a chest X-ray.

Clinical

» Acute heart failure may be associated with shock in addition to congestive symptoms and signs.
» Heart failure is usually associated with fluid retention and congestion.
» History of recent onset of:
  > poor feeding,
  > tachypnoea (> 60 breaths/minute),
  > sweating, and
  > poor or excessive weight gain in excess of 30 g/24 hours.
» Physical findings:
  > tachycardia (> 180 beats/minute),
  > gallop rhythm (with/without a cardiac murmur),
  > cardiomegaly,
  > features of cardiogenic shock, i.e. cold wet skin, weak pulses, hypotension,
  > reduced urinary output,
  > pulmonary venous congestion and fluid retention,
  > systemic venous congestion,
  > hepatomegaly, and
  > signs and symptoms of an underlying condition/disease.
» Always check the femoral pulses.

Special Investigations

» Radiology: cardiomegaly is usually present, cardiothoracic ratio > 60%. Caution – a thymic shadow may be present.
» Electrocardiogram may show evidence of hypertrophy of one or more heart chambers and/or arrhythmias.
» A comprehensive echocardiographic evaluation by an appropriately skilled individual is indicated in all neonates with heart failure.

GENERAL AND SUPPORTIVE MEASURES

» Nurse in a neutral thermal environment.
» Restrict fluids, but ensure adequate nutrition.
  > Administer 75% of estimated daily fluid requirements.
  > Use breast milk or low-salt milk formulae.
  > Tube feed.
» Treat the underlying condition, e.g. sepsis and cardiac tamponade.

MEDICINE TREATMENT

First treat shock, if present.

To prevent hypoxia:

- Oxygen via face mask, nasal cannula or head box.

Combination medicine therapy is usually indicated.

Afterload reduction: ACE inhibitor or vasodilator

Consider ACE inhibitors in persistent heart failure where left-sided outflow obstruction has been excluded, other measures have failed and only after consultation with a paediatrician or paediatric cardiologist.

Monitor blood potassium levels and stop potassium supplements while the patient is on an ACE inhibitor.
ACE inhibitors are contraindicated in renal failure, bilateral renal artery stenosis or a single functioning kidney.

- Captopril, oral, 0.2 mg/kg/dose, 8–12 hourly, initially.
  - Adjust dose and interval based on response to a maximum of 1 mg/kg/dose.
  - Administer 1 hour before feeding.
  - Continue as long as needed to control the heart failure.

Diuretics

Continue diuretic therapy as long as needed to control heart failure.
Monitor blood potassium levels.

Potassium supplements may be necessary if furosemide is used without spironolactone.

- Furosemide, IV/oral, 1–3 mg/kg/24 hours as a single daily dose, or in 3 divided oral doses.
    - Administer IV furosemide slowly over 1–2 minutes.

WITH/WITHOUT

- Spironolactone, oral, 1–3 mg/kg/dose, once daily.

Inotropic support

May help to stabilise patients with severe myocardial dysfunction, hypotension or low cardiac output.
May be lifesaving in severe myocarditis or cardiogenic shock.

- Dobutamine, IV infusion, 2.5–15 mcg/kg/minute.
    - Continue until myocardial function and blood pressure improve.
    - Ensure normovolaemia.
    - Monitor blood pressure.

Acute left-heart failure: acute pulmonary oedema or pulmonary venous congestion

- Oxygen 100%, via nasal cannula.
- Furosemide, IV, 1–3 mg/kg, immediately.

For patients not responding to furosemide:

- Morphine, IV, 0.1 mg/kg.

- Inotropic support, as above.

- Afterload reduction, as above.

To raise the alveolar pressure above pulmonary capillary pressure, intubate with intermittent positive ventilation.
Titrate oxygen according to saturation, 90–94%.

SURGICAL TREATMENT

Palliative or corrective surgery for certain congenital heart lesions.

REFERRAL

» For determination of the underlying cause, and initiation of specialised care, after stabilisation.

19.4.2 CYANOTIC HEART DISEASE IN THE NEWBORN

Q24.9

DESCRIPTION

Blue or grey discolouration of the skin and tongue in room air, with an oxygen saturation of less than 85% in the presence of a cardiac lesion (complex lesions such as common arterial trunk may be associated with saturations greater than 90%).

Note:
Strongly suspect cyanotic cardiac disease if centrally cyanosed, not in respiratory distress and normotensive.

DIAGNOSTIC CRITERIA

» Rule out non-cardiac causes of central cyanosis:
  > Respiratory conditions, e.g. respiratory distress syndrome, pneumonia and pneumothorax. Signs of respiratory distress usually improve with oxygen administration. Chest X-ray may be helpful.
  > Central nervous system involvement, e.g. sedation and asphyxia, which usually improves with oxygen administration.
  > P_aCO_2 may be increased in cyanosis due to respiratory and central nervous system causes.
  > Methaemoglobinaemia
» To confirm a cardiac cause:
  > Do a hyperoxia test.
  > Tachypnoea is present, but usually no retraction.
  > Heart murmur (may be absent).
» Hyperoxia test (Nitrogen wash out test):
  > Administer 100% oxygen via a nasal cannula for 10 minutes.
  Unnecessary if saturation is under 85% on nasal cannula delivering 100% oxygen.
  > Obtain arterial blood from the right radial artery (preductal flow).

P_aO_2 (mmHg)	P_aO_2 (kPa)	Interpretation
< 100	< 15.5	Most likely to be a cyanotic heart lesion, persistent foetal circulation or severe lung disease. P_aCO_2 will be increased with severe lung disease.
≥ 100–200	≥15.5 – 26.5	Unlikely to be a cyanotic heart lesion.
≥ 200	≥ 26.5	Excludes a cyanotic heart lesion.

» Chest X-ray may show cardiomegaly or abnormal cardiac silhouette and/or reduced pulmonary blood flow.
  > Confirm diagnosis with echocardiography.

GENERAL AND SUPPORTIVE MEASURES

» Nurse in a neutral thermal environment.
» Monitor and maintain within physiological range for age:
  - heart rate,
  - respiration,
  - blood pressure,
  - body temperature,
  - electrolytes.
  - calcium, magnesium,
  - blood glucose,
  - blood gases,
  - acid-base status, and
» Provide adequate hydration and nutrition.

MEDICINE TREATMENT

Referral is needed in all patients.

Prior to referral:

To keep ductus arteriosus open if a duct dependent cyanotic heart lesion is suspected:

Prostaglandin therapy, i.e.:

- Alprostadil, IV, (under specialist consultation):
  - Add 1 ampoule (500 mcg) to 50 mL dextrose water at 0.3–0.6 mL/hour (0.05–0.1 mcg/kg/minute).
  - Discard the solution after 24 hours.

OR

- Dinoprostone, via oro/nasogastric tube, (under specialist consultation).
  - For babies < 2.5 kg: 0.125 mg 1–2 hourly ($^1/_4$ tablet suspended in 2 mL sterile water), **or** 50 mcg/kg/dose 1–2 hourly.
  - For babies > 2.5 kg: 0.25 mg hourly (½ tablet suspended in 2 mL sterile water).

Continue with prostaglandin therapy until corrective or palliative surgery can be done or until patency of the duct is not deemed essential for survival of the infant.

If a ductal dependant lesion is suspected, maintain oxygen saturation just above 75%.

Serious side effects of prostaglandins to be aware of may include: Apnoea, fever, diarrhoea, hypotension and seizures.

If pH ≤ 7.2, correct metabolic acidosis:

» Sodium bicarbonate 4.2%, IV.
  HCO_3 needed (mmol) = base excess x 0.3 x body mass (kg).
  2 mL sodium bicarbonate 4.2% = 1 mmol HCO_3.

SURGICAL TREATMENT

» Corrective or palliative surgery.

REFERRAL

» All cyanotic infants with an underlying cardiac cause for central cyanosis.

19.5 INFECTIONS

19.5.1 MENINGITIS BACTERIAL, NEONATAL

G01

DESCRIPTION

A bacterial infection of the meninges in the first month of life.

Consider meningitis in any neonate being evaluated for sepsis or infection, as most organisms implicated in neonatal sepsis also cause neonatal meningitis. The most common causative organisms are *Group B ß-haemolytic streptococcus type III* and Gram-negative organisms such as *E. coli* with K_1 antigen. Consider *S. epidermidis* and *S. aureus* as causative organisms with central nervous system anomalies such as open defects or with indwelling devices such as VP shunts.

Consider HIV infection in neonates with meningitis.

DIAGNOSTIC CRITERIA

Clinical

» Clinical presentation is usually with one or more non-specific signs such as:
  - temperature disturbances,
  - lethargy,
  - irritability,
  - vomiting,
  - feeding problems,
  - vasomotor changes,
  - altered level of consciousness,
  - blood glucose disturbances,
  - bulging/full fontanel,
  - convulsions,
  - apnoea, and

» Complications include:
  - cerebral oedema,
  - raised intracranial pressure,
  - vasculitis, with haemorrhage,
  - ventriculitis,
  - ischaemia and infarctions of the brain,
  - inappropriate antidiuretic hormone (ADH) secretion,
  - convulsions,
  - hydrocephalus,
  - subdural effusion,
  - brain abscess,

» Late complications include:
  - neurological sequelae,
  - deafness, and
  - blindness,
  - intellectual disabilities.

SPECIAL INVESTIGATIONS

» Lumbar puncture:
  - CSF appears turbid to purulent.
  - Protein concentration is increased (> 1.0 g/L).
  - Leucocyte count is increased with a predominance of polymorphonuclear leucocytes (> 6 cells/mm^3).
  - Glucose concentration is low, < $^2/_3$ of blood glucose.

» Gram stain, microscopy, culture and sensitivity of CSF.

» Blood cultures for microscopy, culture and sensitivity.

GENERAL AND SUPPORTIVE MEASURES

» Admit to a high or intensive care unit, if available.
» Maintain a neutral thermal environment.
» Monitor, where indicated:
  > neurological status,
  > vital signs,
  > electrolytes,
  > haematocrit,
  > fluid balance (hydration),
  > calcium and magnesium,
  > acid-base status,
  > blood glucose,
  > serum and urine osmolality,
  > blood gases.
» Ensure adequate nutrition:
  > Enteral feeding where possible, use an oro/nasogastric tube, if necessary.
  > If enteral feeding is not possible, IV fluids, e.g. neonatal maintenance solution and parenteral nutrition under supervision by a paediatrician.
» Limit total daily fluid intake, IV and oral:
  > Do not exceed the daily requirements for age.
  > Prevent fluid overload.

MEDICINE TREATMENT

Antibiotics, empirical

- Cefotaxime, IV, 50 mg/kg over 30 minutes, for 21 days.

Gestational age	Postnatal age	Dose
< 32 weeks	< 14 days	50 mg/kg/dose every 12 hours
	14 to 28 days	50 mg/kg/dose every 8 hours
≥ 32 weeks	≤ 7 days	50 mg/kg/dose every 12 hours
	8 to 28 days	50 mg/kg/dose every 8 hours

PLUS

- Ampicillin, IV, for 14 days.

Gestational Age	Postnatal Age	Dose
≤ 34 weeks	≤ 7 days	50 mg/kg/dose every 12 hours
	8 to 28 days	75 mg/kg/dose every 12 hours
>34 weeks	≤ 28 days	50mg/kg/dose every 8 hours

During the course of treatment, a cranial ultrasound should be done.
Reconsider choice of antibiotic when the results of blood and CSF cultures become available or the child does not improve within 72–96 hours.

No response or intolerant to cephalosporins or ampicillin

For patients not responding to adequate antibiotic therapy where no organisms were identified or cultured, consider viruses, fungi and bacteria not usually causing meningitis.

Convulsions

See section 19.6.2: Seizures, neonate.

Raised intracranial pressure or cerebral oedema

Avoid fluid overload.

Limit total daily intake, IV and oral.
Do not exceed the total fluid maintenance requirements for age.

REFERRAL
» Meningitis not responding to adequate treatment.
» Meningitis with complications.
» Follow-up is essential for assessing neurodevelopment, hearing and vision.

19.5.2 SEPTICAEMIA OF THE NEWBORN
P36.9

DESCRIPTION
Bacterial or fungal invasion of blood before or after birth, which may spread to involve other organs/systems, e.g. meninges (meningitis), lungs (pneumonia), bone (osteomyelitis), and kidneys (pyelonephritis).

DIAGNOSTIC CRITERIA
Clinical
The baby usually presents with one or more non-specific clinical sign, e.g.:
» vasomotor changes,
» feeding problems,
» lethargy,
» jaundice,
» diarrhoea,
» tachypnoea,
» temperature disturbances,
» apnoea attacks,
» sclerema,
» acidosis,
» abdominal distension,
» tachycardia,
» organomegaly,
» petechiae,
» convulsions,
» blood glucose disturbances,
» hypotonia,
» shock,
» anaemia,
» cyanosis.

» Complications include:
> septic shock,
> hypoglycaemia,
> apnoea,
> convulsions,
> anaemia,
> meningitis,
> bronchopneumonia,
> cardiac failure,
> dehydration,
> bleeding tendency,
> DIC and/or thrombocytopenia,
> metabolic acidosis,
> osteomyelitis,
> respiratory failure,
> necrotising enterocolitis,
> ileus,
> renal failure,
> multi-organ failure.

Investigations
» Blood and cerebrospinal fluid cultures.
» Full blood count and differential count.
» C-reactive protein and procalcitonin, if available.

GENERAL AND SUPPORTIVE MEASURES

» Admit to a neonatal high or intensive care facility, if available.
» Ensure a neutral thermal environment.
» Start infusion with appropriate IV fluid, e.g. neonatal maintenance solution.
» Ensure adequate nutrition:
  > Enteral feeding where possible, via oro/nasogastric tube after ileus, obstruction, or other contraindications to enteral feeding have been excluded.
  > If enteral feeding is not possible, IV fluids, e.g. neonatal maintenance solution and parenteral nutrition under supervision by a paediatrician.
» Insert oro/nasogastric tube.
» Oxygen to maintain P_aO_2 at 60–80 mmHg or oxygen saturation of haemoglobin at 90-95%.
» Ventilatory support if P_aCO_2 exceeds 55 mmHg (7.5 kPa).
» Monitor:
  > Body temperature 36.5–37.5°C (axillary or anterior abdominal wall).
  > Maintain blood glucose level of 2.6–6.8 mmol/L.
  > Acid-base status and maintain blood pH of 7.35–7.45.
  > Maintain a haematocrit of 40%.
  > Vital signs and respiration, and maintain blood electrolytes and minerals within their normal physiological ranges.
  > Clinical progress and for the emergence of complications.

MEDICINE TREATMENT

Antibiotic therapy

Be aware of the antibiotic sensitivity/resistance profile of bacterial pathogens in your hospital/community.
Reconsider choice of antibiotic when the results of blood and CSF cultures become available or the child does not improve within 72–96 hours.

Empiric treatment (first line):

Aminoglycoside, e.g.:

- Gentamicin, IV, for 5–7 days.
  - If < 32 weeks gestation: 5 mg/kg/36 hours in the first week of life.
  - If ≥ 32 weeks gestation: 5 mg/kg/24 hours in the first week of life.
  - Monitor blood levels.

PLUS

- Ampicillin, IV, 50 mg/kg/dose for 5–7 days.

Gestational Age	Postnatal Age	Dose
≤ 34 weeks	≤ 7 days	50 mg/kg/dose every 12 hours
	8 to 28 days	75 mg/kg/dose every 12 hours
>34 weeks	≤ 28 days	50mg/kg/dose every 8 hours

If child is deteriorating on above regimen and there are no culture positive results:

Empiric treatment (second line):

- Piperacillin/tazobactam, IV, for 7 days.
  - If < 7 days of age: 50–100 mg/kg 12 hourly (1st week of life).
  - If > 7 days of age: 50–100 mg/kg 6–8 hourly.

PLUS

- Amikacin, IV, for 7 days.
  - 15 mg/kg/dose 24 hourly.
  - Therapeutic drug monitoring to be done where available.

Note: Shorter durations of therapy should be used where there is no culture confirmed infection, and the child shows clinical improvement.

Fungal infections

Where fungal septicaemia is demonstrated or suspected:

- Amphotericin B deoxycolate, IV, 1–1.5 mg/kg/day infusion in 5% dextrose water over 4 hours for 14 days.
- Monitor renal function and serum potassium.

Anaerobic infections

Where anaerobic infection is likely, e.g. after gastrointestinal surgery for sepsis, or where intra-abdominal sepsis is suspected:

- Metronidazole, oral/IV, for 10 days.
  - Loading dose, IV: 15 mg/kg administered over 60 minutes.
  - If ≤ 4 weeks of age: 7.5 mg/kg 12 hourly.
  - If > 4 weeks of age: 7.5 mg/kg 8 hourly.

Note: In patients on piperacillin/tazobactam and amikacin, no additional anaerobic cover is needed.

Inotropic support

Mean blood pressure should not be less than the gestational age (weeks) of the infant plus 5–10 mmHg.

If blood pressure is < 60/40 mmHg in term infants or < 50/35 mmHg in preterm infants:

- Dopamine, IV, 5–15 mcg/kg/minute as a continuous infusion.
  - Continue with dopamine as long as it is necessary to maintain the blood pressure.

REFERRAL

» Septicaemia with complications.
» Septicaemia not responding to treatment.

19.5.3 GROUP B STREPTOCOCCUS

DESCRIPTION

Group B streptococcus is an encapsulated Gram-positive coccus that colonises the gastrointestinal and genitourinary tracts.

Infection in the first 6 days of life is referred to as early-onset disease (EOD).
Late-onset disease (LOD) refers to infection from day 7–89 of life.

DIAGNOSTIC CRITERIA

» Infants may present in respiratory distress or with signs of septicaemia.
» Complications include meningitis, cellulitis, osteomyelitis or septic arthritis.
» A blood culture should be performed before initiation of antibiotics in infants that are at risk of sepsis, namely, maternal fever, prolonged rupture of membranes or prematurity due to an unknown cause.
» Meningitis should be excluded in all patients that have a positive blood culture for group B streptococcus.

GENERAL AND SUPPORTIVE MEASURES

Refer to section on septicaemia of the newborn, section 19.5.2.

MEDICINE TREATMENT

- Ampicillin, IV, 50 mg/kg/dose for 10 days.

Gestational Age	Postnatal Age	Dose
≤ 34 weeks	≤ 7 days	50 mg/kg/dose every 12 hours
	8 to 28 days	75 mg/kg/dose every 12 hours
>34 weeks	≤ 28 days	50mg/kg/dose every 8 hours

Uncomplicated meningitis: 14 days of ampicillin plus:

- Gentamicin, IV, for 5 days for synergy.
  - If < 32 weeks gestation: 5 mg/kg/36 hours in the first week of life.
  - If ≥ 32 weeks gestation: 5 mg/kg/24 hours in the first week of life.
  - Monitor blood levels.

REFERRAL

» For surgical complications such as hydrocephalus, septic arthritis, osteomyelitis.
» Septicaemia not responding to treatment.

19.5.4 SYPHILIS, EARLY CONGENITAL

A50.9
*Notifiable condition.

DESCRIPTION

Multi-organ infection caused by *T. pallidum* and acquired by vertical transmission via the transplacental route during pregnancy.

DIAGNOSTIC CRITERIA

Clinical

» Suspect if mother has syphilis or positive serology for syphilis and the baby a positive non-treponemal serological test at birth with a titre at least 4-fold higher than that of the mother.
» Large, pale, greasy placenta.
» The following signs may be present at birth or will develop within the first 3 months of life:
  > hydrops fetalis,
  > anaemia,
  > hepatosplenomegaly,
  > oedema,
  > condylomata,
  > hepatitis,
  > nephrosis/nephritis,
  > thrombocytopenia,
  > lymphadenopathy,
  > jaundice,
  > hypoalbuminaemia,
  > pneumonia alba,
  > meningitis,
  > interstitial keratitis, and
  > transient bullous lesions, commonly on the hands and feet with later desquamation and an erythematous appearance of palms and soles.
» A generalised, reddish, maculopapular rash that may desquamate.
» Rhinitis with mucopurulent bloodstained discharge excoriating the upper lip.
» Other mucocutaneous lesions of the mouth, anus and genitalia, healing with scars, especially the corners of the mouth and on the chin.
» Involvement of long bones with/without pseudoparalysis of one or more limbs and radiological findings.

Investigations:

If mother is positive for syphilis:

» X-ray of long bones:
  > translucent metaphyseal bands,
  > osteochondritis,
  > osteitits, and
  > metaphysitis and periostitis.
» Confirm syphilis with:
  > Non-treponemal serological tests, i.e. RPR, VDRL, in mother and baby. (Do not use umbilical cord blood at delivery for laboratory investigations.)

GENERAL AND SUPPORTIVE MEASURES

» Nurse infant in a neutral thermal environment.
» Maintain adequate nutrition and hydration.
» Monitor hepatic and renal function.

» Ensure maternal and paternal treatment if positive.

Pneumonia
To maintain oxygen saturation at 90–95% or P_aO_2 at 60–80 mmHg (8 -10.5 kPa):
- Oxygen.
  1 kPa = 7.5 mmHg
  1 mmHg x 0.133 = 1 kPa

Anaemia
If anaemia is present according to thresholds in figure 1 above:
- Packed red cells, IV, 10–15 mL/kg over 3-4 hours in haemodynamically stable patients. More rapid transfusions may be appropriate in bleeding and haemodynamically unstable patients.

MEDICINE TREATMENT

Asymptomatic, well baby
Mother seropositive or result unknown, and mother has not been treated or was only partially treated:
- Benzathine benzylpenicillin (depot formulation), IM, 50 000 units/kg as a single dose into the antero-lateral thigh.

Symptomatic baby
- Procaine penicillin, IM, 50 000 units/kg daily for 10 days (not for IV use).

OR
- Benzylpenicillin (Penicillin G), IV, 50 000 units/kg 12 hourly for 10 days.

CAUTION *Procaine penicillin and benzathine benzylpenicillin must not be given intravenously.*

Follow up children at 3 months post treatment with repeat non-treponemal serological tests, until test becomes non-reactive. Re-treat if drop in titre less than 4-fold.

Prevention
Screen pregnant women for syphilis at first visit and repeat during the second and/or third trimester.
Investigate and treat both parents, if necessary.

REFERRAL

» Symptomatic infant with complications, e.g. respiratory failure, hepatic failure, nephrotic syndrome and meningitis.

19.5.5 TETANUS, NEONATAL

A33
*Notifiable condition.

DESCRIPTION

Tetanus is an acute spastic paralytic illness caused by tetanospasmin, the neurotoxin produced by *C. tetani*. Neonatal tetanus is the most common form of the disease, usually caused by umbilical stump infections or contamination.

The disease only occurs in infants of non-immunised mothers or mothers with insufficient levels of protecting antibody to tetanus toxin.

DIAGNOSTIC CRITERIA

Clinical signs

- Presents with difficulty in sucking and swallowing due to masseter spasm, i.e. trismus, usually on day three, with associated hunger and crying.
- Temperature of 40–41°C.
- Tenseness and rigidity of all muscles, including paraspinal and abdominal muscles.
- Fists clenched and the toes fanned.
- Opisthotonic spasms and clonic jerks following sudden stimulation by touch and noise:
  - spasms are painful,
  - not true seizures,
  - there is no loss of consciousness, and
  - laryngeal spasms may result in respiratory distress.
- Umbilicus may appear normal but there may be discharge from, or dirt/dung on the umbilicus.

REFERRAL

- Seek urgent telephonic guidance prior to referral.
- All infants with suspected neonatal tetanus.

19.5.6 PREVENTION OF MOTHER TO CHILD TRANSMISSION (PMTCT)

Z20.60

See Chapter 9: HIV Infection, section 9.1.1: The HIV exposed infant.

19.5.7 NEONATES WITH EXPOSURE TO CHRONIC HEPATITIS B INFECTION

Neonatal transmission:
Babies born to mothers with acute hepatitis B infection at the time of delivery or to mothers who are HBsAg-positive or HBeAg-positive:

- Hepatitis B immunoglobulin, IM, 200 IU (2 mL) within 12 hours of delivery. (Always consult the product package insert before administering the dose for product specific dosing).

PLUS

- Hepatitis B vaccine, IM, first dose within 12 hours of delivery.
  - Continue hepatitis B immunisation according to the recommended immunisation schedule.

» Continue with routine childhood vaccine schedule thereafter.
» Measure hepatitis B surface antigen (HBsAg) and antibody (HBsAb) at 9 to 12 months. If non-immune at that time, discuss ongoing monitoring and treatment with relevant specialist.

19.6 NEUROLOGICAL

19.6.1 HYPOXIA-ISCHAEMIA OF THE NEWBORN (PERINATAL HYPOXIA/HYPOXIC-ISCHAEMIC ENCEPHALOPATHY (HIE))

P21.9

DESCRIPTION

Ischaemia and decreased oxygen delivery to the foetus/baby during the prepartum, intrapartum or immediate postpartum period, with hypoxic-ischaemic damage to the central nervous system and to other body systems.

Complications include:
» Cardiovascular: heart rate and rhythm disturbances, heart failure and hypotension.
» Pulmonary: respiratory distress/respiratory failure, pulmonary hypertension and pulmonary haemorrhage.
» Renal: renal failure, acute tubular/cortical necrosis and urinary retention.
» Gastrointestinal tract: ileus and necrotising enterocolitis.
» Central nervous system: increased intracranial pressure, cerebral oedema, encephalopathy, seizures, inappropriate antidiuretic hormone (ADH) secretion, hypotonia and apnoea.
» Metabolic: hypoglycaemia, hyperglycaemia, hypocalcaemia, hypomagnesaemia and metabolic acidosis.
» Body temperature: abnormal.
» Other: disseminated intravascular coagulation.

DIAGNOSTIC CRITERIA

To make the diagnosis of HIE, all of the following are required:

» Gestation ≥ 36 weeks (i.e. late preterm or term).
» Evidence of intrapartum asphyxia or hypoxia:
  1. Apgar < 5 at 5 and 10 minutes OR
  2. pH < 7.0 and BD ⩾ 12 mmol/l OR
  3. Ongoing resuscitation for more than 10 minutes.
» Evidence of encephalopathy:
  > Clinical examination using the modified Sarnat staging.
  OR
  > Abnormal aEEG.

Modified Sarnat staging

» Encephalopathy defined as the presence of one or more signs in at least 3 of the 6 categories:

		Moderate encephalopathy	Severe encephalopathy
1.	**Level of consciousness**	Lethargic	Stupor/coma
2.	**Spontaneous activity**	Decreased activity	No activity
3.	**Posture**	Distal flexion/complete extension	Decerebrate
4.	**Tone**	Hypotonia	Flaccid
5.	**Primitive reflexes**		
	» Suck	Weak	Absent
	» Moro	Incomplete	Absent
6.	**Autonomic nervous system**		
	» Pupils	Constricted	Deviated, dilated or non-reactive to light
	» Heart rate	Bradycardia	Variable
	» Respiration	Periodic breathing	Apnoea

Thompson Score (Long-term prognostication)

Score	1	2	3
Limb tone	Generally hypertonic	Generally hypotonic	Flaccid
LOC	Hyperalert, hyper-reactive or staring	Lethargic/Obtunded	Comatose/ Stuporous
Visible fits	Infrequent (< 3/day)	Frequent (> 2/day)	
Posture	Fisting and/or cycling	Strong distal flexion	Decerebrate
Moro	Partial	Absent	
Grasp	Poor	Absent	
Suck	Poor	Absent and/or bites	
Resp. effort	Hyperventilation	Brief apnoea	Apnoea (IPPV)
Fontanelle	Full, not tense	Tense	

Thompson, et al. The value of a scoring system for hypoxic ischaemic encephalopathy in predicting neurodevelopmental outcome. Acta Paediatr. 1997;86:757-761.

GENERAL AND SUPPORTIVE MEASURES

» Resuscitate
» Avoid hyperthermia.
» Admit to a neonatal high care or intensive care facility.
» Mild HIE: ambient temperature at the lower range of a neutral thermal environment.
» Infants ≥ 36 weeks gestation with moderate HIE (stage 2): whole body or head cooling if appropriate monitoring is available.
  > Initiate within 6 hours of birth to maintain rectal (core) temperature at 33.5–34.5ºC (whole body cryotherapy) or 34–35ºC (head cooling) for 72 hours.
  > Slowly rewarm at a rate of 0.5ºC/hour until core temperature 36.5–37.0ºC, then maintain axillary or skin temperature at 36.5–36.8ºC.

Neonates not eligible for cooling:

1. Birth weight less than 2000 g.
2. Gestational age less than 36 weeks.
3. Inability to initiate cooling by 6 hours of age.
4. Suspected coagulopathy.
5. Life-threatening abnormalities of the cardiovascular or respiratory systems such as complex congenital heart disease and persistent pulmonary hypertension of the newborn (PPHN).
6. Major congenital malformations, imperforate anus, suspected neuromuscular disorders, or presence of a known lethal chromosomal anomaly.
7. Death appears imminent.

» Ventilatory support if P_aO_2 < 60 mmHg (8 kPa) and/or P_aCO_2 > 55 mmHg (7.3 kPa) in newborns with moderate HIE (stage 2) or severe HIE (stage 3), depending on available resources.
» Maintain:
  > Blood glucose at 2.6–6 mmol/L.
  > Haematocrit at ≥ 40%.
  > Blood pressure at 70/35 mmHg in a term infant and 50/35 mmHg in a preterm infant. Mean blood pressure at least 5–10 mmHg more than the gestational age.
» IV fluids:
  > Frequent assessment of fluid balance, i.e. intake and output.
  > Restrict fluids to 40 mL/kg in the first 24–48 hours to avoid cerebral oedema.
  > Use dextrose water 10% or a neonatal maintenance solution, potassium-free, until the possibility of renal failure has been excluded.
» Maintain serum electrolytes, calcium, magnesium and acid-base status within normal physiological range.
» Nutrition:
  > No enteral feeds for at least the first 12–24 hours.
  > Enteral milk feeds (preferably breast milk) only after ileus has been excluded.

- > Consider IV alimentation if enteral feeds are not possible after 24 hours.

» Monitor:
- > neurological status,
- > vital signs,
- > acid-base status,
- > blood gases,
- > S_aO_2,
- > blood pressure,
- > brain function (aEEG), where available.
- > fluid balance,
- > temperature,
- > blood glucose,
- > electrolytes,
- > calcium, magnesium,
- > renal function, and

» Brain imaging – at least one cranial US during admission if available.
» Follow-up for assessment of neurodevelopment, hearing and vision.

MEDICINE TREATMENT

To keep P_aO_2 between 60 and 80 mmHg (8 and 10.5 kPa) and saturation 90–95% (normal range):

- Oxygen.

See figure 1: Blood cell transfusion thresholds for preterm neonates.
If anaemia is present according to thresholds in figure 1

- Packed red cells, IV, 10–20 mL/kg (consider pack size) over 3 – 4 hours in haemodynamically stable patients. More rapid transfusions may be appropriate in bleeding and haemodynamically unstable patients.

If infection is suspected or confirmed:
Treat as follows (if no renal dysfunction is present):

- Ampicillin, IV, 100 mg/kg/dose. Decrease the dose to 50 mg/kg/dose once meningitis has been excluded.

Gestational Age	Postnatal Age	Dose
≤ 34 weeks	≤ 7 days	50 mg/kg/dose every 12 hours
	8 to 28 days	75 mg/kg/dose every 12 hours
>34 weeks	≤ 28 days	50mg/kg/dose every 8 hours

PLUS

- Gentamicin, IV, 5 mg/kg once daily.

Where available, gentamicin doses should be adjusted based on therapeutic drug levels.

- Trough levels (taken immediately prior to next dose), target plasma level < 1 mg/L.
- Peak levels (measured 1 hour after commencement of IV infusion or IM/IV bolus dose), target plasma level > 8 mg/L.

Hypotension

- Sodium chloride 0.9%, IV, 10 mL/kg over 1 hour.

AND

- Dopamine, IV, 5–15 µg/kg/minute.

AND/OR

- Dobutamine, IV, 5–15 µg/kg/minute if cardiac dysfunction or failure is present.
  - Continue with blood pressure support until blood pressure is stabilised.

Seizure Control

Administer anticonvulsants with monitoring of cardiorespiratory function.

- Phenobarbitone, IV:
  - Loading dose: 20 mg/kg over 10 minutes.
  - Refractory seizures: Additional 10 mg/kg up to 40 mg/kg.

Maintenance:

- Phenobarbitone, IV or oral:
  - 4 mg/kg/day beginning 12–24 hours after the loading dose.

Admit neonates with seizures refractory to phenobarbitone to a high or intensive care unit.

Cardiorespiratory support is usually required in this category of infants.

For term normothermic neonates:

- Midazolam, IV.
  - Loading dose: 0.05 mg/kg IV over 10 minutes.
  - Followed by a continuous infusion of 0.03-0.3 mg/kg/hour.

OR

- Lidocaine (lignocaine), IV.
  - Loading dose: 2 mg/kg over 10 minutes.
  - Follow with a continuous infusion of:
    6 mg/kg/hour for 6 hours, then
    4 mg/kg/hour for 12 hours, followed by
    2 mg/kg/hour for 12 hours.
  - If seizures are well controlled, taper slowly over 12 hours.

For preterm neonates:

- Midazolam, IV.
  - Loading dose: 0.05 mg/kg over 10 minutes.
  - Followed by a continuous infusion of 0.03–0.3 mg/kg/hour.

OR

A safe dose of lidocaine (lignocaine) in preterm neonates has not been established but the following dosing schedule has been used.

- Lidocaine (lignocaine), IV.
  - Loading dose: 2 mg/kg over 10 minutes.
  - Follow with a continuous infusion of 3 mg/kg/hour for 3 days.
  - Taper dose gradually over the next 2 days.

CAUTION

Do not use lidocaine (lignocaine) if phenytoin was given.
Do not use lidocaine (lignocaine) for seizures in newborns with congenital heart disease, dysrhythmias, acute heart failure and shock.

» A safe lidocaine (lignocaine) dosing regimen for term infants undergoing hypothermia treatment for HIE has not been established; recommended to use half infusion dosages.
» Clearance of lidocaine (lignocaine) is slower in hypothermic preterm infants and neonates and there is a risk of accumulation.
» Start tapering earlier than 3 days if seizures are well controlled.
» Continuous monitoring of ECG, heart rate and blood pressure is mandatory if lidocaine (lignocaine) is used.
» Main adverse effects of lidocaine (lignocaine): dysrhythmias and bradycardia.
» Life threatening dysrhythmias may indicate lidocaine (lignocaine) toxicity. Treat with:
  - Lipid emulsion 20%, IV, 1.5 mg/kg over 1 minute.
    - Follow with a continuous infusion of 0.25 mL/kg/minute for 30 minutes. Refer urgently.

Cardiac failure

Restrict fluid.

- Furosemide, IV/oral/oro/nasogastric tube, 1 mg/kg/24 hours as single daily dose.
- Dobutamine IV, 5–15 µg/kg/minute.

Hypocalcaemia

Serum total calcium < 1.8 mmol/L or ionised calcium < 0.7 mmol/L.

- Calcium gluconate 10%, slow IV, 1–2 mL/kg over 15 minutes under ECG monitoring.

Hypomagnesaemia

Serum magnesium < 0.6 mmol/L:

- Magnesium sulphate 50%, IV, 0.2 mL/kg as a single dose.

Hypoglycaemia

Blood glucose < 2.6 mmol/L:

- Dextrose 10%, bolus IV, 2.5–5 mL/kg (250–500 mg/kg).
  - Dextrose 10% = 10 g dextrose in 100 mL.
  - Do not repeat dextrose bolus; titrate the glucose concentration of the IV fluid to increase glucose delivery.

Syndrome of inappropriate ADH

Moderate fluid restriction of 40 mL/kg/24 hours for the first 24–48 hours.
Raise head of cot by 10–15 cm.

Cerebral oedema/raised intracranial pressure
Moderate hyperventilation to lower P_aCO_2 to 35 mmHg (4.5 kPa), if ventilation facilities are available.

REFERRAL
» Neurological assessment of survivors at 3 months.
» Moderate HIE (gestational age ≥ 36 weeks) to reach referral hospital before 6 hours post birth.
» Lidocaine (lignocaine) toxicity.

19.6.2 SEIZURES, NEONATAL
P90

DESCRIPTION
Neonatal seizures are usually secondary to a serum biochemical disorder or an underlying brain disturbance/injury/malformation. Seizures may be subtle due to the relatively underdeveloped cortex. Seizures persist when limbs are flexed (as opposed to jitteriness).

The most likely causes are:
» perinatal asphyxia,
» birth trauma,
» intracranial haemorrhage,
» meningitis,
» narcotic or alcohol withdrawal syndrome,
» CNS developmental abnormalities.
» hypocalcaemia,
» hypomagnesaemia,
» hyponatraemia,
» hypoglycaemia,
» inborn errors of metabolism,
» pyridoxine deficiency, and

DIAGNOSTIC CRITERIA
Categories of convulsions
» Subtle seizures:
  > tonic deviation of the eyes,
  > 'swimming' movements of the arms,
  > fluttering of the eyelids,
  > 'cycling' movements of the legs,
  > sucking and chewing movements,
  > apnoea,
  > vasomotor changes.
» Tonic clonic movements.
» Focal clonic movements.
» Myoclonic movements.
» Tonic movements/posturing.

GENERAL AND SUPPORTIVE MEASURES

» Identify and treat the underlying cause, e.g. meningitis and hypoxic-ischaemic encephalopathy.
» Ensure an open airway and administer oxygen, if necessary.
» Nurse in a neutral thermal environment.
» Ensure adequate nutrition and hydration.
» Monitor and maintain within accepted physiological range:
  > respiration,
  > heart rate,
  > blood pressure,
  > blood gases,
  > S_aO_2,
  > body temperature.
  > acid-base status,
  > electrolytes,
  > minerals,
  > blood glucose,
  > haematocrit,

MEDICINE TREATMENT

Seizure Control

Administer anticonvulsants with monitoring of cardiorespiratory function.

Phenobarbitone

- Phenobarbitone, IV.
  - Loading dose: 20 mg/kg administered over 10 minutes.
  - Refractory seizures: Additional 10 mg/kg/dose up to 40 mg/kg.

Maintenance:

- Phenobarbitone, IV or oral.
  - 4 mg/kg/day beginning 12–24 hours after the loading dose.

Seizures refractory to phenobarbitone should be admitted to a high or intensive care unit.

Cardiorespiratory support is usually required in this category of infants.

For seizures refractory to phenobarbitone use:

- Midazolam, IV.
  - Loading dose: 0.05 mg/kg IV over 10 minutes.
  - Followed by a continuous infusion of 0.03-0.3 mg/kg/hour.

OR

- Lidocaine (lignocaine)

For term normothermic neonates:

- Lidocaine (lignocaine), IV.
  - Loading dose: 2 mg/kg administered over 10 minutes.
  - Follow with a continuous infusion of:
    6 mg/kg/hour for 6 hours, then,
    4 mg/kg/hour for 12 hours, then,
    2 mg/kg for 12 hours.
  - If seizures are well controlled, slowly taper lidocaine (lignocaine) over 12 hours.

For preterm neonates:

- Midazolam, IV.
  - Loading dose: 0.05 mg/kg IV over 10 minutes.
  - Followed by a continuous infusion of 0.03–0.3 mg/kg/hour.

OR

A safe dose of lidocaine (lignocaine) in preterm neonates has not been established but the following dosing schedule has been used.

- Lidocaine (lignocaine), IV.
  - Loading dose: 2 mg/kg administered over 10 minutes.
  - Follow with a continuous infusion of 3 mg/kg/hour for 3 days.
  - Gradually taper lidocaine (lignocaine) over next 2 days.

CAUTION

Do not use lidocaine (lignocaine) if phenytoin was given.
Do not use lidocaine (lignocaine) for seizures in newborns with congenital heart disease, dysrhythmias, acute heart failure and shock.

» A safe lidocaine (lignocaine) dosing regimen for term infants undergoing hypothermia treatment for hypoxic ischaemic encephalopathy has not been established.
» Clearance of lidocaine (lignocaine) is slower in hypothermic neonates and preterm infants. There is a risk of accumulation.
» Start tapering earlier than 3 days if seizures are well controlled.
» Continuous monitoring of ECG, heart rate and blood pressure is mandatory if lidocaine (lignocaine) is used.
» Dysrhythmias and bradycardia are the main side effects of lidocaine (lignocaine). Life threatening dysrhythmias may indicate lidocaine (lignocaine) toxicity.

Lidocaine (lignocaine) toxicity:

- Lipid emulsion 20%, IV, 1.5 mg/kg administered over 1 minute.
  - Follow with a continuous infusion of 0.25 mL/kg/minute for 30 minutes. (See Referral section.)

Pyridoxine deficiency:

- Pyridoxine, IV/IM, 20 mg/kg.

Maintenance anticonvulsant therapy

» Maintenance anticonvulsant therapy is usually considered for neonates with underlying brain damage due to hypoxic-ischaemic encephalopathy, meningitis, intracranial haemorrhage or birth trauma.
» Continue until neonate is seizure-free for 2 weeks, then slowly taper to stop.
» If seizures recur during tapering of anticonvulsant therapy, continue with maintenance therapy.
» Follow-up by medical practitioner or at clinic/hospital after discharge.

Note:
Patients with head or whole body cooling should have an adjustment of the anticonvulsant doses.

Hypocalcaemia
Serum total calcium ≤ 1.8 mmol/L, or ionized calcium < 0.7 mmol/L.
- Calcium gluconate 10%, IV, 100–200 mg/kg/dose administered over 10 minutes.
  - Dilute 1:4 with dextrose 5% water.
  - Administer under ECG monitoring over 5 minutes (preferred) or until seizure ceases. Repeat if necessary.
    (1 mL of 10% calcium gluconate = 100 mg calcium gluconate.)

Hypoglycaemia
Serum glucose < 2.6 mmol/L.
- Dextrose, IV as bolus, 250–500 mg/kg.
  - Follow with 6–12 mg/kg/minute or more until blood glucose is within the physiological range. (10% Dextrose = 10 g dextrose/100 mL).

Hypomagnesaemia
Serum magnesium < 0.6 mmol/L.
- Magnesium sulphate 50%, IV, 0.25 mL/kg administered slowly over 3 minutes as a single dose.

REFERRAL
» Seizures not responding to adequate therapy.
» Seizures where the underlying cause is unclear.
» Refractory cases for further treatment and aEEG monitoring.
» Lidocaine (lignocaine) toxicity.

19.7 METABOLIC

19.7.1 HYPOCALCAEMIA, NEONATAL
P71.1

DESCRIPTION
Acute symptomatic hypocalcaemia may present within the first 72 hours of birth (early hypocalcaemia) or after 72 hours of birth (late hypocalcaemia) with apnoea, irritability, seizures, jitteriness or prolonged QTc interval on ECG.

Causes of early hypocalcaemia include:
» Prematurity
» Respiratory distress syndrome.
» Asphyxia/hypoxia.
» Neonate of a diabetic mother.
» Sepsis

Causes of late hypocalcaemia include:
» Maternal hyperparathyroidism.
» Congenital hypoparathyroidism.
» Renal failure.
» Hypomagnesaemia
» High phosphate feeds.
» Vitamin D deficiency.

DIAGNOSTIC CRITERIA
» Total serum calcium < 1.8 mmol/L, or
» Ionised calcium < 0.7 mmol/L.

MEDICINE TREATMENT
Symptomatic hypocalcaemia:
- Calcium gluconate 10%, IV, 100–200 mg/kg/dose 6–8 hourly.
  1 mL of calcium gluconate 10% = 100 mg calcium gluconate
  = 10 mg elemental calcium
  = 0.23 mmol calcium

Correct hypomagnesaemia before administering 10% calcium gluconate.
- Magnesium sulphate 50%, IV, 0.25 mL/kg.
  - Monitor levels until deficits are reduced.

Acute hypocalcaemia with seizures:
- Calcium gluconate 10%, IV infusion, 100–200 mg/kg, administered over 10 minutes. Repeat in 15 minutes if necessary.
  - Dilute 1:1 with dextrose 5% or sodium chloride 0.9%.
  - Do not use calcium chloride.

Note: Rapid infusion causes bradycardia/dysrhythmias. Electrocardiographic monitoring is advised. Monitor the heart rate.

CAUTION
Do not mix calcium gluconate with bicarbonate or fluids containing phosphate, as precipitation may occur. Extravasation of calcium can cause tissue necrosis. Do not give intra-arterially or via umbilical venous catheters placed near the heart or inside the liver.

REFERRAL
» Persisting or recurrent unexplained hypocalcaemia.

19.7.2 HYPOGLYCAEMIA, NEONATAL

P70.4

DESCRIPTION

Neonate presenting with whole blood glucose below 2.6 mmol/L.

Risk factors include:

- » prematurity,
- » small for gestational age,
- » neonate of diabetic mother,
- » sepsis,
- » hypothermia/hyperthermia,
- » perinatal asphyxia,
- » hereditary defects in carbohydrate or amino acid metabolism.
- » respiratory distress,
- » rhesus iso-immunisation,
- » hyperinsulinism,
- » post maturity,
- » feeding difficulties,
- » polycythaemia,
- » large for gestational age infants,

DIAGNOSTIC CRITERIA

Clinical

Asymptomatic: Hypoglycaemia detected when screening neonates at risk.

Symptomatic:

- » lethargy,
- » hypotonia,
- » apnoea,
- » jitteriness,
- » irritability,
- » coma.
- » poor feeding,
- » respiratory distress,
- » cardiac failure,
- » convulsions,
- » metabolic acidosis, and

Investigations

- » Whole blood glucose (heel prick) < 2.6 mmol/L.

Monitor the blood glucose of all neonates who are at risk of hypoglycaemia regularly, at least 2 hourly, to prevent the development of hypoglycaemia.

GENERAL AND SUPPORTIVE MEASURES

- » Determine and treat the underlying cause.
- » Enteral feeding, oral or via oro/nasogastric tube, after exclusion of vomiting, ileus or obstruction.

MEDICINE TREATMENT

- Dextrose 10%, bolus IV, 2.5 mL/kg (250 mg/kg).
  - Dextrose 10% = 10 g dextrose in 100 mL.
  - Do not repeat dextrose bolus.

To raise heel prick blood glucose to a level of 2.6 mmol/L or more, follow with:

- Dextrose 10%, continuous IV infusion, 6–12 mg/kg/minute or more.

$$\text{Dextrose dose (mg/kg/min)} = \frac{\text{(\% dextrose solution x rate in mL/hour)}}{\text{(weight x 6)}}$$

If heel prick blood glucose remains below 2.6 mmol/L:

- Dextrose 15%, IV via a central line, 15 mg/kg/minute or more.
  - Dextrose 15% = 15 g dextrose in 100 mL.

If heel prick blood glucose is above 2.6 mmol/L after IV infusion has been started, continue infusion at maintenance rate.

Monitor blood glucose at least 2 hourly until blood glucose level stabilises at 2.6 mmol/L or above. To avoid rebound hypoglycaemia, reduce IV dextrose infusion gradually.

Before the IV infusion is finally discontinued, the neonate should receive all milk feeds orally or via oro/nasogastric tube. If enteral feeds are not tolerated, TPN should be given.

Suspect other serious underlying metabolic or biochemical abnormality if the neonate requires > 12 mg/kg/minute of dextrose to maintain a heel prick whole blood glucose > 2.6 mmol/L.
Use a central venous line for high concentrations of dextrose.

Prior to referral, give the following, if available:

- Glucagon, IM/IV/SC, 0.2 mg/kg single dose.

REFERRAL

» Hypoglycaemia not responding to adequate treatment.
» Recurrent or persistent hypoglycaemia.

Also see Chapter 7: Endocrine System, section 7.6: Hypoglycaemia in children.

19.7.3 THE INFANT OF A DIABETIC MOTHER (IDM)

DESCRIPTION

Infants born to a mother with established or newly diagnosed diabetes mellitus. The foetus will be exposed to high levels of insulin in utero if maternal glycaemic control is not achieved, with foetal pancreatic hypertrophy as an adaptive measure. The infant of a diabetic mother is at increased risk of morbidity and mortality.

DIAGNOSTIC CRITERIA

IDM babies may show signs related to insulin and/or glucose toxicity, as well as complications of the withdrawal of insulin. As maternal diabetes may be undiagnosed, the condition should be suspected in infants with the following:

» Hypoglycaemia
» Polycythaemia
» Hyperbilirubinaemia
» Respiratory distress syndrome.
» Hypertrophic cardiomyopathy.
» Congenital malformations, especially cardiac malformations and sacral agenesis.
» Macrosomia, which predisposes to birth injuries.

GENERAL AND SUPPORTIVE MEASURES
» Strict glucose monitoring: after birth, at 30 minutes, 1 hour, 2 hours and before each feed for all LGA babies or a confirmed IDM.

MEDICINE TREATMENT
Refer to section 19.7.2: Hypoglycaemia, neonatal.

REFERRAL
» Severe, persistent hypoglycaemia requiring more than 12.5% intravenous dextrose to maintain normal glucose levels.
» Congenital malformations or birth injuries requiring specialist management.

19.8 HAEMATOLOGY

19.8.1 HAEMORRHAGIC DISEASE OF THE NEWBORN
P53

DESCRIPTION
This is due to a deficiency of vitamin K-dependent clotting factors II, VII, IX and X. All newborns who did not receive vitamin K_1 at birth, especially preterm babies and breastfed babies, are at risk.

Spontaneous bleeding may be from any site but is usually gastrointestinal, producing haematemesis or melaena. Bleeding from the umbilical stump, epistaxis and a cephalohaematoma or subgaleal haemorrhage are also relatively common.
Complications may include anaemia, hypovolaemic shock and intracranial haemorrhage with neurological damage.

There are three forms of the disorder:
Early form: Presents within 24 hours of birth in newborns of mothers on treatment with anticonvulsants, e.g. phenytoin and phenobarbitone, or oral anticoagulants.
Classical form: Presents during the first week of life, usually on the second to seventh day.
Late form: Presents during the first to fourth month of life usually with intracranial haemorrhage in exclusively breastfed babies who did not receive vitamin K prophylaxis at birth.

DIAGNOSTIC CRITERIA

Special investigations

» Prolonged prothrombin time (PT).
» Normal partial prothrombin time (PTT).
» Increased international normalised ratio (INR) with a normal platelet count.
» Normal fibrinogen levels.
» Normal thrombin time.

Note:
» Exclude other causes of bleeding in the neonate.
» Exclude swallowed blood of mother during delivery in babies with melaena. (Apt test or haemoglobin electrophoresis).

GENERAL AND SUPPORTIVE MEASURES

» Nurse in a neutral thermal environment.
» Provide adequate nutrition.
» Monitor:
  > blood pressure,
  > heart rate,
  > respiratory rate,
  > body temperature,
  > coagulation parameters.
  > hydration,
  > S_aO_2,
  > haematocrit,
  > blood glucose, and

MEDICINE TREATMENT

- Oxygen, if needed.

- Fresh frozen plasma or lyophilised plasma, IV, 20 mL/kg over 1 hour.

If anaemic (haematocrit < 40% or Hb < 13 g/dL):
- Packed red cells, IV, 10 mL/kg over 1 hour.
  - May be repeated if necessary.

- Vitamin K_1, IM, 1 mg as a single dose.

Prophylaxis

- Vitamin K_1, IM, single dose at birth.
  Full term newborns: 1 mg.
  Preterm newborns: 0.5 mg.

Prophylaxis with oral vitamin K formulation is not recommended.

REFERRAL

» Deterioration of clinical condition despite adequate treatment.
» Suspected intracranial haemorrhage.

19.9 UNDERWEIGHT FOR GESTATIONAL AGE (UGA)

DESCRIPTION

UGA is failure of an infant to achieve their genetic growth potential. This may be due to maternal, placental or foetal factors in utero.

DIAGNOSTIC CRITERIA

» The birth weight of the underweight for gestational age infant plots below the 10th centile on the Fenton chart.
» Symmetrically wasted: weight, length and head circumference is below the 10th centile. Causes include chromosomal disorders, genetic abnormalities, chronic intra-uterine infection, maternal under-nutrition, and teratogenic agents such as alcohol.
» Asymmetrically wasted: only the weight is below the 10th centile. Causes include placental insufficiency, hypertension and diabetes mellitus during pregnancy and smoking during pregnancy.

The neonate is at risk of:
» Preterm delivery.
» Birth asphyxia.
» Hypoglycaemia
» Polycythaemia
» Hypothermia
» Increased mortality.

GENERAL AND SUPPORTIVE MEASURES:

» Admit unwell/unstable infants to a neonatal high/intensive care facility.
» Temperature control:
  > Kangaroo mother care: Initiate if baby is well and vital signs are stable.
  > Keep infant's temperature, axilla or skin of anterior abdominal wall, at 36.5–37.5°C.
» Whole blood glucose (heel prick) < 2.6 mmol/L.
  > Monitor the blood glucose, at least 2 hourly, to prevent the development of hypoglycaemia.
  > See management of hypoglycaemia (section 19.7.2: Hypoglycaemia, neonatal) if the glucose < 2.6 mmol/L.
» If renal function is compromised, use a potassium-free solution.
» Hospital discharge if:
  > clinically well,
  > able to breastfeed or formula feed,
  > able to maintain body temperature, and
  > weight > 1.8 kg, and on an upward trend.
» Follow-up visits to assess growth parameters and neurodevelopment.

REFERRAL

Presence of one or more of the following complications that cannot be managed at the facility:

» Respiratory distress requiring ventilatory support.
» Feeding difficulties where the underlying cause is unclear.
» Congenital abnormalities requiring surgical intervention.
» Hypoglycaemia not responding to treatment.

19.10 NEONATAL ABSTINENCE SYNDROME (NAS)

P96.1

DESCRIPTION

Postnatal opioid (or non-opioid illicit drug) withdrawal syndrome occurring in 55–94% of newborns whose mothers were addicted to or treated with opioids or other non-opioid illicit drugs, during pregnancy.

Can result in:

» foetal malformation,
» intrauterine death,
» preterm delivery,
» growth restriction, and
» an increased risk of antepartum haemorrhage (APH).

After birth, withdrawal symptoms are most commonly associated with opiate exposure, but can occur with a wide range of substances, including SSRIs, which have a separate guideline. Babies developing Neonatal Abstinence Syndrome (NAS) risk subsequent morbidity and SIDS mortality. A multi-disciplinary approach is needed to optimise care for often, complex social, psychological and support issues.

DIAGNOSTIC CRITERIA

Mother:

» Assess the mother's drug use – especially during pregnancy.
» The mother's urine may be screened for drugs as well.

Newborn:

» Neonatal abstinence syndrome scoring system (Modified Finnegan can be used: http://www.lkpz.nl/docs/lkpz_pdf_1310485469.pdf), which assigns points based on each symptom and its severity. The infant's score can help determine treatment.
» Toxicology (drug) screen of urine and of first bowel movements (meconium).

GENERAL AND SUPPORTIVE MEASURES

» At birth, record maternal past and current drug use, dosage and route, including time of last use. Inquire about partner’s drug use – consider adding it to the Road-to-Health Chart.
» Record relatives’ awareness of maternal drug use.

» Check and document mother's viral status and offer Hepatitis B vaccine.
» Record mother's choice of feeding method, noting prior discussions and decisions.
» Breastfeeding is not contra-indicated. Mother and baby need to be monitored closely.
» Collect a urine sample from baby within 48 hours to check drug exposure – maternal consent, check antenatal record.
» Commence withdrawal observations 4 hourly/1-hour post feed times for at least 72 hours and record severity level. See the table below for guidance.

Table for timing of symptoms onset.

Typical timing of symptom onset	Substance
3–72 hours	Alcohol, heroin, morphine, buprenorphine, codeine, diazepam, SSRIs.
24 hours–21 days	Methadone, benzodiazepines, barbiturates.

MEDICINE TREATMENT

Withdrawal symptoms are reduced when drugs from the same group are re-introduced. Heroin is the most commonly abused illicit opioid in South Africa and is referred to as 'unga' or 'Thai white'. 'Sugars' is a mixture of cheap heroin and cocaine that can be cut with a variety of other substances that may even include rat poison or other household detergents. 'Nyaope' is a mixture of cheap heroin and cannabis that is commonly used is Gauteng. This mixture is also referred to as 'Pinch' in other some areas. There is debate about the exact content of the street drug, 'Woonga'. It is thought to consist of a number of different substances, that may include heroin, crystal methamphetamine as well as rat poison and antiretroviral medications, specifically efavirenz.

Medicine treatment of NAS

Problem Drug	Treatment Options
Opiate withdrawal	• Morphine sulphate o 40 µg/kg/dose 4 hourly. o Increase dose 20–40 µg/kg/dose 8 hourly until symptoms controlled. o Maximum dose: 100 µg/kg/dose. (Addition of phenobarbitone may reduce symptom severity.)
Non-opiate withdrawal	• Phenobarbitone o 20 mg/kg, orally, loading dose. o Maintenance dose 24 hours later. o 4 mg/kg daily in 2 divided doses.

Seizure management	Any seizures should be fully investigated: Refer to section 19.6.2: Seizures, neonatal.
	
	• Phenobarbitone
	  ○ 20 mg/kg, orally, loading dose.
	  ○ Maintenance dose 24 hours later.
	  ○ 4 mg/kg daily in 2 divided doses.
	
	For opioid withdrawal:
	• Morphine sulphate (for opiate withdrawal) 100 mcg/kg stat dose, oral/IV, according to clinical status.
	If on maintenance morphine sulphate, consider increasing dose.

Weaning process

» Decrease dose, NOT dose interval time.
» Discuss weaning difficulties with a specialist.

Weaning regimen

Drug	Weaning Regimen
Morphine sulphate	After 24–48 hours of symptom control, reduce dose by 10–20% each 24–48 hours as tolerated until dose of 20 mcg/kg reached. Discontinue morphine once dose is 10 mcg/kg/day and observe for 48 hours.
Phenobarbitone	After 24–48 hours of stability, reduce dose by 2 mg/kg/dose 48 hourly as tolerated.

Note:

» Continue NAS assessments for 48 hours after discontinuing medication.
» Ensure Hepatitis B immunisation is given when due.

REFERRAL

» All neonates with repeated seizures.