Neonatal care
Clinical and therapeutic guidelines

Practical guide for doctors, nurses and other healthcare professionals managing common neonatal conditions
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First international edition based on *Neonatal care guidelines MSF-OCP 2016 edition* and *Neonatal guidelines MSF-OCG and OCB*.

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Introduction

Neonatal care is the medical care of neonates from the moment of birth throughout the first 28 days of life. It encompasses essential preventive and supportive activities to advanced curative interventions to reduce mortality in the neonatal period – the most vulnerable moment for a child’s survival and health.

For 1 million neonates every year, the day of birth is also their day of death. Worldwide 2.6 million children die in the first month of life. Despite a significant drop in under 5 child deaths globally (1990-2015), according to the WHO, neonatal deaths accounted for 46% of all under 5 child deaths in 2016, up from 40% in 1990. UNICEF reports that the majority (73%) of neonatal deaths occur in the first week of life, and around 36% in the first 24 hours. Almost all (99%) of these deaths occur in low and middle income countries with limited resources.

Prematurity, intra-partum related disorders, perinatal asphyxia and infections (especially sepsis, meningitis and pneumonia) account for the majority of these largely preventable deaths. Preterm and small for gestational age neonates are particularly at risk, with more than 80% of neonatal deaths in sub-Saharan Africa occurring in this group. Neonates born to the youngest and oldest mothers, those born to mothers living in rural areas and those born shortly after another sibling also carry a higher risk of mortality, according to UNICEF. In the areas with the highest neonatal mortality, fewer than half of all babies and mothers receive a postnatal health check.

Studies have shown that scaling up effective interventions targeting the major causes of neonatal mortality could prevent an estimated 71% of neonatal deaths. The highest impact comes from facility-based care, which although more expensive than community based methods, accounts for 82% of this effect. The greatest effect on neonatal deaths derives from interventions delivered through care during labour and birth plus immediate neonatal care (41%), followed by care of small and ill neonates (30%). Wider coverage and better quality preconception, antenatal, intrapartum and postpartum care could be provided at relatively low-cost.

This guide has been developed to address the growing need for a comprehensive, standardised approach to neonatal care. It aims to provide useful information for clinicians and health staff to care for neonates in the delivery room, maternity and neonatal care units. Most treatments proposed are relatively simple, but require meticulous monitoring and attention to detail to be effective.

Neonatal care in resource-limited contexts is an area that is growing and advancing as new research and resources become available. As such, these guidelines may require adaptation from the time of writing.

Comments should be addressed to the Paediatric Working Group at DL-MSF-PediatricWorkingGroupInternational@geneva.msf.org.
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<th>Description</th>
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<tbody>
<tr>
<td>AOP</td>
<td>Anaemia of prematurity</td>
</tr>
<tr>
<td>ACT</td>
<td>Artemisinin-based combination therapy</td>
</tr>
<tr>
<td>ARV</td>
<td>Antiretroviral</td>
</tr>
<tr>
<td>ART</td>
<td>Antiretroviral therapy</td>
</tr>
<tr>
<td>BCG</td>
<td>Bacillus Calmette-Guérin</td>
</tr>
<tr>
<td>BGL</td>
<td>Blood glucose level</td>
</tr>
<tr>
<td>BMF</td>
<td>Breast milk fortifier</td>
</tr>
<tr>
<td>BMV</td>
<td>Bag mask ventilation</td>
</tr>
<tr>
<td>bpm</td>
<td>Beats per minute</td>
</tr>
<tr>
<td>CGA</td>
<td>Corrected gestational age</td>
</tr>
<tr>
<td>CNS</td>
<td>Central nervous system</td>
</tr>
<tr>
<td>CPAP</td>
<td>Continuous positive airway pressure</td>
</tr>
<tr>
<td>CRP</td>
<td>C-reactive protein</td>
</tr>
<tr>
<td>CRT</td>
<td>Capillary refill time</td>
</tr>
<tr>
<td>CXR</td>
<td>Chest X-ray</td>
</tr>
<tr>
<td>EBM</td>
<td>Expressed breast milk</td>
</tr>
<tr>
<td>ECG</td>
<td>Electrocardiogram</td>
</tr>
<tr>
<td>ELBW</td>
<td>Extremely low birth weight</td>
</tr>
<tr>
<td>EPI</td>
<td>Expanded program on immunisation</td>
</tr>
<tr>
<td>FBE</td>
<td>Full blood examination</td>
</tr>
<tr>
<td>Hb</td>
<td>Haemoglobin</td>
</tr>
<tr>
<td>HDN</td>
<td>Haemorrhagic disease of the newborn</td>
</tr>
<tr>
<td>HIE</td>
<td>Hypoxic ischaemic encephalopathy</td>
</tr>
<tr>
<td>HIV</td>
<td>Human immunodeficiency virus</td>
</tr>
<tr>
<td>HR</td>
<td>Heart rate</td>
</tr>
<tr>
<td>HSV</td>
<td>Herpes simplex virus</td>
</tr>
<tr>
<td>IM</td>
<td>Intramuscular</td>
</tr>
<tr>
<td>IO</td>
<td>Intra-osseous</td>
</tr>
<tr>
<td>IUGR</td>
<td>Intra-uterine growth restriction</td>
</tr>
<tr>
<td>IV</td>
<td>Intravenous</td>
</tr>
<tr>
<td>Acronym</td>
<td>Full Form</td>
</tr>
<tr>
<td>---------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>KMC</td>
<td>Kangaroo mother care</td>
</tr>
<tr>
<td>LBW</td>
<td>Low birth weight</td>
</tr>
<tr>
<td>LP</td>
<td>Lumbar puncture</td>
</tr>
<tr>
<td>MAS</td>
<td>Meconium aspiration syndrome</td>
</tr>
<tr>
<td>MSF</td>
<td>Médecins sans Frontières</td>
</tr>
<tr>
<td>NBM</td>
<td>Nil by mouth</td>
</tr>
<tr>
<td>NEC</td>
<td>Necrotising enterocolitis</td>
</tr>
<tr>
<td>O₂</td>
<td>Oxygen</td>
</tr>
<tr>
<td>O/NGT</td>
<td>Oro/nasogastric tube</td>
</tr>
<tr>
<td>PPHN</td>
<td>Persistent pulmonary hypertension of the newborn</td>
</tr>
<tr>
<td>PR</td>
<td>Per rectum</td>
</tr>
<tr>
<td>PROM</td>
<td>Prolonged rupture of membranes</td>
</tr>
<tr>
<td>RBC</td>
<td>Red blood cell</td>
</tr>
<tr>
<td>RDS</td>
<td>Respiratory distress syndrome</td>
</tr>
<tr>
<td>RDT</td>
<td>Rapid diagnostic test</td>
</tr>
<tr>
<td>Rh</td>
<td>Rhesus</td>
</tr>
<tr>
<td>ROM</td>
<td>Rupture of membranes</td>
</tr>
<tr>
<td>ROP</td>
<td>Retinopathy of prematurity</td>
</tr>
<tr>
<td>RR</td>
<td>Respiratory rate</td>
</tr>
<tr>
<td>SBR</td>
<td>Serum bilirubin</td>
</tr>
<tr>
<td>SPA</td>
<td>Suprapubic aspirate</td>
</tr>
<tr>
<td>SpO₂</td>
<td>Oxygen saturations</td>
</tr>
<tr>
<td>TB</td>
<td>Tuberculosis</td>
</tr>
<tr>
<td>TTN</td>
<td>Transient tachypnoea of the newborn</td>
</tr>
<tr>
<td>UTI</td>
<td>Urinary tract infection</td>
</tr>
<tr>
<td>VLBW</td>
<td>Very low birth weight</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
</tbody>
</table>
Chapter 1:
Birth and neonatal resuscitation

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1.1 Preparation for birth

Ensure suitable equipment and staff trained in resuscitation are available at every birth. To optimise resuscitation, at least two skilled birth attendants\(^a\) are needed. Additional equipment and staff should be available for twins or triplets.

**Table 1.1 - Equipment needed for neonatal resuscitation**

<table>
<thead>
<tr>
<th>Basic equipment (all levels of care)</th>
<th>Special equipment (advanced levels of care)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resuscitation table</td>
<td>Paediatric catheters (24 G, yellow)</td>
</tr>
<tr>
<td>Clock or stopwatch</td>
<td>Syringes (2 mL, 5 mL, 10 mL)</td>
</tr>
<tr>
<td>Clean, dry cloths</td>
<td>Syringes (1 mL for vitamin K)</td>
</tr>
<tr>
<td>Non-sterile gloves</td>
<td>Needles (19 G, 25 G)</td>
</tr>
<tr>
<td>Cord clamps or sterile thread</td>
<td>Intra-osseous needle (18 G)</td>
</tr>
<tr>
<td>Scissors</td>
<td>Oxygen source (concentrator or cylinder)</td>
</tr>
<tr>
<td>Aspiration bulb (Penguin)</td>
<td>Oxygen nasal cannula (neonatal, preterm)</td>
</tr>
<tr>
<td>Neonatal bag-mask (with filter)</td>
<td>Pulse oximeter</td>
</tr>
<tr>
<td>Masks</td>
<td>Mechanical/electrical suction pump</td>
</tr>
<tr>
<td>- Neonate (size 1)</td>
<td>Suction tubes (size 8, 10, 12 or 14)</td>
</tr>
<tr>
<td>- Preterm (size 0)</td>
<td>10% glucose solution</td>
</tr>
<tr>
<td>Hat</td>
<td>0.9% sodium chloride solution</td>
</tr>
<tr>
<td>Stethoscope</td>
<td>Epinephrine (adrenaline)</td>
</tr>
<tr>
<td>Infant warmer</td>
<td>Paediatric infusion set</td>
</tr>
<tr>
<td></td>
<td>Surgical gloves (1 pair)</td>
</tr>
</tbody>
</table>

**Preparedness**

Although 50% of neonates requiring resuscitation have no predictable risk factors, certain antenatal and intrapartum factors increase the risk (see Table 1.2).

**Table 1.2 - Risk factors for neonatal resuscitation**

<table>
<thead>
<tr>
<th>Antenatal factors</th>
<th>Intrapartum factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension during pregnancy</td>
<td>Emergency caesarean</td>
</tr>
<tr>
<td>History of foetal/neonatal death</td>
<td>Instrumental birth (forceps, ventouse)</td>
</tr>
<tr>
<td>Bleeding in second or third trimester</td>
<td>Malpresentation</td>
</tr>
<tr>
<td>Maternal infection</td>
<td>Preterm birth</td>
</tr>
<tr>
<td>- TORCH(^b), fever, HIV, UTI</td>
<td>Intrauterine infection</td>
</tr>
<tr>
<td>Multiple pregnancies (twins, triplets)</td>
<td>PROM(^c) (&gt; 18 hours)</td>
</tr>
<tr>
<td>Large for gestational age neonates</td>
<td>Prolonged labour (&gt; 24 hours)</td>
</tr>
<tr>
<td>Medications during pregnancy</td>
<td>Prolonged second stage (&gt; 2 hours)</td>
</tr>
<tr>
<td>Decrease in foetal activity</td>
<td>Macrosomia</td>
</tr>
<tr>
<td>Age of mother (&lt; 16 years or &gt; 35 years)</td>
<td>Persistent foetal bradycardia</td>
</tr>
<tr>
<td></td>
<td>Use of general anaesthetic</td>
</tr>
<tr>
<td></td>
<td>Meconium-stained amniotic fluid</td>
</tr>
<tr>
<td></td>
<td>Umbilical cord prolapse</td>
</tr>
<tr>
<td></td>
<td>Placenta praevia</td>
</tr>
<tr>
<td></td>
<td>Significant blood loss during delivery</td>
</tr>
</tbody>
</table>

---

\(^a\) Skilled birth attendant can be a midwife, doctor, nurse or other trained healthcare professional.

\(^b\) TORCH infections: Toxoplasmosis, Other (syphilis, varicella-zoster, parvovirus B19), Rubella, Cytomegalovirus, Herpes simplex virus

\(^c\) PROM: Prolonged rupture of membrane
1.2 Neonatal resuscitation

Around 10% of neonates delivered in hospital need help to start breathing properly at birth. Tactile stimulation and clearing the airway may be enough, but half of them need assisted ventilation to establish breathing in the first minute of life. Less than 1% of neonates will need advanced resuscitation. The skilled birth attendant in charge of the delivery is also responsible for the neonate. He/she should start resuscitation immediately and, if necessary, call for help.¹

Steps 1 to 5 should be performed in the first minute of life. For guidance, see Figure 1.5 for basic neonatal resuscitation (Helping Babies Breathe action plan). See Figure 1.6 for an algorithm of advanced neonatal resuscitation. Basic neonatal resuscitation should be applied in all contexts. Only where medical staff with adequate expertise and advanced post-resuscitation care are available should advanced neonatal resuscitation be implemented.

1 - Dry the neonate and keep warm
Drying with a dry, clean cloth will stimulate most neonates to breathe and prevents hypothermia. If the neonate starts to breathe or cry with drying alone, no further action is required and he/she should receive routine care (see Chapter 2). If the neonate is not breathing after 5 seconds of gentle but vigorous drying, stop drying, keep warm and assess airway.

2 - Airway
Lay the neonate on his/her back with the head in a neutral position. Avoid flexion or hyperextension of the airway as this can obstruct the airway (Figure 1.1).

Suctioning is rarely required. In cases where there are copious secretions, meconium or obstruction, gently suction the mouth using a penguin aspiration bulb. Avoid suctioning too deeply (no more than 3 to 5 cm from the corner of the mouth) or for too long (maximum 5 seconds). If the neonate is still not breathing after clearing the airway, or if suction is not required, proceed with active stimulation.

3 - Active stimulation
While keeping the neonate warm, gently but firmly rub the neonate’s back once or twice to stimulate breathing. Do not use other methods of stimulation which may harm the neonate. If the neonate is still not breathing after 5 seconds of active stimulation, proceed to steps 4 and 5.

4 - Clamp and cut the cord
If the neonate needs to be moved for ventilation, clamp and cut the cord immediately without waiting for the recommended 1 to 3 minutes.

5 - Breathing
Ventilation must be commenced in the first minute if the neonate is not breathing or is breathing irregularly. Initiate assisted ventilation with air².
**Position the mask**
Fit the mask over the mouth and nose. Press firmly to prevent air leaks. Hold the mask on the face with the thumb and index finger in a “C” shape. With the remaining three fingers, gently pull the jaw into the mask in an “E” shape, being careful to avoid compression of the soft tissue in the neck.

![Correct Incorrect Incorrect Incorrect](image)

**Figure 1.2 - Mask positioning**

**Commence bag mask ventilation**
With the other hand, gently squeeze the bag at a rate of 30 to 60 breaths/minute for 60 seconds. Ventilation is effective if the chest rises and falls.

![Figure 1.3 - Bag mask ventilation (BMV)](image)

**If the chest fails to rise:**
- Check the connection between the bag and the mask.
- Check the position of the mask on the face.
- Check the head is in a neutral position.

If there is still no chest rise, try two-person ventilation, with one person holding the mask in place with both hands and the other responsible for squeezing the bag.

Every minute check for spontaneous respiratory effort (but do not take the mask off the face). Continue ventilation until there is spontaneous breathing.

Insert an oro/nasogastric tube (O/NGT) and aspirate stomach contents as soon as possible to prevent abdominal distension, vomiting and aspiration of stomach contents into the lungs. The O/NGT should be left on free drainage or actively aspirated to allow gastric air to be continuously released.

**6 - Oxygenation**
If oxygen is available and resuscitation continues beyond 2 minutes, connect the ambu-bag to the oxygen source at 5 L/min without oxygen reservoir initially. Do not stop bag mask ventilation. Put an oxygen reservoir when possible and set oxygen to 2 L/min. Where available, use a pulse oximeter to guide oxygen saturations according to time after birth. Too much oxygen can have negative effects, especially in preterm neonates.
Chapter 1: Birth and neonatal resuscitation

Table 1.3 - Target saturations during resuscitation

<table>
<thead>
<tr>
<th>Time from birth</th>
<th>Target saturations during resuscitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 minutes</td>
<td>65 to 85%</td>
</tr>
<tr>
<td>3 minutes</td>
<td>70 to 90%</td>
</tr>
<tr>
<td>4 minutes</td>
<td>75 to 90%</td>
</tr>
<tr>
<td>5 minutes</td>
<td>80 to 90%</td>
</tr>
<tr>
<td>10 minutes</td>
<td>85 to 90%</td>
</tr>
</tbody>
</table>

7 - Circulation – advanced resuscitation
Check the heart rate (HR) using a stethoscope or by feeling for a pulse at the base of the umbilical cord. Call for extra help at this stage.
– HR < 100 bpm → continue bag mask ventilation.
– HR < 60 bpm after 30 seconds of effective ventilation\(^a\) → commence cardiac massage and continue ventilation at a rate of 90 compressions and 30 breaths per minute (ratio of 3 compressions to 1 breath)\(^b\).
Place the thumbs just below the line connecting the nipples on the sternum and compress 1/3 the antero-posterior diameter of the chest.

8 - Drugs
If HR < 60 bpm after 30 seconds of chest compressions and effective ventilation, administer epinephrine (= adrenaline). Do not stop chest compressions and ventilations while preparing and administering epinephrine.

**epinephrine (adrenaline)** IV or IO: 0.1 mL/kg of a diluted* solution (0.1 mg/mL = 1:10 000)
*Vial of epinephrine = 1 mg/mL: dilute 1 mL epinephrine in 9 mL of 0.9% sodium chloride to obtain a diluted 10 mL solution of 0.1 mg/mL (1:10 000).

Repeat every 3 to 5 minutes as needed (maximum 3 doses). (If necessary, subsequent epinephrine dose can be increased to 0.3 mL/kg.)

If the mother was given morphine or other opiates in the peripartum period, this may cause neonatal respiratory depression. Consider complete reversal of the effects of maternal morphine with naloxone:

**naloxone** IM: 0.1 mg/kg (= 0.25 mL/kg of a 0.4 mg/mL vial)
May be repeated if necessary.

If naloxone is not available, ventilate the neonate for at least 30 minutes if the HR > 60 bpm.

---

\(^a\) Ventilation is effective if the chest rises and falls.
Figure 1.5 - Basic neonatal resuscitation

Advanced Neonatal Resuscitation for Low-Resource Settings

To be used both for sick infants in newborn units and at birth

Effective Ventilation for 30 seconds with room air

1. Start timing resuscitation
   - Stimulate

Breathing or crying?

- NO

- YES

Chest moving?

- NO

- YES

→ Check HR
   - Consider adding O₂ using pulse oximeter* (if available)

HR > 60?

- NO

- YES

→ Recheck HR every 1 minute
   - Compressions + Ventilations (3:1) for 3 min/cycle
     - 1st cycle: Prepare adrenaline IV AND venous access (IV/IO/UVC)
     - ≥ 2nd cycle: Give adrenaline AND consider blood/volume* loss or pneumothorax
     - > 3rd cycle: Consider stopping resuscitation ** and provide comfort care

Corrective Measures

To achieve chest rise:
1. Reposition mask and reposition head
   THEN:
2. Two person ventilation, if staff allows
3. Increase pressure
4. Consider oral airway

Post Resuscitation Care

→ Debrief
   - team
   - family
   - Charting

→ Dry baby, remove wet linen
→ Consider delayed cord clamping
→ NO SUCTION unless thick meconium AND no breathing/crying

CALL FOR HELP

YES

NO

PREVENT HEAT LOSS

1 MIN

Figure 1.6 - Advanced neonatal resuscitation algorithm

<table>
<thead>
<tr>
<th>Medication</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adrenaline (0.1 mg/kg)</td>
<td>1 kg</td>
</tr>
<tr>
<td></td>
<td>2 kg</td>
</tr>
<tr>
<td></td>
<td>3 kg</td>
</tr>
<tr>
<td></td>
<td>4 kg</td>
</tr>
<tr>
<td>Initial Dose (0.01 mg/kg)</td>
<td>0.1 ml</td>
</tr>
<tr>
<td>Repeated Dose</td>
<td>0.1 - 0.3 ml</td>
</tr>
<tr>
<td>NaCl 0.9% (up to 3 boluses)</td>
<td>10 ml</td>
</tr>
</tbody>
</table>

* Minimum O₂ Saturation (per minute of life)
   - 3 min: 70%
   - 4 min: 75%
   - 5 min: 80%
   - ≥ 10 min: 85%

** Consider stopping resuscitation:
   - At 10 minutes: if no perceptible HR
   - At 20 minutes: if no recovery of spontaneous ventilation, even if adequate HR

The manuscript and algorithm have been endorsed by the European Society for Paediatric Research (ESPR) and the European Society for Neonatology (ESN, incorporated in ESPR since Oct. 2017).
Stopping resuscitation
The longer the period of anoxo-ischaemia after delivery, the greater the risk of severe long-term neurological problems. Resuscitation should be stopped in the following circumstances as the risk of death or permanent disability outweighs the chance of survival:
– No HR after 10 minutes effective ventilation
– No spontaneous respirations after 20 minutes of effective ventilation, even if the HR is adequate.

Oxygen can prolong the end of the neonate’s life in a state of severe neonatal asphyxia (and therefore discomfort) and is not recommended.

When the decision is taken to end resuscitation, sensitively explain the outcome to the family. They may then have the option of holding the neonate in their arms until he/she dies.
1.3 Post-resuscitation care

Check the neonate’s temperature, oxygen saturations, blood glucose level and assess for danger signs. Perform a retrospective Apgar score and record the results on the monitoring sheet.

Admit the neonate to the neonatal care unit if there is any of the following:
- Apgar score ≤ 4 at 1 minute or ≤ 6 at 5 minutes
- Ventilation required for more than 2 minutes during resuscitation
- Presence of danger sign(s)
- Need for advanced resuscitation

Neonates who do not require admission to the neonatal care unit should be monitored for at least 24 hours. Assess vital signs (heart rate, oxygen saturations, respiratory rate, blood glucose levels and temperature) and for danger signs while observing in maternity. Commence routine neonatal care.

Keep mother and neonate together if possible.

1.3.1 Apgar score

The Apgar score is a tool for monitoring the neonate’s adaptation to extra-uterine life. It is made up of 5 components (skin colour, respiration, heart rate, muscle tone, responsiveness) and is given as a score out of 10 (see Tables 1.4 and 1.5). It is performed at 1, 5 and 10 minutes after complete delivery of the neonate.

It is not used to determine whether resuscitation is indicated; this should be evaluated at birth based on whether or not there is spontaneous respiratory effort. In the case of resuscitation, the Apgar score is determined retrospectively. The Apgar score must be noted in the medical file and neonate’s health record.

<table>
<thead>
<tr>
<th>Table 1.4 - Apgar score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Skin colour</strong>&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Extreme pallor or central cyanosis</td>
</tr>
<tr>
<td><strong>Respiration</strong></td>
</tr>
<tr>
<td><strong>Heart rate</strong></td>
</tr>
<tr>
<td><strong>Muscle tone</strong></td>
</tr>
<tr>
<td><strong>Responsiveness</strong> (after stimulation)</td>
</tr>
</tbody>
</table>

<sup>a</sup> A healthy neonate is usually born cyanotic (‘blue colouring’) but turns pink within 30 seconds after breathing starts. For neonates with dark skin, assess colour of mucous membranes and skin on palms of hands and soles of feet.
Table 1.5 - Significance of the Apgar score

<table>
<thead>
<tr>
<th>1 minute score</th>
<th>5 minute score</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 4 Asphyxia</td>
<td>0 – 6 Asphyxia</td>
</tr>
<tr>
<td>5 – 7 Difficult adaptation</td>
<td>7 – 8 Difficult adaptation</td>
</tr>
<tr>
<td>8 – 10 Good adaptation</td>
<td>9 – 10 Good adaptation</td>
</tr>
</tbody>
</table>

If the Apgar score is ≤ 4 at 1 minute or ≤ 6 at 5 minutes, the skilled birth attendant should call a doctor and should initiate necessary steps based on neonate’s needs. Once stabilised, the neonate should be kept under observation for at least 24 hours.

1.3.2 Assessment for danger signs

All neonates should be routinely examined for danger signs whether resuscitation was required or not. Non-specific signs can indicate severe illness, which may be present at the time of delivery or may develop after birth.

Neonates manifesting any danger signs require prompt admission to the neonatal care unit and immediate intervention. See Chapter 3 to guide intervention.

Table 1.6 - Danger signs in neonates

<table>
<thead>
<tr>
<th>Danger signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
</tr>
<tr>
<td>&gt; 38 °C (hyperthermia)</td>
</tr>
<tr>
<td>&lt; 35.5 °C (hypothermia)</td>
</tr>
<tr>
<td>Neurological signs</td>
</tr>
<tr>
<td>Bulging fontanelle</td>
</tr>
<tr>
<td>Hypotonia</td>
</tr>
<tr>
<td>Drowsy or unconscious</td>
</tr>
<tr>
<td>Unable to breastfeed</td>
</tr>
<tr>
<td>Seizures (including subtle* or abnormal movements)</td>
</tr>
<tr>
<td>Respiration</td>
</tr>
<tr>
<td>Apnoea or bradypnoea (RR &lt; 30/minute)</td>
</tr>
<tr>
<td>Tachypnoea (RR &gt; 60/minute)</td>
</tr>
<tr>
<td>Severe chest indrawing</td>
</tr>
<tr>
<td>Grunting respirations</td>
</tr>
<tr>
<td>Cardiovascular</td>
</tr>
<tr>
<td>Tachycardia (HR &gt; 180/minute)</td>
</tr>
<tr>
<td>Prolonged capillary refill time (&gt; 2 seconds)</td>
</tr>
<tr>
<td>Abdomen</td>
</tr>
<tr>
<td>Severe abdominal distension</td>
</tr>
<tr>
<td>Skin colour</td>
</tr>
<tr>
<td>Generalised cyanosis</td>
</tr>
<tr>
<td>Extreme pallor</td>
</tr>
<tr>
<td>Jaundice (yellow colouring)</td>
</tr>
<tr>
<td>Skin</td>
</tr>
<tr>
<td>Umbilicus red or oozing blood or pus</td>
</tr>
<tr>
<td>Numerous or large pustules</td>
</tr>
<tr>
<td>Joints</td>
</tr>
<tr>
<td>Swollen, painful joint (irritability when moved)</td>
</tr>
<tr>
<td>with reduced joint movement</td>
</tr>
<tr>
<td>Blood glucose</td>
</tr>
<tr>
<td>Recurrent hypoglycaemia (BGL &lt; 45 mg/dL or &lt; 2.5 mmol/L on more than 2 episodes)</td>
</tr>
</tbody>
</table>

* Subtle movements: sucking or chewing, blinking or disorganised eye movements, disordered arm or leg movements (pedalling).
1.4 Birth trauma

Factors that increase risk of birth trauma to the neonate include:
– Macrosomia
– Cephalopelvic disproportion (CPD)
– Instrumental delivery (forceps or ventouse)
– Breech position
– Shoulder dystocia

1.4.1 Skull injuries

Caput succedaneum
This is a poorly defined, subcutaneous collection of serosanguinous fluid that spreads over suture lines and the midline. It is very common after prolonged labour and does not cause significant problems.

Cephalhaematoma
A cephalhaematoma is a haemorrhage (bruising) between the periosteum and the skull as a result of trauma. It is more commonly seen after instrumental deliveries or following prolonged labour. It presents as a well demarcated, fluctuant swelling that does not cross suture lines. It usually appears on the second or third day of life and worsens over the first few days. Most cases resolve over time. With severe haematomas the neonate is at increased risk of developing jaundice.

Subgaleal haematoma
A subgaleal haematoma is bleeding between the periosteum and the scalp and is usually associated with ventouse extraction. It normally appears 12 to 72 hours after birth as a soft, fluctuant mass within the scalp especially over the back of the head, and is not restricted by suture lines. Patients need to be carefully monitored as the bleeding can spread leading to profound shock.

1.4.2 Facial injuries

Facial nerve palsy
Facial nerve (or 7th cranial nerve) damage results from hyperextension, traction and over-stretching with simultaneous rotation. The neonate presents with an asymmetrical face on crying and drooping at the side of the mouth. Most cases recover, but full recovery may take several months. The eye on affected side should be protected with a covering and synthetic tears (eye drops or 0.9% sodium chloride).

1.4.3 Upper limb injuries

Clavicle fractures
Clavicle fractures are a relatively common complication of vaginal births, with an increased incidence in macrosomia, forceps delivery and shoulder dystocia. They most commonly present with decreased movement of the arm on the affected side. Check for brachial plexus
injury (see further below). The fracture usually heals without any problem within a few weeks and a lump may develop at the fracture site. Pinning the sleeve of the affected arm to the chest can help with immobilisation.

**Humerus fractures**
The risks for long bone fractures include breech position, caesarean section, low birth weight (LBW), macrosomia and shoulder dystocia. Clinical findings include decreased range of motion, swelling of the fracture site and pain on palpation. The diagnosis can be confirmed on x-ray, where facilities are available. Treatment of long bone fractures includes immobilisation and splinting for 2 weeks. Pinning the sleeve of the affected limb to the chest aids immobilisation.

**Brachial plexus injuries**
Brachial plexus injuries result from stretching of the brachial plexus during birth. They are much more common in large neonates.

**Erb’s palsy**
- Upper brachial plexus injury involving C5, C6 and sometimes C7.
- Causes the affected arm to be adducted and internally rotated.
- The arm is held in extension at the elbow, pronation of the forearm and flexion at the wrist (‘waiter’s tip’ position).
- Paralysis of the upper arm is more common than paralysis of the lower arm or the entire arm. The grasp reflex remains intact, but the Moro reflex is absent on the affected side.

**Klumpke’s palsy**
- Purely a lower brachial plexus injury involving C7-8 and T1.
- Presents with a clawed hand with function at the shoulder and elbow.
- There is associated dilatation of the pupil on the side of the injury.

**Complete brachial plexus injury**
- Presents with a limp, dangling arm, without any trace of movement.

**Management of brachial plexus injuries**
- Most cases of brachial plexus injuries resolve spontaneously.
- If full function has not returned after about one month, encourage the mother to gently move the arm at the shoulder, elbow, wrist and hand to prevent joint contracture.
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Chapter 2:
Routine neonatal care

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Chapter 2: Routine neonatal care

2.1 Introduction

Neonatal mortality is highest in the first 24 hours after birth. Mother and neonate are encouraged to stay for 24 hours after delivery in maternity. Routine neonatal care and monitoring is to be provided for all neonates from birth, regardless of gestation, birth weight or clinical condition. It starts in the delivery room and continues until hospital discharge.

Routine care includes cord care, thermoregulation, breastfeeding support, and prophylaxis for gonococcal eye disease, vitamin K injection, vitamin D supplementation, vaccinations, assessment of risk factors and a full clinical examination.

Neonates born at home should receive routine care as soon as possible.

Table 2.1 - Summary of routine care after birth

<table>
<thead>
<tr>
<th>Care</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cord care</td>
<td>Clamp, cut, disinfect cord</td>
</tr>
<tr>
<td>Maintain thermal care</td>
<td>Dry, hat, wrap or skin-to-skin with mother</td>
</tr>
<tr>
<td>Support breastfeeding</td>
<td>Monitor breastfeeding</td>
</tr>
</tbody>
</table>
| Routine prophylactic treatments | 1% tetracycline eye ointment  
Vitamin K (phytomenadione)  
Vitamin D                   |
| Vaccinations                | BCG  
Polio  
Hepatitis B                  |
| Assessment                  | Clinical examination and assess risk factors     |
Chapter 2: Routine neonatal care

2.2 Immediate care in the delivery room

In addition to the equipment for neonatal resuscitation, the following should be available in the delivery room:
- Cord clamps or sterile thread
- 7.1% chlorhexidine digluconate dermal gel (delivering 4% chlorhexidine) 3 g sachet or, if unavailable, 10% povidone iodine solution
- 1% tetracycline eye ointment
- Vitamin K (2 mg/0.2 mL vial), 1 mL syringe and 23G and 25G needles\(^a\)
- Vaccines (cold chain\(^b\)): hepatitis B (monovalent), polio, BCG
- Drugs for PMTCT\(^c\) if mother HIV positive (see Chapter 4, Section 4.4 and Appendix 9)

2.2.1 Cord clamping and cord care

- Delay cord clamping until 1 to 3 minutes after birth in all neonates who are crying vigorously (especially those weighing less than 2500 g). Keep neonate on mother’s chest to help blood flow\(^1\).
- Clamp cord early (within 1 minute of birth) if neonate is asphyxiated and needs to be moved immediately for resuscitation.
- Clamp the cord with two Kocher forceps 10 cm from the umbilicus and cut between the two forceps. Use a sterile blade or scissors – a different pair than were used for episiotomy, if performed.
- Tie off the cord with a Barr clamp or sterile thread (double ligature), leaving a 2 to 3 cm stump.

Disinfection of umbilicus

- For all neonates born in a health facility, disinfect the umbilicus using:

\[
\text{7.1% chlorhexidine digluconate dermal gel (delivering 4% chlorhexidine): apply entire sachet}^*\text{ to the tip, stump and base of the cord once only at birth with a gloved finger.}
\]

If not available, use: 10% povidone iodine solution soaked sterile compress (single application at birth).

- For all neonates born at home and presenting to a health facility within 7 days of birth, disinfect the umbilicus using:

\[
\text{7.1% chlorhexidine digluconate dermal gel (delivering 4% chlorhexidine): apply entire sachet}^*\text{ to the tip, stump and base of the cord with a gloved finger daily for 7 days}^\star\star\text{.}
\]

If not available, use: 10% povidone iodine solution soaked sterile compress (single application at first presentation to health facility).

\(^a\) Preferable to use single-use 3g sachets of 7.1% chlorhexidine digluconate dermal gel.

\(^\star\star\) 7.1% chlorhexidine digluconate dermal gel can be provided at home by the mother provided that she has been shown how to administer the gel by a healthcare worker. It is recommended that the mother applies one dose of 7.1% chlorhexidine digluconate dermal gel under supervision before leaving the health facility.

\(^a\) For > 2500 g, use 23G needle. For ≤ 2500 g, use 25G needle.

\(^b\) Vaccine carrier if necessary.

\(^c\) PMTCT = prevention of mother to child transmission (of HIV)
– Keep the umbilical cord clean and dry without any dressing. Explain to the mother not to apply anything to the cord (such as milk, soil, honey, butter, dung) and explain the signs of infection (redness, swelling, pus).

– The cord will normally fall off at about 1 week of age (5 to 15 days). If an umbilical granuloma remains and there are no signs of infection, silver nitrate can be applied (at health centre level) one or two times per week by trained staff.

2.2.2 Thermoregulation

Neonates are susceptible to hypothermia due to a large body surface area, a decrease in subcutaneous fat stores and heat loss through evaporation. Preterm (< 37 weeks gestation) and low birth weight (LBW) neonates are particularly at risk. Neonates rely on external help to maintain body and skin temperature, particularly in the first 12 hours after birth.

Immediately after birth:
– Dry the neonate with a clean, dry cloth. Then wrap the neonate in another clean, dry cloth. Cover the head with a cap to reduce heat loss.
– Keep the neonate in a warm room (between 23 to 25 °C).
– Place the neonate skin-to-skin against the mother’s (dried) body and cover with a dry cloth or blanket.
– Delay bathing the neonate until 24 hours after birth. If it is not possible for cultural reasons, delay for at least 6 hours.
– The axillary temperature should be kept between 36 °C and 37 °C, and the neonate should have pink, warm feet.

2.2.3 Feeding

– Exclusive breastfeeding is the best option.
– Put the neonate to the breast as soon as possible within 1 hour of birth.
– Encourage breastfeeding on demand day and night (at least 8 times/24 hours, i.e. every 3 hours).
– If the mother is infected with HIV, breastfeeding is still recommended (see Chapter 4, Section 4.5).

---

d The use of 7.1% chlorhexidine digluconate dermal gel for 7 days can be considered to replace the application of harmful traditional substances to the cord stump in settings where such harmful practices are common.

e Note: Reference temperatures in this guide are axillary temperatures. The temperature displayed on the thermometer is the temperature that should be recorded and interpreted. The addition of 0.5 °C to the axillary temperature is not recommended. If there is any doubt as to the accuracy of the reading or to confirm an abnormal reading or if the axillary temperature is > 37.5 °C, where good hygienic practices can be assured, take a rectal temperature to verify.
2.3 Preventive treatments

2.3.1 Routine prophylaxis for gonococcal ocular infections

For all neonates:

Apply 1% tetracycline eye ointment once into both eyes as soon as possible, preferably within an hour of birth.

Note: if the mother has symptomatic genital infection at the time of delivery, see Chapter 4, Section 4.1.

2.3.2 Routine prophylaxis for haemorrhagic disease of the newborn

Vitamin K is needed for blood clotting. Neonates are born with a low level of vitamin K, so routine vitamin K injection should be given to reduce the risk of haemorrhagic disease of the newborn.

For all neonates:

phytomenadione (vitamin K) IM anterolateral thigh within first few hours of life:

- < 1500 g: 0.5 mg single dose (= 0.05 mL of a 2 mg/0.2 mL vial)
- ≥ 1500 g: 1 mg single dose (= 0.1 mL of a 2 mg/0.2 mL vial)

Can be given intravenously for sick neonates who have an intravenous catheter.

Note: open ampoules of phytomenadione should be used immediately or discarded. Do not store open ampoules, even in the refrigerator.

2.3.3 Routine prophylaxis for rickets and vitamin D deficiency

Neonates are born with low vitamin D reserves and require breast milk, sunlight exposure and supplements as sources of vitamin D in the first months of life. Vitamin D content of breast milk is low, maternal vitamin D status is often low and neonates may receive inadequate sun exposure due to climatic or cultural reasons. Vitamin D plays an important role in bone metabolism and immunity. Vitamin D deficiency can lead to bone disease (rickets), seizures, developmental delay and infections.

All neonates should receive daily oral vitamin D supplements from birth (or any time after) until 6 months of age.

Note: where it is not feasible to provide all neonates with daily vitamin D supplements, prioritise the following high risk groups: preterm, LBW, maternal malnutrition, contexts with high prevalence of vitamin D deficiency.

vitamin D PO: (Give drops directly PO or on mother’s nipple just before breastfeeding)

Term (≥ 37 weeks): 400 to 800 IU once daily

Preterm (< 37 weeks) or neonates living in areas of high risk vitamin D deficiency: 600 to 1200 IU once daily

---

a Two bottles of vitamin D drops (10 mL with 10,000 IU/mL) provide a 6 months daily supply.

DORACOLC1S1 - COLECALCIFEROL (vit.D3) 10,000 IU/ml, sol., 10 ml, bot
Note: check vitamin D bottle for IU corresponding to number of drops as this varies by manufacturer.

Ensure counselling on exclusive breastfeeding also includes importance of some sunlight exposure for neonates as a source of vitamin D. Adequate sunlight exposure would be around 30 minutes of afternoon sun per week with 40% body area exposed (keep nappy on)\textsuperscript{5}. 
2.4 Vaccinations

For the oral Polio vaccine, the dose administered at birth is an extra dose (called and recorded as “dose 0”). It does not count as one of the 3 doses required by the expanded programme on immunisation (EPI) during the postnatal period.

The hepatitis B birth dose is to prevent mother-to-child transmission of the virus. It should be administered as soon as possible, preferably in the delivery room, or at least within the first 24 hours of life. If administration within 24 hours is not feasible, a late birth dose has some effectiveness. Although effectiveness declines progressively in the days after birth, a late birth dose can still be effective in preventing horizontal transmission and therefore remains beneficial.

Medically stable preterm and LBW neonates should receive all routinely recommended childhood vaccinations at the chronological age, as is recommended for term neonates. The BCG may be delayed until after medical stabilisation and the neonate weighs > 1500 g, though evidence suggests that early administration of BCG vaccination, even in LBW neonates, reduces mortality compared to delayed vaccination. It should preferably be given 2 to 3 days before hospital discharge to monitor for apnoea, a rare side effect.

Table 2.2 - Neonatal vaccination

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Contra-indications</th>
<th>Dose/route of administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hepatitis B monovalent</td>
<td>None, but use monovalent vaccine only.</td>
<td>One dose = 10 micrograms IM injection, anterolateral thigh</td>
</tr>
<tr>
<td>Bivalent (type 1 and 3)</td>
<td>None</td>
<td>One dose = 0.1 mL (2 drops) Oral route</td>
</tr>
<tr>
<td>oral Polio dose 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BCG</td>
<td>Clinically suspected HIV infection or virologically confirmed HIV infection. Maternal active TB* (see Chapter 4, Section 4.4) Immunodeficiencyc</td>
<td>One dose = 0.05 mL Intradermal injection, deltoid region (junction of lower 2/3 and upper 1/3 lateral aspect of upper arm)</td>
</tr>
</tbody>
</table>

* Start the neonate on isoniazid preventive therapy and administer the BCG vaccination when the isoniazid therapy is complete.

---

*a* To complete the primary series for hepatitis B vaccination, hepatitis B birth dose should be followed by 2 additional doses. However, 3 additional doses are given in countries using DPT-HepB-Hib vaccine (6, 10, 14 weeks of age). The additional dose does not cause any harm.

*b* Late hepatitis B birth dose can be given at any time up to the day of the next dose of the primary schedule (usually at 6 weeks for DPT-HepB-Hib).

*c* Primary immunodeficiency syndrome: usually presents within first few weeks of life, though rarely obvious at birth. Secondary immunodeficiency: a sick neonate with a congenital infection or neonatal sepsis will have a weakened immune system, so the BCG vaccine is not recommended until the neonate is clinically well.
2.5 Assessment of risk factors

2.5.1 Neonates at risk of hypoglycaemia

If any of the following risk factors are present the blood glucose level (BGL) should be checked within one hour of birth and then before breastfeeding.

Risk factors
- Birth weight < 2500 g or > 4000 g
- Maternal diabetes
- Mother treated with labetalol
- Presence of one or more of the following signs:
  - Hypothermia (axillary temperature < 35.5 °C)
  - Irritability or trembling
  - Bradypnoea, apnoea or cyanosis
  - Difficulty breastfeeding (difficulty attaching to the breast, difficulty sucking or inadequate milk production)
  - Hypotonia or poor response to stimulation
  - Seizures
- Neonatal asphyxia
- Neonatal resuscitation with bag mask ventilation > 2 minutes or chest compression

Management
If the blood glucose level (BGL) is normal (BGL ≥ 45 mg/dL or ≥ 2.5 mmol/L):
- Keep the neonate warm.
- Continue breastfeeding every 3 hours.
- Check BGL before each feed until normal on 3 consecutive occasions.

If there is moderate hypoglycaemia (BGL 35 to 45 mg/dL or 2 to 2.5 mmol/L):
- Feed the neonate immediately, preferably with breast milk.
- If unable to feed with breast milk, give 5 mL/kg 10% glucose solution oral or via oro/nasogastric tube.
- Recheck BGL after 30 minutes.
- Check BGL before each feed until normal on 3 consecutive occasions.

In symptomatic, recurrent or severe hypoglycaemia (BGL < 35 mg/dL or < 2 mmol/L):
- This is a medical emergency.
- Admit to neonatal care unit and manage for hypoglycaemia (see Chapter 3, Section 3.1.4).

2.5.2 Neonates at risk of neonatal sepsis

Sepsis in neonates can sometimes be prevented with prophylactic antibiotics. The aim is to identify asymptomatic neonates at risk of neonatal sepsis who should receive prophylaxis.

The need for prophylactic antibiotics is determined by the presence of identified risk factors plus the adequacy of maternal antibiotic treatment received during labour and delivery. See Figure 2.1 for assessment and recommended action.
Risk factors for neonatal sepsis are either maternal or neonatal and can be classified as major or minor:

**Table 2.3 - Risk factors for early onset sepsis**

<table>
<thead>
<tr>
<th>Major risk factors</th>
<th>Minor risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal fever (≥ 38 °C) before or during labour</td>
<td>Preterm or birth weight &lt; 2000 g</td>
</tr>
<tr>
<td>Prolonged rupture of membranes (PROM) (≥ 18 hours)</td>
<td>Neonatal resuscitation</td>
</tr>
<tr>
<td>Chorioamnionitis (foul smelling amniotic fluid, uterine sensitivity)</td>
<td>Meconium stained amniotic fluid</td>
</tr>
<tr>
<td>Twin with clinical signs of sepsis (in cases of multiple pregnancy)</td>
<td>Home delivery</td>
</tr>
</tbody>
</table>

If maternal risk factors are present but the neonate is asymptomatic 72 hours after birth, it is unlikely the neonate will develop neonatal sepsis. So neonates born at home that come to a health facility at more than 72 hours of age and are asymptomatic, do not need to receive prophylactic antibiotics.

**Adequacy of maternal antibiotic treatment:**
- At least 2 doses of IV **ampicillin** prior to delivery
- First dose more than 4 hours before delivery
- Compliance at 4 hourly intervals throughout labour until delivery

Oral antibiotics, antibiotics other than ampicillin, less than 2 doses of IV ampicillin, and missed doses of antibiotics are considered to provide inadequate protection.

Limited diagnostic evaluation in asymptomatic neonates at risk of sepsis includes:
- Full blood examination, C-reactive protein and blood culture

Where available, it can help to determine the duration of prophylactic antibiotics in neonates with identified risk factors.
Chapter 2: Routine neonatal care

### Assessment of risk factors

- **Two or more major risk factors** WITH or WITHOUT adequate maternal antibiotics* → Prophylactic antibiotics 48 hours
- **Maternal chorioamnionitis** WITH or WITHOUT adequate maternal antibiotics* → Prophylactic antibiotics 48 hours
- **Neonates whose twin has clinical signs of sepsis** WITH or WITHOUT adequate maternal antibiotics* → Prophylactic antibiotics 48 hours
- **PROM > 18 hours** WITHOUT adequate maternal antibiotics* → Prophylactic antibiotics 48 hours
- **PROM > 18 hours** WITH adequate maternal antibiotics* → Observation 48 hours
- **Maternal fever** WITHOUT adequate maternal antibiotics AND preterm** or birth weight < 2000 g → Prophylactic antibiotics 48 hours
- **Maternal fever** WITHOUT adequate maternal antibiotics AND term → Observation 48 hours
- **Maternal fever** WITH adequate maternal antibiotics regardless of birth weight or gestation → Observation 48 hours
- **One or two minor risk factors** WITHOUT any major risk factor for sepsis* → Observation 48 hours
- **Three or more minor risk factors** WITH or WITHOUT adequate maternal antibiotics* → Prophylactic antibiotics 48 hours

* Regardless of birth weight or gestation
** Preterm < 37 weeks gestation

Figure 2.1 - Assessment of risk factors for neonatal sepsis and recommended action
Management

- If prophylactic antibiotics are indicated for 48 hours, the first line combination treatment is ampicillin slow IV (3 minutes) + gentamicin slow IV (3 minutes) or IM:

<table>
<thead>
<tr>
<th></th>
<th>&lt; 2 kg</th>
<th>≥ 2 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 7 days</td>
<td><strong>ampicillin</strong> IV 50 mg/kg every 12 hours + <strong>gentamicin</strong> IV 3 mg/kg every 24 hours</td>
<td><strong>ampicillin</strong> IV 50 mg/kg every 8 hours + <strong>gentamicin</strong> IV 5 mg/kg every 24 hours</td>
</tr>
</tbody>
</table>

- If after 48 hours, the neonate does not develop any signs of infection (and the blood culture, if taken, is negative) stop antibiotics and observe in hospital for a further 24 to 48 hours (pending on context).
- If blood cultures are taken and are positive, even in an asymptomatic neonate, manage as neonatal sepsis (see Chapter 3, Section 3.4.2).
- If at any moment clinical signs of sepsis manifest, manage as neonatal sepsis (see Chapter 3, Section 3.4.2).
- Neonates placed under observation for 48 hours should have a thorough clinical assessment and be reviewed regularly for signs of sepsis. Maintain a low threshold for starting antibiotics in all neonates under observation, but especially in preterm neonates or neonates with birth weight less than 2000 g.

Monitoring

- Neonates under observation should be kept in the maternity ward with careful monitoring (4 times per day) of vital signs, feeding and assessment of danger signs. A clinician should review the neonate once daily.
- The mother/caregiver should be implicated in the care and observation of the neonate and any abnormality should be communicated immediately to the responsible clinician.
- If the neonate develops signs of infection at any time, manage as for neonatal sepsis.
- In neonates receiving antibiotics, the IV site should be checked every time medication is administered.
- If a neonate who is already on prophylactic antibiotics develops signs of infection at any time, treat with a full course of antibiotics for neonatal sepsis (see Chapter 3, Section 3.4.2). Consider transfer to the neonatal unit.

2.5.3 Macrosomia and neonates of diabetic mothers

Macrosomia refers to a birth weight > 4000 g regardless of gestational age and is typical for neonates born to diabetic mothers. Large for gestational age neonates (birth weight > 90th centile for gestational age) are also at risk.

Complications include:
- Hypoglycaemia
- Hypocalcaemia
- Respiratory distress (e.g. transient tachypnoea of the newborn)
- Obstetric trauma (clavicle fracture, brachial plexus injuries)
- Jaundice
- Polycythaemia
Management

These neonates require early assessment and close observation in the maternity ward:

- Examine neonate within 2 hours of birth.
- Check for danger signs including difficulty feeding, hypotonia, tremors or convulsions or abnormal respiratory rate.
- Check for any signs of obstetric trauma and treat pain if present.
- Feed neonate within an hour of birth.
- Monitor for hypoglycaemia. Check BGL within an hour of birth and then before each feed until normal on 3 consecutive occasions (see Section 2.5.1).
2.6 Clinical examination

2.6.1 Neonatal examination

A skilled birth attendant should perform a complete examination as soon as possible and preferably within 2 hours of birth. The examination should be done under a warmer where possible. Record all observations on a monitoring sheet.

Review the details of the pregnancy and note any maternal illness (such as tuberculosis, HIV, syphilis, pre-eclampsia, diabetes, etc.).

Review the details of the delivery (including duration of rupture of membrane, antibiotics received by the mother, appearance of amniotic fluid, type of delivery, need for resuscitation and Apgar score).

Perform a systematic “top to toe” examination (table 2.4). Assess for danger signs, including risk factors for infection and hypoglycaemia. Notify the clinician if any abnormal signs are detected.

Table 2.4 - Neonatal examination

<table>
<thead>
<tr>
<th>Neonatal examination</th>
<th>Abnormal signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vital signs</td>
<td>RR &lt; 30/minute or RR &gt; 60/minute</td>
</tr>
<tr>
<td></td>
<td>HR &lt; 100 bpm or HR &gt; 180 bpm</td>
</tr>
<tr>
<td></td>
<td>Temp &lt; 36 °C or &gt; 37.5 °C</td>
</tr>
<tr>
<td>Weight (naked)</td>
<td>Birth weight &lt; 2500 g or &gt; 4000 g</td>
</tr>
<tr>
<td>Skin</td>
<td>Skin colour and condition</td>
</tr>
<tr>
<td></td>
<td>Pallor</td>
</tr>
<tr>
<td></td>
<td>Central cyanosis</td>
</tr>
<tr>
<td></td>
<td>Jaundice in first 24 hours of life</td>
</tr>
<tr>
<td>Head</td>
<td>Fontanelles</td>
</tr>
<tr>
<td></td>
<td>Mucous membranes</td>
</tr>
<tr>
<td></td>
<td>Oral cavity and palate</td>
</tr>
<tr>
<td></td>
<td>Eyes</td>
</tr>
<tr>
<td></td>
<td>Ears</td>
</tr>
<tr>
<td></td>
<td>Skull injuries (e.g. cephalhaematoma)</td>
</tr>
<tr>
<td></td>
<td>Cleft lip or palate</td>
</tr>
<tr>
<td></td>
<td>Ineffective suck</td>
</tr>
<tr>
<td>Chest</td>
<td>Respiratory effort</td>
</tr>
<tr>
<td></td>
<td>Breath sounds</td>
</tr>
<tr>
<td></td>
<td>Heart sounds</td>
</tr>
<tr>
<td></td>
<td>Tachypnoea, apnoea</td>
</tr>
<tr>
<td></td>
<td>Indrawing, nasal flaring, grunting</td>
</tr>
<tr>
<td></td>
<td>Heart murmur</td>
</tr>
<tr>
<td></td>
<td>Clavicular fracture</td>
</tr>
<tr>
<td>Abdomen/ pelvis</td>
<td>Size, shape and symmetry</td>
</tr>
<tr>
<td></td>
<td>Umbilicus</td>
</tr>
<tr>
<td></td>
<td>Genital organs</td>
</tr>
<tr>
<td></td>
<td>Femoral pulses</td>
</tr>
<tr>
<td></td>
<td>Anus patent</td>
</tr>
<tr>
<td></td>
<td>Abdominal distension</td>
</tr>
<tr>
<td></td>
<td>Abdominal mass</td>
</tr>
<tr>
<td></td>
<td>Omphalitis</td>
</tr>
<tr>
<td></td>
<td>Genito-urinary malformation/ anomalies (hypospadias, hydrocele, testis retention, inguinal hernia)</td>
</tr>
<tr>
<td>Exremities</td>
<td>Upper limbs and hands</td>
</tr>
<tr>
<td></td>
<td>Lower limbs and feet</td>
</tr>
<tr>
<td></td>
<td>Abnormal digits</td>
</tr>
<tr>
<td></td>
<td>Hip dislocation</td>
</tr>
<tr>
<td></td>
<td>Talipes equinovarus (club foot)</td>
</tr>
</tbody>
</table>
**Neonatal examination**

<table>
<thead>
<tr>
<th>Neurology</th>
<th>Abnormal signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spontaneous movements</td>
<td>Lethargy</td>
</tr>
<tr>
<td>Posture</td>
<td>Irritability, jitteriness</td>
</tr>
<tr>
<td>Tone</td>
<td>Floppy</td>
</tr>
<tr>
<td>Spine</td>
<td>Neural tube defects (spina bifida)</td>
</tr>
<tr>
<td>Reflexes (suck, grasp, Moro response to stimulation)</td>
<td>Convulsions Brachial plexus injury</td>
</tr>
</tbody>
</table>

**2.6.2 Common benign and congenital skin conditions**

**Erythema toxicum neonatorum**

This is the most common transient skin rash in neonates. Onset is the second or third day of life, mostly in term neonates. Lesions are characterised by a central whitish to yellowish papule surrounded by a ring of erythema mainly over the trunk, but also on the limbs and face (see Figure A-1 and Figure A-2). Lesions come and go over the following 3 to 7 days. It is a benign, self-limiting condition and no treatment is required, though if there is evidence of superimposed infection or there are any signs of illness, treat as for infection (see Chapter 3, Section 3.4.9).

**Milia**

These consist of tiny white papules and commonly occur on the face and scalp, but can appear anywhere (see Figure A-3). Similar lesions may be seen in the mouth in some neonates (Epstein’s pearls and Bohn’s nodules). They usually resolve within a few months and don’t require treatment.

**Miliaria**

Miliaria results from sweat retention due to high heat and humidity. Various subtypes exist. Miliaria crystallina presents with small vesicles on the scalp, face and trunk without associated erythema (see Figure A-4). Miliaria rubra, also known as heat rash or prickly heat, results from deeper sweat gland obstruction and presents with small erythematous papules and vesicles. No treatment is required but lesions resolve with cooling.

**Transient pustulosis**

Lesions are present at birth and characterised by superficial pustules that rupture easily leaving a spot of hyperpigmentation (see Figure A-5 and Figure A-6). The lesions have no associated erythema. Any area of the body may be involved. The pustules last for a few days, but hyperpigmentation may persist. No intervention is required.

**Neonatal acne**

Neonatal acne may be present at birth or develop over the first 2 to 4 weeks of life. It consists of erythematous pustules mainly over the cheeks, but also other areas of the face and scalp (see Figure A-7). Neonatal acne is benign and resolves spontaneously without scarring.

**Salmon patches (naevus simplex)**

These are midline capillary malformations (often on the forehead, eyelids and nape of neck) seen commonly in the neonatal period (see Figure A-8). They are more common in Caucasian neonates. Most will resolve over the first couple of years of life, but some may persist into adulthood.
Mongolian blue spot (dermal melanocytosis)
This is a common benign bluish skin pigmentation occurring frequently in Polynesian, Asian and Mediterranean neonates. The lumbosacral region and buttocks are the most common sites (see Figure A-9). They gradually fade over the first few years of life.

Vitiligo
Vitiligo is an inherited disorder which causes depigmentation of the skin. Patches of lighter skin appear commonly on the hands, face and feet but can ultimately affect any area of the body (see Figure A-10). It is not a contagious or life-threatening condition, and no treatment is required.

Lamellar ichthyosis (Collodion neonate)
This is an extremely rare, inherited skin condition which presents at birth or in the first few weeks of life. Neonates are born with a tight clear film (collodion membrane) covering their skin (see Figure A-11) which sheds after a few days or weeks. Generalised erythema follows and the skin becomes dry, flaky and scaly (see Figure A-12). Due to increased permeability of the skin, neonates born with this condition are susceptible to heat and fluid loss, and infection. If necessary, grease skin with vaseline or equivalent topical cream. It is a life-long condition with varying severity and management is symptomatic.

Infantile haemangioma (Strawberry naevus)
This benign lesion is the most common vascular tumour in infancy and can occur anywhere on the body, appearing as a red or purplish protruding mass (see Figure A-13, Figure A-14 and Figure A-15). Small or not visible at birth, haemangiomas grow rapidly from 2 weeks until around 3 to 9 months of age before stabilising. Spontaneous regression (involution) occurs in the majority of cases by the age of 3 years old and usually no treatment is required. Rarely, if the lesion is causing functional impairment such as visual or airway obstruction, treatment with the β-blocker propranolol is indicated. There is no place for laser or surgical interventions for infantile haemangiomas unless there is significant ulceration and/or bleeding.
2.7 Routine daily monitoring

All neonates need to be monitored as a routine on a daily basis for the following:
✔ Temperature, heart rate, and respiratory rate two times a day
✔ Cord disinfection on the first day. After that, keep it clean, dry and exposed to air (no dressing).
✔ Breastfeeding support
✔ Monitoring of urine and stool production
✔ Daily weight

Record the observations on the neonate’s monitoring sheet. Some neonates may require increased frequency of monitoring.

Table 2.5 - Normal neonatal vital signs

<table>
<thead>
<tr>
<th>Normal vital signs</th>
<th>Normal values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (axillary)</td>
<td>36 to 37 °C</td>
</tr>
<tr>
<td>Heart rate</td>
<td>100 to 180 bpm</td>
</tr>
<tr>
<td>Respiratory rate</td>
<td>30 to 60 breaths/min</td>
</tr>
</tbody>
</table>

– Neonates without any risk factor and birth weight > 2500 g can be monitored in maternity.
– Neonates with a birth weight between 2000 g and 2500 g may be monitored in maternity if there is the capacity to check BGL to assess for hypoglycaemia (see Section 2.5.1).
## 2.8 Discharge criteria

- No danger signs
- Appropriately assessed and managed for risk factors such as neonatal sepsis and hypoglycaemia
- Healthy neonate: breastfeeding well on demand, normal vital signs
- Weight > 1500 g (pending on context, adapt to > 1750 g or > 1500 g only if > 10 days old and above birth weight)

and

- Preventive treatments given (chlorhexidine digluconate dermal gel, tetracycline eye ointment and vitamin K)
- Vaccinations given (BCG, hepatitis B and polio (0))
- Clinical record completed (including discharge weight)

and

### Information for the mother

- Breastfeeding
- Newborn care:
  - Wash newborn with soap and water once a day and immediately dry with a towel or cloth to avoid hypothermia.
  - Cord care: clean with soap and water each time it is soiled, rinse well, dry and leave it uncovered. Do not apply antiseptic or any other product or dressing to the cord. The cord will fall off between 5 to 15 days after birth.
  - Kangaroo mother care (KMC) if weight < 2500 g.
  - Lay newborn on his/her back.
  - Use a mosquito net day and night when the newborn sleeps.
  - Keep the newborn away from sick (contagious) children and adults.
  - Wash hands before and after caring for the newborn.
  - Dispose of stool in the latrine.
- Danger signs requiring consultation:
  - Inability to breastfeed normally
  - Abnormal movements
  - Reduced activity
  - Difficulty breathing
  - Abnormal colour
  - Redness or discharge from umbilicus
  - Fever or hypothermia
  - Vomiting
  - Abdominal distension
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Care of the sick neonate

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3.1 Emergency management

3.1.1 Danger signs

Neonates often present with non-specific signs that can indicate severe illness. These signs may be present at the time of delivery or may develop after birth. All neonates should be routinely examined for danger signs at birth or on arrival if coming from outside the hospital and during their hospital stay. The following signs indicate severe illness and require immediate intervention and transfer to a neonatal unit:

Table 3.1 - Danger signs in neonates

<table>
<thead>
<tr>
<th>Dangerous signs</th>
<th>Details</th>
</tr>
</thead>
</table>
| Temperature     | > 38 °C (hyperthermia)  
< 35.5 °C (hypothermia) |
| Neurological signs | Bulging fontanelle  
Hypotonia  
Drowsy or unconscious  
Unable to breastfeed  
Seizures (including subtle* or abnormal movements) |
| Respiration     | Apnoea or bradypnoea (RR < 30/minute)  
Tachypnoea (RR > 60/minute)  
Severe chest indrawing  
Grunting respirations |
| Cardiovascular  | Tachycardia (HR > 180/minute)  
Prolonged capillary refill time (> 2 seconds) |
| Abdomen         | Severe abdominal distension |
| Skin colour     | Generalised cyanosis (blue colouring)  
Extreme pallor  
Jaundice (yellow colouring) |
| Skin            | Umbilicus red or oozing blood or pus  
Numerous or large pustules |
| Joints          | Swollen, painful joint (irritability when moved) with reduced joint movement |
| Blood glucose   | Recurrent hypoglycaemia (BGL < 45 mg/dL or < 2.5 mmol/L on more than 2 episodes) |

* Subtle movements: sucking or chewing, blinking or disorganised eye movements, disordered arm or leg movements (pedalling)

RR = respiratory rate
HR = heart rate
BGL = blood glucose level
Management

Emergency management of danger signs

– Call for help.
– Airway: maintain head and neck in neutral position to keep airway patent.
– Breathing: commence oxygen via nasal prongs and monitor oxygen saturations (aim 90-95%). Use bag and mask ventilation if neonate apnoeic or RR < 20/minute.
– Circulation: establish intravenous (IV) access and assess for signs of shock or poor perfusion. If IV insertion difficult, do not delay to proceed to intra-osseous insertion.

If signs of shock or poor perfusion present:
• Administer IV bolus of 0.9% sodium chloride or Ringer lactate 10 mL/kg over 20 minutes.
• Re-evaluate and repeat IV bolus after 20 to 30 minutes if necessary (maximum 3 boluses total)\(^a\).

Check BGL:
• If BGL < 45 mg/dL or < 2.5 mmol/L, administer by slow IV 2 mL/kg of 10% glucose.
• Where blood glucose cannot be measured quickly, assume hypoglycaemia if clinical signs such as jitteriness present. Administer by slow IV 2 mL/kg of 10% glucose.
• If unable to insert an IV line, give expressed breast milk or 10% glucose through an oro/nasogastric tube (O/NGT).

– If convulsing, anticonvulsant therapy may be needed (see Section 3.1.3).

– Insert O/NGT:
  • If there is abdominal distension, aspirate contents and leave open to drain.
  • If there is respiratory distress, leave in place for feeding (if appropriate).

Throughout initial emergency management, try to determine the underlying cause.

Indications for admission to a neonatal unit, whether the neonate was born in a health facility or at home, include:
– Presence of any danger signs
– Apgar score ≤ 4 at 1 minute or ≤ 6 at 5 minutes, or any neonate requiring > 2 minutes bag mask ventilation at birth, even if stabilised and in good condition.
– Low birth weight (LBW) neonates weighing < 2000 g.

Where possible, try to keep the mother and neonate together.

3.1.2 Neonatal shock

Shock is a complex and critical condition of impaired circulatory function with reduced oxygen and nutrient delivery to peripheral systems and ultimately central organs.

Clinical features

– Cardiovascular signs:
  • Poor perfusion: cold peripheries, capillary refill time (CRT) > 3 seconds
  • Weak pulses (femoral or brachial)
  • Tachycardia
  • Bradycardia (if advanced shock or asphyxia)
– Effects of poor perfusion/hypotension on other organ systems:
  • Lethargy, coma
  • Decreased urine output
– In septic shock, peripheries may stay warm due to vasodilation\(^1\).

\(^a\) In the case of suspected cardiogenic shock or hypoxic ischaemic encephalopathy (HIE), assess carefully prior to repeating fluid boluses.
In early shock, compensatory regional vasoconstriction may temporarily maintain normal blood pressure and adequate flow to vital organs. As shock progresses, compensatory mechanisms fail and widespread cellular damage occurs. If shock persists, irreversible damage to vital organs occurs, leading to death.

Classification of the type of shock is the same as for shock in adults and children, but some underlying causes and clinical features are more unique to the neonatal period. Conditions or risk factors that can lead to neonatal shock include foeto-maternal haemorrhage, vasa praevia\(^b\), cord accidents, perinatal asphyxia, acute bleeding, LBW/preterm neonate, chorioamnionitis, severe sepsis and high fluid losses (see Table 3.2 for more details).

**Management**

This section describes initial management of any type of shock to stabilise the neonate, during which the underlying cause should be identified and then addressed where possible. Only with advanced resources can management of neonatal shock be specified to the type of shock.

Recognise and manage shock early, once secondary complications develop, it is very difficult to treat.

- **Airway**: maintain head and neck in neutral position to keep airway patent.
- **Breathing**: commence oxygen via nasal prongs and monitor oxygen saturations (aim 90-95%). Use bag and mask ventilation if neonate apnoeic or RR < 20/minute.
- **Circulation**: establish IV access (if IV insertion difficult, do not delay to proceed to intra-osseous insertion)
  - Administer IV bolus of 0.9% sodium chloride or Ringer lactate 10 mL/kg over 20 minutes.
  - Re-evaluate and repeat IV bolus after 20 to 30 minutes if necessary (maximum 3 boluses total)\(^c\).
  - Check haemoglobin (Hb) level if ≥ 2 fluid boluses are given.
- **Check BGL**:
  - If BGL < 45 mg/dL or < 2.5 mmol/L, administer by slow IV 2 mL/kg of 10% glucose.
- **Insert O/NG T**: empty the stomach and keep neonate “nil by mouth”.
- As it is clinically difficult to differentiate the underlying cause of shock, all neonates with signs of shock should receive antibiotic therapy. First line combination treatment is **ampicillin** slow IV (3 minutes) for 7 to 10 days + **gentamicin** slow IV (3 minutes) or IM for 5 days:

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Weight</th>
<th>Ampicillin Treatment</th>
<th>Gentamicin Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 7 days</td>
<td>&lt; 2 kg</td>
<td>ampicillin IV 50 mg/kg every 12 hours + gentamicin IV 3 mg/kg every 24 hours</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥ 2 kg</td>
<td>ampicillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours</td>
<td></td>
</tr>
<tr>
<td>8 days to &lt; 1 month</td>
<td></td>
<td>ampicillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours</td>
<td></td>
</tr>
</tbody>
</table>

- Take a history including maternal factors (history, underlying conditions e.g. HIV status), perform a full clinical examination and investigations, to try to identify and manage the underlying cause of shock (see Table 3.2).
- See Section 3.4.2 for alternative antibiotic therapy according to clinical indication of underlying cause of septic shock. An alternative to ampicillin is **benzylpenicillin** combined with **gentamicin**. Where there is strong evidence for staphylococcal infection (skin pustules, skin cellulitis, abscess), first line treatment is **vancomycin**.

---

\(^b\) Vasa praevia is a condition where foetal blood vessels cross or run near the internal opening of the uterus. These vessels are at risk of rupture when the membranes rupture, as they are unsupported by the umbilical cord or placenta.

\(^c\) In the case of suspected cardiogenic shock or HIE, assess carefully prior to repeating fluid boluses.
cellulitis, umbilical cord infection, pneumatocoeles or empyema) substitute ampicillin with cloxacillin (see Appendix 5 for drug doses).

- For neonates suspected of meningitis, see Section 3.3.2.
- Consider malaria in endemic areas, see Section 3.4.6.

Investigations

- BGL and Hb level
- Malaria tests in malaria-endemic areas
- Chest x-ray
- Lumbar puncture (LP): consider in any sick neonate, even if classic meningitis features are not present. Note: LP can still be done up to 48 hours after starting antibiotics or neonates presenting at > 72 hours of life.
- Perform a septic screen: blood culture, full blood examination (FBE), C-reactive protein (CRP) (where available).
- If available, consider cardiac echography.

<table>
<thead>
<tr>
<th>Type of shock</th>
<th>Aetiology</th>
<th>Specific management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypovolaemic (critical decrease in intravascular volume)</td>
<td>Severe dehydration Blood loss Foeto-maternal haemorrhage</td>
<td>Stop any bleeding if visible blood loss. Consider blood transfusion if blood loss evident. See Appendix 4.</td>
</tr>
<tr>
<td>Distributive (inadequate intravascular volume caused by excessive vasodilation and impaired distribution of blood flow)</td>
<td>Sepsis</td>
<td>Administer IV antibiotics. Consider additional fluids: severe sepsis may require 40 to 60 mL/kg to establish adequate circulating volume.</td>
</tr>
<tr>
<td>Cardiogenic (reduced cardiac output due to a primary cardiac disorder)</td>
<td>Cardiomyopathy Congenital malformation Hypoxic-ischaemic injury Arrhythmia</td>
<td>In cardiogenic shock, be cautious with additional fluid boluses after the first bolus.</td>
</tr>
<tr>
<td>Obstructive (mechanical factors that interfere with the emptying or filling of the heart)</td>
<td>Cardiac tamponade Tension pneumothorax</td>
<td>Consider surgical emergency management if an experienced clinician is present.</td>
</tr>
</tbody>
</table>

Monitoring

Neonates with signs of shock, if not already, should be admitted to the neonatal unit as soon as they are stabilised. They require intensive monitoring and measurement of vital signs:
- RR, breathing pattern
- Oxygen saturation (aim to keep SpO2 90-95%)
- Heart rate and pulse intensity, CRT
- Temperature, skin temperature of hands/feet
- Neurological status
- Monitor BGL and Hb levels as necessary.

Note: administration of high fluid volumes without the possibility to provide intensive care can worsen the clinical condition. Only give more than 2 fluid boluses in settings where advanced respiratory and inotropic support are available.
**Emergency phase**
During the acute phase when the neonate is being stabilised with volume replacement, vital signs should be recorded every 15 minutes.

**Post-emergency phase**
After stabilisation, there is a risk of recurrence or deterioration over the ensuing 24 to 48 hours and neonates require careful observation. Vital signs should be taken every hour, at least for the first 6 hours. Ensure integration of care with the parents/caregivers.

**Recovery phase**
Once the neonate has stabilised and feeding commences they should have routine observations.

### 3.1.3 Seizures
Seizures are involuntary movements accompanied by a loss of consciousness, as a result of paroxysmal alterations (abnormal electrical discharges) in the brain. Seizures occur most commonly in the neonatal period, particularly in the first week of life. They are rarely idiopathic and usually represent significant neurological disease.

Seizures in neonates are usually subtle, featured as any unusual repetitive or stereotypic movement, including:
- Deviation of the eyes with or without jerking
- Eyelid blinking or fluttering
- Sucking, smacking or other mouth movements
- Swimming or pedalling movements
- Occasionally apnoeic spells

**Table 3.3 - Outline of clinical manifestations of neonatal seizures**

<table>
<thead>
<tr>
<th>Type</th>
<th>Clinical manifestation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subtle</strong></td>
<td>Eye: staring, deviation, blinking&lt;br&gt;Oral: chewing, sucking, lip smacking&lt;br&gt;Limbs: cycling, swimming, rowing&lt;br&gt;Systemic: apnoea, tachycardia, blood pressure alterations</td>
</tr>
<tr>
<td><strong>Clonic</strong></td>
<td>Usually involve one limb or one side of the body jerking rhythmically at 1 to 4 times per second.&lt;br&gt;Consciousness usually preserved.</td>
</tr>
<tr>
<td><strong>Myoclonic</strong></td>
<td>Rapid isolated jerking of muscles.&lt;br&gt;May be focal or multifocal.</td>
</tr>
<tr>
<td><strong>Tonic</strong></td>
<td>Sustained posturing of the limbs or trunk or deviation of the head. It may mimic decerebrate or decorticate posturing.&lt;br&gt;Focal or generalised.</td>
</tr>
</tbody>
</table>

Differential diagnoses important to distinguish from neonatal seizures are:
- Jitteriness: symmetrical, fine, rapid movements of the hands and feet that stop when limb is held. There are no associated eye movements.
- Benign sleep myoclonus: unilateral or bilateral jerking during active sleep.

The priority is to manage the seizures and determine the cause.

---

* Neonates have a central nervous system that is vulnerable to seizure activity, and as a result have a relatively high incidence of seizures.*
Investigations

- BGL
- LP when clinically stable
- Tests for malaria in malaria-endemic areas

Where available:
- Check electrolytes (especially sodium, calcium and magnesium levels).
- Septic screen: blood culture, FBE, CRP
- Electroencephalography (EEG), cranial ultrasound scan

Management

During a seizure

- Airway: maintain head and neck in neutral position to keep airway patent.
- Breathing: commence oxygen via nasal prongs and monitor oxygen saturations (aim 90-95%). Use bag and mask ventilation if neonate apnoeic or RR < 20/minute.
- Circulation: establish IV access and assess for signs of shock.
  
  If signs of shock present:
  - Administer IV bolus of 0.9% sodium chloride or Ringer lactate 10 mL/kg over 20 minutes.
  - Re-evaluate and repeat IV bolus after 20 to 30 minutes if necessary (maximum 3 boluses total).
- Check BGL:
  - If BGL < 45 mg/dL or < 2.5 mmol/L, administer by slow IV 2 mL/kg of 10% glucose.
- Correct metabolic disturbances (hypocalcaemia) as necessary (with cardiac monitoring).

Anticonvulsant therapy

- Most seizures are self-limiting but the use of anticonvulsants may be indicated.
- Indications for the use of anticonvulsants include:
  - Seizure duration > 3 minutes, or
  - Seizure recurrence of > 2 to 3 episodes/hour, or
  - Associated cardiorespiratory disturbance.
- First line treatment is with IV phenobarbital:

<table>
<thead>
<tr>
<th>phenobarbital</th>
</tr>
</thead>
<tbody>
<tr>
<td>First dose: 20 mg/kg by slow IV infusion (diluted) over 20 to 30 minutes</td>
</tr>
<tr>
<td>May be given IM (undiluted) if there is no IV access.</td>
</tr>
<tr>
<td>A repeat dose of 10 mg/kg may be administered 15 to 30 minutes after the first dose (if administered by IV infusion) or 60 minutes after the first dose (if administered by IM injection). Maximum total loading dose = 40 mg/kg.</td>
</tr>
</tbody>
</table>

- If neonatal status epilepticus, defined as seizure persisting after 30 minutes or recurrent seizures lasting a total of > 30 minutes without regaining baseline neurologic status between seizures, despite maximum phenobarbital, give IV phenytoin as 2nd line:

| phenytoin IV: 20 mg/kg slow infusion over 20 to 30 minutes |
| Note: never give phenytoin through IM route. |

Caution: Anticonvulsants can cause respiratory depression and apnoea. Patients must be admitted to a neonatal unit with careful monitoring. Cardiac monitoring is recommended, if available. A bag and mask must be kept at the patient’s bedside.

f If phenobarbital is not available, replace first line with levetiracetam IV: 40 mg/kg slow IV over 10 mins. If seizures persist after another 5 mins, repeat with levetiracetam IV: 20 mg/kg slow IV over 10 mins, then phenytoin as 2nd line if needed. If phenytoin is not available, give phenobarbital as first line but levetiracetam as 2nd line. If both phenobarbital and phenytoin are not available, give levetiracetam as first line then midazolam as 2nd line. Refer to Paediatric seizure algorithms “Interim during ruptures” by Paediatric Working Group.
**Maintenance management**

If seizures persist for longer than 30 minutes or recur within 2 days, commence maintenance treatment:

<table>
<thead>
<tr>
<th>phenobarbital</th>
<th>PO (or IV): 5 mg/kg once daily (slow injection if IV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note:</td>
<td>start 12 hours after last loading dose of phenobarbital or phenytoin</td>
</tr>
</tbody>
</table>

In neonates with normal neurological examination and/or normal EEG, consider stopping oral phenobarbital if neonate has been seizure-free for > 72 hours. Phenobarbital should be reinstituted in case of recurrence of seizures.

If seizures persist despite all above measures, consider treating with a single dose of pyridoxine for possible pyridoxine (vitamin B₆) deficiency². Consider this particularly for any neonate with seizures where the mother is on isoniazid therapy.

<table>
<thead>
<tr>
<th>pyridoxine (vitamin B₆)</th>
<th>IV or IM: 100 mg single dose (PO or via NGT if IV or IM not possible)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note:</td>
<td>pyridoxine can cause excessive sedation effects in neonates. Ensure resuscitation equipment is available.</td>
</tr>
</tbody>
</table>

Further management depends on the specific management of the underlying cause. See relevant chapters.

**Determine the cause of the seizures where possible**

Neonatal seizures may be caused by:
- Perinatal asphyxia/HIE: usually occurs in the first 12 to 48 hours of life (see Section 3.3.1)
- Metabolic disturbances including hypoglycaemia (see Section 3.1.4) and hypocalcaemia
- Infections: sepsis, meningitis, encephalitis, congenital malaria, tetanus (see Section 3.3 and Section 3.4)
- Cerebral trauma or infarction
- Intoxication (e.g. drugs, traditional medicines)
- Narcotic drug withdrawal (neonatal abstinence syndrome)
- Structural brain lesions (rare)

### 3.1.4 Hypoglycaemia

Hypoglycaemia is a decreased level of glucose in the blood (< 45 mg/dL or < 2.5 mmol/L) and is a common problem in neonates. Recurrent or persistent hypoglycaemia can lead to neurological sequelae.

Neonates with hypoglycaemia are often asymptomatic or manifest with non-specific signs such as lethargy, pallor, hypotonia, poor feeding, irritability, jitteriness, temperature instability, sweating, apnoea, cyanosis or seizures.

Neonates with risk factors for hypoglycaemia should be screened immediately by measuring BGL (see Table 3.4).

**Table 3.4 - Risk factors indicative of BGL screening**

<table>
<thead>
<tr>
<th>Birth factors</th>
<th>Neonatal factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preterm</td>
<td>Hypothermia</td>
</tr>
<tr>
<td>LBW (&lt; 2500 g)</td>
<td>Illness (e.g. asphyxia, sepsis, respiratory distress)</td>
</tr>
<tr>
<td>Macrosomia or maternal gestational diabetes</td>
<td>“Nil by mouth”</td>
</tr>
<tr>
<td>Maternal drug therapy with labetalol or propranolol</td>
<td>Change of feeding method</td>
</tr>
</tbody>
</table>
Management
- Treat underlying cause (e.g. hypothermia, sepsis, respiratory distress).
- Avoid hypothermia.
- Treat hypoglycaemia according to BGL.

Asymptomatic moderate hypoglycaemia (BGL 35 to 45 mg/dL or 2 to 2.5 mmol/L)
- Enteral feeding, preferably breast milk.
- If unable to feed with breast milk, give 5 mL/kg of 10% glucose solution orally or via O/NGT.

Symptomatic, recurrent or severe hypoglycaemia (< 35 mg/dL or < 2 mmol/L)
- This is an emergency and requires urgent IV treatment of 2 mL/kg of 10% glucose as a single dose.
- If recurrent, administer a second IV bolus of 2 mL/kg of 10% glucose.
- Commence an infusion of 10% glucose at 4 to 6 mg/kg/minute (or 60 to 80 mL/kg/day of 10% glucose) for at least 24 hours. This minimises the risk of rebound hypoglycaemia. If IV access is not possible, give 5 mL/kg of 10% glucose via O/NGT (may be repeated if still hypoglycaemic after 30 minutes).
- If hypoglycaemia persists despite continuous infusion of 10% glucose, administer further IV bolus of 2 ml/kg of 10% glucose for each hypoglycaemic episode and increase the volume or concentration of the glucose infusion (maximum 12.5% glucose).
- Severe hypoglycaemia can recur if the infusion is ceased abruptly. When BGL has been stable for 12 to 24 hours, wean the infusion by 20 mL/kg/day every 6 hours.

Sublingual 50% glucose (1 mL/kg) is only recommended if it is impossible to administer 10% glucose via an IV or O/NGT.

Monitoring
- Check BGL every 30 minutes until normalised.
- Check BGL 20 minutes after decreasing or ceasing a glucose infusion.
- Once stabilised, check BGL every 2 to 4 hours before feeds until normal on three consecutive occasions.

Prevention
- Initiation of skin-to-skin contact to avoid hypothermia and early breastfeeding (within 1 to 2 hours) after birth.
- Screening of symptomatic neonates and asymptomatic neonates at risk.

Hyperglycaemia
- Defined as BGL > 125 mg/dL or > 6.9 mmol/L.
- Most common in very low birth weight (VLBW) neonates receiving IV glucose.
- Impact is unclear but prolonged, severe hyperglycaemia has been associated with increased morbidity and mortality.
- Risk factors include prematurity, VLBW, neonatal illness (sepsis, perinatal asphyxia), IV infusions, drugs (e.g. caffeine, corticosteroids, phenytoin).
- Usually neonate is asymptomatic. At very high levels there may be glycosuria with osmotic diuresis with loss of weight and dehydration. If BGL > 180 mg/dL or > 10 mmol/L, do urine dipstick for glycosuria.

Management if BGL is > 180 to 200 mg/dL or > 10 to 11.1 mmol/L
- Look for and treat underlying cause (e.g. antibiotics for neonatal sepsis).
- Reduce the IV glucose concentration from 10% to 5%. Do not use a concentration less than 5%. Never stop the fluids in neonates who are not on enteral feeds.
– Switch to enteral feeding as soon as possible.
– Use of insulin is potentially fatal and is not feasible in settings with limited monitoring.
– Check BGL every 3 to 4 hours until levels normalise, then once daily until IV fluids stopped.

### 3.1.5 Cyanosis

Cyanosis is characterised by the blue discolouration of skin and mucous membranes, caused by increased levels of reduced haemoglobin. Central cyanosis indicates the presence of potentially life threatening disease and requires urgent assessment and management. Cyanosis that is limited to the extremities is termed acrocyanosis and is common in neonates.

Underlying causes include:
– Respiratory diseases (respiratory distress syndrome, pneumonia, meconium aspiration syndrome)
– Some congenital cardiac malformations
– Upper airways obstruction
– Persistent pulmonary hypertension of the newborn
– Severe congestive heart failure
– Sepsis
– Polycythemia
– Asphyxia
– Metabolic conditions (hypoglycaemia)

**Investigations**

– BGL and Hb levels
Where available:
– Chest x-ray and electrocardiogram (ECG)
– Septic screen: blood culture, FBE, CRP
– Blood gas analysis
– Cardiac echography for persistent cyanosis: to look for underlying congenital cardiac malformations or elevated pulmonary pressures (persistent pulmonary hypertension of the neonate).

**Management**

Definitive management is treatment of the underlying cause.

**Emergency management**

– Airway: maintain head and neck in neutral position to keep airway patent.
– Breathing: commence oxygen via nasal prongs and monitor oxygen saturations (aim 90-95%). Use bag and mask ventilation if neonate apnoeic or RR < 20/minute.
– Circulation: establish IV access and assess for signs of shock.
  
  If signs of shock present:
• Administer IV bolus of 0.9% sodium chloride or Ringer lactate 10 mL/kg over 20 minutes.
• Re-evaluate and repeat IV bolus after 20 to 30 minutes if necessary (maximum 3 boluses total)\(^h\).
• Check Hb level after ≥ 2 fluid boluses.
– Check BGL:
• If BGL < 45 mg/dL or < 2.5 mmol/L, administer by slow IV 2 mL/kg of 10% glucose.

---

\(^g\) Tetralogy of Fallot, transposition of the great arteries, total anomalous pulmonary venous return, tricuspid atresia, truncus arteriosus.

\(^h\) In the case of suspected cardiogenic shock or HIE, assess carefully prior to repeating fluid boluses. High fluid volumes without advanced support can worsen the clinical condition. Only give more than 2 fluid boluses in settings where respiratory and inotropic support is available.
Antibiotic therapy

- If central cyanosis is present, give empirical antibiotics as the underlying cause is difficult to differentiate clinically. First line combination treatment is **ampicillin** slow IV (3 minutes) for 7 to 10 days + **gentamicin** slow IV (3 minutes) or IM for 5 days:

| 0 to 7 days | < 2 kg | ampicillin IV 50 mg/kg every 12 hours + gentamicin IV 3 mg/kg every 24 hours |
| 8 days to < 1 month | ≥ 2 kg | ampicillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours |

If there are signs of respiratory distress, provide support in feeding and fluid intake.

Approach to determine the underlying cause of cyanosis

- Check vital signs for respiratory distress and signs of sepsis.
- Assess right hand against left side or right foot oxygen saturations for a ductal difference that might be a clue to an underlying cardiac cause.
- Check blood pressure if possible.
- Check peripheral pulses and listen for heart murmurs (a heart murmur associated with cyanosis is strongly suggestive of cardiac disease).
- Assess perfusion (CRT, warmth of extremities).
- Perform a hyperoxia test to help differentiate between respiratory and cardiac causes of cyanosis. Give 100% oxygen for 10 minutes. In general, oxygenation will improve with respiratory problems but may not change significantly with some cyanotic cardiac lesions.

3.1.6 Apnoea

Apnoea is defined as no effective respiratory effort for 20 seconds, or shorter if associated with bradycardia (< 100 bpm), cyanosis or pallor. Apnoea may be classified as:

- Central apnoea: pause of ventilation due to immature central nervous system. There is complete cessation of both chest movement and airflow.
- Obstructive apnoea: a pause of ventilation due to obstruction in the upper airway. There may or may not be respiratory effort but there is no airflow.
- Mixed: a combination of central and obstructive apnoea.

Apnoea may result from severe respiratory disease due to impending respiratory failure, but more often is caused by underlying non-pulmonary conditions:

- Anatomical anomalies of the upper airway
- Temperature disturbance (hypothermia or hyperthermia)
- Metabolic causes, especially hypoglycaemia
- Infection, especially sepsis, bronchiolitis and necrotising enterocolitis (NEC)
- Gastro-oesophageal reflux
- Anaemia
- Cardiac causes: cardiac failure, patent ductus arteriosus
- CNS: intra-ventricular haemorrhage, seizures and perinatal asphyxia
- Drugs
- Apnoea of prematurity: preterm neonates < 34 weeks gestation (or < 1500 g)

Periodic breathing, which are respiratory pauses < 20 seconds, are common in neonates and is not apnoea.
Investigations
- Check BGL and Hb levels.
- Septic screen: blood culture, FBE and CRP (where available)
- Further investigations may be necessary depending on suspected cause.

Management

Acute management during an apnoea episode
- Airway: maintain head and neck in neutral position to keep airway patent.
- Tactile stimulation: gentle rubbing of the soles of the feet or chest wall may be all that is required for mild, intermittent episodes.
- Breathing: commence oxygen via nasal prongs and monitor oxygen saturations (aim 90-95%). Use bag and mask ventilation if neonate remains apnoeic or RR < 20/minute.
- Treatment with non-invasive ventilation (e.g. CPAP) may be indicated.

Definitive management is treatment of underlying cause.

Antibiotic therapy
- Indication: recurrent apnoea or any signs of infection (such as temperature instability, poor perfusion or seizures).
- First line combination treatment is ampicillin slow IV (3 minutes) for 7 to 10 days + gentamicin slow IV (3 minutes) or IM for 5 days:

<table>
<thead>
<tr>
<th></th>
<th>&lt; 2 kg</th>
<th>≥ 2 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 7 days</td>
<td>ampicillin IV 50 mg/kg every 12 hours + gentamicin IV 3 mg/kg every 24 hours</td>
<td>ampicillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours</td>
</tr>
<tr>
<td>8 days to &lt; 1 month</td>
<td>ampicillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours</td>
<td></td>
</tr>
</tbody>
</table>

Feeding
- At first presentation keep “nil by mouth” as neonates are at risk of further apnoea requiring bag mask ventilation.
- Commence IV fluids: restrict fluid to 2/3 maintenance volume.
- Once stable and serious underlying disorders have been excluded, feeding can be recommenced.
- Caffeine is only recommended for apnoea occurring in preterm neonates < 34 weeks gestational age or weight < 1500 g (see Chapter 5, Section 5.4.2).

Supportive measures
- Monitor BGL every 2 to 3 hours while on IV fluids.
- Keep in a high visibility area, and if available, use continuous monitoring.
- Keep neonate warm and dry: hypo- and hyperthermia should be avoided as they can exacerbate respiratory distress.
- Practice “minimal handling” to avoid upsetting the neonate. Try to attend to cares at the same time (e.g. nappy change after vital signs).

i CPAP = continuous positive airway pressure
3.2 Respiratory problems

3.2.1 Introduction

Breathing difficulties, or respiratory distress, is the most common reason for neonatal admission. In the first hours and days after birth, neonates need to physiologically adapt from in-utero foetal life to the extra-uterine environment. In the lungs, the transition from fluid-filled foetal lungs to air-filled airways down to the alveolar level happens with the first gasp the neonate takes immediately after birth. As gas-exchange starts, foetal fluid in the lungs needs to be reabsorbed and pulmonary vascular pressure decreased to increase blood flow to the lungs.

Difficulties with this transition to extra-uterine life makes neonates particularly vulnerable to respiratory problems as seen in transient tachynoea of newborn. In preterm neonates, the transition needs to occur in immature lungs, increasing the risk of respiratory distress. The very preterm have immature lungs with inadequate development of the alveoli and surfactant deficiency, resulting in respiratory distress syndrome.

Respiratory distress may also be acquired during delivery (meconium aspiration, congenital pneumonia), or acquired as a post-natal infection (pneumonia, bronchiolitis). Congenital anomalies that in-utero may have not affected the foetus can cause respiratory distress and/or cyanosis.

Extra-pulmonary conditions can also present with respiratory distress or other respiratory signs such as cyanosis or apnoea:

| Neurologic | Apnoea due to lack of respiratory effort: perinatal asphyxia, apnoea of prematurity, HIE |
|            | Intraventricular haemorrhage |
|            | Seizures |
| Anatomic   | Congenital heart disease |
|            | Upper airways obstruction |
|            | Diaphragmatic hernia |
|            | Gastro-oesophageal reflux |
| Metabolic  | Hypoglycaemia |
|            | Drugs |
| Infective  | Sepsis, NEC |
| Other      | Hypothermia, hyperthermia, anaemia |

Respiratory distress, cyanosis or apnoea require prompt assessment to determine the underlying cause and appropriate management to ensure a good outcome for the neonate. Respiratory distress may be transient, but around 10% of neonates with respiratory distress will need resuscitative efforts at birth.

This sub-chapter will cover the management of the pulmonary causes of respiratory problems.
Clinical presentation and features

Signs of respiratory distress:

- Tachypnoea (RR > 60/minute)
- Chest indrawing
- Nasal flaring
- Grunting
- Cyanosis
- Irregular breathing
- Apnoea

Table 3.5 - Assessment of severity of respiratory distress

<table>
<thead>
<tr>
<th></th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Oxygen</strong></td>
<td>Mild hypoxia, SpO₂ 90 to 93%</td>
<td>Hypoxia, SpO₂ 85 to 90%</td>
<td>Severe hypoxia, SpO₂ &lt; 85%</td>
</tr>
<tr>
<td><strong>Chest wall indrawing</strong></td>
<td>None or minimal</td>
<td>Moderate</td>
<td>Marked with tracheal tug</td>
</tr>
<tr>
<td><strong>Respiratory sounds</strong></td>
<td>None or minimal</td>
<td>Intermittent grunting +/- nasal flaring</td>
<td>Grunting with every breath and nasal flaring</td>
</tr>
<tr>
<td><strong>Ability to feed</strong></td>
<td>Normal</td>
<td>Reduced</td>
<td>Unable to feed</td>
</tr>
</tbody>
</table>

Management

Definitive management is treatment of the underlying cause.
- Airway: maintain head and neck in neutral position to keep airway patent.
- Breathing: commence oxygen via nasal prongs and monitor oxygen saturations (aim 90-95%). Use bag and mask ventilation if neonate apnoeic or RR < 20/minute.
- Administer non-invasive ventilation e.g. CPAP for moderate and severe respiratory distress (see Table 3.5), where available.

Supportive measures

- Support feeding, if necessary, via oral or nasogastric tube feeding. If severe respiratory distress, avoid enteral feeding and commence IV fluids (restrict total fluid volume to 2/3 maintenance fluids). Keep nil-by-mouth for first 24 hours then reassess.
- Monitor BGL while on IV fluids.
- Keep in a high visibility area, and if available, use continuous monitoring.
- Keep neonate warm and dry: hypo- and hyperthermia should be avoided as they can exacerbate respiratory distress.
- Practice “minimal handling” to avoid upsetting the neonate. Try to attend to cares at the same time (e.g. nappy change after vital signs).
3.2.2 Transient tachypnoea of the newborn

Transient tachypnoea of the newborn (TTN) is respiratory distress due to failure of reabsorption, or delayed clearance of foetal pulmonary fluid. It affects 1 to 2% of neonates and is mainly seen in full term neonates. TTN is a benign, self-limiting condition in itself, but must be differentiated from more serious causes of respiratory distress, especially infection.

Risk factors include: birth by caesarean section (3 times more common than normal delivery), large for gestational age, maternal diabetes, maternal asthma.

Clinical features

Tachypnoea (RR > 60/minute) and signs of respiratory distress. Presents usually in the first hours of life, lasting from few hours to 2 days.

Investigations

Chest x-ray: bilateral perihilar linear streaking may be visible due to engorged lymphatic or blood vessels. Patchy infiltrates due to fluid retention may be seen in first 24 to 48 hours which resolve.

Management

Observe and monitor the severity of distress:

– Airway: maintain head and neck in neutral position to keep airway patent.
– Breathing: commence oxygen via nasal prongs and monitor oxygen saturations (aim 90-95%). Use bag and mask ventilation if neonate apnoeic or RR < 20/minute.
– Administer non-invasive ventilation e.g. CPAP for moderate and severe respiratory distress, where available.

Antibiotic therapy

– Indicated if there is no improvement after 6 hours or the neonate deteriorates.
– First line combination treatment is ampicillin slow IV (3 minutes) for 7 to 10 days + gentamicin slow IV (3 minutes) or IM for 5 days:

<table>
<thead>
<tr>
<th>Age</th>
<th>Weight</th>
<th>Antibiotics</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 7 days</td>
<td>&lt; 2 kg</td>
<td>ampicillin IV 50 mg/kg every 12 hours + gentamicin IV 3 mg/kg every 24 hours</td>
</tr>
<tr>
<td></td>
<td>≥ 2 kg</td>
<td>ampicillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours</td>
</tr>
<tr>
<td>8 days to &lt; 1 month</td>
<td>ampicillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours</td>
<td></td>
</tr>
</tbody>
</table>

Supportive measures

– Support feeding, if necessary, via oral or nasogastric tube feeding. If severe respiratory distress, avoid enteral feeding and start IV fluids (restrict total fluid volume to 2/3 maintenance fluids). Keep nil-by-mouth for first 24 hours then reassess.
– Monitor BGL every 3 to 4 hours while on IV fluids.
– Keep in a high visibility area, and if available, use continuous monitoring.
– Keep neonate warm and dry: hypo- and hyperthermia should be avoided as they can exacerbate respiratory distress.
– Practice “minimal handling” to avoid upsetting the neonate. Try to attend to cares at the same time (e.g. nappy change after vital signs).
3.2.3 Respiratory distress syndrome

Respiratory distress syndrome (RDS) (also known as hyaline membrane disease) occurs predominantly in preterm neonates and is due to alveolar immaturity and surfactant deficiency at birth. Risk increases with degree of prematurity.

Clinical features

– Signs of respiratory distress (tachypnoea, chest wall in drawing) and cyanosis usually manifests shortly after birth and progressively worsens over 48 hours.
– Typically grunting and nasal flaring are present.
– Tachypnoea can be sustained for hours or days before progressing to respiratory failure. This may be signalled by apnoea, increasing oxygen requirement or increasing respiratory effort.
– Sudden deterioration may be caused by pneumothorax, failure of oxygen supply, or increase in disease severity.

Investigations

– Perform a septic screen: blood culture, FBE, CRP (where available)
– Chest X-ray: typical findings are a diffuse, reticulogranular, ground glass appearance with air bronchograms and low lung volume.

Management

Observe and monitor severity of distress:
– Airway: maintain head and neck in neutral position to keep airway patent.
– Breathing: commence oxygen via nasal prongs and monitor oxygen saturations (aim 90-95%). Use bag and mask ventilation if neonate apnoeic or RR < 20/minute.
– Administer non-invasive ventilation e.g. CPAP for moderate and severe respiratory distress, where available.
– Consider surfactant therapy where this is available.

Antibiotic therapy

– Commence first line combination of ampicillin slow IV (3 minutes) for 7 to 10 days + gentamicin slow IV (3 minutes) or IM for 5 days:

<table>
<thead>
<tr>
<th></th>
<th>&lt; 2 kg</th>
<th>≥ 2 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 7 days</td>
<td>ampicillin IV 50 mg/kg every 12 hours + gentamicin IV 3 mg/kg every 24 hours</td>
<td>ampicillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours</td>
</tr>
<tr>
<td>8 days to &lt; 1 month</td>
<td>ampicillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours</td>
<td></td>
</tr>
</tbody>
</table>

Supportive measures

– Support feeding, if necessary, via oral or nasogastric tube feeding. If severe respiratory distress, avoid enteral feeding and start IV fluids (restrict total fluid volume to 2/3 maintenance fluids). Keep nil-by-mouth for first 24 hours then reassess.
– Monitor BGL every 3 to 4 hours while on IV fluids.
– Keep in a high visibility area, and if available, use continuous monitoring.
– Keep neonate warm and dry: hypo- and hyperthermia should be avoided as they can exacerbate respiratory distress.

Surfactant therapy requires an advanced neonatal care setting. If it is available, use local protocol for its use.
– Practice “minimal handling” to avoid upsetting the neonate. Try to attend to cares at the same time (e.g. nappy change after vital signs).

Note: treatment with steroids is not recommended in neonates with RDS.

**Prevention**

Antenatal administration of glucocorticoids reduces the incidence of RDS by approximately 50%.

In women 26 to 34 weeks pregnant presenting with risk of preterm delivery, lung maturation can be helped with **dexamethasone** IM: 6 mg every 12 hours for 48 hours.

### 3.2.4 Neonatal pneumonia

Pneumonia is a viral or bacterial infection of the pulmonary alveoli. It is an important cause of neonatal infection and accounts for significant morbidity and mortality. Common bacterial organisms include *E. coli*, *Klebsiella* spp, *Staphylococcus aureus*, *group B Streptococcus* and *Streptococcus pneumoniae*. Atypical pathogens including syphilis (see Chapter 4, Section 4.2.2) and chlamydia\(^{b}\) can also cause neonatal pneumonia but the neonate is usually not critically unwell.

Risk factors for developing pneumonia include prematurity, chorioamnionitis (foul smelling amniotic fluid), maternal fever and PROM (> 18 hours).

**Clinical features**

– Difficulty in breathing or respiratory distress: tachypnoea, chest indrawing, grunting, cyanosis.
– Fever or temperature instability, but may have no fever (often a sign of serious illness).
– Onset may be within hours of birth and part of a generalised sepsis syndrome, or after 7 days and confined to the lungs.

**Investigations**

– Perform septic screen: blood culture, FBE, CRP (where available).
– Chest X-ray: often non-specific but can be useful for diagnosis and to monitor progress. Can present with diffuse reticulonodular shadowing similar to RDS or with patchy, asymmetric infiltrates with hyperaeration similar to meconium aspiration. Presence of a small pleural effusion is a useful distinguishing feature as it is a common finding in neonatal pneumonia (up to 2/3) and is uncommon in RDS\(^4\).

**Management**

– Airway: maintain head and neck in neutral position to keep airway patent.
– Breathing: commence oxygen via nasal prongs and monitor oxygen saturations (aim 90-95%). Use bag and mask ventilation if neonate apnoeic or RR < 20/minute.
– Administer non-invasive ventilation e.g. CPAP for moderate and severe respiratory distress, where available.

\(^{b}\) Exposure to chlamydia during delivery may result in chlamydial pneumonia at 2 to 18 weeks. May present with tachypnoea, characteristic paroxysmal staccato cough, and chest crackles are often present. Wheezing is uncommon. Approximately one-half of these neonates have a history of conjunctivitis.
Antibiotic therapy

- First line combination treatment is **ampicillin** slow IV (3 minutes) for 7 to 10 days + **gentamicin** slow IV (3 minutes) or IM for 5 days:

<table>
<thead>
<tr>
<th>0 to 7 days</th>
<th>&lt; 2 kg</th>
<th><strong>ampicillin</strong> IV 50 mg/kg every 12 hours + <strong>gentamicin</strong> IV 3 mg/kg every 24 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≥ 2 kg</td>
<td><strong>ampicillin</strong> IV 50 mg/kg every 8 hours + <strong>gentamicin</strong> IV 5 mg/kg every 24 hours</td>
</tr>
<tr>
<td>8 days to &lt; 1 month</td>
<td></td>
<td><strong>ampicillin</strong> IV 50 mg/kg every 8 hours + <strong>gentamicin</strong> IV 5 mg/kg every 24 hours</td>
</tr>
</tbody>
</table>

- First line alternative to ampicillin is **benzylpenicillin** slow IV (3 to 5 minutes) for 7 to 10 days (combined with gentamicin as above):

<table>
<thead>
<tr>
<th>0 to 7 days</th>
<th>&lt; 2 kg</th>
<th><strong>benzylpenicillin</strong> IV 25 mg/kg every 12 hours + <strong>gentamicin</strong> IV 3 mg/kg every 24 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≥ 2 kg</td>
<td><strong>benzylpenicillin</strong> IV 25 mg/kg every 12 hours + <strong>gentamicin</strong> IV 5 mg/kg every 24 hours</td>
</tr>
<tr>
<td>8 days to &lt; 1 month</td>
<td></td>
<td><strong>benzylpenicillin</strong> IV 25 mg/kg every 8 hours + <strong>gentamicin</strong> IV 5 mg/kg every 24 hours</td>
</tr>
</tbody>
</table>

Note: IV route is preferred for benzylpenicillin but IM route may be an alternative.

- Where there is strong evidence for staphylococcal infection (skin pustules, cellulitis, umbilical cord infection, pneumatoceles or empyema) substitute ampicillin with **cloxacillin** for 7 to 10 days:

<table>
<thead>
<tr>
<th>0 to 7 days</th>
<th>&lt; 2 kg</th>
<th><strong>cloxacillin</strong> IV 50 mg/kg every 12 hours + <strong>gentamicin</strong> IV 3 mg/kg every 24 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≥ 2 kg</td>
<td><strong>cloxacillin</strong> IV 50 mg/kg every 8 hours + <strong>gentamicin</strong> IV 5 mg/kg every 24 hours</td>
</tr>
<tr>
<td>8 days to &lt; 1 month</td>
<td></td>
<td><strong>cloxacillin</strong> IV 50 mg/kg every 8 hours + <strong>gentamicin</strong> IV 5 mg/kg every 24 hours</td>
</tr>
</tbody>
</table>

- ≥ 2 kg | **cloxacillin** IV 50 mg/kg every 6 hours + **gentamicin** IV 5 mg/kg every 24 hours |

- If chlamydia pneumonia suspected, add:

  First line: **azithromycin** PO: 10 mg/kg once daily for 5 days
  Alternative: **erythromycin** PO: 12.5 mg/kg, 4 times daily for 14 days

Note: both erythromycin and azithromycin use in neonates are associated with the potential risk of pyloric stenosis. Side effects should be monitored with use of either medication.

Supportive care as for neonates with respiratory distress includes temperature control, minimal handling and feeding support (see Section 3.2.3).
Prevention
Active treatment of PROM with maternal IV antibiotics has been shown to decrease the incidence of neonatal pneumonia and sepsis.

3.2.5 Meconium aspiration syndrome
Meconium aspiration syndrome (MAS) is respiratory distress and hypoxia in a neonate who has aspirated meconium into the lungs before or around the time of birth. The inhalation of meconium causes obstruction of the lower respiratory tract, lung inflammation and promotes the development of infectious pneumonia (even if meconium is a sterile substance). It primarily affects term or post-term neonates and is rarely seen in preterm births. Difficulties during delivery or obstructive labour leading to foetal distress and/or maternal conditions such as pre-eclampsia, pregnancy-induced hypertension and gestational diabetes increase the risk of meconium passage prior to birth.

Clinical features
- ‘Meconium-stained’ appearance
- Early onset (within 2 hours of birth) respiratory distress:
  - Tachypnoea
  - Chest wall indrawing
  - Nasal flaring
  - Grunting
  - Cyanosis and hypoxia
- Variable hyperinflation
- On auscultation there are widespread “wet” inspiratory crackles and occasionally expiratory noises.
- Complications include persistent pulmonary hypertension of the newborn, pneumothorax and pulmonary haemorrhage.
- May co-exist with symptoms suggestive of perinatal asphyxia (e.g. seizures, oliguria) (see Section 3.3.1).

Investigations
The diagnosis is normally based on clinical findings.
- Septic screen: blood culture, FBE, CRP (where available)
- Chest X-ray: early x-rays show widespread atelectasis, later progressing to widespread patchy opacification with areas of hyperinflation and/or atelectasis.

Management
- Airway: maintain head and neck in neutral position to keep airway patent.
- Breathing: commence oxygen via nasal prongs and monitor oxygen saturations (aim 90-95%). Use bag and mask ventilation if neonate apnoeic or RR < 20/minute.
- If moderate or severe respiratory distress or hypoxia, treat with non-invasive ventilation such as CPAP, where available. Worsening hypoxia indicates progressive pulmonary hypertension.
- Insert O/NGT and aim to remove meconium from the stomach.
- Keep neonate “nil by mouth” for 24 hours then reassess.
- Administer IV fluids (10% glucose on D1 to D2, then 1/5 0.9% sodium chloride + 4/5 10% glucose from D3 onwards) at a restricted volume of 50 mL/kg/day IV, increasing by 10 mL/kg/day, as for perinatal asphyxia.
- Monitor BGL and avoid hypoglycaemia while on IV fluids.
- Feeding can be restarted once the neonate is stable and respiratory distress has reduced to moderate.
Antibiotic therapy
- First line combination treatment is **ampicillin** slow IV (3 minutes) for 7 to 10 days + **gentamicin** slow IV (3 minutes) or IM for 5 days:

<table>
<thead>
<tr>
<th>0 to 7 days</th>
<th>&lt; 2 kg</th>
<th><strong>ampicillin</strong> IV 50 mg/kg every 12 hours + <strong>gentamicin</strong> IV 3 mg/kg every 24 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 2 kg</td>
<td></td>
<td><strong>ampicillin</strong> IV 50 mg/kg every 8 hours + <strong>gentamicin</strong> IV 5 mg/kg every 24 hours</td>
</tr>
<tr>
<td>8 days to &lt; 1 month</td>
<td></td>
<td><strong>ampicillin</strong> IV 50 mg/kg every 8 hours + <strong>gentamicin</strong> IV 5 mg/kg every 24 hours</td>
</tr>
</tbody>
</table>

Prevention
Prevention involves obstetric measures to prevent foetal distress that leads to meconium passage prior to birth. Recognition of risk factors for perinatal asphyxia, and early detection of signs of foetal distress in utero are key to prevention.
3.3 Central nervous system

3.3.1 Perinatal asphyxia

Perinatal asphyxia is a condition resulting from oxygen deprivation that lasts long enough to cause metabolic acidosis, encephalopathy and multi organ dysfunction in the neonate. Oxygen deprivation can occur at any time during the birth process - before, during or just after birth – and often presents with failure to establish breathing at birth.

Perinatal asphyxia remains a severe condition leading to significant mortality and morbidity; with an incidence of 1 to 6 per 1,000 live full-term births, and representing the third most common cause of neonatal death (23%) after preterm birth (28%) and severe infections (26%).

All organs can be affected, but the brain is the most susceptible and frequently affected leading to hypoxic ischaemic encephalopathy (HIE). The management of perinatal asphyxia is mainly supportive with oxygen, attention to fluid balance, management of seizures and of any other symptoms resulting from organ damage.

Risk factors include maternal-foetal infection, chorioamnionitis, pre-eclampsia, eclampsia, obstetric complications (e.g. placental abruption, cord prolapse) and failure of effective neonatal resuscitation.

Any neonate requiring bag mask ventilation for ≥ 2 minutes at birth should be treated for asphyxia. Close monitoring is mandatory, ideally in the neonatal unit.

Clinical features

At delivery: neonate is typically “flat” at birth (delayed onset of breathing, bradycardia, poor muscle tone) and requires resuscitation. There is disturbed neurological function.

After birth: neonate may present with an altered level of consciousness, respiratory depression, abnormal muscle tone, poor suck, and/or seizures. Seizures peak in the first 48 hours. Aside from the consequences of HIE, clinical features may present due to consequences resulting from hypoxia and ischaemia of other organ systems (see Table 3.6):

Table 3.6 - Clinical consequences resulting from perinatal asphyxia

<table>
<thead>
<tr>
<th>System</th>
<th>Consequences</th>
</tr>
</thead>
</table>
| Neurological | HIE  
|            | Seizures                                         |
|            | Intracranial haemorrhage                          |
| Respiratory | Apnoea                                           |
|            | Respiratory distress                              |
| Cardiovascular | Hypotension   
|              | Cardiac failure                                  |
| Renal      | Oliguria (< 1 mL/kg/hour) or anuria               |
|            | Transient haematuria                              |
| Intestinal | Abnormal gut motility and feed intolerance        |
|            | NEC                                               |
| Hepatic    | Impaired liver function                           |
|            | Jaundice                                          |
Chapter 3: Care of the sick neonate

System Consequences

<table>
<thead>
<tr>
<th>Metabolic</th>
<th>Hypo/hyperglycaemia Hypocalcaemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haematological</td>
<td>Coagulopathy, disseminated intravascular coagulopathy Thrombocytopenia</td>
</tr>
</tbody>
</table>

Management

Emergency management (if necessary)
- Airway: maintain head and neck in neutral position to keep airway patent.
- Breathing: commence oxygen via nasal prongs and monitor oxygen saturations (aim 90-95%). Use bag and mask ventilation if neonate apnoeic or RR < 20/minute.
- Circulation: establish IV access and assess for signs of shock or poor perfusion.
  - If signs of shock or poor perfusion present:
    - Administer IV bolus of 0.9% sodium chloride or Ringer lactate 10 mL/kg over 20 minutes.
    - Re-evaluate and repeat IV bolus after 20 to 30 minutes if necessary (maximum 3 boluses total)a.
- Check BGL:
  - If BGL < 45 mg/dL or < 2.5 mmol/L, administer by slow IV 2 mL/kg of 10% glucose.

Anticonvulsant therapy
If convulsing, anticonvulsant treatment may be needed (see Section 3.1.3).

Feeding and fluid support
- Keep “nil by mouth” initially.
- Administer IV fluids (10% glucose on D1-D2, then 1/5 0.9% sodium chloride + 4/5 10% glucose from D3 onwards) at a restricted volume of 50 mL/kg/day IV, increasing by 10 mL/kg/day.
- Monitor BGL as necessary.
- Check for urinary retention or dehydration. If these signs are not present, start to reduce IV fluids.
- These neonates are at risk of NEC. Introduce enteral feeds cautiously after 24 to 48 hours at 10 mL/kg/day, if haemodynamically stable and there is no paralytic ileus.

Antibiotic therapy
- Consider treating empirically for infection.
- First line combination treatment of ampicillin slow IV (3 minutes) for 7 to 10 days + gentamicin slow IV (3 minutes) or IM for 5 days:

<table>
<thead>
<tr>
<th>0 to 7 days</th>
<th>&lt; 2 kg</th>
<th>ampicillin IV 50 mg/kg every 12 hours + gentamicin IV 3 mg/kg every 24 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≥ 2 kg</td>
<td>ampicillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours</td>
</tr>
<tr>
<td>8 days to &lt; 1 month</td>
<td></td>
<td>ampicillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours</td>
</tr>
</tbody>
</table>

- Administer Vitamin K if not already done (for doses see Chapter 2, Section 2.3.2). Consider a further dose if there is evidence of coagulopathy.

---
a In the case of suspected cardiogenic shock or HIE, assess carefully prior to repeating fluid boluses.
Chapter 3: Care of the sick neonate

Monitoring and observation
Any neonate who had significant resuscitation at birth should be monitored clinically for multi-organ dysfunction as a consequence of asphyxia (see Table 3.6). See respective chapters for the treatment of the presenting consequences.

Specifically for HIE, assess the neonate 24 to 48 hours after birth using Sarnat staging (Table 3.7) to guide further management, supportive care and potential outcome.

Table 3.7 - Sarnat staging for HIE

<table>
<thead>
<tr>
<th>Sarnat Stage</th>
<th>Clinical</th>
<th>Symptoms</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Mild</td>
<td>Moderate</td>
<td>Lethargic, mild hypotonia, hyper-reflexic Parasympathetic autonomic symptoms Seizures in 70% Symptoms last 2 to 14 days</td>
<td>25% develop cerebral palsy</td>
</tr>
<tr>
<td>2 Severe</td>
<td>Stuporous, flaccid, hypo-/areflexic Depressed autonomic functionS Seizures normally prolonged Symptoms may persist for weeks</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Therapeutic cooling is a mainstay treatment that is only safe to perform in highly advanced resource settings.

Important differential diagnoses that require prompt diagnosis and treatment include: neonatal sepsis, meningitis, encephalitis, congenital malaria, metabolic abnormalities (hypoglycaemia), cerebral trauma, intracranial haemorrhage, and structural brain abnormalities.

Follow up and prognosis
Neurological assessment at 2 weeks of age is a good predictor of outcome. Any neonate who is normally active and sucking well one week after birth will usually do well. Those who are still floppy, spastic, unresponsive or cannot suck have a severe brain injury and will do poorly (cerebral palsy and seizures are likely). A Sarnat 2 that lasts more than a week is similar to a Sarnat 3.

The diagnosis and prognosis should be sensitively discussed with the family throughout the hospital stay. It may be appropriate to set limits of treatment (e.g. limited resuscitation in the event of apnoea) for neonates with a poor prognosis (see Chapter 8, Section 8.2).

Prevention
Prevention of perinatal asphyxia involves appropriate care during the antenatal, intra-partum and immediate postnatal period. Implementing immediate, effective resuscitation to neonates who are not vigorous at birth is essential.
3.3.2 Meningitis

Neonatal meningitis is an acute bacterial infection of the meninges in neonates in the first 28 days of life. It is a medical emergency and can affect the brain and lead to irreversible neurological damage. Meningitis is more common in the neonatal period than any other time of life.

Treatment is based on early parenteral administration of antibiotics that penetrates well into the cerebrospinal fluid. Duration of antibiotic therapy depends on the causative organism and clinical response. If the pathogen cannot be identified or while waiting for laboratory results, empirical antibiotic therapy should be administered.

Most common pathogens are *Klebsiella* sp., *E.coli* and *Staphyloccocus aureus*. In high resource contexts, consider Group B Streptococcus and coagulase-negative Staphylococcus although they are thought to be less prevalent in low-resource settings. Unlike in high-resource settings, *Listeria monocytogenes* is thought to be rare.

Worldwide, organisms are highly context dependent and have variable resistance patterns, and microbiological confirmation should be sought whenever possible.

Note that presentation and risk factors for neonatal meningitis are generally the same as for neonatal sepsis, but the distinction is important to determine the duration of antibiotic therapy.

Clinical features
- Classic signs of meningitis are usually absent.
- General features include temperature instability, irritability or lethargy, poor feeding or vomiting.
- Neurological signs include irritability, poor tone, apnoea, altered consciousness, tremors or twitching, and seizures. A full or bulging fontanelle (when not crying) may be present.

Investigations

Septic screen: blood culture, FBE, CRP (where available)

LP\(^b,c\) for examination and analysis of the cerebrospinal fluid (CSF) (Table 3.8):
- Macroscopic examination: antibiotic therapy should be initiated immediately if the LP yields a turbid CSF.
- Microscopic examination: Gram stain (identifies bacteria but negative result does not exclude diagnosis) and white blood cell count (WBC).
- Biochemistry: Protein level, including Pandy\(^d\). Glucose - normal CSF glucose level is about half to 2/3 of BGL. Low level of CSF glucose is seen in most forms of meningitis, except viral meningitis\(^10\).
- Culture: allows definitive diagnosis and will exclude meningitis if sample taken prior to commencing antibiotics (note limited availability in resource limited settings).

---

\(^b\) If an LP cannot be done immediately, it is acceptable to perform it within 48 hours of commencing antibiotic therapy (for cell count, rapid diagnostic tests and biochemistry).

\(^c\) See Appendix 3.4 for LP procedure.

\(^d\) Pandy test is a screening test, which detects increased levels of globulin in CSF. It is of value when it is not possible to measure CSF total protein.
### Table 3.8 - Interpretation of CSF

<table>
<thead>
<tr>
<th></th>
<th>Appearance</th>
<th>WBC (leucocytes/mm³)</th>
<th>Protein</th>
<th>Glucose</th>
<th>Other tests</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Normal CSF</strong></td>
<td>Clear</td>
<td>&lt; 5/mm³</td>
<td>0.15 to 0.4 g/L</td>
<td>2.5 to 4.0 mmol/L</td>
<td>—</td>
</tr>
<tr>
<td><strong>Bacterial meningitis</strong></td>
<td>Cloudy, turbid</td>
<td>&gt; 20/mm³ mainly neutrophils</td>
<td>Protein: high Pandy: positive</td>
<td>Low (&lt; 1/2 BGL)</td>
<td>Gram stain +</td>
</tr>
</tbody>
</table>

A traumatic sample (containing blood) may not be interpretable for microscopy but can be used for culture.

### Management

**Emergency management (if necessary)**
- Airway: maintain head and neck in neutral position to keep airway patent.
- Breathing: commence oxygen via nasal prongs and monitor oxygen saturations (aim 90-95%). Use bag and mask ventilation if neonate apnoeic or RR < 20/minute.
- Circulation: establish IV access and assess for signs of shock or poor perfusion.
  - If signs of shock or poor perfusion present:
    - Administer IV bolus of **0.9% sodium chloride** or **Ringer lactate** 10 mL/kg over 20 minutes.
    - Re-evaluate and repeat IV bolus after 20 to 30 minutes if necessary (maximum 3 boluses total).
- Check BGL:
  - If BGL < 45 mg/dL or < 2.5 mmol/L, administer by slow IV 2 mL/kg of **10% glucose**.

#### Antibiotic therapy

For the choice of antibiotic therapy and dosages according to age and weight, see Table 3.9.

**Duration of antibiotic therapy:**
1) **According to pathogen:**
   - *E.coli, Klebsiella* spp and other gram-negative bacteria: 21 days
   - Group B streptococcus, *S. aureus* and other gram-positive bacteria: 14 to 21 days
2) **If the pathogen is unknown:**
   - Full 21-day treatment course

Contexts with known antibiotic resistance profiles may require adapted treatment guidelines.

#### Supportive measures

- If convulsing, anticonvulsant therapy may be needed (see Section 3.1.3).
- Support feeding, if necessary, by O/NGT feeding. If altered conscious level or recurrent seizures, avoid enteral feeding for 24 to 48 hours and start IV fluids (see Appendix 7.2).
- Monitor BGL while on IV fluids.
- Keep neonate in a high visibility area, and if available, use continuous monitoring.
- Practice “minimal handling” to avoid upsetting the neonate.
- If persistent fever > 38 °C associated with discomfort or pain, consider treatment with **paracetamol** PO: 10 to 15 mg/kg every 6 to 8 hours (maximum 60 mg/kg/day).
- Use of dexamethasone is not recommended.

#### Prevention

Prevention is the same as for neonatal sepsis, including administration of intrapartum antibiotics to mothers with associated complications and prophylactic antibiotics for neonates with identified risk factors at birth (see Chapter 2, Section 2.5.2).

---

* Ceftriaxone is generally avoided in neonates because of the increased risk of jaundice. It may be used as an alternative when cefotaxime is not available in a neonate without jaundice.
Table 3.9 - Antibiotic table for neonatal meningitis

<table>
<thead>
<tr>
<th></th>
<th>No associated skin infection</th>
<th>Associated skin infection (including umbilical cord infection)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>First line</td>
<td>Alternative</td>
</tr>
<tr>
<td></td>
<td></td>
<td>First line</td>
</tr>
<tr>
<td>0 to 7 days</td>
<td><strong>ampicillin</strong> IV 100 mg/kg</td>
<td><strong>ampicillin</strong> IV 100 mg/kg every 12 hours + <strong>gentamicin</strong> IV 3 mg/kg every 24 hours</td>
</tr>
<tr>
<td>&lt; 2 kg</td>
<td>every 12 hours</td>
<td><strong>coli</strong> IV 50 mg/kg every 12 hours + <strong>cefotaxime</strong> IV 50 mg/kg every 12 hours</td>
</tr>
<tr>
<td></td>
<td><strong>cefotaxime</strong> IV 50 mg/kg</td>
<td><strong>coli</strong> IV 50 mg/kg every 12 hours + <strong>cefotaxime</strong> IV 50 mg/kg every 12 hours</td>
</tr>
<tr>
<td></td>
<td>every 12 hours</td>
<td><strong>coli</strong> IV 50 mg/kg every 12 hours + <strong>gentamicin</strong> IV 3 mg/kg every 24 hours</td>
</tr>
<tr>
<td>0 to 7 days</td>
<td><strong>ampicillin</strong> IV 100 mg/kg</td>
<td><strong>ampicillin</strong> IV 100 mg/kg every 8 hours + <strong>gentamicin</strong> IV 5 mg/kg every 24 hours</td>
</tr>
<tr>
<td>≥ 2 kg</td>
<td>every 8 hours</td>
<td><strong>coli</strong> IV 50 mg/kg every 8 hours + <strong>cefotaxime</strong> IV 50 mg/kg every 8 hours</td>
</tr>
<tr>
<td></td>
<td><strong>cefotaxime</strong> IV 50 mg/kg</td>
<td><strong>coli</strong> IV 50 mg/kg every 8 hours + <strong>gentamicin</strong> IV 5 mg/kg every 24 hours</td>
</tr>
<tr>
<td></td>
<td>every 8 hours</td>
<td><strong>coli</strong> IV 50 mg/kg every 8 hours + <strong>cefotaxime</strong> IV 50 mg/kg every 8 hours</td>
</tr>
<tr>
<td>8 days</td>
<td><strong>ampicillin</strong> IV 100 mg/kg</td>
<td><strong>ampicillin</strong> IV 100 mg/kg every 8 hours + <strong>gentamicin</strong> IV 5 mg/kg every 24 hours</td>
</tr>
<tr>
<td>to &lt; 1 month</td>
<td>every 8 hours</td>
<td><strong>coli</strong> IV 50 mg/kg every 6 hours + <strong>cefotaxime</strong> IV 50 mg/kg every 8 hours</td>
</tr>
<tr>
<td></td>
<td><strong>cefotaxime</strong> IV 50 mg/kg</td>
<td><strong>coli</strong> IV 50 mg/kg every 6 hours + <strong>gentamicin</strong> IV 5 mg/kg every 24 hours</td>
</tr>
</tbody>
</table>
3.4 Infections

3.4.1 Fever

Fever in the neonate is defined as a rectal temperature higher than or equal to 38 °C. Axillary and tympanic membrane temperatures are less reliable in neonates, so for any neonate with an axillary temperature > 37.5 °C, check the rectal temperature as well. Fever can be the only presenting sign of a serious infection in a neonate. Prompt assessment is important, especially in preterm/VLBW neonates.

Take a detailed history, assess risk factors for sepsis and perform a thorough clinical examination looking for signs of neonatal sepsis and localised infection. Look for signs of serious illness, then try to establish a diagnosis.

Common causes of a fever in a neonate include:
- Serious bacterial infection (bacteraemia, meningitis, pneumonia, urinary tract infection, bacterial gastroenteritis, skin, joint and soft tissue infections).
- Congenital or neonatal malaria (see Section 3.4.6)
- Viral infections
- Thermal environment: high ambient temperature, excessive coverings

Investigations
- Urine microscopy (and culture where available) if neonate > 5 days old: obtain clean sample by suprapubic aspirate or catheter.
- Chest X-ray if respiratory signs present.
- LP if the neonate appears sick or there is any suspicion of meningitis, particularly if the neonate is > 3 days old.
- Malaria thick/thin films or rapid diagnostic test (RDT) in malaria endemic areas.
- Septic screen: blood culture, FBE, CRP (where available)

Management
- Treat according to (probable) cause of fever.
- Control thermal environment. Remove any blankets/coverings and undress the neonate if necessary.
- If rectal temperature ≥ 38 °C persists after environmental control and no source of infection identified, hospitalise and treat for neonatal sepsis with IV antibiotics (see Section 3.4.2).
- Assess the neonate’s hydration status and ensure breastfeeding is adequate.
- A fever does not always need to be treated with medication. However, if there is associated pain or discomfort, consider treatment with paracetamol PO: 10 to 15 mg/kg every 6 to 8 hours (maximum 60 mg/kg/day).

3.4.2 Neonatal sepsis

Neonatal sepsis is an invasive bacterial infection occurring in the first 28 days of life. Sepsis can present with subtle and non-specific signs. Consider the diagnosis in any neonate who appears sick and commence IV antibiotics. Left untreated, neonatal sepsis can lead to severe consequences and death.
Most common pathogens are a *Klebsiella* spp., *E.coli* and *Staphylococcus aureus*. In high resource contexts, consider Group B *Streptococcus* and coagulase-negative *Staphylococcus* although they are thought to be less prevalent in low-resource settings. Unlike in high-resource settings, *Listeria monocytogenes* is thought to be rare. Worldwide, organisms are highly context dependent and have variable resistance patterns, and microbiological confirmation should be sought whenever possible.

<table>
<thead>
<tr>
<th>Table 3.10 - Risk factors for neonatal sepsis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perinatal factors</td>
</tr>
<tr>
<td>PROM (&gt; 18 hours)</td>
</tr>
<tr>
<td>Prolonged labour</td>
</tr>
<tr>
<td>Maternal fever or other evidence of infection</td>
</tr>
<tr>
<td>Chorioamnionitis or malodorous neonate</td>
</tr>
<tr>
<td>Preterm</td>
</tr>
<tr>
<td>LBW (&lt; 2000 g)</td>
</tr>
<tr>
<td>Birth outside a health facility</td>
</tr>
<tr>
<td>Some traditional practices (such as application of cow dung to cord)</td>
</tr>
</tbody>
</table>

**Clinical features**

Neonates often present with non-specific signs of infection. Neonates presenting with any one of the following signs should be considered to have neonatal sepsis:

- Severe chest indrawing
- Lethargy (movement only with stimulation)
- Feeding difficulty (confirmed by observation)
- Fever
- Hypothermia (axillary temperature < 35.5 °C)
- Increased apnoea

Presentation can be highly variable; consider the diagnosis of neonatal sepsis in any sick or deteriorating neonate with signs such as irritability, recent hypotonia, seizures, jaundice or gastrointestinal issues (vomiting, diarrhoea and abdominal distension).

Perform a thorough clinical examination searching for localising signs of infection.

---

a Although in high-resource settings neonatal sepsis is typically classified as either early- or late-onset, in low-resource countries, most pathogens isolated before and after 72 hours of life are similar.
Differential diagnoses or underlying causes of sepsis

- Meningitis or encephalitis (see Section 3.3.2)
- Pneumonia (see Section 3.2.4)
- Urinary tract infection (see Section 3.4.3)
- Skin or soft tissue infection, omphalitis (see Section 3.4.4)
- Gastrointestinal infection, NEC (see Section 3.5.6)
- Congenital or neonatal malaria (see Section 3.4.6)

Clinical signs and symptoms may overlap with many other conditions such as perinatal asphyxia or respiratory conditions (RDS, MAS). Consider the diagnosis of neonatal sepsis in any neonate who is sick or with danger signs (see Section 3.1) and treat with IV antibiotics.

Investigations

- BGL
- Malaria tests in malaria-endemic areas
- Maternal syphilis test if status unknown
- Chest x-ray
- LP: consider in any sick neonate even if classic meningitis features are not present (see Appendix 3.4). Note: LP can be done up to 48 hours after commencing antibiotic therapy for CSF microscopy and protein (but not culture).
- Perform a septic screen: blood culture, FBE, CRP (where available).

For sepsis presenting in neonates after 72 hours of life:

- Consider an LP.
- Perform urine microscopy (and culture where available): obtain clean sample by suprapubic aspirate or catheter.

Management

Emergency management (if necessary)

- Airway: maintain head and neck in neutral position to keep airway patent.
- Breathing: commence oxygen via nasal prongs and monitor oxygen saturations (aim 90-95%). Use bag and mask ventilation if neonate apnoeic or RR < 20/minute.
- Circulation: establish IV access and assess for signs of shock or poor perfusion.
  
  If signs of shock or poor perfusion present:
  - Administer IV bolus of 0.9% sodium chloride or Ringer lactate 10 mL/kg over 20 minutes.
  - Re-evaluate and repeat IV bolus after 20 to 30 minutes if necessary (maximum 3 boluses total).
- Check BGL:
  - If BGL < 45 mg/dL or < 2.5 mmol/L, administer by slow IV 2 mL/kg of 10% glucose.

Antibiotic therapy

- First line combination treatment is ampicillin slow IV (3 minutes) for 7 to 10 days (according to clinical response) + gentamicin slow IV (3 minutes) or IM for 5 days:

<table>
<thead>
<tr>
<th>0 to 7 days</th>
<th>&lt; 2 kg</th>
<th>ampicillin IV 50 mg/kg every 12 hours + gentamicin IV 3 mg/kg every 24 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 2 kg</td>
<td></td>
<td>ampicillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours</td>
</tr>
<tr>
<td>8 days to &lt; 1 month</td>
<td></td>
<td>ampicillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours</td>
</tr>
</tbody>
</table>
First line alternative to ampicillin is **benzylpenicillin** slow IV (3 to 5 minutes) for 7 to 10 days (combined with gentamicin for 5 days as above):

<table>
<thead>
<tr>
<th>0 to 7 days</th>
<th>&lt; 2 kg</th>
<th>benzylpenicillin IV 25 mg/kg every 12 hours + gentamicin IV 3 mg/kg every 24 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≥ 2 kg</td>
<td>benzylpenicillin IV 25 mg/kg every 12 hours + gentamicin IV 5 mg/kg every 24 hours</td>
</tr>
</tbody>
</table>

| 8 days to < 1 month | benzylpenicillin IV 25 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours |

Note: IV route is preferred for benzylpenicillin but IM route may be used.

Where there is strong evidence for staphylococcal infection (skin pustules, cellulitis, umbilical cord infection, pneumatoceles or empyema) substitute ampicillin with **cloxacillin** for 7 to 10 days:

<table>
<thead>
<tr>
<th>0 to 7 days</th>
<th>&lt; 2 kg</th>
<th>cloxacillin IV 50 mg/kg every 12 hours + gentamicin IV 3 mg/kg every 24 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≥ 2 kg</td>
<td>cloxacillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours</td>
</tr>
</tbody>
</table>

| 8 days to < 1 month | cloxacillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours |

| ≥ 2 kg | cloxacillin IV 50 mg/kg every 6 hours + gentamicin IV 5 mg/kg every 24 hours |

* Cloxacillin dose may be doubled in case of serious infection.

For neonates suspected of meningitis, see Section 3.3.2.

Exceptions to above recommended duration of antibiotics:

- In neonates in whom symptoms are mild and resolve within 24 hours of commencing antibiotics, consider stopping antibiotics after 5 days.
- Where blood cultures are available, rationalise antibiotics at 48 hours once results are known. Total duration of antibiotic treatment in culture positive sepsis depends on the pathogen identified and the sensitivity to available antibiotics.

Note: there is growing concern of increasing resistance patterns globally, and first line treatment may not be adequate. Second line treatment varies according to context and culture results, and local guidelines should be followed. Contexts with known antibiotic resistance profiles may require adapted treatment guidelines (e.g. imipenem, ceftazidime) and recommendations will be revised as new evidence emerges.

Neonates receiving prolonged antibiotic therapy, particularly VLBW neonates, are at risk of invasive fungal disease\(^\text{13}\). Therefore, for VLBW neonates receiving antibiotics add:

nystatin PO: 1 mL of the oral suspension (100 000 IU), 4 times daily while on antibiotics
Supportive measures

- Monitor BGL every 2 to 3 hours as needed.
- Aim to maintain temperature between 36 °C to 37 °C. Avoid hypothermia.
- Monitor for jaundice and commence phototherapy if indicated.
- Monitor feeding and fluid intake. Commence IV fluids in any neonate who is unstable or in severe respiratory distress (see Appendix 7.2).
- Monitor vital signs.

Special Circumstances

If there are features of herpes virus encephalitis (maternal active lesions at delivery, skin or neurological features), add aciclovir (see Chapter 4, Section 4.2.5).

If there is suspected congenital syphilis due to a positive maternal syphilis test in an untreated mother, add benzylpenicillin in addition to antibiotics for sepsis (see Chapter 4, Section 4.2.2).

If there are concerning abdominal signs raising suspicion of a diagnosis of NEC, add metronidazole (see Section 3.5.6).

For suspected invasive fungal infection (prolonged use of broad spectrum antibiotics in a preterm or VLBW neonate, candidiasis of the perineum) consider adding fluconazole PO or IV.

<table>
<thead>
<tr>
<th>fluconazole</th>
<th>PO or IV infusion (over 20 minutes; do not exceed infusion rate of 5 mL/minute):</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to &lt; 14 days: 6-12 mg/kg every 72 hours, continued according to clinical response</td>
<td></td>
</tr>
<tr>
<td>14 to 28 days: 6-12 mg/kg every 48 hours, continued according to clinical response</td>
<td></td>
</tr>
</tbody>
</table>

Prevention

- Intra-partum antibiotics are recommended to mothers with premature rupture of membranes and other recognisable risk factors for infection (e.g. fever, unexplained preterm labour, foetal tachycardia, purulent discharge). See Essential Obstetric and Newborn Care, MSF.14
- Prophylactic antibiotics should be given to asymptomatic neonates with identified risk factors (see Chapter 2, Section 2.5.2).
- Hand washing and general hygiene measures decrease spread of bacteria, particularly within the neonatal care unit.
- Nursery design: where possible separation of “inborn” from “outborn” neonates can limit exposure to pathogens, particularly for vulnerable LBW neonates. Overcrowding of neonates exacerbates the problem of cross-infection.
- Breastfeeding: infection is greatly reduced in neonates fed breast milk compared with formula-fed neonates, and exclusive breastfeeding is recommended (use expressed breast milk if the neonate is still not able to feed directly from the breast).

3.4.3 Urinary tract infections

Most UTIs in neonates represent upper tract bacterial infections (pyelonephritis) rather than simple cystitis. UTIs are associated with bacteraemia and congenital abnormalities of the kidney and urinary tract in neonates. In term neonates they are thought to be a result of ascending infection rather than haematogenous spread. UTIs typically present in the second or third week of life in term neonates. The incidence of UTI is low in the first few days after birth.

In term neonates, Escherichia coli (E. coli) and other gram negative organisms (Klebsiella, Proteus, Enterobacter) predominate. Gram-positive bacteria (coagulase negative Staphylococcus, Enterococcus and, rarely, Staphylococcus aureus) are also possible. In preterm hospitalised neonates, Staphylococcus and Klebsiella are more commonly seen.
All neonates with a suspected UTI require treatment with IV antibiotics.

**Clinical features**

Signs and symptoms are non-specific: fever or hypothermia, irritability, poor feeding, altered general condition, altered conscious state, failure to thrive, jaundice and vomiting. Absence of fever does not rule out the diagnosis, but fever with no obvious cause may be the only manifestation.

**Investigations**

- Urine microscopy (and culture where available): obtain clean sample by suprapubic aspirate or catheter. Urine bag specimens are frequently contaminated and can only be used for urine dipstick.
- Urine dipstick: (testing for leucocyte esterase and nitrites) may support the diagnosis of UTI, but testing is neither sensitive nor specific in neonates and is not diagnostic of infection.
- Perform a septic screen: blood culture, FBE, CRP (where available).

**Management**

**Emergency management**

- Airway: maintain head and neck in neutral position to keep airway patent.
- Breathing: commence oxygen via nasal prongs and monitor oxygen saturations (aim 90-95%). Use bag and mask ventilation if neonate apnoeic or RR < 20/minute.
- Circulation: establish IV access and assess for signs of shock or poor perfusion.
  
  If signs of shock or poor perfusion present:
  
  - Administer IV bolus of **0.9% sodium chloride** or **Ringer lactate** 10 mL/kg over 20 minutes.
  - Re-evaluate and repeat IV bolus after 20 to 30 minutes if necessary (maximum 3 boluses total).
- Check BGL:
  
  - If BGL < 45 mg/dL or < 2.5 mmol/L, administer by slow IV 2 mL/kg of 10% glucose.

**Antibiotic therapy**

- First line treatment is the combination **ampicillin** slow IV (3 minutes) for 7 to 10 days + **gentamicin** slow IV (3 minutes) or IM for 5 days:

<table>
<thead>
<tr>
<th>0 to 7 days</th>
<th>&lt; 2 kg</th>
<th>ampicillin IV 50 mg/kg every 12 hours + gentamicin IV 3 mg/kg every 24 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≥ 2 kg</td>
<td>ampicillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours</td>
</tr>
</tbody>
</table>

  | 8 days to < 1 month | ampicillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours |

- An alternative treatment is **cefotaxime** slow IV (3 minutes) for 7 to 10 days:

<table>
<thead>
<tr>
<th>0 to 7 days</th>
<th>&lt; 2 kg</th>
<th>cefotaxime IV 50 mg/kg every 12 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≥ 2 kg</td>
<td>cefotaxime IV 50 mg/kg every 8 hours</td>
</tr>
</tbody>
</table>

  | 8 days to < 1 month | cefotaxime IV 50 mg/kg every 8 hours |

In settings where antimicrobial susceptibility testing is available, adjust antibiotic therapy based on results.
– Obtain a renal ultrasound where available to check for evidence of a structural abnormality. This should be performed once antibiotic treatment has started and the patient is stabilised.

### 3.4.4 Omphalitis

Omphalitis is an infection of the umbilicus and/or surrounding tissues, which can range from a mild infection to severe disease with associated necrotising fasciitis. It is a polymicrobial infection and common causative organisms include *Staphylococcus aureus* and other gram-positive organisms, as well as gram-negative bacteria. In addition, anaerobic bacteria can contribute to infection.

**Risk factors include:**
- PROM > 18 hours
- Prolonged labour
- Maternal infection
- Low birth weight
- Birth outside a health facility
- Inappropriate cord handling (cultural practices such as application of cow dung, butter, talc powder, palm oil)

**Clinical features**

**Local signs:** purulent or foul smelling discharge from the umbilicus/umbilical stump, periumbilical erythema, oedema and tenderness *(Figure A-30).*

**Systemic signs:** fever, lethargy, poor tone, and respiratory distress may be present and suggest more serious infection. Necrotising fasciitis is a severe complication of omphalitis and should be suspected if there is evidence of discolouration or bruising of the skin, tissue necrosis or crepitus.

**Differential diagnosis**

- Umbilical granuloma
- NEC (abdominal distension, vomiting, bloody stools)
- Neonatal sepsis
- Patent vitello-intestinal duct (fistula with faecal matter draining)
- Patent urachus (fistula with urine draining)

**Management**

**Local treatment**

- Indicated in all cases regardless of severity:

| 7.1% chlorhexidine digluconate dermal gel (delivering 4% chlorhexidine): apply to cord 3 times daily for as long as necessary |

- If unavailable, use 0.9% sodium chloride. 10% polyvidone should not be used more than 3 times due to risk of iodine toxicity.

**Antibiotic therapy**

According to severity of infection and duration 7 to 10 days, pending on clinical response.
Localised omphalitis in a term neonate where oral therapy is appropriate, first line treatment is **cefalexin**.

<table>
<thead>
<tr>
<th>cefalexin PO</th>
<th>0 to 7 days: 25 mg/kg every 12 hours</th>
<th>8 days to &lt; 1 month: 25 mg/kg every 8 hours</th>
</tr>
</thead>
</table>

Moderate to severe omphalitis, treat with **cloxacillin** IV infusion over 60 minutes for 7 to 10 days pending on clinical response:

<table>
<thead>
<tr>
<th>0 to 7 days</th>
<th>&lt; 2 kg</th>
<th>cloxacillin IV 50 mg/kg every 12 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 2 kg</td>
<td></td>
<td>cloxacillin IV 50 mg/kg every 8 hours</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>8 days to &lt; 1 month</th>
<th>&lt; 2 kg</th>
<th>cloxacillin IV 50 mg/kg every 8 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 2 kg</td>
<td></td>
<td>cloxacillin IV 50 mg/kg every 6 hours</td>
</tr>
</tbody>
</table>

Systemic infection or in a preterm neonate, treat with combination therapy of **cloxacillin** IV infusion over 60 minutes for 7 to 10 days plus **gentamicin** slow IV (3 minutes) or IM for 5 days:

<table>
<thead>
<tr>
<th>0 to 7 days</th>
<th>&lt; 2 kg</th>
<th>cloxacillin IV 50 mg/kg every 12 hours + gentamicin IV 3 mg/kg every 24 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 2 kg</td>
<td></td>
<td>cloxacillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>8 days to &lt; 1 month</th>
<th>&lt; 2 kg</th>
<th>cloxacillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 2 kg</td>
<td></td>
<td>cloxacillin IV 50 mg/kg every 6 hours + gentamicin IV 5 mg/kg every 24 hours</td>
</tr>
</tbody>
</table>

Rapidly evolving or extensive omphalitis with necrotising fasciitis:

- Prompt surgical management accompanied by IV antibiotic therapy may at times reduce the high mortality rate. In case of septic shock, stabilize the neonate and, where possible, refer early to a paediatric surgeon.
- Emergency surgical treatment: debridement, drainage and wide excision of necrotic tissue if necessary. Surgical re-evaluation within 24 to 36 hours to check for eventual progression of the necrosis and need for further debridement.
- Antibiotic therapy for at least 10 to 14 days or more depending on clinical response:
  - **clindamycin** IV infusion (30 minutes):
    - 0 to 7 days (< 2 kg): 5 mg/kg every 12 hours
    - 0 to 7 days (≥ 2 kg): 5 mg/kg every 8 hours
    - 8 days to < 1 month (< 2 kg): 5 mg/kg every 8 hours
    - 8 days to < 1 month (≥ 2 kg): 10 mg/kg every 8 hours
    + **ceftriaxone** slow IV (3 minutes) or IV infusion (30 minutes): 100 mg/kg every 24 hours +/-
  - **gentamicin** slow IV (3 minutes)
    - 0 to 7 days (< 2 kg): 3 mg/kg every 24 hours
    - 0 to 7 days (≥ 2 kg): 5 mg/kg every 24 hours
    - 8 days to < 1 month: 5 mg/kg every 24 hours

Gentamicin should be given for a maximum of 5 days total.
Metronidazole IV can be used as an alternative to clindamycin. **Metronidazole** IV infusion (over 60 minutes)

- 0 to 7 days: 15 mg/kg on D1, then after 24 hours, 7.5 mg/kg every 12 hours
- 8 days to < 1 month (< 2 kg): same as above
- 8 days to < 1 month (≥ 2 kg): 15 mg/kg every 12 hours

**Prevention**

Hygienic birth practices and cord care with an antiseptic applied to the cord at birth help prevent infection. The umbilical cord should be kept clean and dry without any dressing. The family should be explained how to manage the cord and instructed on the importance of not applying foreign substances (such as milk, soil, butter, cow dung) to the cord.

### 3.4.5 Neonatal tetanus

Tetanus is a life threatening neurological infection that causes muscle rigidity and painful muscle spasms. It is caused by the toxin producing bacteria *Clostridium tetani*, found in soil and human and animal faeces. The infection is non-communicable. Neonatal tetanus is caused by contamination of the umbilical cord in neonates born to mothers with inadequate vaccination coverage. Cultural practices that involve application of substances such as butter and cow dung to the umbilical stump contribute to transmission. Disease can also result from poor hygiene and use of non-sterile equipment during delivery.

**Clinical features**

Incubation period is normally 3 to 21 days. Shorter incubation periods (< 7 days) are associated with fatal outcomes. The onset of symptoms is typically more rapid in neonates than older children.

Tetanus is characterised by muscle rigidity and painful muscle spasms. Stiffness and pain often begin in the jaw muscles (known as trismus or “lock jaw”) leading to difficulty sucking and irritability. As the disease progresses, generalised rigidity, opisthotonus (stiff arching of the back) and seizure-like muscle spasms develop.

Any neonate, who initially sucked and cried normally, presenting with irritability and difficulty sucking 3 to 28 days after birth and demonstrating rigidity and muscle spasms should be assumed to have neonatal tetanus.

Autonomic dysfunction (labile blood pressure and heart rate) is associated with severe tetanus and a poor prognosis.

The umbilicus is the usual portal of entry, but omphalitis (clinical infection of the cord) is present in only about half of cases (see Section 3.4.4). Neonatal sepsis is frequently associated.

**Investigations**

Tetanus is a clinical diagnosis and there are no specific diagnostic tests. Neonates often have associated bacterial sepsis and should have:

- BGL
- Septic screen: blood culture, FBE and CRP (where available)

**Management**

- Hospitalisation is necessary and admission is usually required for 4 to 6 weeks. Correct management can reduce mortality even in hospitals with limited resources.
- The neonate should be carefully managed in a neonatal unit with intensive nursing care. Isolation is not necessary and increases the risk of reduced monitoring.
**General measures**

- Practice “minimal handling” so as not to trigger painful muscle spasms:
  - Limit weighing the neonate to twice per week.
  - Do no attempt to breastfeed until spasms subside.
  - Pay careful attention to moving the neonate to avoid pressure sores.
- Lay the neonate on a soft surface (such as a urine bag filled with water covered with a cloth).
- Limit stimulation from noise and light by covering the ears and eyes with a cloth bandage. External stimuli often cause intensely painful muscle spasms and should be avoided.
- Airways: ensure airways patency and suction oropharynx gently if excessive secretions.
- Breathing: ensure a bag and mask is at the neonate’s bedside at all times. Neonates with tetanus are at risk of apnoea and respiratory depression (both due to disease and as a side effect of medications).
- Establish IV access for medications and hydration.
- Insert a nasogastric tube for feeding.
- Ensure the bladder is empty, and apply gentle pressure if needed.
- Teach family the danger signs and instruct them to call the nurse if there are the slightest respiratory concerns (cough, difficulty breathing, apnoea, excessive secretions, cyanosis, etc.) or worsening pain or spasms.

**Neutralisation of toxin**

| human tetanus immunoglobulin IM: 500 IU single dose, injected into 2 separate sites |

**Inhibition of toxin production**

Treat with **metronidazole** IV infusion (over 60 minutes) for 7 days:

<table>
<thead>
<tr>
<th>metronidazole IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 7 days: 15 mg/kg on D1, then after 24 hours, 7.5 mg/kg every 12 hours</td>
</tr>
<tr>
<td>8 days to &lt; 1 month (&lt; 2 kg): same as above</td>
</tr>
<tr>
<td>8 days to &lt; 1 month (≥ 2 kg): 15 mg/kg every 12 hours</td>
</tr>
</tbody>
</table>

If an alternative is necessary, treat with **benzylpenicillin** IV for 14 days (for doses see Section 3.4.2).

**Treatment of associated sepsis**

Treat with combination therapy of **cloxacillin** IV infusion over 60 minutes for 7 to 10 days plus **gentamicin** slow IV (3 minutes) or IM for 5 days:

<table>
<thead>
<tr>
<th>0 to 7 days</th>
<th>&lt; 2 kg</th>
<th>cloxacillin IV 50 mg/kg every 12 hours + gentamicin IV 3 mg/kg every 24 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 2 kg</td>
<td></td>
<td>cloxacillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours</td>
</tr>
<tr>
<td>8 days to &lt; 1 month</td>
<td>&lt; 2 kg</td>
<td>cloxacillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours</td>
</tr>
<tr>
<td></td>
<td>≥ 2 kg</td>
<td>cloxacillin IV 50 mg/kg every 6 hours + gentamicin IV 5 mg/kg every 24 hours</td>
</tr>
</tbody>
</table>

Note: cefotaxime IV can be used as an alternative to gentamicin as a combination therapy of cloxacillin IV + cefotaxime IV (for doses, see Appendix 5).
Chapter 3: Care of the sick neonate

Local treatment of infected wounds and umbilical site

7.1% chlorhexidine digluconate dermal gel (delivering 4% chlorhexidine): apply to cord 3 times daily for as long as necessary.

Control of rigidity, hypertonia and muscle spasms

Diazepam should decrease the frequency and intensity of spasms without causing respiratory depression. The dose and frequency of administration depends on clinical response and tolerance.

⚠️ There is a high risk of respiratory depression and hypotension when using diazepam. Constant and close monitoring of the neonate’s RR and oxygen saturation is essential, with immediate availability of equipment for bag mask ventilation and suction. A continuous IV infusion of diazepam requires the use of a dedicated vein (no other infusion/injection in this vein) and can be administered if available through an electric syringe driver. This should be managed by qualified staff. Do not stop treatment abruptly; an abrupt stop can cause tetanic spasms.

**diazepam emulsion** for injection (10 mg vial, 5 mg/mL, 2 mL)
- 0.1 to 0.3 mg/kg by slow IV injection (3 to 5 minutes) every 1 to 4 hours depending on the severity and the persistence of the spasms as long as the RR is ≥ 30.
- If despite hourly diazepam the spasms persist, start a continuous infusion of diazepam with an electric syringe driver: 0.1 to 0.5 mg/kg/hour (2.4 to 12 mg/kg every 24 hours). Start with 0.1 mg/kg/hour and if symptoms persist, increase by 0.1 mg/kg/hour as long as RR is ≥ 30.
- If in spite of 0.5 mg/kg/hour symptoms persist, the dose can be increased up to 0.8 mg/kg/hour as long as RR ≥ 30.
- Diluted diazepam does not keep for more than 6 hours.

If an electric syringe driver is not available, diluting the diazepam emulsion in an infusion bag for continuous infusion may be considered. Weigh the risks associated with this mode of administration (accidental bolus or insufficient dose). The infusion should be monitored closely to avoid any change, however small, of the prescribed rate.

Treatment of pain

**morphine**
- PO/NG: 0.1 to 0.4 mg/kg every 4 hours if necessary (immediate release formulation)
- IV: 0.05 to 0.1 mg/kg slow IV injection (3 to 5 minutes) every 4 to 6 hours

*Side effects:* sedation, constipation, oliguria, nausea and vomiting

Caution: Both diazepam and morphine can cause respiratory depression. Bag-mask ventilation must always be available at the patient’s bedside.

In case of respiratory depression:
- Commence bag-mask ventilation.
- If suspected morphine-induced respiratory depression, give:

**naloxone** IV: 0.01 mg/kg every 2 to 3 minutes as needed until resolution of respiratory depression
Chapter 3: Care of the sick neonate

**Fluid and feeding management**
- IV fluids may be needed initially due to severe spasms and risk of aspiration (see Appendix 7.2).
- Muscle spasms cause increased caloric needs: start O/NGT feeding with expressed breast milk. Give small feeds more frequently (1 to 2 hourly) due to decreased gut motility.
- Monitor for hypoglycaemia.

**Weaning morphine and diazepam**
When the frequency and severity of the spasms have decreased, start weaning the diazepam (gradually decrease the rate of infusion):
- Calculate the total daily dose of IV diazepam and administer in 4 doses 6 hours apart via NGT.
- Give first NG dose and decrease rate of IV infusion by 50%.
- Give second NG dose and stop IV diazepam infusion.
- If withdrawal signs\(^b\) appear, wean more slowly.
- Once on oral diazepam, wean by 10 to 20% of the original dose daily, until at a dose of 0.05 mg/kg every 6 hours.
- Then increase the interval from every 6 hours to every 8 hours for 24 hours as tolerated (wean more slowly if withdrawal signs appear).
- Continue to increase the interval between the doses from every 8 hours to every 12 hours and then to every 24 hours before stopping the diazepam.
- Each step should be for 24 hours or more if withdrawal signs appear.
- Monitor the neonate for 48 to 72 hours after stopping all sedating medications.

**Notes:**
- It is often at these smaller doses that it is difficult to wean diazepam. If this is the case, slow the wean further: dropping the % wean (e.g. 5% wean every 24 hours instead of 10% wean) or increasing the interval between weans (e.g. going from every 24 hours to every 48 hours).
- If the patient is also receiving morphine, wean diazepam first then, wean morphine.
- Non-pharmacological measures to reduce withdrawal: reduce environmental stimuli, swaddle, frequent feedings.
- Neonates who have had tetanus remain hypertonic, even when they are no longer having spasms.

**Prognosis**
Tetanus toxin producing effects are usually long lasting, and the usual duration of illness is 4 to 6 weeks. The severity of disease is variable, and related to disease onset and rapidity of disease progression. Case fatality rates range between 10 to 80%, even with hospital care.

**Prevention**
Tetanus disease does not induce immunity and all neonates should follow standard EPI vaccinations (a total of 5 tetanus containing vaccinations during childhood). The mother should be vaccinated prior to discharge from hospital.

Neonatal tetanus is preventable through immunisation of the mother during the antenatal period. All pregnant women should receive 2 tetanus toxoid vaccinations during pregnancy given at least 4 weeks apart. The second dose should be given at least 2 weeks before delivery to confer protective immunity to the neonate. All women of childbearing age should receive a total of 5 vaccinations during the childbearing years.

Hygienic practices, use of sterile equipment and cord care at birth help prevent the neonate from contracting disease.

\(^b\) Withdrawal signs: excessive irritability, tremors, increased muscle tone, increased RR, frequent yawning, poor feeding, watery stools and sweating.
3.4.6 Congenital and neonatal malaria

**Congenital malaria** is defined as asexual parasitaemia detected in the first week of life and is acquired vertically, either transplacentally or peripartum from the mother. All types of malaria can be transmitted congenitally.

**Neonatal malaria** occurs from 8 to 28 days of life as a result of an infective mosquito bite.

**Clinical features**

Malaria during pregnancy has been associated with miscarriage, stillbirth, prematurity and low birth weight.

Clinical features are non-specific and similar to those seen in neonatal sepsis including fever, lethargy and poor feeding. Neurological features include irritability and seizures. There may be pallor, jaundice or hepatosplenomegaly.

Consider other differential diagnoses with similar clinical signs including congenital infections (e.g. CMV, rubella, toxoplasmosis, syphilis).

**Investigations**

Test for malaria in:
- Asymptomatic neonates born to mothers diagnosed with malaria in the third trimester or at delivery.
- All neonates with fever or suspected sepsis.

Repeat malaria testing (e.g. at 12, 24, 48 hours) where clinical suspicion remains, even if previous result was negative. Low-level parasitaemia can occur in young neonates.

RDT: Rapid tests detect parasite antigens. They give only a qualitative result (positive or negative) and may remain positive several days or weeks following effective treatment. RDTs using pLDH are the most reliable at detecting neonatal malaria. HRP2-based RDTs are less specific and have a higher risk of detecting maternal rather than neonatal infection, therefore positive results using HRP2 RDTs should be verified with blood smear, provided that quality microscopy can be assured.

**Microscopy** (blood smear)

Blood smear (thin and thick blood film) enable parasite detection, species identification, quantification and monitoring of parasitaemia. Recommended only where reliable laboratory facilities are available and quality microscopy can be assured.

**Additional investigations**
- BGL
- Hb level (or FBE where available)

**Management**

All neonates with suspected malaria should be hospitalised in the neonatal unit.

**Emergency management** (if necessary)
- Airway: maintain head and neck in neutral position to keep airway patent.
- Breathing: commence oxygen via nasal prongs and monitor oxygen saturations (aim 90-95%). Use bag and mask ventilation if neonate apnoeic or RR < 20/minute.

---

*Systematic testing of all neonates in malaria endemic areas is not recommended as some neonates clear the parasitaemia spontaneously.*
Chapter 3: Care of the sick neonate

– Circulation: establish IV access and assess for signs of shock or poor perfusion. If signs of shock or poor perfusion present:
  • Administer IV bolus of 0.9% sodium chloride or Ringer lactate 10 mL/kg over 20 minutes.
  • Re-evaluate and repeat IV bolus after 20 to 30 minutes if necessary (maximum 3 boluses total).
– Check BGL:
  • If BGL < 45 mg/dL or < 2.5 mmol/L, administer by slow IV 2 mL/kg of 10% glucose.

Antimalarial treatment
Symptomatic neonates should be given an initial course of IV therapy (minimum 3 doses) due to their vulnerability and variable absorption of oral medications:

<table>
<thead>
<tr>
<th>artemesinin-combination therapy (ACT) is used in asymptomatic neonates with a positive malaria screen and in symptomatic neonates who have received 3 doses of IV or IM artemesinin and have clinically improved.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>artesunate</strong> IV/IM: 3 mg/kg slow IV injection (3 to 5 minutes) or, if not possible, slow IM injection, into anterior thigh.</td>
</tr>
<tr>
<td>– One dose on admission (H0)</td>
</tr>
<tr>
<td>– One dose 12 hours after admission (H12)</td>
</tr>
<tr>
<td>– One dose 24 hours after admission (H24)</td>
</tr>
<tr>
<td>– Thereafter one dose every 24 hours until the neonate can tolerate oral therapy (up to 7 days treatment).</td>
</tr>
</tbody>
</table>

See Appendix 5, Table 3 for artemesinin dosing table.

ACT preparations are unstable and require immediate administration. The combination artemesinin-sulfadoxine/pyrimethamine should not be used in the first weeks of life.

Antibiotic therapy for neonatal sepsis should be commenced in all symptomatic neonates due to the difficulty in differentiating the two diagnoses and the relatively higher frequency of neonatal sepsis (see Section 3.4.2).

Blood transfusion is indicated if Hb < 7 g/dL, or < 10 g/dL with associated respiratory distress or shock (see Appendix 4).

Monitor for jaundice and commence phototherapy if indicated (see Section 3.6.1)

Monitor feeding and fluid intake. Commence IV fluids in any neonate who is unstable or in severe respiratory distress (see Appendix 7.2).

Monitor BGL 2 to 4 hourly until stable, especially if on IV fluids.
Prevention
Preventive measures include:
– Adequate screening and treatment of malaria during pregnancy (see Essential Obstetric and Newborn Care, MSF14).
– Use of insecticide treated bed nets.

3.4.7 Oral candidiasis (thrust)
Oral candidiasis (“thrush”) is caused by the fungus Candida albicans and presents with white patches on the tongue, gums, cheeks or palate (see Figure A-16). Thrush can cause pain and difficulty feeding. It is important to enquire about infection of the vagina or nipples in the mother and treat if necessary.

Treatment for neonates:

nystatin PO: 100 000 IU (1 mL) oral suspension 4 times daily for 7 to 14 days, to be given after feeds.

3.4.8 Diaper dermatitis (nappy rash) and uro-genital candidiasis
Nappy rash is a common problem in the first few months of life. It is thought to occur as a result of moisture in the nappy area with irritation from urine and stool. Typically there is erythema of the skin in the convex zones that are in contact with the nappy; buttocks, perineum, upper thighs and lower abdomen (see Figure A-17). Erythematous papules may occur. To treat mild to moderate nappy rashes, advise caregivers to change soiled and wet nappies promptly and keep the nappy area clean and dry. If necessary, advise also the liberal use of barrier creams such as 10% zinc oxide ointment or petroleum jelly.

A secondary superimposed infection with Candida albicans may occur causing uro-genital candidiasis. This can be differentiated to simple nappy rash as candidal infections usually involve skin folds with satellite lesions and desquamation of the skin (see Figure A-18). Use topical treatment with 2% miconazole cream and liberal use of barrier creams (e.g. 10% zinc oxide or petroleum jelly):

2% miconazole cream: apply to lesions 2 times daily for 10 days or until lesions resolve

3.4.9 Infective skin lesions

Staphylococcal pustules
These are normally seen after the first few days of life and may affect any part of the body, but are more common in the neck, axillary and inguinal regions. It is usually caused by Staphylococcus aureus. Topical treatment is indicated, and if more than one lesion is present, systemic antibiotics should be commenced:

7.1% chlorhexidine digluconate dermal gel (delivering 4% chlorhexidine), apply to affected area 3 times daily until lesions heal
Plus
cefalexin PO for 7 days
0 to 7 days: 25 mg/kg every 12 hours
8 days to < 1 month: 25 mg/kg every 8 hours
Bullous impetigo

Bullous impetigo is caused by toxin-producing *Staphylococcus aureus*. Lesions usually appear in the later part of the first week or into the second week. It is often found in moist areas, including the diaper area, axillae and neck folds. Superficial vesicles progress rapidly to enlarging, flaccid bullae with sharp margins and no surrounding erythema (see Figure A-19). When the bullae rupture, ooze may result and reveal a red moist base. The lesions heal rapidly, without scarring.

Treatment should be commenced quickly to prevent proliferation or dissemination. The neonate should be isolated and monitored for signs of systemic disease. Neonates with periumbilical lesions are at risk of omphalitis. Topical and systemic therapy against *staphylococcus* includes:

<table>
<thead>
<tr>
<th>7.1% chlorhexidine digluconate</th>
<th>dermal gel (delivering 4% chlorhexidine), apply to affected area 3 times daily until lesions heal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plus</td>
<td><em>cefalexin</em> PO for 7 days</td>
</tr>
<tr>
<td>0 to 7 days: 25 mg/kg every 12 hours</td>
<td></td>
</tr>
<tr>
<td>8 days to &lt; 1 month: 25 mg/kg every 8 hours</td>
<td></td>
</tr>
</tbody>
</table>

In preterm neonates, or in severe cases treat for neonatal sepsis with IV *cloxacillin* and *gentamicin* (for dosing and duration see Section 3.4.2).

Mastitis

Mastitis is an infection of the nipple with *Staphylococcus aureus*. It usually presents with a unilateral, tender, erythematous, swollen breast which may develop into an abscess (see Figure A-20). Mastitis in neonates is usually a localised infection therefore systemic signs such as fever are absent. It should be differentiated from neonatal breast enlargement due to maternal hormones, which resolves spontaneously within one week of birth and requires no treatment. Treatment for mastitis is topical and systemic:

<table>
<thead>
<tr>
<th>7.1% chlorhexidine digluconate</th>
<th>dermal gel (delivering 4% chlorhexidine), apply to affected area 3 times daily until lesions heal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plus</td>
<td><em>cefalexin</em> PO for 7 days</td>
</tr>
<tr>
<td>0 to 7 days: 25 mg/kg every 12 hours</td>
<td></td>
</tr>
<tr>
<td>8 days to &lt; 1 month: 25 mg/kg every 8 hours</td>
<td></td>
</tr>
</tbody>
</table>

Ecthyma gangrenosum

This rare, systemic infection commonly occurs in immunocompromised children secondary to *Pseudomonas aeruginosa*, but it has been described in otherwise healthy neonates with sepsis due to many other organisms. It is characterised by the appearance of multiple erythematous vesicles or bullae which ulcerate and become necrotic (see Figure A-21). There may be tissue destruction in severe cases. Urgent treatment is required (see Section 3.4.2). If pseudomonas is suspected, treatment with *ceftazidime* is recommended.

| *ceftazidime* IV: |                                                                 |
| 0 to 7 days: 25 mg/kg every 24 hours |                                                                 |
| 8 days to < 1 month: 25 mg/kg every 12 hours |                                                                 |

\[d\] Note: *ceftazidime* IV is currently not available in MSF.
Staphylococcal scalded skin syndrome

Staphylococcal scalded skin syndrome is an extensive exfoliative dermatitis caused by toxin producing strains of *Staphylococcus aureus*. Generalised erythema is followed by superficial blistering of the skin which desqumates giving the skin a scalded appearance (see Figure A-22). Exfoliative toxins are spread in the bloodstream, causing widespread lesions distant to the original site of infection. The infection should be treated as severe sepsis (see Section 3.4.2), with skin care as for burns.

Neonatal necrotising cellulitis, myositis and fasciitis

These necrotising soft tissue infections are characterised by rapid and extensive destruction of tissue and are usually caused by polymicrobial infections with group A *Streptococcus*, *Staphylococcus aureus* and anaerobes. Occasionally, monomicrobial infections can occur. The difference between the 3 conditions is related to the depth of infection: neonatal necrotising cellulitis (see Figure A-23) is the most superficial, affecting only the skin; neonatal necrotising fasciitis involves subcutaneous tissues and fascia (see Figure A-24); while neonatal necrotising myositis is a deeper infection involving muscle (see Figure A-25 and Figure A-26). Clinically, they can be very difficult to differentiate and often coexist (see Figure A-27) but regardless of depth, treatment for all necrotising soft tissue infections is the same. Associated mortality is very high in the acute infective stage and urgent medical and surgical treatment is required.

*Antibiotic combination therapy*

**Clindamycin, ceftriaxone +/- gentamicin** IV as first line. Metronidazole IV can be used as an alternative to clindamycin. (See Section 3.4.4 for dosages and duration.) Antibiotics may be tailored where culture and sensitivity is available.

Necrotic lesions often require repeated surgical debridement and the healing process is lengthy, necessitating prolonged hospitalisation (see Section 3.4.4).
Chapter 3: Care of the sick neonate

3.5 Gastrointestinal problems

3.5.1 Vomiting

Vomiting is the forceful throwing up of stomach contents and can represent a serious underlying condition. Neonates presenting with vomiting associated with other signs of illness, such as fever, loss of weight/failure to thrive, or signs of bowel obstruction require prompt assessment and management (see Table 3.11).

Differential diagnoses

– ‘Possets’ or small, frequent vomits in an otherwise well and thriving neonate is common and normal.
– Gastro-oesophageal reflux, characterised by the effortless regurgitation, is also common and is not of clinical concern if there is no weight loss or failure to thrive. Observe next feed and provide parental advice and reassurance.

Table 3.11 - Clinical features associated with vomiting of clinical concern

<table>
<thead>
<tr>
<th>Clinical presentation</th>
<th>Differential diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vomit contains blood</td>
<td>Swallowed maternal blood</td>
</tr>
<tr>
<td></td>
<td>Bleeding due to haemorrhagic disease of newborn (HDN)</td>
</tr>
<tr>
<td></td>
<td>Stress gastritis</td>
</tr>
<tr>
<td>Vomit is bile</td>
<td>Bowel obstruction</td>
</tr>
<tr>
<td></td>
<td>Imperforate anus</td>
</tr>
<tr>
<td>Abdominal distension</td>
<td>Bowel obstruction</td>
</tr>
<tr>
<td></td>
<td>NEC</td>
</tr>
<tr>
<td>Delayed passage of meconium</td>
<td>Bowel obstruction</td>
</tr>
<tr>
<td></td>
<td>Imperforate anus</td>
</tr>
<tr>
<td>Projectile vomiting</td>
<td>Duodenal obstruction</td>
</tr>
<tr>
<td></td>
<td>Pyloric stenosis</td>
</tr>
<tr>
<td>Sick neonate</td>
<td>Sepsis/infection</td>
</tr>
<tr>
<td></td>
<td>Metabolic problem</td>
</tr>
<tr>
<td></td>
<td>NEC</td>
</tr>
<tr>
<td>Failure to thrive</td>
<td>Sepsis/infection</td>
</tr>
<tr>
<td></td>
<td>Gastro-oesophageal reflux</td>
</tr>
<tr>
<td>Associated diarrhoea</td>
<td>Gastroenteritis</td>
</tr>
</tbody>
</table>

3.5.2 Bowel obstruction

Neonatal bowel obstruction is the partial or complete block of passage of contents through the small or large intestine. It is a medical emergency. Early assessment and management is crucial, as delayed treatment can result in the loss of large amounts of functioning bowel.
Clinical features
– Vomiting – with or without bile (never ignore bilious vomiting in a neonate).
– Abdominal distension
– Increased gastric residuals before feeding (see Appendix 8).
– Failure to pass meconium in the first 24 hours of life.

Probable causes of obstruction include:
– Obstruction without bilious vomiting: suggests upper intestinal obstruction including pyloric stenosis and duodenal atresia/stenosis.
– Obstruction with bilious vomiting: may be due to duodenal or ileojejunal atresia, malrotation with volvulus, meconium ileus or NEC.
– Obstruction with marked abdominal distension: suggests more distal bowel obstruction.
Differential diagnoses include ileal atresia, Hirschsprung’s disease, meconium ileus and imperforate anus.

Investigations
– Plain abdominal x-rays, including supine and decubitus views (where available)
– FBE and blood culture (where available)

Management

Emergency management (if necessary)
– Airway: maintain head and neck in neutral position to keep airway patent.
– Breathing: commence oxygen via nasal prongs and monitor oxygen saturations (aim 90-95%). Use bag and mask ventilation if neonate apnoeic or RR < 20/minute.
– Circulation: establish IV access and assess for signs of shock or poor perfusion.
If signs of shock or poor perfusion present:
• Administer IV bolus of 0.9% sodium chloride or Ringer lactate 10 mL/kg over 20 minutes.
• Re-evaluate and repeat IV bolus after 20 to 30 minutes if necessary (maximum 3 boluses total).
– Check BGL:
• If BGL < 45 mg/dL or < 2.5 mmol/L, administer by slow IV 2 mL/kg of 10% glucose.

General measures
– Nurse supine with head elevated.
– Stop feeds and make the neonate “nil by mouth”.
– Insert an O/NGT (size CH8). Leave on free drainage and aspirate stomach contents every 60 minutes. The amount and type of fluid aspirated should be recorded (e.g. containing blood, bile).
– Commence IV fluids: maintenance fluids + replacement of nasogastric aspirates mL for mL with 0.9% sodium chloride every 4 hours (see Appendix 7).
– Monitor BGL every 2 to 3 hours.
– If it is difficult to rule out NEC, treat as for NEC with combination antibiotic therapy of IV ampicillin + metronidazole + gentamicin (see Section 3.5.6).
– Where possible, consider referral and transfer to a surgical facility.

3.5.3 Upper gastrointestinal bleeding

Upper gastrointestinal (GI) bleeding refers to bleeding in the upper gastrointestinal tract (oesophagus, stomach and duodenum). It commonly presents with haematemesis (vomiting of red blood or coffee-ground material) and/or melaena (black, tarry stools). Upper GI bleeding is rare in the first month of life, but can occur due to an ulcer, trauma or underlying coagulation disorder.
Table 3.12 - Causes of upper GI bleeding

<table>
<thead>
<tr>
<th>Cause</th>
<th>Features and Risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stress gastritis/ulcer</strong></td>
<td>Critical illness, perinatal asphyxia, severe prolonged sepsis Drugs (e.g. corticosteroids, aminophylline, caffeine Maternal use of drugs in 3rd trimester (e.g. NSAIDS)</td>
</tr>
<tr>
<td><strong>Trauma</strong></td>
<td>O/NGT insertion Vigorous suctioning</td>
</tr>
<tr>
<td><strong>HDN</strong></td>
<td>Neonate did not receive vitamin K injection at birth.</td>
</tr>
<tr>
<td><strong>Coagulopathy</strong></td>
<td>Infection, liver failure, congenital coagulation defect. Other features likely: large cephalhaematoma, oozing from the umbilical stump, prolonged bleeding after blood sampling, intracranial haemorrhage. Jaundice can indicate underlying liver disease.</td>
</tr>
<tr>
<td><strong>Swallowed maternal blood</strong></td>
<td>Neonate is clinically well with normal examination. Blood swallowed during delivery usually presents 6 to 12 hours after birth. Blood swallowed from cracked nipples normally presents after 24 hours in a breastfed neonate.</td>
</tr>
</tbody>
</table>

**Investigations**

Depending on the clinical findings:
- Check HB or FBE where available.
- Stool specimen
- Liver function tests and coagulation profile, where available

**Management**

In case of massive haemorrhage or shock, emergency treatment and stabilisation:
- Airway: maintain head and neck in neutral position to keep airway patent.
- Breathing: commence oxygen via nasal prongs and monitor oxygen saturations (aim 90-95%). Use bag and mask ventilation if neonate apnoeic or RR < 20/minute.
- Circulation: establish IV access and assess for signs of shock or poor perfusion. If signs of shock or poor perfusion present:
  - Administer IV bolus of **0.9% sodium chloride** or **Ringer lactate** 10 mL/kg over 20 minutes.
  - Re-evaluate and repeat IV bolus after 20 to 30 minutes if necessary (maximum 3 boluses total).
- Check BGL:
  - If BGL < 45 mg/dL or < 2.5 mmol/L, administer by slow IV 2 mL/kg of **10% glucose**.
- Administer blood transfusion (see **Appendix 4**).
- Insert NGT to identify severity and continuity of bleeding and to prevent aspiration.
- Treat with **vitamin K**:
  - **Phytonadione (vitamin K)** slow IV or IM: 1 mg single dose (≈ 0.1 mL of a 2 mg/0.2 mL vial).
  - Can be repeated after 6 hours depending on clinical response and coagulation results (if available). For mild bleeding, IM injection may be given (unless coagulopathy or HDN).
- Consider antibiotics to cover for neonatal sepsis if there is fever or the neonate appears sick despite above management.
If haemodynamically stable, treat probable underlying cause:

**Suspected gastritis/stress ulcer**
- Stop drugs that might be causing bleeding (such as corticosteroids, caffeine).
- Continue milk feeds if feasible.
- Administer an antacid\(^{15}\):

  **omeprazole** slow IV: 1 mg/kg once daily for 10 days

**Trauma**
- In most cases observation is all that is needed. If the tube is too large, replace with a smaller size.

**Swallowed maternal blood**
- Blood swallowed during birth will clear from the GI tract. Reassurance and expectant management is all that is needed.
- If the mother’s nipples are cracked or bleeding, she may require medical attention and lactation advice about nipple attachment.

**Prevention**
All neonates should receive **vitamin K** injection at birth for prevention of HDN (see Chapter 2, Section 2.3.2).

### 3.5.4 Lower gastrointestinal bleeding

Lower GI bleeding includes bleeding sources in the small bowel and colon. Haematochezia refers to passage of bright red blood per rectum and usually suggests lower GI bleeding, typically from the colon or anus.

Rarely, it is due to upper GI bleeding, due to rapid transit time or massive upper GI bleeding.

**Table 3.13 - Causes of lower GI bleeding**

<table>
<thead>
<tr>
<th>Cause</th>
<th>Features and Risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEC</td>
<td>Neonate who appears sick with other clinical signs, including abdominal distension, tenderness and/or vomiting (see Section 3.5.6).</td>
</tr>
<tr>
<td>Acute infectious colitis</td>
<td>Fever, unwell, diarrhoea due to intestinal pathogens causing bleeding (<em>Shigella, Salmonella, Campylobacter, Yersinia</em>).</td>
</tr>
<tr>
<td>Anorectal fissures</td>
<td>Streaks of bright red blood in the stool. Can be due to constipation or prolonged diarrhoea.</td>
</tr>
<tr>
<td>Mechanical</td>
<td>Associated with signs of bowel obstruction. Associated distension, tenderness or vomiting. Malrotation with volvulus, Hirschsprung’s disease with enterocolitis, Meckel’s diverticulum.</td>
</tr>
<tr>
<td>HDN</td>
<td>Neonate did not receive vitamin K injection at birth.</td>
</tr>
</tbody>
</table>
### Cause

<table>
<thead>
<tr>
<th>Cause</th>
<th>Features and Risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coagulopathy</td>
<td>Infection, liver failure, congenital coagulation defect. Other features likely: large cephalhaematoma, oozing from the umbilical stump, prolonged bleeding after blood sampling, intracranial haemorrhage. Jaundice can indicate underlying liver disease.</td>
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<td>Neonate is clinically well with normal examination. Blood swallowed during delivery usually presents 6 to 12 hours after birth. Blood swallowed from cracked nipples normally presents after 24 hours in a breastfed neonate.</td>
</tr>
</tbody>
</table>

### Investigations

Depending on the clinical findings:
- Hb or FBE where available
- Stool specimen
- Liver function test and coagulation profile, where available

### Management

In case of massive haemorrhage or shock, emergency treatment and stabilisation:
- Airway: maintain head and neck in neutral position to keep airway patent.
- Breathing: commence oxygen via nasal prongs and monitor oxygen saturations (aim 90-95%). Use bag and mask ventilation if neonate apnoeic or RR < 20/minute.
- Circulation: establish IV access and assess for signs of shock or poor perfusion.
  - If signs of shock or poor perfusion present:
    - Administer IV bolus of **0.9% sodium chloride** or Ringer lactate 10 mL/kg over 20 minutes.
    - Re-evaluate and repeat IV bolus after 20 to 30 minutes if necessary (maximum 3 boluses total).
  - Check BGL:
    - If BGL < 45 mg/dL or < 2.5 mmol/L, administer by slow IV 2 mL/kg of **10% glucose**.
  - Administer blood transfusion (see Appendix 4).
  - Treat with *vitamin K*:
    - **Phytomenadione** (vitamin K) slow IV or IM: 1 mg single dose (= 0.1 mL of a 2 mg/0.2 mL vial). Can be repeated after 6 hours depending on clinical response and coagulation results (if available). For mild bleeding, IM injection may be given (unless coagulopathy or HDN).

If haemodynamically stable, manage probable underlying cause:

#### Anal fissure or rectal trauma
- Observation and expectant management.
- Petroleum jelly applied once to the anus may promote healing.
- Avoid taking intra-rectal temperature.

#### Surgical conditions
- Manage as for bowel obstruction (see Section 3.5.2) and arrange immediate referral for surgical evaluation.
**Necrotising enterocolitis**
- Stop feeds and see Section 3.5.6.

**Prevention**
All neonates should receive vitamin K injection at birth for prevention of HDN (see Chapter 2, Section 2.3.2).

### 3.5.5 Diarrhoea and dehydration

Diarrhoea is defined as the passage of 3 or more loose or watery stools per day, or more often than usual. The high mortality from diarrhoeal disease is due to acute dehydration. This can be prevented by careful monitoring and adequate rehydration.

Diarrhoea is rare in the early neonatal period and the following recommendations are for term neonates who present in the late neonatal period (after 2 weeks of life). Causes of diarrhoea include: acute infectious diarrhoea (usually viral), incorrect formula preparation in a non-breastfed neonate, NEC, surgical causes, cow’s milk protein colitis, or a side effect of phototherapy.

**Clinical features**

**Assess for dehydration**

Take a history:
- Duration of illness, frequency, consistency and colour of stools (including presence of blood in stools).
- Milk intake: how is the neonate fed, reduced feeding, any vomiting.
- Urine output (number of wet nappies).
- Presence of fever raises the suspicion for neonatal sepsis.

**Clinical assessment:**
- If possible, perform a naked weight on the neonate and compare with any available recent weights to estimate degree of dehydration.
- Assess degree of dehydration (see Table 3.14)

**Table 3.14 - Assessment of dehydration**

<table>
<thead>
<tr>
<th>Degree of dehydration</th>
<th>Clinical signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild (&lt; 5%)</td>
<td>No clinical signs</td>
</tr>
<tr>
<td>Moderate (6 to 9%)</td>
<td>Delayed capillary refill time (CRT) &gt; 2 seconds, increased RR, mild decreased tissue turgor (skin fold goes back slowly)</td>
</tr>
<tr>
<td>Severe (&gt; 10%)</td>
<td>Very delayed CRT &gt; 3 seconds, mottled skin, deep, acidotic breathing, decreased tissue turgor (skin fold goes back very slowly), other signs of shock (tachycardia, weak pulse, cold peripheries, irritable or reduced conscious state)</td>
</tr>
</tbody>
</table>

Other signs (such as sunken eyes, sunken fontanelle, dry mucous membranes) may be considered but are less reliable than the above signs.
Management

Emergency management (if necessary)
- Airway: maintain head and neck in neutral position to keep airway patent.
- Breathing: commence oxygen via nasal prongs and monitor oxygen saturations (aim 90-95%). Use bag and mask ventilation if neonate apnoeic or RR < 20/minute.
- Circulation: establish IV access and assess for signs of shock or poor perfusion.
  If signs of shock or poor perfusion present:
  • Administer IV bolus of 0.9% sodium chloride or Ringer lactate 10 mL/kg over 20 minutes.
  • Re-evaluate and repeat IV bolus after 20 to 30 minutes if necessary (maximum 3 boluses total).
- Check BGL:
  • If BGL < 45 mg/dL or < 2.5 mmol/L, administer by slow IV 2 mL/kg of 10% glucose.

Management of dehydration
Mild dehydration:
- Continue exclusive breastfeeding Increase frequency of feeds.

Moderate dehydration:
- Continue exclusive breastfeeding at increased frequency.
- Give an extra 10 mL/kg of breast milk or oral rehydration solution (ORS) for every episode of diarrhoea.
- If not tolerating oral fluids, insert an O/NGT and commence nasogastric rehydration with ORS at 150 mL/kg/day. Reassess after 6 hours and commence breastfeeding if neonate able to tolerate oral fluids.
- If there is ongoing severe vomiting, start IV fluids ½ 0.9% sodium chloride + ½ 10% glucose at 150 mL/kg/day. Reassess after 12 hours and commence breastfeeding as soon as the neonate is able to feed, or, if necessary, change IV fluids to 1/5 0.9% sodium chloride + 4/5 10% glucose.

Severe dehydration:
- After initial bolus treatment, correct dehydration slowly over 24 hours.
- Start IV fluids ½ 0.9% sodium chloride + ½ 10% glucose at 200 mL/kg/day.
- If unable to insert an IV line, insert a nasogastric tube and give ORS at 200 mL/kg/day.
- Commence breastfeeding as soon as the neonate is able to feed. Adjust the fluid rate according to oral intake and clinical degree of dehydration.

Zinc is not recommended for gastroenteritis in neonates.16

Antibiotic therapy
- Usually not indicated, but should be considered in case of:
  • Blood in the stools: consider possibility of infectious colitis or NEC.
  • Associated fever – treat for sepsis (see Section 3.4.2).

Monitoring and observation
Neonates with severe dehydration should be admitted to hospital and meticulously monitored.
- Vital signs (HR, RR, oxygen saturation) should be assessed every 15 minutes and then every hour until there is clinical improvement.
- BGL should be monitored every 2 to 3 hours while on IV fluids.
- Urine output (normally 1 to 4 mL/kg/hour). If urine output has not returned to normal after 6 hours of treatment, increase IV infusion by 20 mL/kg/day.
- Fluid balance – record fluid intake and losses (vomit, diarrhoea).
- Weigh every 4 to 6 hours.
- Clinical signs of dehydration and fluid overload.
Prevention

Exclusive breastfeeding protects neonates from most common intestinal infections and reduces the frequency and severity of diarrhoeal stools. Use of water or homemade drinks (such as herbal teas) should not be used. Exclusive breastfeeding is recommended to the age of 6 months.

Family and health-care workers should wash hands with soap and water to prevent further spread of an infectious cause. Linen of infected neonate should not be shared with others.

3.5.6 Necrotising enterocolitis

NEC is an inflammatory condition of the gut and is primarily a disease of neonates. It consists of a vascular component in which there is ischaemia and necrosis of intestinal walls, and an infectious component attributed to multiple pathogens. It is a serious and potentially life threatening disease which requires urgent management.

Risk factors for NEC include:
– Prematurity/LBW: incidence increases with decreasing gestational age and birth weight.
– Hypoxia/perinatal asphyxia
– Enteral feeding
– Formula feeding
– Intestinal infection or sepsis
– Polycythaemia/hyperviscosity (transfusion/dehydration)

Clinical features

NEC generally appears in the second or third week of life after the introduction of enteral feeds. Clinical signs are highly variable ranging from mild feed intolerance to profound systemic illness.

Abdominal signs

Abdominal distension, tenderness, vomiting, bilious drainage from enteral feeding tubes and bloody stools.

Systemic signs

Non-specific and include temperature instability, lethargy, poor feeding, apnoea and respiratory failure. In severe cases the neonate may present with signs of septic shock.

Differential diagnoses

– Dysmotility of prematurity
– Septic ileus
– Bowel obstruction
– Gastroenteritis
– Anal fissure
– Cow’s milk protein enterocolitis

Investigations

– Hb and BGL
– Abdominal X-ray: looking for diffuse gaseous distension, dilated bowel loops, bowel wall thickening and pneumotosis intestinalis (submucosal cystic appearance)
– Septic screen: blood culture, FBE, CRP (where available)
Management

Emergency management (if necessary)
- Airway: maintain head and neck in neutral position to keep airway patent.
- Breathing: commence oxygen via nasal prongs and monitor oxygen saturations (aim 90-95%). Use bag and mask ventilation if neonate apnoeic or RR < 20/minute.
- Circulation: establish IV access and assess for signs of shock or poor perfusion.
  If signs of shock or poor perfusion present:
  • Administer IV bolus of 0.9% sodium chloride or Ringer lactate 10 mL/kg over 20 minutes.
  • Re-evaluate and repeat IV bolus after 20 to 30 minutes if necessary (maximum 3 boluses total).
- Check BGL:
  • If BGL < 45 mg/dL or < 2.5 mmol/L, administer by slow IV 2 mL/kg of 10% glucose.

Fluid management and feeding
- Insert a nasogastric tube and leave on free drainage.
- Stop feeds for at least 5 to 10 days.
- Commence IV fluids.
- Monitor BGL regularly to avoid hypoglycaemia (see Section 3.1.4).
- Cautious re-feeding can start when:
  • Abdominal examination is normal, and
  • Stools are normal, and
  • Gastric aspirates are < 3 mL/kg every 3 hours and clear for at least 2 days (see Appendix 8).

Antibiotic therapy
First line treatment is the combination ampicillin slow IV (3 minutes) + gentamicin slow IV (3 minutes) or IM + metronidazole IV infusion (over 60 minutes).
Ampicillin + metronidazole duration of 10 to 14 days depending on severity of illness and clinical response. Gentamicin duration of 5 daysa.

<table>
<thead>
<tr>
<th>Age range</th>
<th>&lt; 2 kg</th>
<th>≥ 2 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 7 days</td>
<td>ampicillin IV 50 mg/kg every 12 hours + gentamicin IV 3 mg/kg every 24 hours + metronidazole IV 15 mg/kg as a loading dose then after 24 hours 7.5 mg/kg every 12 hours</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ampicillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours + metronidazole IV 15 mg/kg as a loading dose then after 24 hours 7.5 mg/kg every 12 hours</td>
<td></td>
</tr>
<tr>
<td>8 days to &lt; 1 month</td>
<td>ampicillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours + metronidazole IV 15 mg/kg as a loading dose then after 24 hours 7.5 mg/kg every 12 hours</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ampicillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours + metronidazole IV 15 mg/kg every 12 hours</td>
<td></td>
</tr>
</tbody>
</table>

a Gentamicin should not be continued beyond 5 days maximum due to potential toxicity and inability to measure serum drug levels in many settings.
An alternative to gentamicin is cefotaxime slow IV injection (3 to 5 minutes) or IV infusion (20 to 60 minutes) in 0.9% sodium chloride or 5% glucose or IM.

<table>
<thead>
<tr>
<th></th>
<th>0 to 7 days</th>
<th>8 days to &lt; 1 month</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2 kg</td>
<td>cefotaxime</td>
<td>cefotaxime</td>
</tr>
<tr>
<td>≥ 2 kg</td>
<td>IV 50 mg/kg every 12 hours</td>
<td>IV 50 mg/kg every 8 hours</td>
</tr>
</tbody>
</table>

For suspected invasive fungal infection (prolonged use of broad spectrum antibiotics in a preterm or VLBW neonate, candidiasis of the perineum) consider adding IV fluconazole.

<table>
<thead>
<tr>
<th></th>
<th>fluconazole</th>
</tr>
</thead>
<tbody>
<tr>
<td>PO or IV infusion (over 20 minutes; do not exceed infusion rate of 5 mL/minute):</td>
<td></td>
</tr>
<tr>
<td>0 to &lt; 14 days: 6-12 mg/kg every 72 hours, continued according to clinical response</td>
<td></td>
</tr>
<tr>
<td>14 to 28 days: 6-12 mg/kg every 48 hours, continued according to clinical response</td>
<td></td>
</tr>
</tbody>
</table>

**Analgesia**

Management includes minimal handling and pain management (IV paracetamol, IV morphine) (see Chapter 8, Section 8.1).

**Blood transfusion**

- Consider if haemoglobin < 7 g/dL or < 10 g/dL with associated respiratory distress or shock (see Appendix 4).

Definitive management of NEC involves consultation with a paediatric surgeon and potential bowel resection where available. In contexts where surgical services are available, discuss management options early.

**Monitoring and observation**

Neonates with suspected NEC require intensive monitoring including:
- Vital signs
- Record contents and amount of drainage from NGT
- Fluid balance
- Assessment of level of pain
- BGL
- Laboratory and radiological monitoring where facilities available
- Stool inspection

**Prevention**

Preventative strategies include:
- Antenatal corticosteroids
- Exclusive feeding with breast milk and gradual upgrading of feeds
- Early intervention for suspected NEC (total gut rest)
3.6 Haematological problems

3.6.1 Jaundice

Jaundice refers to yellow discolouration of the skin and sclerae and is caused by increased levels of bilirubin in the blood (hyperbilirubinaemia). It is one of the most common problems in neonates, presenting in about 60% of term and 80%\textsuperscript{17} of preterm neonates. Neonatal jaundice is generally harmless, but very high levels of serum bilirubin (SBR) may lead to kernicterus (permanent brain damage or death). Jaundice occurring in the first 24 hours of life or jaundice extending to the hands and feet is abnormal and needs urgent phototherapy where available.

Neonates who are preterm, breastfeeding, have bruising or cephalhaematoma, have sepsis, or poor feeding and are dehydrated are at increased risk of developing jaundice. Incompatibility between maternal and foetal blood group or a family history of severe jaundice in siblings are also risk factors of neonatal jaundice.

Clinical features

Examine neonates for jaundice in natural daylight once or twice a day in the first 3 to 5 days of life. Press on the neonate’s skin and look to see if it is yellow immediately after removing pressure.

Jaundice typically starts on the face and extends to the chest, abdomen and extremities. Referring to Figure 3.2, use Kramer’s rule\textsuperscript{18} to estimate the approximate SBR level by the level of skin discolouration. Note that this estimation may not be reliable in pigmented skin.

<table>
<thead>
<tr>
<th>Zone</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of skin ‘colouring’</td>
<td>Head and neck</td>
<td>Chest</td>
<td>Lower body and thighs</td>
<td>Arms and below knees</td>
<td>Hands and feet</td>
</tr>
<tr>
<td>Serum bilirubin (micromoles/L)</td>
<td>100</td>
<td>150</td>
<td>200</td>
<td>250</td>
<td>&gt; 250</td>
</tr>
</tbody>
</table>

Figure 3.2 - Estimation of SBR level according to Kramer’s rule

Types of hyperbilirubinaemia\textsuperscript{19}

Physiological jaundice is common. It is due to a physiological increase in bilirubin production with an immature liver to metabolise bilirubin. Usually presents 24 to 72 hours after birth. Consider in neonates that are clinically well, have no risk factors for severe jaundice and are zone 4 or less (Kramer’s rule).

Breastfeeding jaundice is common in breastfed neonates. Physiological jaundice is exacerbated due to sub-optimal breastfeeding or lactation failure which leads to inadequate milk intake. The neonate may have significant weight loss and be dehydrated. Usually presents between 24 and 72 hours of life and resolves in 1 to 2 weeks. Associated with higher risk of severe jaundice and kernicterus.
Breast milk jaundice is different to breastfeeding jaundice. It usually presents around day 5 of life and persists beyond 2 to 3 weeks of life. It is thought to be caused by substances in breast milk that reduce breakdown of bilirubin and enhance reabsorption of bilirubin into the bloodstream. Usually a prolonged but mild jaundice.

Pathological jaundice is likely if there is:
- Jaundice extending to hands and feet
- Jaundice appears within first 24 hours, after first week, or persists > 2 weeks of life.
- High level of SBR
- Evidence of conjugated bilirubin present (dark urine)

More common underlying conditions that cause pathological jaundice are listed in Table 3.15. Jaundice appearing in the first 24 hours of life usually indicates haemolysis. Haemolytic jaundice occurs with Rhesus (Rh) factor incompatibility, ABO blood group incompatibility or glucose-6-phosphate dehydrogenase (G6PD) deficiency, amongst other more rare conditions.

Table 3.15 - Underlying causes of hyperbilirubinaemia (note: this is not exhaustive)

<table>
<thead>
<tr>
<th>Presentation</th>
<th>Underlying causes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Too early:</strong> Jaundice occurring &lt; 24 hours of age (or &lt; 48 hours if &lt; 1500 g)</td>
<td>• Usually haemolytic cause with excess bilirubin production (such as ABO incompatibility or Rh isoimmunisation) • Sepsis (due to haemolysis) • Hepatitis – rare (e.g. toxoplasmosis, rubella, CMV, herpes, syphilis)</td>
</tr>
<tr>
<td><strong>Too high:</strong> Jaundice extending to palms of hands and soles of feet (Kramer 5), or lower arms/legs if &lt; 1500 g (Kramer 4)</td>
<td>• Breastfeeding jaundice • Haemolysis • Resorption of haematomas (e.g. cephalhaematoma, bruising) • Sepsis or malaria (especially if other signs such as fever, lethargy)</td>
</tr>
<tr>
<td><strong>Too long:</strong> Persistence of jaundice &gt; 14 days of age (or 21 days if &lt; 1500 g)</td>
<td>• Breast milk jaundice • Dehydration • Haemolysis • Infection/sepsis • Bowel obstruction (increased entero-hepatic circulation) • Hypothyroidism</td>
</tr>
<tr>
<td>Jaundice with fever</td>
<td>Consider malaria and/or sepsis.</td>
</tr>
</tbody>
</table>

a Most causes of jaundice are due to unconjugated hyperbilirubinaemia. Conjugated hyperbilirubinaemia occurs with hepatic or post-hepatic dysfunction or obstruction. Bilirubin is conjugated in the liver, which is then eliminated via bile passing to the intestinal tract.
b Rh factor incompatibility occurs if mother is Rh-negative and neonate is Rh-positive. Haemolysis can be significant.
c Mother and foetus have incompatible ABO blood group (mother has blood group O and neonate has A or B blood group). Incidence: 15–20% of all pregnancies.
d G6PD deficiency: consider if significant jaundice in family history or in malaria-endemic contexts (sub-Saharan Africa, Arabic peninsula and parts of Asia/Mediterranean.).
e Sepsis is a known cause of haemolysis though the mechanism is unknown. There is a suggestion that increased oxidative stress due to sepsis damages neonatal red blood cells that are susceptible to cell injury.
Investigations

In neonates with any visible jaundice:
- Hb and FBE
- Malaria blood film
- SBR where available
- Blood type of neonate and mother and Coomb’s test (where available)

Management

Ensure adequate hydration
- If able to breastfeed, neonate should be put to the breast 8 to 12 times per day in the first several days. If supplementation is required, this should be done with expressed breast milk (in some cases formula may be needed temporarily), but not water.
- If oral intake is inadequate, supplement with NGT or IV fluids (see Appendix 7.2).

Treat hyperbilirubinaemia
- Treatment is guided by clinical features, presence of risk factors and, where available, SBR levels.
- Phototherapy (treatment with light) reduces high SBR levels. See Appendix 2 for the procedure.
- Exchange transfusion is used for severe hyperbilirubinaemia. The neonate’s blood is replaced by donor blood, rapidly removing bilirubin and haemolytic antibodies.
- Where SBR cannot be measured, initiate phototherapy treatment according to clinical features and presence of risk factors (see Table 3.16):

Table 3.16 - Phototherapy treatment based on clinical features and risk factors

<table>
<thead>
<tr>
<th>Age</th>
<th>Clinical features and risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>Any visible jaundice</td>
</tr>
<tr>
<td>Day 2</td>
<td>&lt; 1500 g or risk factors: any visible jaundice</td>
</tr>
<tr>
<td></td>
<td>&gt; 1500 g: extensive jaundice (grade 3)</td>
</tr>
<tr>
<td>Day 3 or more</td>
<td>&lt; 1500 g or risk factors: extensive jaundice (grade 4)</td>
</tr>
<tr>
<td></td>
<td>&gt; 1500 g: extensive jaundice (grade 5)</td>
</tr>
</tbody>
</table>

- Where SBR level can be measured, commence phototherapy treatment based on SBR level and risk factors (gestational age and clinical condition) (Table 3.17).
- If SBR levels are above the threshold requiring exchange transfusion (Table 3.18), commence phototherapy immediately while preparing exchange transfusion or awaiting urgent transfer to a facility where it is possible.

Note: where exchange transfusion is not available or referral is not possible, treat with phototherapy. (This will apply to most contexts.)

Table 3.17 - Phototherapy treatment threshold based on SBR level

<table>
<thead>
<tr>
<th>Age</th>
<th>Serum bilirubin level (micromoles/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Healthy neonates ≥ 35 weeks gestation</td>
</tr>
<tr>
<td>Day 1</td>
<td>Any visible jaundice</td>
</tr>
<tr>
<td>Day 2</td>
<td>260</td>
</tr>
<tr>
<td>Day 3 or more</td>
<td>310</td>
</tr>
</tbody>
</table>
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Table 3.18 - Exchange transfusion treatment threshold based on SBR level\textsuperscript{25}

<table>
<thead>
<tr>
<th>Age</th>
<th>Serum bilirubin level (micromoles/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Healthy neonates ≥ 35 weeks gestation</td>
</tr>
<tr>
<td>Day 1</td>
<td>260</td>
</tr>
<tr>
<td>Day 2</td>
<td>425</td>
</tr>
<tr>
<td>Day 3 or more</td>
<td>425</td>
</tr>
</tbody>
</table>

**Stopping phototherapy**

Phototherapy should be stopped once:
- Neonate is well and there are no signs of jaundice on the palms or soles.
- SBR level is 50 micromoles/L below the phototherapy threshold.

Review neonate and, where possible, repeat SBR level, 12 to 18 hours after stopping phototherapy to check for rebound hyperbilirubinaemia.

**Treat probable underlying cause**

If infection or sepsis is suspected, manage as for neonatal sepsis (see Section 3.4.2). First line antibiotic combination therapy is ampicillin slow IV (3 minutes) for 7 to 10 days + gentamicin slow IV (3 minutes) or IM for 5 days:

| 0 to 7 days | < 2 kg | ampicillin IV 50 mg/kg every 12 hours + gentamicin IV 3 mg/kg every 24 hours |
| 8 days to < 1 month | ≥ 2 kg | ampicillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours |

If congenital malaria is suspected, start appropriate anti-malarial treatment (see Section 3.4.6).

**Prevention**

Primary prevention involves early frequent breastfeeding (8 to 12 times per day for the first few days). Risk factors should be checked and the neonate examined for jaundice prior to hospital discharge.

3.6.2 Anaemia

In neonates, anaemia refers to Hb levels lower than expected for the neonate’s age (< 5\textsuperscript{th} centile).

Table 3.19 - Lower limit for Hb in term neonates according to age\textsuperscript{26}

<table>
<thead>
<tr>
<th>Age</th>
<th>Hb (g/dL) (&lt; 5\textsuperscript{th} centile)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 3 days</td>
<td>14.5</td>
</tr>
<tr>
<td>2 weeks</td>
<td>13.4</td>
</tr>
<tr>
<td>1 month</td>
<td>10.7</td>
</tr>
<tr>
<td>2 months</td>
<td>9.4</td>
</tr>
</tbody>
</table>
Clinically, anaemia is characterised by the physiological impact of reduced oxygen delivery to the tissues. In compensated anaemia the signs are often subtle and include pallor (sometimes jaundice), feeding difficulties, poor weight gain and tachycardia. Signs of decompensated anaemia include increasing oxygen requirement, respiratory distress, apnoea and signs of heart failure.

After birth, all neonates have a physiological decrease in Hb level during the first 2 to 3 months of life. In very preterm neonates this decrease occurs earlier and is more pronounced.

Anaemia may result from blood loss, decreased red blood cell (RBC) production, or increased RBC destruction:

1. **Blood loss**
   - Obstetric causes: placental abruption, placenta praevia, cord accidents
   - Foeto-maternal haemorrhage
   - Twin-twin transfusion
   - Internal haemorrhage: cephalhaematoma, subgaleal haemorrhage
   - Iatrogenic blood loss (due to frequent blood sampling)

2. **Decreased RBC production**
   - Anaemia of prematurity due to transient deficiency of erythropoietin (see Chapter 5, Section 5.4.3).
   - Bone marrow suppression (e.g. viral infection)
   - Nutritional deficiency (e.g. iron deficiency) – usually presents after neonatal period

3. **Increased RBC destruction:**
   - Intrinsic causes:
     - Hereditary RBC disorders such as G6PD deficiency, hereditary spherocytosis, thalassemia
   - Extrinsic causes:
     - Immune haemolysis (e.g. Rh or ABO incompatibility)
     - Acquired haemolysis (e.g. associated with congenital infections, malaria, bacterial sepsis, drugs)

Neonates at risk of developing anaemia include preterm, low birth weight neonates or those with severe illness or blood loss.

**Investigations**
- Haemoglobin
- FBE, blood group, Coomb’s test, reticulocyte count (where available)
- Serum bilirubin level

**Management**
- Address the underlying cause.
- Consider the risks and benefits of performing a blood transfusion (see Appendix 4). Consider transfusion in the following circumstances:
  - Haemoglobin (Hb) < 8 g/dL in term neonates or < 7 g/dL in preterm neonates.
  - Hb < 10 g/dL with associated clinical signs of intolerance of anaemia (tachypnoea, tachycardia).
- For neonates who are tolerating anaemia well, it may be better to monitor the neonate.
**Prevention**

Preventative measures include:

- Prevention of maternal anaemia during pregnancy by routine administration of oral iron and folic acid supplementation (see *Essential Obstetrics and Newborn Care*, MSF14).
- Delayed clamping of the umbilical cord.
- Restricting frequency of blood sampling in neonates and taking the smallest volume necessary for testing.
- Use of iron supplements starting at one month of age for LBW neonates who are breastfed (see Chapter 5, *Section 5.4.3*).
References Chapter 3


2. http://apps.who.int/iris/bitstream/10665/77756/1/9789241548304_engpdf?ua=1


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Chapter 4:
Mother-to-child transmissible diseases

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4.1 Neonatal conjunctivitis

Neonatal conjunctivitis (or ophthalmia neonatorum) is an acute, mucopurulent conjunctivitis during the first month of life. Typical pathogens are Neisseria gonorrhoeae, Chlamydia trachomatis or bacteria from skin or gastrointestinal tract, or more rarely, herpes simplex virus. In neonates, conjunctivitis can be associated with systemic illness, sepsis or secondary complications. Early treatment is important.

Gonococcal conjunctivitis usually occurs 2 to 7 days after birth with bilateral purulent discharge, profuse exudate and eyelid oedema. Without prompt treatment, the infection can lead to corneal ulceration, scarring and visual impairment.

Chlamydial conjunctivitis usually occurs 5 to 14 days after birth and is less severe than gonococcal conjunctivitis. Clinical features vary from mild swelling with a unilateral or bilateral watery eye discharge which becomes mucopurulent, to marked swelling of the eyelids with red and thickened conjunctivae (chemosis). A pseudomembrane may form as the exudate adheres to the conjunctiva. Systemic illness may be associated, including pneumonia.

Bacterial conjunctivitis from skin or gastrointestinal system presents similarly to gonococcal conjunctivitis with purulent discharge and occurs usually 2 to 5 days after birth.

Herpes simplex keratoconjunctivitis presents usually in the second week of life. Early signs include very watery eyes, redness of the conjunctiva and potentially crying from eye pain. There may be skin vesicles around the eyes. Without prompt treatment, it may progress to cataracts and chorioretinitis, resulting in loss of vision. It can be associated with generalised herpes simplex virus infection (see Section 4.2.5).

Management

- Clean eyes with isotonic sterile solution (0.9% sodium chloride or Ringer lactate) at least 4 times a day until discharge disappears.

- Indication for antibiotics: neonates with purulent conjunctivitis or asymptomatic neonates born to mothers who are symptomatic at time of delivery.

- For gonococcal or bacterial conjunctivitis:

  First line: **ceftriaxone** IM or IV: 50 mg/kg as a single dose (maximum 125 mg)
  Alternative: **cefoxatime** IM or IV: 100 mg/kg as a single dose (for neonates with jaundice)

  If symptoms persist 48 hours after ceftriaxone injection or appear after 7 days of life:

  Add **azithromycin** PO: 20 mg/kg once daily for 3 days
  Alternative: **erythromycin** PO: 12.5 mg/kg, 4 times daily for 14 days

- For chlamydial conjunctivitis:

  First line: **azithromycin** PO: 20 mg/kg once daily for 3 days
  Alternative: **erythromycin** PO: 12.5 mg/kg, 4 times daily for 14 days

Note: both erythromycin and azithromycin use in neonates are associated with the potential risk of pyloric stenosis. Side effects should be monitored with use of either medication.

Topical therapy (e.g. with tetracycline eye ointment) is not necessary if systematic antibiotic therapy is given.
– For herpes simplex keratoconjunctivitis:
  • Clean eyes with isotonic sterile solution (0.9% sodium chloride or Ringer lactate).
  • See Section 4.2.5 for treatment with IV aciclovir.

| aciclovir IV: 20 mg/kg every 8 hours | Duration: 10 days if asymptomatic, 14 days if disease limited to skin, 21 days if disseminated or CNS disease. |

**Prevention**

All neonates are routinely given prophylaxis at birth for gonococcal ophthalmia with 1% tetracycline ointment (see Chapter 2, Section 2.3.1).

Ensure mother and partner are assessed and treated if necessary.
4.2 Infections associated with congenital anomalies

Some infections during pregnancy may cause only a mild illness for the mother, but can have serious consequences to the foetus. Toxoplasmosis, Other (syphilis, varicella-zoster, parvovirus B19), Rubella, Cytomegalovirus (CMV), and Herpes simplex virus (HSV), (known as TORCH infections) are some of the most common perinatal infections associated with congenital anomalies.

Treatment is limited once the foetus is affected. Management after birth is mostly supportive unless advanced medical care is available. Treatment of maternal infection often has no impact on foetal outcome. Prevention of maternal infection is thus the priority.

Laboratory confirmation for most TORCH infections requires serological analysis that may not be available. Most neonates with a TORCH infection will be asymptomatic. If present, clinical signs are overlapping and not specific, while some do have specific features, making clinical diagnosis difficult.

The objective of this section is to be able to provide a diagnosis and prognosis to family members or guardians of the child, to contribute to a better understanding of the epidemiology and disease burden of perinatal infections resulting in congenital anomalies, and to thereby encourage the implementation of preventive measures.

4.2.1 Toxoplasmosis

A parasitic infection due to protozoa *Toxoplasma gondii*, which crosses the placenta to the neonate. Infection occurs due to ingestion of inadequately cooked meat containing cysts or from oocysts found in food or water contaminated with cat faeces. The rate of transmission to the foetus is higher in women infected during later pregnancy, but the severity of infection decreases with increasing gestational age.

Most infected neonates are asymptomatic at birth, but clinical features include: prematurity, intra-uterine growth restriction (IUGR), microcephaly or hydrocephalus, hepatosplenomegaly, jaundice, pneumonitis, rashes, seizures, chorioretinitis.

Prognosis: Some neonates have a fulminant course and early death. Both symptomatic neonates and those with subclinical disease are at risk of long-term sequelae, most commonly chorioretinitis and visual impairment.

Preventive measures in pregnant women:
- Avoid contact with cat litter boxes and other areas contaminated with cat faeces
- Avoid undercooked meat
- Wash their hands after preparing food or exposure to dirt

4.2.2 Other: syphilis

Infection due to the spirochete *Treponema pallidum* which causes transplacental infection at any stage of pregnancy (the risk is higher in the second half of pregnancy). The likelihood of transmission is related to the stage of maternal syphilis during pregnancy — early in the disease course maternal-foetal risk of transmission can be as high as 80%, decreasing to around 10% for established latent disease. Untreated syphilis in pregnancy leads to adverse outcomes in more than half of women with active disease including early foetal loss, stillbirth, preterm, low birth weight, neonatal death and congenital disease.
If clinical features are present, they include: born preterm, low birth weight, hepatomegaly +/- splenomegaly, blistering skin rash followed by skin peeling on palms and soles (Figure A-29), generalised lymphadenopathy, rhinitis with nasal obstruction (“snuffles”), and rarely, meningitis, hydrocephalus, osteochondritis, perichondritis.

Diagnosis and treatment choice are based on:
- Positive syphilis test in mother: If not already done in antenatal care, test mother at delivery using a Treponema-specific rapid test. Note: this test cannot distinguish between active and past treated infection.
- Clinical signs in neonate: examine all neonates with maternal positive syphilis test.
- Adequacy of maternal treatment: mother was treated more than 4 weeks before delivery with penicillin (other drugs such as erythromycin, azithromycin or ceftriaxone do not adequately protect the foetus) and received at least 3 doses of benzathine penicillin at weekly intervals.

A lumbar puncture should be done in:
- Symptomatic neonates
- Asymptomatic neonates whose mothers received inadequate treatment.

Management
- Nurse with “contact precautions”: use of gloves and protective gown at each contact with the neonate.
- Breastfeeding can be continued and should be encouraged.
- Antibiotic therapy:
  - Clinical signs of syphilis present in neonate or Mother did not receive adequate treatment during pregnancy
    | benzylpenicillin IV: |
    | Day 1 to 7: 30 mg/kg every 12 hours |
    | Day 8 to 10: 30 mg/kg every 8 hours |
  - No clinical signs of syphilis in neonate and Mother received adequate treatment
    | benzathine benzylpenicillin IM: |
    | 50 000 IU/kg as a single dose |
- If more than one dose of penicillin is missed, the entire course should be restarted.

Prevention
Adequate treatment of the mother at least one month before delivery with penicillin reduces the risk of congenital infection to 1 to 2%. Treat partner to prevent re-infection.

4.2.3 Rubella
An acute viral infection that during pregnancy, especially during the first trimester, may result in foetal death or cause various congenital defects. It is the leading cause of vaccine-preventable birth defects.

---

a Osteochondritis is the inflammation of bone and cartilage.

b Perichondritis is the inflammation of the perichondrium (membrane of fibrous connective tissue that invests cartilage except at joints).

c Both treponemal and non-treponemal maternal IgG antibodies can be transferred across the placenta to the foetus, complicating the interpretation of tests in neonates (possible false positive test). A negative test in the neonate does not mean the neonate is not infected.

d A single dose is considered adequate only in case of ‘early’ maternal syphilis (i.e. primary, secondary or early latent syphilis of < 1 year duration). In practice, timing of maternal infection will be difficult to confirm in most cases.
Neonates with congenital rubella infection may be asymptomatic or may present with various birth defects (e.g. hearing loss, cloudy cornea, cataracts, congenital cardiac defects) described as congenital rubella syndrome. Clinical features also include IUGR, meningoencephalitis, hepatosplenomegaly, jaundice, pneumonitis, petechiae and purpura, or adenopathy. Management is supportive. No specific treatment is available. Prevention is by vaccination.

4.2.4 Cytomegalovirus

Most common congenital viral infection. Symptomatic disease may result from maternal infection at any time during pregnancy, although the risk is highest in the first trimester. Most neonates are asymptomatic at birth, but approximately 10% have clinical features including IUGR, prematurity, microcephaly, hepatosplenomegaly, jaundice, petechiae, pneumonitis, sensorineural hearing loss and seizures. Symptomatic neonates have a mortality of around 30%. Long-term neurological complications include hearing loss, intellectual disability and visual disturbance. Five to 15% of asymptomatic neonates will also develop neurological sequelae (most commonly hearing loss). Prolonged treatment with IV ganciclovir requires advanced laboratory facilities to carefully monitor potential drug toxicity. In most cases, management is supportive.

4.2.5 Herpes simplex virus infection

Usually caused by HSV-2 as a result of direct contact with infected vaginal secretions during delivery (occasionally infection occurs in-utero or postnatally). Mother to child transmission is high (25-50%) among women who acquire the virus near the time of delivery, and low (< 1%) among women with prenatal histories of recurrent disease. Left untreated, neonatal HSV can lead to severe long-term consequences and death. Most are asymptomatic at birth. Clinical features usually present at 7 to 14 days of life (up to 4 weeks) with:
- Vesicular lesions on skin, eye, mouth accounts for around 45% of neonatal HSV (Figure A-28). May seem benign initially but there is a high risk of progression to central nervous system (CNS) or disseminated diseases if not treated.
- CNS disease: encephalopathy and seizures
- Disseminated disease: non-specific signs of sepsis (irritability, lethargy, fever, poor feeding)

Management
- Nurse with “contact precautions”: use of gloves and protective gown at each contact with the neonate. Isolate mother and neonate if extensive external lesions.
- High risk of herpes infection: Neonate with symptoms of neonatal herpes, or Active primary or unknown maternal genital herpes at the time of delivery, or Active recurrent maternal genital herpes at the time of delivery with any of the following risk factors: rupture of membranes ≥ 6 hours before delivery (vaginal or Caesarean), birth weight < 2000 g, preterm ≤ 37 weeks, skin lacerations, maternal HIV infection.

Neonates with high risk of herpes infection, even if currently asymptomatic, treat with:

<table>
<thead>
<tr>
<th>aciclovir</th>
<th>IV: 20 mg/kg every 8 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration:</td>
<td>10 days if asymptomatic, 14 days if disease limited to skin, 21 days if disseminated or CNS disease.</td>
</tr>
</tbody>
</table>

Note: up to 50% of neonatal HSV infection presents without skin lesions.
**Low risk of herpes infection**
- Active recurrent maternal genital herpes with none of the above risk factors

Observe for 5 days. If the neonate becomes symptomatic, refer to neonatal unit for IV aciclovir (as above). The neonate may be discharged after 5 days if they remain well, with advice to the parents to return if symptoms develop.

Supportive management for neonates being treated for HSV infection includes:
- Respiratory support and provision of oxygen, if needed.
- Control of seizures (see Chapter 3, Section 3.1.3).
- Maintenance fluids if necessary (see Appendix 7).
- Monitoring and treatment of hypoglycaemia (see Chapter 3, Section 3.1.4).
- Antibiotic therapy to cover for secondary bacterial infections with ampicillin IV for 7 to 10 days + gentamicin IV for 5 days (see Chapter 3, Section 3.4.2 for doses).

Breastfeeding is encouraged as long as the mother has no breast lesions. The mother should be educated regarding hand hygiene when handling the neonate.

**Prevention**

See Essential Obstetric and Newborn Care, MSF guide or national guidelines for maternal herpes treatment.
4.3 Hepatitis B infection

Transmission of hepatitis B virus (HBV) from mother to child occurs primarily from blood exposure during labour or delivery. Vaccination started soon after birth as part of the standard hepatitis vaccine regimen has a protective efficacy of 75 to 95%. When combined with hepatitis B immunoglobulin, the protective efficacy is 85 to 95%\(^1\).

Prevention of transmission is important as long-term consequences of hepatitis B infection acquired in early childhood include chronic hepatic insufficiency, cirrhosis and hepatocellular carcinoma.

Infected neonates are asymptomatic at birth but jaundice may appear later in less than 3% of cases.

**Prevention of mother-to-child transmission**

Hepatitis B vaccination (see Chapter 2, Section 2.4):

- To be given routinely as soon as possible after birth, preferable in the delivery room, or at least within the first 24 hours of life.
- If administration within 24 hours is not feasible, a late birth dose has some effectiveness. Although effectiveness declines progressively in the days after birth, a late birth dose can be given at any time up to the day of the next dose of the primary schedule (usually at 6 weeks for DPT-HepB-Hib).
- The monovalent hepatitis B vaccine must be used for the birth dose of the vaccination.
- Further vaccination at 6, 10 and 14 weeks of age according to EPI (Expanded Program of Immunisation). Either monovalent or combination vaccines can be used for later doses in the HBV schedule.

Neonates born to mothers who are HBs Ag positive:

- Hepatitis B vaccine as soon as possible after birth (ideally no later than 12 hours after birth).
- If available, administer hepatitis B immunoglobulin IM: 100 IU/kg (in the opposite leg to hepatitis B vaccination). It is most effective if given within 12 hours of birth, but can be given up to 7 days of life.
- Mother-to-child transmission can also be prevented by administration of anti-retroviral to the mother (e.g. tenofovir and lamivudine). Refer to local guidelines.

There is no evidence that caesarean section prevents mother-child transmission. Breastfeeding should be continued and encouraged.
4.4 HIV infection

Human immunodeficiency virus (HIV) is a retroviral infection that leads to progressive immunologic deterioration, opportunistic infections and cancers. End stage disease results in acquired immunodeficiency syndrome (AIDS).

Perinatal transmission of HIV can occur during pregnancy, delivery, or from breastfeeding, and accounts for more than 90% of paediatric HIV infections. All pregnant women should be offered HIV counselling and testing at each antenatal appointment and at every opportunity when the child comes to hospital after birth. When HIV is diagnosed before or during pregnancy, the risk of perinatal transmission can be reduced drastically if appropriate medical treatment is taken and the virus becomes undetectable.

HIV diagnosis
Refer to available HIV guidelines for early infant diagnosis (EID) testing.

Prevention of mother-to-child transmission (PMTCT) of HIV
Administer antiretroviral (ARV) prophylaxis immediately after birth or as soon as exposure is discovered. See Appendix 9 for ARV prophylaxis regimens.

Breastfeeding
To reduce the risk of HIV transmission, mothers should receive long-term antiretroviral therapy or for as long as they are breastfeeding. Exclusive breastfeeding is recommended for the first 6 months of life, with gradual weaning over 1 month starting at 12 months of age. Stopping breastfeeding abruptly is not recommended.

Breast milk substitutes can be used as an alternative to exclusive breastfeeding only under the following conditions:
- There is enough infant formula available for exclusive use until the age of 6 months and for weaning after this time.
- The mother (or person in charge) is able to prepare the formula under hygienic conditions, using safe drinking water, and frequently enough to limit the risk of diarrhoea and malnutrition (see Chapter 6, Section 6.6).
- There is access to a health care facility offering a full range of paediatric care.
- The use of breast milk substitutes is acceptable in the cultural context.
4.5 Neonatal tuberculosis

Tuberculosis (TB) is due to infection with *Mycobacterium tuberculosis*. Worldwide it is the leading cause of death due to a single infectious agent\(^1\). Mother to child transmission is well documented, and TB in pregnancy is common\(^2\). Congenital TB can occur due to transplacental infection during pregnancy or in the intrapartum period, but is rare\(^3\). The majority of neonatal TB is due to respiratory transmission, usually from a mother with active TB\(^4\). Transmission through breast milk does not occur.

Early diagnosis and treatment is crucial as TB in neonates is associated with high mortality (up to 60%) and morbidity.

Neonates born to mothers with active TB but show no clinical indication of TB infection or illness should be given isoniazid (INH) prophylaxis for 6 months to protect them against transmission.

**Clinical features**

Clinical features usually present between 2 and 8 weeks of life. Clinical signs are non-specific, including fever, poor feeding, irritability and hepatosplenomegaly. Typical features such as cough and difficulty breathing are less common in neonates.

Diagnosis relies on maternal history of disease, contact history for neonates that have been home, a high index of suspicion, careful clinical assessment and follow up. Chest x-ray and bacteriology may be useful but are not essential in most cases. To support clinical diagnosis, refer to the paediatric TB diagnostic algorithms in the guide *Tuberculosis, MSF*\(^5\).

**Management**

All neonates born to mothers with active TB should be screened for signs and symptoms of TB infection.

Any neonate brought in from home with a household contact with known or suspected TB should be screened for signs and symptoms of TB infection.

Refer to the paediatric TB diagnostic algorithm for contacts in the guide *Tuberculosis, MSF*\(^5\).

For any neonate with clinical signs indicating potential TB infection, consider carefully a diagnosis of TB infection and commence a full course of TB treatment according to the guide *Tuberculosis, MSF*\(^5\).

**Asymptomatic neonates**

- Start isoniazid preventive therapy (IPT):
  
  | **isoniazid** PO: 10 mg/kg (7-15 mg/kg/day) once daily for 6 months |

- Do not give BCG vaccine at birth\(^a\). Administer BCG after completion of 6 months of INH.

- If the neonate subsequently develops features of TB, they should undergo complete clinical assessment referring to the TB diagnostic algorithm. This is unlikely if prophylaxis has been administered correctly, but is possible in cases of primary resistance to INH.

Note: BCG should not be given if the neonate is symptomatic of TB infection, is symptomatic of HIV infection, or is confirmed HIV infected by virological testing (see Chapter 2, Section 2.4).

\(^a\) BCG vaccination should be postponed as INH interferes with the immune response to BCG. If it has already been given, BCG vaccination should be repeated upon completion of INH therapy.
Breastfeeding

Breastfeeding should be continued and encouraged. A smear positive mother can wear a surgical mask during periods of close contact (i.e. breastfeeding) until she has completed 3 weeks of TB treatment. The mother should be started on anti-TB therapy as soon as possible. If the mother is too ill to breastfeed, she should be assisted whenever possible to express breast milk. Where feasible, consider adding pyridoxine PO: 10 mg once daily to breastfed neonates while on isoniazid prophylaxis.\textsuperscript{16}
References Chapter 4


Chapter 5:
Care of low birth weight neonates

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5.1 Introduction and definitions

Low birth weight (LBW) neonates, whether preterm or not, are at significant short-term risk of hypothermia, hypoglycaemia, respiratory distress, apnoea, infection, jaundice, anaemia, feeding problems, dehydration and necrotising enterocolitis. Long-term complications include neurodevelopmental delay and growth problems.

At birth, initial care is the same as for neonates of normal weight. Additional considerations include thermoregulation, monitoring of respiration and heart rate, blood glucose screening, meticulous infection prevention and control, and special attention to details of feeding.

LBW is usually due to prematurity or intrauterine growth restriction (IUGR), or both. It is defined as a birth weight of < 2500 g, regardless of gestation.

LBW = birth weight < 2500 g
Very low birth weight (VLBW) = birth weight < 1500 g
Extremely low birth weight (ELBW) = birth weight < 1000 g

Prematurity refers to neonates born alive before 37 weeks completed pregnancy.
Late preterm = 34 to < 37 weeks
Moderate preterm = 32 to < 34 weeks
Very preterm = 28 to < 32 weeks
Extremely preterm = < 28 weeks

Small for gestational age (SGA) is defined as a birth weight < 10th centile for gestational age. It includes neonates who are constitutionally small.

IUGR is a reduction of expected foetal growth pattern due to genetic or environmental factors. Neonates may or may not be SGA.

Asymmetric IUGR refers to a restriction of weight, and then length with a relative “head sparing” effect. This is commonly due to extrinsic factors affecting growth later in pregnancy, such as pre-eclampsia, chronic hypertension and uterine abnormalities.

Symmetric IUGR affects all growth parameters. Early gestational growth restriction can have permanent neurological consequences. Causes include genetic abnormalities, intrauterine infections (such as CMV, toxoplasmosis, syphilis) and maternal alcohol use.

Risk factors include ethnicity, maternal age (young mothers and older mothers), multiple birth, maternal health problems (e.g. malaria, HIV, hypertension, pre-eclampsia, sepsis).

A summary of management issues is provided in Table 5.1.
### Table 5.1 - Management of preterm and LBW neonates

<table>
<thead>
<tr>
<th>Section</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Resuscitation</strong></td>
<td>if needed.</td>
</tr>
<tr>
<td><strong>Early assessment of gestational age.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Measure weight, length and head circumference.</strong></td>
<td></td>
</tr>
</tbody>
</table>
| **Thermoregulation** |  - Cover the head to reduce heat loss.  
- Ensure the room temperature is 23 to 25 °C.  
- Use kangaroo mother care in all non-sick neonates (see Section 5.3). |
| **Respiratory** |  - Provide oxygen if O₂ saturation < 90% (aiming for saturations of 90-95%).  
- Consider non-invasive ventilation (NIV) e.g. CPAP\(^a\) if signs of severe respiratory distress, where available. Consider surfactant therapy where available.  
- If < 34 weeks gestation or < 1500 g, commence caffeine for apnoea of prematurity (see Section 5.4.2). |
| **Infection** |  - Assess risk factors for sepsis and commence IV antibiotics if indicated (see Chapter 2, Section 2.5.2). |
| **Hypoglycaemia** |  - Check blood glucose level within an hour of birth and check before every feed until normal on 3 consecutive occasions (see Chapter 2, Section 2.5.1). |
| **Fluids and feeding** |  - Assess ability to suck and swallow.  
- Commence intravenous fluids or feeding (oral or via O/NGT) according to birth weight, age and clinical condition (see Chapter 6, Section 6.5).  
- Monitor feeding volumes, tolerance to feeds and abdominal distension. |
| **Jaundice** |  - Monitor for jaundice and commence phototherapy if indicated (if available) (see Chapter 3, Section 3.6.1). |
| **Anaemia** |  - Commence iron supplementation at 4 to 6 weeks of age and continue until 6 months old (see Section 5.4.3). |

### Monitoring

Neonates < 34 weeks gestation, or with a birth weight < 1500 g should be admitted to the neonatal care unit. Neonates weighing 1500 to 2000 g may be cared for either in maternity or the neonatal unit depending on the neonate’s clinical condition and available resources. Regardless of where these neonates are cared for, close collaboration between maternity and the neonatal team is essential. They require meticulous attention and close monitoring.

\(^a\) CPAP = Continuous Positive Airway Pressure
Routine care is the same as for all neonates, plus:
- Daily weight
- Temperature 4 hourly
- Vital signs at least twice a day
- Daily clinical examination
- Blood glucose monitoring – within an hour of birth and then before every feed until normal on 3 consecutive occasions.
- Monitoring fluids and feeding (at least every 2 to 3 hours if breastfeeding).
5.2 Assessment of gestation

Definitions
Term neonate = neonate between 37 to 42 weeks gestation
Preterm neonate = < 37 weeks gestation
Post-term neonate = > 42 weeks gestation

Gestation may be estimated using several methods. Ultrasound dating during pregnancy is commonly performed where resources are available. Estimation based on the woman’s history of last menstrual period (LMP) may also be used. Where ultrasound is not available or the history may be unreliable, a rapid clinical assessment can be used to estimate the neonate’s gestation.

Rapid assessment of gestation involves the assessment of 5 physical criteria at delivery:\n1. Creases in the sole of the foot
2. Size of the breast nodules
3. Nature of the scalp hair
4. Development of ear cartilage
5. External genitalia:
   – Males: testicular descent
   – Females: protuberance of the labia minora and clitoris

Table 5.2 - Assessment of gestational age

<table>
<thead>
<tr>
<th>Feature</th>
<th>&lt; 34 weeks</th>
<th>34-36 weeks</th>
<th>37 weeks or more</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creases in soles of feet</td>
<td>1 or 2 anterior creases, ¾ of sole smooth</td>
<td>Multiple creases anterior, ½ of heel smooth</td>
<td>Entire sole including heel covered with creases</td>
</tr>
<tr>
<td>Breast nodule</td>
<td>Not visible, or 1-2 mm in diameter</td>
<td>Raised, 3-4 mm in diameter</td>
<td>Raised, 5-7 mm</td>
</tr>
<tr>
<td>Scalp hair</td>
<td>Fine and woolly, in clusters</td>
<td>Fine and woolly, flexible</td>
<td>Thick, silky, distinct</td>
</tr>
<tr>
<td>Ear lobe</td>
<td>No cartilage</td>
<td>Moderate amount of cartilage</td>
<td>Stiff ear lobe with thick cartilage</td>
</tr>
<tr>
<td>Testes and scrotum</td>
<td>Partially descended, scrotum small, few rugae</td>
<td>Intermediate, variable</td>
<td>Testes fully descended; scrotum normal</td>
</tr>
<tr>
<td>Clitoris and labia</td>
<td>Clitoris prominent, labia majora do not cover labia minora</td>
<td>Intermediate, variable</td>
<td>Labia majora cover labia minora and clitoris</td>
</tr>
</tbody>
</table>

More detailed assessments of gestation which incorporate assessment of physical and neurological maturity may also be used (see Ballard score in Appendix 10.1).
5.3 Kangaroo mother care

Kangaroo mother care (KMC) is a method of caring for neonates that involves putting them on the mother’s chest, skin-to-skin, preferably 24 hours a day. This method can be used to care for all non-sick neonates with a birth weight < 2500 g whether in maternity or in a neonatal care/KMC unit. Non-sick neonates with a birth weight < 2000 g should be admitted to a KMC unit where available.

Benefits of KMC

- Keeps the neonate warm and therefore used in the treatment and prevention of hypothermia.
- Helps establish and promote exclusive breast feeding.
- Promotes weight gain.
- Fosters the mother-baby bond and reduces neonate’s stress.
- Reduces apnoea in preterm neonates. Skin-to-skin contact stimulates the neonate’s breathing and synchronises it with that of the mother’s.
- Decreases exposure to infectious diseases.
- Reduces length of hospital stay.
- Allows the mother to continue daily activities whilst caring for the neonate.

Technique

- Cover the neonate’s head with a hat.
- Position the neonate against the mother’s chest in direct skin-to-skin contact. Ensure that the neonate’s mouth is always able to reach the mother’s nipple. The neonate may wear a nappy and socks.
- Keep the neonate in position using a cloth.
- KMC can be used continuously. When the mother is sleeping, her bust must be raised and the neonate monitored.

Figure 5.1 - Kangaroo mother care

- KMC can be carried out anywhere: in the neonatal unit, in maternity or at home.
- Skin-to-skin contact can also be done by the father, another family member or a wet nurse during periods when the mother is not available.
- It is important to provide support to parents and families to encourage KMC to be carried out as often as possible. Already experienced mothers can act as trainers and advocates.
5.4 Complications of prematurity and low birth weight

Most complications of prematurity/LBW relate to dysfunction of immature organ systems. In some cases these complications resolve completely, in others there is residual organ dysfunction.

**Neonatal resuscitation**

Preterm neonates more frequently require resuscitation at birth due to pulmonary immaturity and decreased respiratory drive.

**Thermoregulation**

Preterm and LBW neonates are at high risk of hypothermia (see Section 5.4.1).

**Respiratory**

Respiratory complications include:
- Respiratory distress syndrome (RDS) (see Chapter 3, Section 3.2.3).
- Chronic lung disease

**Cardiac**

The most common cardiac complication is patent ductus arteriosus (PDA). The incidence of PDA increases with increasing prematurity. A PDA may be asymptomatic or present with signs of heart failure. In neonates born > 30 weeks gestation the ductus closes spontaneously by the time of hospital discharge in most cases.

**Central nervous system (CNS)**

CNS complications include:
- Poor sucking and swallowing reflexes
- Apnoeic episodes (see Section 5.4.2)
- Intra-ventricular haemorrhage
- Developmental and/or cognitive delays

**Eyes**

Ocular complications include:
- Retinopathy of prematurity (ROP)
- Strabismus and myopia

Retinal vascularisation is not complete until near term. Preterm delivery may interfere with normal vascularisation process, resulting in abnormal defects in vision and blindness (ROP). Excessive and prolonged oxygen use increases the risk.

**Gastrointestinal**

Gastrointestinal problems include:
- Feed intolerance
- Necrotising enterocolitis (see Chapter 3, Section 3.5.6)

Feed intolerance is a common problem due to a smaller stomach size, immature sucking and swallowing reflexes and impaired gastric and intestinal motility. This leads to a decreased ability to tolerate both oral and O/NGT feeds and increases the risk of aspiration.
Infection
Infectious complications include:
– Neonatal sepsis (see Chapter 3, Section 3.4.2)
– Meningitis (see Chapter 3, Section 3.3.2)

Metabolic
Metabolic complications include:
– Hypoglycaemia (see Chapter 3, Section 3.1.4)
– Hyperglycaemia (see Chapter 3, Section 3.1.4)
– Jaundice (hyperbilirubinaemia) (see Chapter 3, Section 3.6.1)

Hypoglycaemia is common in preterm and LBW neonates due to decreased stores of glycogen and fat. This is further aggravated by hypoxia and hypothermia due to increased metabolic demands. All neonates with a birth weight < 2500 g should be routinely screened and managed for hypoglycaemia (see Chapter 2, Section 2.5.1).

Haematologic
Anaemia of prematurity (see Section 5.4.3)

5.4.1 Hypothermia
Hypothermia, defined as an axillary temperature < 35.5 °C, is a major factor in morbidity and mortality of LBW neonates. Hypothermia may be associated with increased oxygen and metabolic demands, respiratory compromise, hypoglycaemia and death. In order to avoid hypothermia, action should be taken as soon as the temperature falls below normal (36 °C).

Management
If the axillary temperature is < 36 °C:
– Wrap the neonate in a clean, dry cloth.
– Ensure the head is covered with a cap.
– In non-sick neonates, provide KMC by placing the neonate skin-to-skin on the mother’s chest.
– If the neonate does not respond, use an external heating device such as an infant warmer or place the neonate on an electrical heating pad, if available. Ensure that an appropriate distance is maintained between the heat source and the neonate to avoid burns.

Screen for complications:
– Check for hypoglycaemia.
– Search for signs of sepsis and consider treatment with antibiotics whenever there is persistent hypothermia despite appropriate management (see Chapter 2, Section 2.5.2).

Monitoring
Aim to maintain axillary temperature between 36 °C and 37 °C:
– Record axillary temperature every hour until it is > 36 °C.
– Measure the temperature every 30 minutes if using an external heating source.

Prevention
Neonatal thermoregulation is a major priority starting from the time of delivery and continuing throughout the hospital stay. Measures should be implemented immediately after birth (see Chapter 2, Section 2.2.2).
Throughout hospital stay:
– Keep the neonate in a warm room (23 to 25°C).
– Cover the head with a cap to reduce heat loss.
– Change wet nappies, clothing and bedding to keep the neonate dry.
– Encourage KMC whenever possible.
– Feed every 2 to 3 hours (including during the night) if on enteral feeds.
– Minimise exposure during clinical examinations and procedures (use a heat source whenever possible).

5.4.2 Apnoea of prematurity

Apnoeic spells are common in preterm neonates, usually occurring in the first two to three days after birth. It is due to immature respiratory control and typically resolves before 37 weeks gestation.

Apnoeic episodes that last > 20 seconds or that are accompanied by hypoxia (SpO₂ < 90%) and/or bradycardia (HR < 100) are clinically significant.

Management

Acute management during an apnoea episode:
– Airway: maintain head and neck in neutral position to keep airway patent.
– Tactile stimulation: gentle rubbing of the soles of the feet or chest wall may be all that is required for mild, intermittent episodes.
– Breathing: commence oxygen via nasal prongs and monitor oxygen saturations (aim 90-95%). Use bag and mask ventilation if neonate remains apnoeic or RR < 20/minute.
– Treatment with non-invasive ventilation (NIV) (e.g. CPAP) may be indicated.

Feeding
– Neonates with prolonged apnoeas requiring bag and mask ventilation should be kept “nil by mouth”. Commence IV fluids (see Appendix 7).

Clinically stable neonates with short apnoeas requiring stimulation only, and in whom serious underlying disorders have been excluded, may continue to be fed.

Search for the underlying cause, especially looking for signs of infection or anaemia. If the apnoea is recurrent or there are any signs of infection (such as temperature instability, poor perfusion or seizures) commence antibiotic therapy of ampicillin slow IV (3 minutes) for 7 to 10 days + gentamicin slow IV (3 minutes) or IM for 5 days (for doses see Chapter 3, Section 3.4.2).

Prevention

Neonates born < 34 weeks gestation (or < 1500 g) are at high risk of developing apnoea and should be commenced on caffeine as prophylactic treatment. Oral route is preferred over IV administration.

<table>
<thead>
<tr>
<th>caffeine citrate</th>
<th>(10 mg/mL caffeine citrate = 5 mg of caffeine base)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Loading dose:</strong> caffeine citrate</td>
<td>IV: 20 mg/kg = 2 mL/kg</td>
</tr>
<tr>
<td><strong>Maintenance dose:</strong> caffeine citrate</td>
<td>PO or IV: 5 mg/kg once daily. Increase to 10 mg/kg once daily if no response.</td>
</tr>
</tbody>
</table>

See Appendix 5, Table 5: caffeine citrate dosing according to weight.

Side effects: if there is tachycardia, vomiting or irritability the dose should be reduced or postponed. Administer only in a hospital setting.
Stopping caffeine: consider stopping caffeine when the neonate reaches a weight of 1500 g or 34 to 36 weeks corrected gestational age, and there has been no apnoea or bradycardia for at least 5 days.

After stopping the caffeine, monitor the neonate for recurrent apnoea (vital signs 4 times/day including SpO\textsubscript{2}) and teach the mother to recognise when the neonate stops breathing. The neonate may go home 5 days after cessation of caffeine if there have been no problems.

### 5.4.3 Anaemia of prematurity

All neonates have a fall in haemoglobin soon after birth. In preterm neonates, this response occurs earlier, is more pronounced and is termed anaemia of prematurity (AOP). The primary cause of AOP is decreased production of erythropoietin (EPO) in the setting of anaemia. A reduced red blood cell life span and low iron stores also contribute.

#### Clinical features

Anaemia of prematurity normally occurs 3 to 12 weeks after birth in neonates < 32 weeks gestation. Many neonates remain asymptomatic despite haemoglobin levels as low as 7 g/dL. Clinical signs include tachycardia, poor weight gain, increased oxygen requirement, and increased episodes of apnoea/bradycardia.

#### Management

Anaemia of prematurity often resolves spontaneously in many preterm neonates within 3 to 6 months of birth. For those in whom intervention is necessary, blood transfusion is the most efficient way to increase the haemoglobin. However, transfusion is a temporary measure that can suppress EPO production and involves significant risks. The decision to transfuse should carefully weigh risks against expected benefit.

Consider blood transfusion in preterm neonates with Hb < 7 g/dL, or < 10 g/dL with associated clinical signs (see Chapter 3, Section 3.6.2).

#### Prevention

Preventative measures include iron supplementation during pregnancy, delayed clamping of the umbilical cord, limiting the amount of blood sampled for investigations and iron supplementation in LBW neonates.

Iron supplementation: all neonates < 2500 g who are breastfed should commence on iron supplementation\textsuperscript{3} at 4 to 6 weeks of age and continue until 6 months of age.

| elemental iron PO: 4.5 mg = 0.5 mL (45 mg/5 mL syrup) once daily |

### 5.4.4 Osteopaenia of prematurity

Osteopaenia, a condition characterised by a reduction in bone mineral content, is a significant problem for very preterm and ELBW neonates and usually appears between the sixth and twelfth week of life.
Risk factors
- Gestation < 30 weeks or birth weight < 1000 g
- Delayed establishment of full enteral feeds
- Enteral feeds with low mineral content
- Phosphorus deficiency
- Vitamin D deficiency
- Chronic illness (respiratory diseases, necrotising enterocolitis)

Investigations
Measure serum calcium, phosphate, ALP$^a$ at 4 weeks of age (to be repeated every 2 weeks).

Clinical features
The neonate may remain asymptomatic or present with features of rickets, depending on severity of demineralisation.

Prevention
Early introduction of enteral feeds with human milk may increase the bone mineral content in preterm neonates. For neonates born < 32 weeks gestation, or < 1500 g aim to grade up enteral feeds to 180 mL/kg/day of expressed breast milk (EBM) within the first two weeks of life.

The addition of fortifier to EBM once full enteral feeds have been established decreases the risk of disease. Breast milk fortifier (BMF) is recommended in special situations for neonates with a birth weight < 2000 g (see Appendix 6).

All exclusively breastfed neonates and VLBW neonates should receive vitamin D supplements at doses ranging from 400 IU to 1000 IU per day until 6 months of age (see Chapter 2, Section 2.3.3).

If breast milk is not available, use of a formula specifically designed for preterm neonates is preferred.

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$^a$ ALP = alkaline phosphatase
References Chapter 5


Chapter 6:
Feeding and fluid management

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6.1 Total daily volume

The total daily volume of fluids (mL/kg/day) required by a neonate is determined by weight and day of life. Day of life 1 (D1) refers to the first 24 hours of birth (or calendar date of birth of the neonate) and so on; there is no day 0. Very low birth weight (VLBW) neonates require a higher intake of fluids (per kg body weight), largely due to increased insensible fluid loss through their skin.

<table>
<thead>
<tr>
<th></th>
<th>&lt; 1500 g</th>
<th>≥ 1500 g</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>80</td>
<td>60</td>
</tr>
<tr>
<td>D2</td>
<td>100</td>
<td>80</td>
</tr>
<tr>
<td>D3</td>
<td>120</td>
<td>100</td>
</tr>
<tr>
<td>D4</td>
<td>140</td>
<td>120</td>
</tr>
<tr>
<td>D5</td>
<td>160</td>
<td>140</td>
</tr>
<tr>
<td>D6</td>
<td>180</td>
<td>160</td>
</tr>
<tr>
<td>D7 +</td>
<td>180*</td>
<td>160-180</td>
</tr>
</tbody>
</table>

* The usual maximum oral intake for a neonate is 180 mL/kg/day. Occasionally, VLBW neonates who are stable and not gaining weight require an increase in feeds to 200 to 220 mL/kg/day.

The total daily volume of fluids is spread over 24 hours. It is composed of either enteral only, intravenous only, or a combination of the two. In neonates > 1500 g who are not sick, it is unnecessary to perform these calculations if exclusively breastfeeding and gaining weight. Special care should be taken in low birth weight (LBW) neonates in whom very small volumes of fluid can be very significant considering their weight.

The reference weight is the birth weight until the birth weight is exceeded. If the birth weight is unavailable, use the weight obtained on admission. If the neonate later loses weight, use the last highest weight recorded for calculations.

Increase fluid volume by 20 mL/kg/day in the first days of life. In certain situations adjustment of total daily fluid volumes are necessary, for example:
- Increase total daily fluid volume by 10 mL/kg/day if external temperature > 35 °C or if neonate is receiving phototherapy.
- Reduce total daily fluid volume in perinatal asphyxia (see Chapter 3, Section 3.3.1) or fluid overload.

The maximum volume of intravenous fluids for a neonate is 150 mL/kg/day.

See Appendix 7 for detailed feeding charts with calculated volumes of feeds per day according to birth weight.
6.2 Breastfeeding

Exclusive breastfeeding (no solid or liquid other than breast milk) is recommended for all neonates until the age of 6 months. During this time neonates do not need to be given water or any other food or drink. Colostrum is the special milk that is secreted in the first 2 to 3 days after delivery. It is produced in small amounts but is all a neonate normally requires during this time.

**Indications**
Breast milk contains all the nutrients that a neonate needs in the first 6 months of life (including those born preterm). It is easily digested and efficiently used.

Most neonates > 34 weeks gestation are able to suck unless they are unwell. If sucking is ineffective, check for hypoglycaemia, hypothermia and danger signs. Breastfeeding should be initiated within the first hour after birth. Allow mothers to room in with their neonates so they can breastfeed on demand.

Always check maternal medications are compatible with breastfeeding, and, if necessary, adjust treatment accordingly. For HIV infected mothers, breastfeeding is still recommended (see Chapter 4, Section 4.4).

Breastfeeding should be frequent and on demand by the neonate, night and day.

**Benefits**
For the neonate:
- Helps prevent hypoglycaemia
- Helps prevent infection
- Best source of nutrition for the neonate
- Reduces risk of infection from preparing bottles
- Promotes development

For the mother:
- Promotes emotional attachment
- Protects the mother’s health
- Helps prevent pregnancy
- Accessible anywhere
- Free of charge

**Position of the mother**
To be well attached to the breast, the neonate and mother need to be appropriately positioned. The mother can be seated, lying down (see Figure 6.1) or standing if she wishes. She should be relaxed and comfortable, without any strain. If seated, her back should be supported and she should be able to hold the neonate at the breast without leaning forward.
Position of the neonate

The neonate can breastfeed in several different positions: across the chest and abdomen, under her arm, or alongside the body.
- The neonate should be straight, not twisted. Extending the neck slightly helps the chin to be in close contact with the breast.
- The neonate should be facing the breast and turned slightly on his or her back to be able to see the mother’s face.
- The neonate’s body should be close to the mother.
- The neonate’s whole body should be supported using the bed or pillow, or the mother’s lap or arm. She should not support the neonate’s head and neck.

Simultaneous breastfeeding of twins is possible and should be encouraged.

Attachment

In order to stimulate the nipple and allow removal of milk from the breast, and to ensure an adequate supply of milk, a neonate needs to be well attached to the breast so they can suckle effectively. Difficulties often occur because the neonate does not take the breast into the mouth properly, impairing ability to suckle effectively.

Signs of good attachment are:
- More of the areola is visible above the neonate’s top lip than below the lower lip.
- The neonate’s mouth is wide open.
- The lower lip is curled outwards.
- The neonate’s chin is touching or almost touching the breast.

These signs show that the neonate is close to the breast and opening his/her mouth to take plenty of the breast.

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Figure 6.1 - Position of mother during breast feeding (seated and lying down)a

Figure 6.2 - Good attachment (left) and poor attachment (right)

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Effective suckling

Proper attachment to the breast allows the neonate to suckle effectively. The neonate should take slow, deep suckles followed by a visible or audible swallow about once per second. Sometimes the neonate pauses for a few seconds to allow the ducts to fill with milk again. When the neonate starts to suckle again, he/she may suckle quickly initially to stimulate milk flow, and then start slow deep suckles again. The neonate’s cheeks should remain rounded during the feed.

Towards the end of the feed, suckling usually slows down. At this time there is less milk, but the breast contains fat-rich hind milk and so it is important for the feed to continue. When the neonate is satisfied, he/she usually releases from the breast spontaneously.

Improper attachment to the breast and poor suckling can cause pain during breastfeeding and result in cracked nipples, breast engorgement and mastitis. Insufficient intake in the neonate may lead to feeding difficulties and poor weight gain.

Frequency of breastfeeds

To ensure adequate milk production for 6 months of exclusive breastfeeding, the neonate should feed as often and for as long as he or she wants, both night and day. This is called demand feeding or baby-led feeding. The mother should learn to respond to her neonate’s cues of hunger and readiness to feed including restlessness, rooting (searching) with the mouth and sucking hands before the neonate starts to cry.

The duration and frequency of breastfeeding varies with each neonate. In general, neonates weighing > 1500 g should feed at least 8 times in 24 hours (approximately every 3 hours). Neonates weighing ≤ 1500 g should feed more frequently, up to 12 times per day (every 2 hours).

Prolonged, frequent feeds may be a sign of poor attachment and ineffective suckling. It is essential to support the mother and supervise feeding in order to identify the problem. Factors to consider include timing and duration of feeding, mother’s general health, fluid and caloric intake, positioning and attachment of the neonate, and maternal stress and anxiety.

Breastfeeding success factors

The factors for successful breastfeeding are:
- Informing pregnant women about breastfeeding benefits and implementation.
- Putting neonate to breast early, within an hour of birth.
- Correct and comfortable positioning of mother and neonate. Proper latch-on allows effective sucking and reduces nipple cracks: the neonate should face the mother’s body, with the chin against her breast, the nose free and the nipple and most of the areola in the mouth.
- For women with inverted or flat nipples: use techniques to help nipple protrude (nipple massage, use of breast pump just before the neonate feeds).
- Maternal milk production is directly related to good hydration (at least 3 litres per day) and a caloric intake > 2500 Kcal/day.
- Nipple care, washing with water before nursing.
- As much as possible, keep neonate and mother together 24 hours a day.
- Breastfeeding on demand at least 8 times a day (at least every 3 hours).
- Maintaining exclusive breastfeeding (unless medically contra-indicated).
- Help with maintaining lactation even if the mother has to be separated from her neonate (preventing cessation of milk production due to lack of stimulation).

Do not stop breastfeeding if:
- The neonate has diarrhoea. Explain to the mother that her milk is not causing the diarrhoea.
- The mother is sick (unless the condition is serious). Explain to the mother that her milk is not of poor quality because she is sick.
6.3 Alternative feeding methods

The selection of feeding method depends on a neonate’s birth weight, ability to breast feed and digestive tolerance. Before 32 to 34 weeks gestation, a neonate can have difficulties coordinating sucking and swallowing, even if the suck reflex is present. For neonates who are not able to breastfeed effectively, feeds are given via an alternative method, either orally (using cup/paladai/spoon) or via oro/nasogastric tube.

Neonates who require feeding support should be monitored in a medical facility. Breast milk, including volume and method of administration should be prescribed by a medical officer daily. It is important to perform these calculations in all neonates weighing < 1800 g due to frequent insufficient weight gain in this group.

Neonates weighing > 1500 g should be fed every 3 hours (at least 8 feeds per day), whilst those weighing ≤ 1500 g should start with feeding every 2 hours (up to 12 feeds per day).

6.3.1 Expressing and storing breast milk

Indications

Neonates who are unwell or suffered trauma during delivery, and some neonates who are preterm or low birth weight may not be able to feed directly from the breast. In these situations it is helpful for the mother to express her milk to build up and maintain supply for when the neonate is able to start breastfeeding. Milk is expressed every 2 to 3 hours.

Hand expression is an alternative when breast pumps are unavailable. Show the mother the technique. Give her a clean cup or container for collecting the milk. The container should be washed, rinsed with boiled water and air-dried before each use.

Technique

– Wash hands, sit comfortably and hold the container under the breast.
– With the other hand, hold the breast up with 4 fingers and place the thumb above the areola.
– Squeeze the areola between the thumb and the fingers while pressing backward toward the rib cage. This should not hurt – if it hurts the technique is wrong. Compress all the way around the breast with the finger and thumb the same distance from the nipple.
– Express each breast until the milk drips slowly. Repeat expressing from each breast 5 to 6 times. Stop expressing when the milk drips slowly from the start of compression and does not flow.
– Avoid rubbing or sliding fingers along the skin and pinching or squeezing the nipple.

Storage

Feed the neonate immediately after expressing the breasts (by cup and spoon, oro/nasogastric tube or the double suction technique). If the neonate does not take all of the collected milk, it can be stored in a clean container at room temperature for up to 4 hours if the ambient temperature is < 22 °C or up to 1 hour if the ambient temperature is > 22 °C. If there is the possibility of using a refrigerator (2 to 8 °C), milk can be stored for up to 24 hours. Warm the milk (using a water bath) to room temperature before feeding.
6.3.2 Feeding using a cup or spoon

Indications

Expressed milk can be administered using a cup, spoon, paladai or syringe. It is used in situations where neonates can swallow effectively but are not able to feed directly from the breast, either because they have a weak suck reflex, they are unable to feed for long enough or they are unable to take a sufficient quantity. This method can be combined with the double suction method or oro/nasogastric feeding.

Technique

- Any clean, open container can be used (cup or container that has been washed in boiling water and air dried). Use clean containers and utensils for each feed.
- Allow the mother to feed her neonate unless she is not available.
- Measure the volume of expressed breast milk in the cup and check that it meets the recommended amount for the age and weight of the neonate (see Appendix 7).
- Hold the neonate while sitting down, semi-upright, resting on the mother’s knees.
- Gently position the cup on the neonate’s lower lip and touch the outside of the neonate’s lip with the rim of the cup/spoon.
- Tilt the cup/spoon so the milk just touches the neonate’s upper lip.
- Allow the neonate to drink the milk at their own pace. Do NOT pour milk into the neonate’s mouth or try to speed it up.
- Stop the feed when the neonate closes their mouth and is no longer interested in feeding.

Precautions

- If the neonate coughs or regurgitates multiple times when feeding using a cup or spoon, or is not able to take a sufficient quantity it means he/she does not yet have a sufficient swallow reflex. In this case, the neonate should be fed using an oro/nasogastric tube until a later time.
- Use of infant teats or bottles are not encouraged in most resource-limited settings due to high risk of contamination and limited ability to adequately sterilise them. Cups and spoons are easy to clean and can be used from birth, even in LBW neonates.

Figure 6.3 - Feeding a neonate by cup

6.3.3 Supplementary nursing technique

Indications

This technique is used to maintain breastfeeding when milk production is less than the daily amount needed by the neonate, or in neonates who have difficulty suckling at the breast. The neonate receives a temporary supplement in the form of expressed breast milk or formula. The neonate suckles and stimulates the breast at the same time drawing supplement from the tube and is thereby nourished and satisfied.

![Figure 6.4 - Feeding using a supplementary line](image)

This technique usually needs to be practiced under supervision in a health facility.

Technique

- Cut the end of a CH8 gastric tube (1 cm from the holes) and remove the cap from the other end.
- Attach the first end to the nipple using adhesive tape. Place the other end in the cup. The neonate should have both the nipple and the tube in the mouth while nursing (see Figure 6.4).
- The mother should hold the cup 10 cm below the breast level so that the milk is not sucked up too quickly. The mother can control the flow by raising or lowering the cup so that the neonate suckles for about 30 minutes each feed.

The neonate may need 2 to 3 days to adjust to the technique. If, for the first few days, the neonate does not take all the milk in the cup, give the rest with a cup, spoon or syringe.

6.3.4 Orogastric and nasogastric tube feeding

Indications

- Preterm or VLBW neonates (< 34 weeks or < 1500 g) with poor suck, uncoordinated suck and swallow reflex, rapid fatigue.
- Respiratory distress due to risk of aspiration, rapid fatigue.
- Sick neonates (asphyxia, meningitis, seizures) due to poor suck, weak reflexes.

Technique

For placement and maintenance of an orogastric (OGT) or nasogastric tube (NGT) see Appendix 3, Section 3.1.
Gastric feeding should be performed only under supervision in a health facility. In cases of respiratory distress or birth weight < 1500 g, an OGT is preferred to keep nostrils unobstructed to facilitate breathing.

**Before each feed**
- Check the abdomen is not distended or painful.
- Aspirate the gastric contents and use pH test to verify the tube is in the correct position (see Appendix 3, Section 3.1).
- Gastric residual volume does not need to be assessed routinely. However, if there are signs of feed intolerance (vomiting, distended or tender abdomen, bloody stools), checking the gastric residual is recommended. Bilious, bloody, or large volume (> 3 mL/kg/feed) residuals should be considered abnormal (see Appendix 8).

**To feed**
- Calculate the amount of milk to be given according to age and weight of the neonate (see Appendix 7).
- Take a sterile or clean (washed, rinsed with boiled water and air-dried) 20 mL enteral syringe large enough to hold the total volume of feed.
- Remove the plunger and connect the syringe barrel to the conic end of the tube (tulip).
- Put the required volume of milk in the syringe and hold it vertically with the tip of the syringe pointing downward.
- Ask the mother to hold the syringe or hang the syringe 10 cm above the neonate and let the milk in the syringe flow through the tube by gravity.
- Do NOT use the plunger of the syringe to force the milk down the syringe.
- The neonate may be held to the breast as if breastfeeding throughout the feed.
- Each feed should last 10 to 15 minutes.

**After each feed**
- Rinse the O/NGT with 2 mL of clean water after each use to minimise risk of infection.
- Keep the neonate at an angle of 30° for one hour to prevent gastro-oesophageal reflux (be careful with the position of the head to avoid obstruction of the airways).

The O/NGT should be replaced every 3 days, or sooner if it is dirty or blocked, and skin integrity around nostrils and mouth should be monitored.

**When to stop gastric feeding**
Feeding via O/NGT may be combined with other methods. When the neonate is able to swallow without coughing or regurgitating milk, feeding using a cup, spoon or supplementary nursing technique may be used. This may take several days or several weeks depending on the gestation and clinical condition.

When the neonate is able to tolerate 100 mL/kg/day with an alternative feeding method the gastric tube can be removed.

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b Syringes are for individual use, i.e. no sharing of syringes between patients even if washed. Maximum use of 24 hours per syringe then replace with a new one.
6.4 Intravenous fluids

Indications
- Birth weight < 1500 g
- Haemodynamic instability, respiratory distress or apnoea
- Severe dehydration, hypovolaemic shock
- Perinatal asphyxia
- Neonatal convulsions
- Severe neonatal infections
- Gastrointestinal problems such as necrotising enterocolitis (NEC), bowel obstruction
- Persistent or recurrent hypoglycaemia

Fluid types

10% glucose
In the first few days of life (day 1 to 3) 10% glucose alone is used in all neonates requiring intravenous fluids.
Glucose concentrations > 12.5% can lead to skin and soft tissue necrosis and are not recommended.

0.9% sodium chloride
After the first few days of life, the neonate also requires sodium (salt). It is not used alone, because it is too concentrated and the neonate also requires sugar. Therefore a combination of sodium and glucose is used:

\[
\frac{1}{5} \text{0.9% sodium chloride} + \frac{4}{5} \text{10% glucose}
\]
Prepare by adding 100 mL of 0.9% sodium chloride to 400 mL of 10% glucose

0.9% sodium chloride is preferred over Ringer Lactate (RL) to avoid giving additional lactate to neonates, however RL can be used if 0.9% sodium chloride is not available.

Potassium chloride
This is only to be used where monitoring of potassium levels is available.

When 0.9% sodium chloride is used for extended periods of time (more than 3 days) and the neonate is not taking any milk feeds (e.g. NEC), it is recommended to add 10 mmol/L of KCl to the maintenance infusion. Strict procedures must be in place before potassium containing fluids are used to avoid potentially fatal cardiac effects from improper preparation or too rapid administration.

In settings where there is no possibility to measure serum electrolytes or perform cardiac monitoring, administration of IV fluids containing potassium is not considered safe.

Once the neonate begins passing urine, maintenance oral potassium chloride replacement can be commenced. The normal potassium requirement in neonates is 2 to 4 mmol/kg/day.

potassium chloride PO: 1 mmol/kg 2 times daily
**Calcium gluconate** (10% solution)

Many neonates present with calcium deficiency in the first few days of life. This is more pronounced in sick and VLBW neonates. It is usually asymptomatic but may present with tremors, convulsions or spasms in severe cases.

Asymptomatic hypocalcaemia often resolves once the neonate starts feeding. In neonates who are not feeding (e.g. asphyxia or birth weight < 1500 g) addition of calcium to maintenance intravenous fluids may be considered.

<table>
<thead>
<tr>
<th>calcium gluconate</th>
<th>IV: 2 to 4 mL/kg of a 10% solution administered by continuous infusion for first 48 hours of life.</th>
</tr>
</thead>
</table>

Monitoring of calcium levels is preferred but not mandatory, provided safe administration and nurse monitoring is available. The IV site should be carefully monitored as calcium gluconate can cause skin necrosis. Intravenous calcium should not be given unless safe administration can be guaranteed.

Do not administer ceftriaxone and calcium containing products through the same IV line, as fatal reactions with ceftriaxone-calcium precipitates in the lungs and kidneys have occurred.

**Amount of fluid**

The amount of IV fluid depends on the neonate’s age and weight (see Appendix 7). The maximum IV fluid rate in neonates is 150 mL/kg/day.

**Administration**

Syringe pump: this is the preferred method of fluid delivery where appropriate facilities and expertise are available.

Paediatric infusion set (1 mL = 60 drops) can be used if syringe pumps are not available. Do not use an adult infusion set as the flow rate is more difficult to control.

- Bolus infusions should only be used in emergency management.
- Replace fluid bag after 24 hours, even if it is not empty as it is a potential source of infection.
- Often IV infusion is combined with breast feeding. When the enteral feeding volume reaches 2/3 of the total daily fluid volume (100 mL/kg/day) and the neonate is tolerating enteral feeds, the IV infusion may be stopped. This allows moving to exclusive milk feeds more quickly, which is more physiological and allows the IV catheter to be removed.
- Flush the IV catheter with 1 mL of 0.9% sodium chloride before and after the administration of medicines to ensure patency.

**Special situations**

*Perinatal asphyxia*

- These patients often have multiple organ damage and mild fluid restriction is therefore recommended.
- The neonate should be kept ‘nil by mouth’ for at least 24 hours after birth, and IV fluids should be started at 50 mL/kg/day (see Chapter 3, Section 3.3.1).
- Thereafter, increase fluids by 10 mL/kg/day.
- These neonates are at risk of NEC and enteral feeds should be introduced cautiously.
Monitoring

- Check IV catheter site before each injection and regularly during infusion to avoid issues with extravasation. If there are signs of erythema, oedema, or leakage, remove the catheter immediately and insert another at a different location.
- Routinely change the catheter after a maximum of 5 days. Remove the catheter immediately when the neonate is no longer receiving IV fluids or medications.
- Monitor weight and hydration and adjust the total infusion volume according to the clinical condition.

Blood glucose levels

- Check blood glucose level (BGL) 1 hour after starting the infusion, and then every 4 to 6 hours until stable.
- If BGL < 45 mg/dL or > 180 mg/dL, see Chapter 3, Section 3.1.4.
6.5 Feeding according to birth weight

Feeding neonates with a birth weight < 1500 g

VLBW neonates usually have a gestation < 32 weeks (very or extremely preterm). VLBW and very preterm neonates are at high risk of having digestive problems and developing NEC if enteral feeding is advanced too quickly.

Neonates < 1500 g should be given 10% glucose as a continuous infusion from D1.

If the neonate is clinically stable (i.e. without severe respiratory distress or signs of shock), start trophic feedsa via O/NGT on D1, as soon as possible (aim within 6 to 12 hours after birth). Trophic feeds should be given as 10 mL/kg/day of expressed breast milk (EBM). Note this volume of trophic milk is an extra amount and not included in the total daily volume. Trophic feeds allow priming of the gut.

Refer to corresponding tables by birth weight in Appendix 7, Section 7.2.

If well tolerated, on D3 advance enteral feeds by 15 to 20 mL/kg/day, with feeds given every 2 hours (12 feeds per day) and included as increasing total fluid volume.

Once the neonate is tolerating full volume feeds and blood glucose is stable, transition feeding to every 3 hours (8 feeds per day).

Neonates < 1250 g represent a very vulnerable group with very high mortality. When it is not possible to administer a continuous IV infusion, as a last resort, EBM and 10% glucose can be administered simultaneously by mouth (see Appendix 7, Section 7.1). In some contexts, palliative care may be recommended due to feasibility and limited resources (see Chapter 8, Section 8.2).

Stopping the IV infusion

– Once enteral feeds are approximately 100 mL/kg/day and well tolerated the IV infusion can be stopped. Aim to stop IV fluids by day 7 to 8 of life.
– After this time continue upgrading enteral feeds as tolerated to a total daily volume of 180 mL/kg/day.

Feeding neonates with a birth weight ≥ 1500 g

Neonates with a birth weight ≥ 1500 g usually have a gestation > 32 weeks. Milk feeds can normally be started from birth if the neonate is clinically well.

Choice of feeding method depends on the ability of the neonate to breastfeed:

– Neonates able to breastfeed: feed within an hour of birth and continue breastfeeding at least every 3 hours. If the neonate feeds well and is gaining weight it is not necessary to measure the volume of feeds.
– Neonates who are not yet able to suck or swallow effectively should be fed every 3 hours with expressed breast milk via an alternative feeding method (see Section 6.3).

If the neonate is sick at birth and requires IV fluids, refer to corresponding tables by birth weight in Appendix 7, Section 7.2.

---

a Trophic feeds are very small volumes of enteral feeds given to preterm neonates in order to stimulate the development of the immature gastrointestinal tract.
6.6 Replacement feeding

**Indications**

Breast milk is always the preferred feeding method. In rare situations when breastfeeding is impossible or for orphaned neonates, replacement of breast milk with a suitable breast milk substitute for the first 6 months of life may be required. Replacement feeds should be given with a cup or spoon, the use of bottles should be avoided.

**Type of replacement feed**

If breast milk is only temporarily unavailable:
- Give the total daily volume with **10% glucose** solution, either with a cup or O/NGT.
- Alternatively give **10% glucose** via continuous infusion (maximum 3 days).
- If breast milk is still not available after 3 days, give infant formula a.

If breast milk will never be possible:
- In areas where HIV prevalence is low (< 1% women of reproductive age), the first choice is feeding by a wet nurse.
- In areas where HIV prevalence is > 1% in women of reproductive age, wet-nurses can be used but they should first be tested for HIV.
- If there is no possibility of a wet nurse or if the wet nurse is HIV positive, the neonate should be fed exclusively with formula up to the age of 6 months and then supplemented with a varied diet until the age of 2 years.

Formula milk specific for the neonatal period (e.g. for preterm neonates) may be available. If not, term formula should be available. Ensure that the family have access to the same formula as prescribed in hospital.

Milk from cows, goats and other animals is not adapted to the needs of a neonate and can cause gastrointestinal problems, infection and malnutrition.

**AFASS (Acceptable, Feasible, Affordable, Sustainable, Safe) criteria**

Before prescribing replacement feeds, check that it is widely available and ensure that all of the following conditions can be met for the entire duration of use:
- **Acceptable**: The mother or caregiver perceives no significant barrier to choosing a feeding option for cultural or social reasons or for fear of stigma or discrimination.
- **Feasible**: The mother or caregiver has adequate time, knowledge, skills and other resources to prepare the feeds and to feed the neonate, as well as the necessary family and community support.
- **Affordable**: The mother and family (with available community or health system support) has sufficient means to pay for the costs of replacement feeds – including all ingredients, fuel and clean water without compromising the family’s health budget.
- **Sustainable**: The family has access to a continuous and uninterrupted supply of all materials required for exclusive replacement feeding for the first 6 months of life.
- **Safe**: The family has access to safe drinking water and good sanitation. Replacement feeds are correctly and hygienically prepared using clean hands and utensils – preferably using a cup (bottle and teats are not recommended).

---

a In extenuating circumstances, when neither breast milk nor infant formula is available, F100 can be diluted for use in neonates until breast milk or infant formula become available. This should be a short-term solution, as the use of specially diluted therapeutic milk is not recommended in neonates under 1 month.
6.7 Management of feeding problems

6.7.1 Breast conditions

Breast engorgement
Usually the whole of both breasts are affected and they are red, shiny, swollen and painful. It is caused by failure to remove breast milk adequately usually as a result of delayed initiation of breastfeeding, infrequent feeds, poor attachment and ineffective suckling.

The breast milk must be removed from the breasts. If the neonate can attach well and suckle, breastfeeding should continue. If the neonate is not able to attach well, manually expressing the milk until the breasts are softer may help with attachment. Warm compresses applied to the breast before feeding helps with milk flow. Cold compresses used after feeding helps to reduce oedema.

Mastitis (breast infection)
There is hard swelling of the breast with overlying redness and associated severe pain. Usually only part of the breast is affected. The woman has fever and is ill. Mastitis usually results from milk stasis (milk staying in the breast too long) resulting in inflammation and infection.

The mother should be assessed and commenced on treatment if necessary (see Essential Obstetric and Newborn Care, MSF²). The milk should be removed from the breast and discarded. It may be helpful to apply warm compresses and start breast feeding with the unaffected breast to stimulate the oxytocin reflex and milk flow, and to vary the position of the neonate.

Cracked nipples
The mother has severe nipple pain when the neonate is suckling and there may be a visible fissure across the tip of the nipple or around the base. The main cause is poor attachment. The neonate should continue breastfeeding. Vary the neonate’s position when breast feeding and carefully dry the nipple after each feed.

Flat or inverted nipples
Nipples come in a variety of shapes and sizes that usually do not affect the woman’s ability to breastfeed. However, sometimes a nipple that appears too flat or long may create difficulties with attachment. Most flat nipples are protractile (if the woman pulls them out with her fingers they stretch) and the neonate is able to suckle. Sometimes an inverted nipple is non-protractile making breastfeeding more difficult.

The mother should be encouraged to continue breastfeeding. It may help to vary the position to attach the neonate. Frequent skin-to-skin contact can help the neonate to find the most effective position for taking the breast.

If the neonate is not able to attach in the first few weeks, the mother should express her milk and feed the neonate with a cup. As the neonate grows and the mouth becomes larger attachment becomes easier. Feeding bottles or using dummies, which do not encourage the neonate to open the mouth widely, should be avoided.

A 20 mL syringe with the adaptor end cut off and the plunger put in backwards to stretch the inverted nipple just before feeding may help (see Figure 6.5).
6.7.2 Inadequate breast milk production

Assess the health status of the mother. It is important that she receives adequate hydration (at least 3 litres per day) and nutrition (at least 2500 Kcal/day). If needed, the mother’s diet may be supplemented with Ready to Use Therapeutic Foods. Take time to discuss her concerns and any stressors which may contribute to poor feeding. It is crucial to explain her role and the importance of breastfeeding, and to help build her confidence.

Check the nipples have no lesions and treat any redness, fissures or cracks by applying a thick coat of Vaseline® or equivalent. Nipples should be washed with clean water before each breast feed.

Stimulate maternal milk production in order to ensure adequate exclusive breastfeeding. Encourage breastfeeding on demand at least every 3 hours. Feeding should continue for 20 minutes (10 minutes on each breast). Insufficient stimulation is the most common reason for poor milk supply. Expressing breast milk with a breast pump and using the “supplementary nursing” technique can help build milk production (see Section 6.3.3).

Table 6.2 - Summary of management of feeding problems

<table>
<thead>
<tr>
<th>Situation</th>
<th>Management</th>
</tr>
</thead>
</table>
| Problem with breastfeeding but breastfeeding seems possible (milk production, sucking and swallowing are all adequate). | • Give the mother advice and build her confidence.  
• Observe breastfeeding, and record observations in the neonate’s chart. |
| Breastfeeding with inadequate amount of breast milk (amount of milk produced less than neonate’s daily requirements). | • Stimulate milk production by frequent breastfeeding (8 times/day).  
• Use breast pump and “supplementary nursing” technique. |

---

Figure 6.5 - Using an inverted syringe for treatment of inverted nipples

---

\[\text{Reprinted with permission from Neumate and young child feeding: model chapter for textbooks for medical students and allied health professionals. World Health Organization (WHO). Management of breast conditions and other breastfeeding difficulties, page 68. Copyright 2009.}\]
### Situation Management

<table>
<thead>
<tr>
<th>Situation</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ineffective sucking, but good swallowing reflex</td>
<td>• Express breast milk with a pump, or by hand.</td>
</tr>
<tr>
<td></td>
<td>• Administer the milk using a cup, spoon or syringe.</td>
</tr>
<tr>
<td>Ineffective sucking and inadequate swallowing reflex</td>
<td>• Express breast milk with a breast pump or by hand.</td>
</tr>
<tr>
<td></td>
<td>• Feed breast milk via O/NGT tube.</td>
</tr>
</tbody>
</table>

#### 6.7.3 Feeding intolerance

Feeding intolerance is demonstrated when the preterm neonate is not capable of digesting prescribed enteral feeds without complications such as intrapulmonary aspiration of feeds, infection and gastrointestinal dysfunction. It is a significant problem for VLBW neonates (< 1500 g) and can lead to delayed establishment of enteral feeds and growth failure.

**Clinical features**

The neonate should be assessed for feeding intolerance before every feed. Features include vomiting, abdominal distension, visible bowel loops and diarrhoea. Gastric residual volumes of more than half of the prior feed volume and bilious gastric residuals are considered significant (see Appendix 8).

Signs such as apnoea, bradycardia and temperature instability may indicate progression to NEC, a serious complication (see Chapter 3, Section 3.5.6).

**Management**

Withhold the feed. Commence treatment for NEC if the neonate is unwell. The feeds may need to be advanced more slowly. Adjust IV fluids accordingly, if necessary.

#### 6.7.4 Weight loss

- Weight loss in the first few days of life is normal, but ≥ 10% weight loss (or ≥ 15% in preterm) should be carefully assessed and monitored.
- Weight gain (approximately 15 to 20 grams/kg/day) starts around day 3 to 5 of life. A term breastfed neonate regains their birth weight after about 10 days, and a preterm neonate after about 15 days.
- Assess carefully to ensure neonate is not sick and/or showing any danger signs (see Chapter 3, Section 3.1.1).
- If the neonate is clinically well, consider the following causes of weight loss:
  - Ineffective milk transfer due to poor positioning and attachment.
  - Infrequent feeding patterns.
  - Reduction in breast milk production due to the above factors.
  - Delay in milk “let down” due to factors such as stress, anxiety and pain.

**Management**

- Enquire about breastfeeding frequency and production of urine and stools.
- Perform a clinical examination looking for signs of dehydration (hypotonia, skin pinch goes back slowly, dry mucous membranes).
– Observe a breastfeed to assess positioning, attachment, sucking ability and the mother’s milk let-down.

If there are features of dehydration, manage fluids depending on severity (see Chapter 3, Section 3.5.5).

If there are no concerning features on physical examination:
– Ensure a minimum of 8 feeds in 24 hours. Advise the mother to initiate feeds every 3 hours if neonate not showing feeding cues regularly.
– Skin-to-skin contact to encourage breastfeeding.
– Monitor weight every 12 hours until weight stabilises or increases.
– Monitor urine and stool production.

Prevention
– Early implementation of breastfeeding and skin-to-skin contact after birth.
– Ensure that the neonate is fed at least 8 times per day (and woken for feeds during the night).
– Lactation advice and support for mothers after birth. Education of the mother to optimise milk production.
– If the neonate is too weak to suck effectively, an alternative feeding method should be used (see Section 6.3).
– Always ensure the neonate can properly breastfeed before discharging from hospital.
References Chapter 6


Chapter 7: Common congenital problems

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7.1 Cleft lip and cleft palate

Cleft means ‘split’ or ‘separation’. A cleft lip is a congenital anomaly that occurs when one or both sides of the upper lip fail to fuse. A cleft palate is found when one or both sides of the roof of the mouth fail to fuse. Orofacial clefts can occur as cleft lip with or without cleft palate, or isolated cleft palate.

Clinical features
Neonates with isolated unilateral cleft lip are usually able to breast feed normally.
Cleft palate is associated with feeding difficulties. The neonate is able to swallow normally but unable to suck adequately and milk regurgitates through the nose and may be aspirated into the lungs.
Clefts can occur in isolation or be associated with various congenital syndromes.

Management
Feed using expressed breast milk via a cup and spoon, or, if available and adequate sterility can be assured, a special teat may be used. The aim of feeding is to deliver a bolus of milk to the back of the tongue into the pharynx; the neonate will then swallow normally. Insertion of an NGT may be necessary in the short term if it seems the only temporary solution.
Close follow-up during infancy is required to monitor feeding and growth.
Definitive management is via surgical repair of cleft lip between 3 and 6 months and cleft palate around 1 year of age. Refer, where possible, to a surgical program that can manage these conditions.

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7.2 Congenital heart disease

Congenital heart disease refers to structural or functional heart diseases that are present at birth. In high-resource settings, these defects are most often discovered on antenatal ultrasound, but in low-resource settings they are usually only discovered once the neonate presents sick.

Clinical features

Congenital heart disease presents in one of four ways in the neonatal period:

1. Abnormal examination in an asymptomatic baby
   Murmurs that are easy to hear, radiate to other areas or persist are more likely to be significant. Try to decide where the murmur is loudest, and the timing in the cardiac cycle (systolic or diastolic).
   Six grades are used to classify the intensity of a murmur:
   1. Very faint murmur, heard with difficulty
   2. Faint murmur that can be identified immediately
   3. Moderately loud murmur, but no thrill
   4. Loud murmur associated with a palpable thrill
   5. Very loud murmur with thrill, but cannot be heard without stethoscope
   6. Loudest murmur that can be heard without stethoscope
   Weak femoral pulses may be a sign of co-arctation of the aorta. Look for pre- and post ductal differences in oxygen saturation with pulse oximetry, and if feasible to perform accurately, take four-limb blood pressure measurements.

2. Cyanosis
   Many neonates with cyanotic heart disease will appear blue from birth with or without respiratory distress. Look at the tongue and lips, and perform pulse oximetry. Pulse oximetry reading of the right hand that is > 10% different to other peripheral oximetry reading indicates pulmonary hypertension with an open patent ductus arteriosus.

3. Heart failure/ respiratory distress
   It is unusual for left-to-right shunt lesions to present in the early neonatal period. Typically large ventricular septal defects (VSDs) present with signs of heart failure (tachycardia, tachypnoea, respiratory distress) at 2 to 4 weeks of age after pulmonary pressures have fallen.

4. Shock/cardiovascular collapse
   Ductal dependent lesions (such as critical aortic stenosis, hypoplastic left heart, co-arctation of the aorta) may present with signs of shock. In these conditions, the only way the blood can reach the systemic circulation is via the ductus arteriosus. Neonates are often asymptomatic while the duct is patent, and present with cardiovascular collapse during the first week of life when it closes. Neonates present pale and shocked with respiratory distress and weak pulses.
Investigations

Without advanced resources it is often not possible to investigate for congenital heart disease. Where available, the following investigations can support diagnosis:
- Echocardiogram
- Chest x-ray
- ECG

Management

Without surgical expertise, management options are limited for severe congenital heart lesions. It is important to treat for other conditions (respiratory diseases, neonatal sepsis) where the diagnosis is not certain.

Management of symptoms of heart failure includes fluid restriction (2/3 of usual maintenance volume) and diuretic therapy with furosemide and spironolactone.

The diagnosis should be sensitively discussed with the family, and where there is no option for surgical correction of severe disease, palliative care should be considered (see Chapter 8, Section 8.2).
7.3 Neural tube defects

Neural tube defects are a group of conditions in which the brain or spinal cord fail to close properly during early human development. Encephalocele is a sac like protrusion of the brain and covering membranes through an opening in the skull (see Figure A-31), while myelomeningocele is characterised by a cleft in the vertebral column, with a corresponding defect in the skin so that the meninges and spinal cord are exposed. Myelomeningocele is also known as open spinal dysraphism, or spina bifida aperta. A cleft in the vertebral column without a corresponding epithelial defect, is known as occult spinal dysraphism or spina bifida occulta.

Clinical features

Signs of spina bifida occulta may include a hairy patch, dimple, dark spot, or swelling on the back at the site of the gap in the spine.

In myelomeningocele, the unfused portion of the spinal column allows the spinal cord and meningeal membranes to protrude through an opening, forming a sac with exposed spinal elements. The lumbar region is the most common site. Patients are at risk of meningitis/ventriculitis and hydrocephalus.

Long-term problems include leg weakness and paralysis, orthopaedic abnormalities (club foot, hip dislocation, scoliosis), bladder and bowel dysfunction with problems of sphincter control, pressure sores and abnormal eye movements.

Management

Acute management at birth:
– Apply a sterile, saline soaked gauze dressing using latex-free gloves. A plastic flap should cover the dressing to prevent from soiling.
– Where there is a possibility for neurosurgical intervention, patients should be commenced on prophylactic antibiotics for meningitis until closure of the defect (see Chapter 3, Section 3.3.2).
– Advise the mother or caretaker not to interfere with the lesion and avoid lying the neonate on his/her back to avoid exerting pressure.

The role of surgery depends on service availability, severity, complications and wishes of the family. Where possible, consider referral to neurosurgery services for potential closure of open defects and lesions associated with severe hydrocephalus.

For severe lesions associated with neurological complications and little possibility for improvement, palliative care should be considered and discussed with the family (Chapter 8, Section 8.2).

Prevention

Maternal supplementation with folic acid (400 micrograms daily) before conception and in the first trimester reduces the risk of neural tube defects. Women with a history of neural tube defects are at increased risk and should receive high dose folic acid in future pregnancies (recommended dose 4 mg daily).
7.4 Abdominal wall defects

An abdominal wall defect is an opening in the abdomen through which various abdominal contents can protrude.

Gastroschisis
Gastroschisis is a full thickness, para-umbilical abdominal wall defect, usually associated with evisceration of bowel. It is usually located to the right of the cord insertion site. There is no covering membrane. The prevalence of gastroschisis is increasing worldwide, with an incidence of 4 to 5 per 10,000 live births. Young maternal age is a risk factor.

Management
- For definitive surgical management refer to an experienced paediatric surgeon where possible.
- Apply a sterile dressing and cover with a plastic bag to prevent fluid loss. Exposed bowel can lead to rapid fluid loss and hypothermia.
- Make the neonate “nil by mouth”.
- Insert an oro/nasogastric tube (O/NGT) for free drainage.
- Maintain normothermia.
- Commence IV fluids:
  - Correct dehydration with IV 0.9% sodium chloride or Ringer Lactate 10 mL/kg over 20 minutes.
  - Give maintenance IV fluids (see Appendix 7).
- Commence IV combination antibiotic therapy with ampicillin slow IV (3 minutes) + metronidazole IV infusion (over 60 minutes) for 7 to 10 days (according to clinical response) + gentamicin slow IV (3 minutes) or IM for 5 days:

<table>
<thead>
<tr>
<th>0 to 7 days</th>
<th>&lt; 2 kg</th>
<th>ampicillin IV 50 mg/kg every 12 hours + gentamicin IV 3 mg/kg every 24 hours + metronidazole IV 15 mg/kg as a loading dose then after 12 hours 7.5 mg/kg every 12 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 2 kg</td>
<td></td>
<td>ampicillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours + metronidazole IV 15 mg/kg as a loading dose then after 12 hours 7.5 mg/kg every 12 hours</td>
</tr>
<tr>
<td>8 days to &lt; 1 month</td>
<td>&lt; 2 kg</td>
<td>ampicillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours + metronidazole IV 15 mg/kg as a loading dose then after 12 hours 7.5 mg/kg every 12 hours</td>
</tr>
<tr>
<td>≥ 2 kg</td>
<td></td>
<td>ampicillin IV 50 mg/kg every 8 hours + gentamicin IV 5 mg/kg every 24 hours + metronidazole IV 15 mg/kg every 12 hours</td>
</tr>
</tbody>
</table>

- If specialist surgery is not possible, consider the overall condition and prognosis of the neonate and consider palliative care. Communicate and involve family and caregivers in the supportive care of the neonate.
Omphalocoele

Omphalocoele refers to a midline defect of variable size at the site of the cord insertion. It is covered by a membrane of peritoneum with Wharton’s jelly between the two layers, and contains abdominal contents. Ascites may be present and associated anomalies are common (see Figure A-32). Incidence ranges from 1 in 3000 to 10,000 live births.3,4,5

Figure 7.2 - Neonate with omphalocoele

Management

– For definitive surgical management, refer to an experienced paediatric surgeon where possible.
– Apply a sterile dressing and cover with a plastic bag to prevent fluid loss. Exposed bowel can lead to rapid fluid loss and hypothermia.
– Feed normally if tolerating well. Some may have a good spontaneous evolution over months if surgical management is not available.
– For neonates not tolerating feeds or unwell, manage as for gastroschisis.

---

7.5 Hernias

7.5.1 Umbilical hernias

Umbilical hernias represent a gap in the fascia beneath the umbilicus through which abdominal contents may protrude, covered by skin. They are common in neonates.

Clinical features

Although the hernia may be prominent with straining or crying it is painless and should be easily reducible (see Figure A-33). Incarceration or strangulation is very rare.

Management

Dressings to cover the hernia (such as coins and strapping) are not effective and may damage the surrounding skin. In most cases uncomplicated hernias spontaneously regress (approximately 90% by 2 years of age) and they may be safely left alone.\(^6\)

7.5.2 Inguinal hernias

Inguinal hernias are peritoneal pouches that extend through the inguinal canal, sometimes as far as the scrotum, and may contain bowel.

Clinical features

Inguinal hernias often present as intermittent swellings so may not be noticed until the neonate cries or strains. They are more common in preterm neonates. They require surgical referral once diagnosed as the small bowel can easily become trapped, compromising the blood supply and causing strangulation.

Signs of strangulation include:
- Inability to squeeze the hernia back (irreducible)
- Excessive crying
- Vomiting, abdominal distension and constipation (late sign)

Management

An irreducible or strangulated hernia requires urgent surgical referral. A reducible inguinal hernia requires early surgical consult.
7.6 Genital anomalies

7.6.1 Hydrocoele
A hydrocoele is a painless, fluid filled sac around the testis that is present from birth.

Clinical features
Hydrocoeles are cystic, irreducible and non-tender. It may not be possible to feel the testis separate from the hydrocoele if the hydrocoele is tense. Shining a light through the testicle (transillumination) reveals a cystic scrotal mass.

Management
The parents should be reassured that the fluid does not harm the testis and that it will usually resolve within a year. No follow-up is required if both testes are felt and a hernia is not suspected.

7.6.2 Hypospadias
Hypospadias is a congenital anomaly of the penis where the urethral opening is not located in its normal position. It occurs in around 1 in 500 neonates and occurs due to a failure of the urethral folds fusing completely. The urethral opening is usually located more ventrally and proximally, but can be anywhere from the glans to the shaft or near the scrotum.

Management requires non-urgent referral to a paediatric surgeon.
7.7 Anorectal malformations

Anorectal malformations (imperforate anus) are birth defects in which there are abnormalities of the anus and rectum of varying severity, ranging from fairly minor lesions to complex anomalies. The cause of anorectal malformations is unknown.

**Clinical features**

Neonates may present with failure to pass meconium after birth, or a physical examination may reveal absence of the anus or a misplaced anal opening (see Figure A-34). If a fistula is present, meconium may be seen to pass from the vagina or urethra.

**Management**

These patients require urgent review by an experienced surgeon or paediatric surgeon and referral options should be discussed. If a fistula is evident, cautious insertion of an O/NGT may be beneficial to allow the release of gas.
7.8 Talipes equinovarus (club foot)

Club foot (talipes equinovarus) is a congenital deformity of the foot and ankle. In approximately 50% of cases both feet are affected.

Clinical features
There is:
- Plantar flexion of the foot
- Inversion of the heel
- In-turning of the forefoot

Management
- Mild positional deformity (where the foot is able to be passively corrected): simple stretching of the foot beginning shortly after birth.
- Moderate deformity: involves serial manipulations shortly after birth7:
  - Maintain position with either tape strapping or well-padded plaster of Paris casts. Apply this in the sequential steps (1, then 2 then 3) as shown in the figure below.
  - These manipulations need to be repeated every 2 weeks or until the deformity is corrected.
  - Where possible the neonate may need to be referred for fitting of special splints.

7.9 Developmental dysplasia of the hip

Developmental dysplasia of the hip (DDH) refers to a spectrum of abnormalities in the immature hip that can range from subtle dysplasia to dislocation. If DDH remains undetected and untreated, the affected limb eventually becomes shorter and the hip may become painful. Breech position, multiple pregnancy and family history of DDH are risk factors.

Clinical features
Asymmetric skin creases in the thigh and groin are common, but also occur in neonates without DDH. Two screening manoeuvres are commonly used to test for hip joint instability. Each hip should be examined separately with the neonate supine on the bed and hips and knees flexed to 90°.

Ortolani’s sign
The thigh of the hip being tested is abducted and gently pulled anteriorly. When the flexed hip is abducted, a ‘clunk’ can often be felt as the dislocated femoral head enters the acetabulum (reducible).

Barlow’s sign
The hip is returned to the starting position and then slightly adducted (knee drawn across the body) and the thigh is pushed gently posteriorly. A clunk indicates the head of the femur is moving out of the acetabulum (dislocatable).

Investigations
In neonates, x-rays are not usually helpful due to immature ossification of the hip joint. Where available facilities and expertise exist, patients with identified risk factors are usually followed up with ultrasound (after 6 weeks of age).

Management
In milder cases, keep the hip in flexion and abduction through double nappies or an abduction brace in the abducted position for 2 to 3 months. The cultural practice of carrying the neonate on the back with the hip flexed and abducted serves the same purpose.

In more severe cases, keep the hip flexed and abducted in a splint. Depending on the context, seek options for referral to an experienced paediatric surgeon.
7.10 Polydactyly

Polydactyly refers to extra digits and is the most frequent congenital limb deformity. It can occur in isolation or in association with various congenital syndromes.

Clinical features
The extra digit can be seen on the hand (most commonly) or the foot. It may be present on one or both sides. The digit is usually rudimentary and underdeveloped attached by a small skin bridge and neurovascular bundle (see Figure A-35). Occasionally it contains bone, tendons and soft tissue structures. Polydactyly may be:

Pre-axial: duplication of the thumb or toe (radial side)
Post-axial: duplication of the 5th digit (ulnar or fibular side), most common
Central: duplication of the 2nd, 3rd, or 4th digits

Management
If there are no signs of bone involvement and the skin bridge is narrow:
– Tie suture tightly around the base of the peduncle, as low as possible on the skin bridge.
– The digit will fall off after 1 to 2 weeks.

Surgical management depends on the severity and complexity of the lesion. Most lesions do not pose long-term problems and can be left alone.
References Chapter 7


Chapter 8:
Pain and palliative care

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Chapter 8: Pain and palliative care

8.1 Assessment and management of neonatal pain

Pain prevention and management are an integral part of neonatal care. Neonates, both term and preterm, experience pain and should receive effective and safe pain relief. Exposure to prolonged or repeated pain can have many adverse effects including increased duration of illness, increased morbidity, long-term cognitive effects and development of an abnormal response to painful stimuli.

**Acute pain:** often related to diagnostic or therapeutic procedures such as tape removal, skin breaking procedures (such as intravenous insertion or injections), succioning or oro/nasogastric tube insertion.

**Established pain:** occurs following surgery, inflammatory conditions or birth trauma.

**Prolonged or disease-related pain:** results from severe diseases such as necrotising enterocolitis and meningitis.

**Assessment of pain**

Neonates cannot verbalise pain, so depend on caregivers to assess and manage signs of pain. The frequency of pain assessment will depend on the neonate’s clinical condition and underlying diagnosis. Every neonate within the neonatal unit should be assessed for pain at least once per shift. The following signs may indicate underlying pain in a neonate:

**Physiological indicators**

- Changes in heart rate, respiratory rate, breathing pattern, oxygen saturation, skin colour and palmar sweating

**Behavioural indicators**

- Crying patterns, hand and body movements, increased muscle tone, change in sleep patterns, behavioural state changes and consolability
- Neonatal Facial Coding System (NFCS)\(^1\) is an observational evaluation scale (refer to Figure 8.1) that:
  - Assesses 4 facial expressions associated with neonatal pain: brow bulge, eye squeeze, deepening of the nasolabial furrow and open mouth.
  - A score of 1 is given for each feature present, and a score of 0 if the action is not observed, so the maximum total score possible is 4 and the minimum is 0.
  - Pain management is recommended when the score is ≥ 2.

<table>
<thead>
<tr>
<th>Items</th>
<th>Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brow bulge</td>
<td>0</td>
</tr>
<tr>
<td>Eye squeeze</td>
<td>0</td>
</tr>
<tr>
<td>Nasolabial furrow</td>
<td>0</td>
</tr>
<tr>
<td>Open lips</td>
<td>0</td>
</tr>
</tbody>
</table>

*Figure 8.1 - Neonatal Facial Coding System (NFCS)*
Management

Management of neonatal pain should be performed in a stepwise manner depending on the severity of pain and response to interventions.

**STEP 1 (NFCS Score = 1-2): Non-pharmacologic measures**
- Administration of oral sugar solutions
- Swaddling
- Breastfeeding
- Kangaroo mother care (KMC)
- Sensorial saturation – use of touch, massage, voice

Non-pharmacologic measures are most useful when used in combination (e.g. using oral sugar solutions and KMC). These measures may avoid the need for pharmacologic intervention, or reduce the required dosage of medications.

Oral sugar solutions are useful for prevention of pain associated with technical procedures:

**30% glucose** (IV solution for oral use): 0.5 mL (≤ 2500 g) or 1 mL (> 2500 g)
Give oral via syringe, 2 to 3 minutes before procedure. Oro/nasogastric administration has no analgesic effect. If procedure is > 5 minutes a further dose may be administered.

If 30% glucose is not available, a 25% glucose solution can be obtained as follows:
- Mix 50% glucose with water for injection in equal measures.
- Give the same dose as outlined above for 30% glucose.

**STEP 2 (NFCS Score = 3)**
Non-pharmacologic measures + **paracetamol**

**paracetamol**
- PO: 10 to 15 mg/kg every 6 to 8 hours; maximum 60 mg/kg per day
- IV: 7.5 mg/kg every 6 hours; maximum 30 mg/kg per day

*Note*: the efficacy of IV paracetamol is not superior to the efficacy of oral paracetamol; the IV route is restricted to situations where oral administration is impossible.

**STEP 3 (NFCS Score = 4)**
Non-pharmacologic measures + **paracetamol** + **morphine**

**morphine**
- Oral: 0.1 to 0.4 mg/kg every 4 hours, as needed (prompt release formulation)
- IV: 0.05 to 0.1 mg/kg, slow IV (over 3 to 5 minutes), every 4 to 6 hours

*Side effects*: sedation, constipation, urinary retention, nausea and vomiting. In case of overdose respiratory depression is possible. Carefully monitor for above effects and ensure ambu bag readily available.

In case of respiratory depression (RR < 30):
- Commence bag-mask ventilation.
- If suspected morphine-induced respiratory depression, give:
  **naloxone** IV: 0.01 mg/kg (= 10 micrograms/kg) every 2 to 3 minutes as needed until resolution of respiratory depression.
**Ibuprofen** is not recommended as an analgesic in the neonatal period due to the risk of renal and gastrointestinal complications.

**Codeine** is not recommended due to an uncertain efficacy and safety profile.

**EMLA® cream** is not recommended due to its delayed onset of action (requires up to 60 minutes to achieve local anaesthesia).

For severe pain, especially if related to dressings or surgical procedures, consider involving the anaesthetic team where available.

**Prevention**

Strategies for preventing pain in neonates include:

– Routine assessments for neonatal pain.
– Minimising the number of painful procedures and neonate handling.
– Preventing or reducing pain associated with routine minor procedures (see Table 8.1).
– Avoiding chronic pain and stress associated with neonatal intensive care.

**Table 8.1 - Analgesia for specific neonatal procedures**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Restraint (swaddling, KMC)</th>
<th>Oral sugar solution</th>
<th>IV morphine</th>
</tr>
</thead>
<tbody>
<tr>
<td>O/NGT insertion</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Nasal suctioning</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>IM injection</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>IV cannulation</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Capillary/venous blood sampling</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Removal of adhesive tape</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Lumbar puncture</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Skin care and dressings</td>
<td>+</td>
<td>+</td>
<td>+           (if extensive)</td>
</tr>
</tbody>
</table>
8.2 Withdrawal of treatment and palliative care

Palliative care aims to relieve pain and provide comfort while allowing the natural process of death to occur.

Palliative care is provided for neonates with conditions in which intensive therapy is not in the neonate’s best interest. The aim is not to end life, but relieve pain and provide comfort while allowing the process of death to occur in the best conditions for the patient and their family. Palliative care does not seek to hasten or delay death.

Decisions about palliative care should be made after discussion with parents and caregivers and carried out using an open and honest approach. Try to discuss with the family in a quiet, private space in simple terminology.

Indications

Situations may include extreme prematurity, severe hypoxic ischaemic encephalopathy, extensive congenital anomalies and severe, incurable diseases. The decision to provide palliative care is not an individual decision, but should be discussed with the medical and nursing team and the family. The following situations may be encountered:

*Neonate not viable at birth and decision not to resuscitate*

In the case of extreme prematurity, extremely low birth weight, or lethal congenital malformations, it may be appropriate not to resuscitate at birth. In this situation, the neonate should be dried and wrapped and given to the family members if they wish to hold the neonate. Administration of oxygen is not recommended as it can extend life without improving prognosis.

*Neonatal resuscitation fails*

The longer anoxia continues after birth, the higher the risk of serious long-term sequelae. Resuscitation should be stopped in the following circumstances as the risk of death or permanent disability outweighs the chance of survival:

- No heart rate after 10 minutes of effective ventilation
- No spontaneous respirations after 20 minutes of effective ventilation, even if heart rate is adequate.

Oxygen can prolong the end of the neonate’s life in a state of severe neonatal asphyxia (and therefore discomfort) and is not recommended. When the decision is taken to end resuscitation, sensitively explain the outcome to the family. They may then have the option of holding the neonate in their arms until he dies.

*The neonate has a serious, incurable pathology*

In situations where there is no treatment that would enable the neonate to survive or live under conditions that would be deemed acceptable, the priority is to provide comfort to the neonate. Avoid unnecessary and painful procedures and cease monitoring vital signs. Curative treatments (such as antibiotics, caffeine, intravenous infusions) should be stopped and the focus should be on control of symptoms.

**Symptom management**

The management of symptoms is based on assessment of the neonate in order to prevent or manage pain, discomfort and distress. Maintain warmth and encourage skin-to-skin contact for comfort. Avoid any procedures that are unnecessary or cause pain or discomfort.
Manage pain and distress:

**morphine**
Oral: 0.1 to 0.4 mg/kg every 4 hours, as needed (prompt release formulation)
IV: 0.05 to 0.1 mg/kg, slow IV (over 3 to 5 minutes), every 4 to 6 hours

*Side effects*: sedation, constipation, urinary retention, nausea and vomiting. In case of overdose respiratory depression is possible. Carefully monitor for above effects.

In case of respiratory depression (RR < 30):
– Commence bag-mask ventilation.
– If suspected morphine-induced respiratory depression, give:

**naloxone** IV: 0.01 mg/kg (= 10 micrograms/kg) every 2 to 3 minutes as needed until resolution of respiratory depression.

Management of seizures:

**phenobarbital**
First dose: 20 mg/kg by slow IV infusion (diluted) over 20 to 30 minutes
A second dose of 10 mg/kg may be administered 15 to 30 minutes after the first dose (if administered by IV infusion) or 60 minutes after the first dose (if administered by IM injection).
If seizures persist or recur, consider maintenance dose of 5 mg/kg oral (or IV) once daily.

Eye, lip and mouth care:
– Keep the eyes clean and moist with artificial tears.
– Keep the mouth and lips clean and dry and apply petroleum jelly to the lips.

**Place of death**
Where possible, the parents should be able to choose where the neonate dies. The opportunity to take the neonate home should be provided. If this is not possible, the parents should be offered privacy and a separate area in the hospital if there is sufficient space.
Depending on the context, it may be appropriate to involve community or religious leaders for emotional support.
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Appendix 1. Oxygen therapy

Indications
Neonates with an oxygen saturation < 90% in room air (after the first 10 minutes of life), or any of the following:
- Central cyanosis
- Constant grunting on expiration
- Severe chest indrawing
- Severe nasal flaring
- Head bobbing

Fitting the nasal prongs
- Use nasal cannula sized for neonatal or preterm neonates. Use 1 mm prongs for a small neonate (< 2.5 kg) and 2 mm prongs for a bigger neonate.
- Use one set of cannula for each neonate.
- Oxygen masks are not recommended for neonates because it is difficult to keep the mask firmly on the face. Masks also require a much higher flow rate to deliver the same amount of oxygen and interfere with breastfeeding.

![Figure 1 - Administering oxygen through nasal prongs](image)

Oxygen supply
- Oxygen should be provided via an oxygen concentrator, which has the benefit of humidifying and warming the oxygen.
- One oxygen concentrator should be used per neonate unless a flow splitter device is available. For oxygen flow rates < 1 L/minute, humidification is not required\(^1,2\). For oxygen flow rates of 1 L/minute or above, humidification is required.
- Standard flow rate through nasal cannula for neonates is 0.5 to 1 L/minute and must not exceed 2 L/minute.
- Use the minimum flow rate to achieve 90 to 95% O\(_2\) saturation. Excessive O\(_2\) administration can cause lung and eye (retinopathy of prematurity) damage.

Maintenance

- Check nasal cannula several times a day to ensure they are clean and not blocked.
- Change the nasal cannula at least every 3 days, or more often if they become blocked, dirty or they have touched the floor.
- If the oxygen needs increase, consider cleaning the nose using 0.9% sodium chloride or changing the neonate’s position to improve pulmonary ventilation.

Weaning

- Begin to wean oxygen when the clinical condition is clearly improving, there are no signs of severity and the SpO₂ has been > 94% with constant oxygen flow for at least 6 hours.
- Wean gradually in 0.2 to 0.5 L/minute decrements and monitor for 6 hours after each decrease in oxygen flow before weaning further.
- Ensure that SpO₂ is monitored both at rest and during feeds. It may be necessary to increase oxygen during feeds initially.
- Continue to wean oxygen until the neonate has SpO₂ > 90% both at rest and during feeds without any oxygen.
- Continue to monitor SpO₂ in air for at least 2 days after oxygen therapy has been stopped before considering discharge.
Appendix 2. Phototherapy

Indications

Severe jaundice:
- Any jaundice occurring in the first 24 hours after birth.
- Features of severe clinical jaundice or identified risk factors (see Chapter 3, Section 3.6.1, Table 3.15).
- Elevated serum bilirubin level for weight and age (see Chapter 3, Section 3.6.1, Table 3.16).

Procedure

- Consult the biomedical protocol of the specific device for regular user maintenance and daily checks. Do not use improvised or unauthorised equipment.
- Use white linen in the bed around the phototherapy lamp and place a white sheet around the unit to reflect as much light as possible back onto the neonate.
- The phototherapy lamp should be at 25 to 30 cm from the neonate for optimal effect (see the manufacturer’s instructions for specific device).
- Undress the neonate ensuring they are wearing only a nappy and eye protection to maximise the surface area exposed to light.
- Place a protective covering over the neonate’s eyes.

![Figure 2 - Neonate receiving phototherapy](image)

- Whilst phototherapy should be continuous (day and night) it may be interrupted for breastfeeding. Remove the neonate from phototherapy only for procedures that cannot be performed under the phototherapy light.

Monitoring

- Check temperature and other vital signs every 4 hours.
- Monitor hydration and urine output.
- Turn the neonate every 3 hours.
- Increase fluid intake (milk or IV) by 10 mL/kg/day whilst neonate is receiving phototherapy.

---

If it is not possible to monitor bilirubin levels:
- Continue phototherapy for 3 days.
- Reassess jaundice clinically, and, if indicated, continue phototherapy for a further 3 days.

If it is possible to monitor bilirubin levels:
- Check serum bilirubin once daily.
- Stop phototherapy when it is no longer indicated.
- Re-check bilirubin 24 hours after stopping phototherapy.

Complications
- Hypothermia or hyperthermia
- Dehydration
- Diarrhoea
- ‘Bronzing’ of the neonate’s skin
Appendix 3. Practical procedures

For all painful procedures, consider analgesia with an oral sugar solution. Ensure that appropriate hygiene or infection prevention and control guidelines are followed for all procedures.

3.1 Oro/nasogastric tube insertion

Indications
- Drainage of gastric contents in bowel obstruction or gastrointestinal bleeding
- Aspiration of air following bag-mask ventilation
- Feeding of sick or preterm neonates

Equipment
- Examination gloves
- 2 mL syringe
- Tube CH6 for most neonates
- Tube CH8 for bigger neonates or those requiring gastric drainage
- Adhesive tape
- Scissors
- Stethoscope
- Oral sugar solution (see Chapter 8, Section 8.1)

Technique
- Perform hand hygiene: wash hands and put on gloves.
- Hold the neonate firmly. If appropriate, wrap in a sheet or blanket.
- Measure the distance from the mouth (oro-) or bridge of nose (naso-) to the earlobe, and then from the earlobe to a point halfway between the xiphisternum and the umbilicus.

![Figure 3 - Measuring gastric tube length (A. orogastric and B. nasogastric)](image)

- Lubricate the tube with water and insert the tube in a continuous motion until the measured distance is reached. For NGT, insert the tube vertically in the nose if the neonate is lying down and not in the direction of the forehead.
- Secure the tube to the neonate’s nose and cheek with a small piece of adhesive tape.

---

Confirm the position of the tube by the aspiration method:

- Using a syringe, aspirate some fluid from the tube and test it on pH paper (0.5 to 1 mL aspirate is sufficient).
- Allow ten seconds for any colour change to occur.
- If an aspirate of pH 5.5 or below is obtained, the position is confirmed.
- If the aspirate is pH 6 or above: DO NOT USE.

(Note: the pH will only be representative of stomach acid if it is a pre-feed test (especially in neonates on a milk only diet) i.e. at least 2 hours after the last feed. So if the pH is > 6, consider time of last meal before removing and replacing the oro/nasogastric tube (O/NGT)).

- If there is any doubt about the tube position, withdraw and start over. Pulmonary aspiration can be fatal.

Maintenance

Always check the tube position before administering any liquid or medications. If not positioned correctly, reinsert/replace the tube and check that it is correctly positioned.

Check nostril with NGT regularly to prevent skin breakdown. If the nostril is reddened or the skin is irritated, remove the tube and replace it in the other nostril, if possible.

Clean regularly the area with warm water around the tube to ensure nostril is not blocked.

Change tape if it’s wet, soiled or loose.

Replace the tube every 3 days, each time switching nostrils or side of mouth, or sooner if it becomes clogged. Evaluate if the tube is still necessary before replacing.

3.2 Intravenous insertion

Indications

Intravenous (IV) access for delivery of fluid, blood and medications. If a peripheral IV line cannot be inserted quickly in an emergency situation, proceed to intra-osseous insertion by trained or experienced staff.

Equipment

- Examination gloves
- Swab or cotton-wool ball soaked in antiseptic solution
- Intravenous cannula - normally 24G (yellow)
- Syringe (2-5 mL) with 0.9% sodium chloride to flush
- Soft gauze for tourniquet or rubber band (if using a scalp vein)
- Adhesive tape or IV film dressings
- Arm board or splint
- Medication for injection or IV infusion equipment
- Sharps container
- Oral sugar solution (see Chapter 8, Section 8.1)

Technique

- Ensure that all components of the IV infusion set are filled with fluid to prevent air embolus.
- Select suitable site: it is essential to spend time methodically looking for suitable veins.

Common sites for neonates include:

- Peripheral veins on the back of the hand or top of the foot are the most common and preferred sites.
- Veins on the forearm, cubital fossa or around the ankle.
- Scalp veins (not the preferred site due to risk of scalp necrosis).
Appendix 3

- Provide oral sugar solution for pain relief.
- Perform hand hygiene.
- Apply a tourniquet:
  - If using the hand, this can be achieved by flexing the wrist and stretching the skin on the dorsum of the hand.
  - If using the arms or legs, gently tie a piece of gauze or soft cloth above the area of insertion, or have an assistant gently encircle the limb.
  - If using a scalp vein, place a rubber band around the neonate’s head.

![Figure 4 - Using a rubber band as a tourniquet for a scalp vein](image)

- Clean selected site with antiseptic solution and allow to dry.
- Put on non-sterile gloves.
- Insert the needle at a 15° angle with the bevel of the needle facing upward.
- Once the blood enters the hub of the cannula, advance slightly then withdraw the needle slightly while advancing the cannula until it reaches the hub.
- Release the tourniquet, apply pressure to the vein above the cannula tip without touching the insertion site and remove the stylet.
- Attach syringe and flush line, checking for resistance to flow, swelling or leakage.
- Connect the IV infusion or place a cap on the end of the cannula using aseptic technique.
- Fix the cannula securely in place, but not too tightly, using tape or IV film dressings and splint the limb.
- Dispose of sharps in the appropriate container.
- Remove gloves and perform hand hygiene.

### Maintenance

- Inspect insertion site for swelling and redness each time the vital signs are checked and when administering medications/fluids.
- IV cannula must be flushed with 1 mL of 0.9% sodium chloride every 4 to 6 hours to ensure patency.
- Stop infusion immediately if the line is difficult to flush or any leakage, swelling or discolouration are observed.

### 3.3 Intra-osseous insertion and management

#### Indications

Emergency vascular access for delivery of fluids, blood, medications when peripheral intravenous access cannot be secured immediately.

---

Equipment
- Sterile gloves
- Swab or sterile gauze soaked with antiseptic solution
- Intra-osseous needle (18G for neonate) or, if unavailable use a 19G IV needle. EZ-IO drill can also be used in neonates.
- Sterile 5 mL syringe filled with 0.9% sodium chloride
- IV infusion equipment
- Adhesive tape and splint
- Sharps container
- Sterile gauze

Technique
- Prepare solution to be infused, ensuring there is no air in the infusion set.
- Position the neonate’s leg with the knee bent to 30 degrees and heel resting on table.
- Identify site: proximal tibia (preferred site) or distal femur
  • Tibia: 1 to 2 cm below and 1 cm medial to tibial tuberosity
  • Femur: 2 to 3 cm above lateral condyle
- Perform hand hygiene and put on sterile gloves.
- Prepare the skin using antiseptic solution and allow to dry.
- Support the upper tibia with one hand such that the hand is not directly behind the insertion site.
- Insert the needle perpendicular to the skin, pointing slightly downward, away from the epiphyseal growth plate and proceed slowly with a firm, twisting motion. There is a change in resistance when bone marrow is reached, and the needle should hold by itself if it is well inserted.

Figure 5 - Site for intra-osseous insertion

- Remove the trocar and confirm the position by aspirating 0.5 to 1 mL marrow through a 5 mL syringe (the aspirate should appear like blood). Marrow cannot always be aspirated, but it should flush easily.
- Slowly inject 3 mL of 0.9% sodium chloride solution to check for proper placement. Observe closely for swelling indicating leakage of fluid under the skin. If swelling is seen remove the needle and start again. If there is resistance but no swelling, withdraw the needle slightly and try to inject IV fluid again.
- Secure the needle and splint the leg. Start the infusion.
- Remove gloves and perform hand hygiene.
- Dispose of sharps in the appropriate container.

**Maintenance**

- Inspect the infusion site every hour:
  - Look for redness and swelling indicating extravasation. If any redness or swelling is seen, stop the IV infusion, remove the needle and attempt peripheral IV access or establish a new intra-osseous line (do not use the same site within 24 hours as there is the risk of extravasation due to previous perforation).
  - Check that the volume of fluid infused corresponds to medical orders. Flow rates can change significantly with changes in position of the leg.
- Remove intra-osseous needle when other venous access has been obtained. Intra-osseous access should not continue beyond 8 hours.

### 3.4 Lumbar puncture

**Indications**

Confirmation of the diagnosis in a neonate with suspected meningitis. A lumbar puncture (LP) should only be performed by an experienced medical officer.

**Contra-indications**

- Focal neurological signs
- Signs of raised intra-cranial pressure (bradycardia, dilated pupils, sunset eyes)
- Cardiovascular compromise/shock
- Respiratory compromise
- Bleeding disorder
- Local infection at site of insertion

*Note: In neonates in a state of coma or convulsing, although an LP is not absolutely contra-indicated, assess the neonate well for any serious risks prior to performing the LP.*

**Equipment**

- Sterile gloves
- Sterile drapes and procedure tray
- Sterile gauze
- Antiseptic solution
- Spinal needle (22 or 25G)
- CSF collecting tubes (2)
- Protective dressing
- Sharps container
- Oral sugar solution (see Chapter 8, Section 8.1)
Technique
- Place the neonate under an infant warmer, if possible, and undress only when ready to perform the procedure.
- Administer oral sugar solution for pain relief.
- Positioning of the neonate is crucial. Have an experienced assistant hold the neonate. The LP may be performed with the neonate lying on his/her side or sitting up. Aim for maximum flexion of the spine (foetal position), but avoid hyperflexion of the neck which can obstruct the airway. Ensure the hips and shoulders are in line.

**Figure 6 - Positioning for lumbar puncture (lying and seated)**
- Identify the site for insertion. Draw an imaginary line between the top of the iliac crests. This intersects the spine at approximately the L3-4 interspace. Aim for the L3-4 or L4-5 interspace.
- Wash hands and put on sterile gloves.
- Cleanse the area with antiseptic solution and allow to dry. Set up sterile drapes.
- Insert the needle into the identified space ensuring that the back is vertical and the needle is perpendicular to the back. Direct the needle slightly toward the umbilicus. Advance the needle slowly and stop when you feel a change in resistance as you enter the spinal space.
- Remove the central stylet and wait for CSF to flow.
- Collect the CSF into sterile collecting tubes (about 5 to 10 drops in each).
- Note the pressure and appearance of the CSF (clear/turbid/bloody).
- Replace the central stylet and remove the needle.
- Dispose of sharps in the appropriate container.
- Label CSF specimens and transport immediately to the laboratory.
- Remove gloves and perform hand hygiene.

If the procedure fails:
- Consult a more experienced practitioner.
- Attempt the procedure using another disc space (but no higher than L3).
- Failure to obtain CSF should not delay antibiotic treatment in a septic neonate.

**Monitoring after procedure**
- Apply pressure to the insertion site and apply a small protective dressing.
- The neonate should remain lying down for one hour after the procedure to minimise the risk of headache.
- Cardiorespiratory and oxygen saturation monitoring for one hour after the procedure and then continue with routine clinical care.

---

3.5 Capillary blood sample (heel prick)

Indications
Capillary sampling for bedside or laboratory analysis, most commonly used for monitoring blood glucose levels.

Equipment
– Examination gloves
– Swab or cotton wool ball soaked in warm water
– Dry cotton wool ball
– Sterile low-flow lancet (or, if unavailable, use a 25G needle)
– Capillary sample tube, or reagent strip if performing blood glucose testing
– Sharps container
– Oral sugar solution (see Chapter 8, Section 8.1)

Technique
– Administer oral sugar solution for pain relief.
– Perform hand hygiene and put on gloves.
– Prepare the skin using warm water:
  • Clean the heel by washing with plain water using gauze/cotton wool. The water should not be heated and the neonate’s foot should not be immersed (to avoid scalding/burns).
  • Ensure the heel is warm but additional pre-warming of the foot is not required.
– Dry the skin with dry cotton before pricking.
– Massage the area before and while taking the sample to enhance blood flow rather than using a tourniquet.
– Flex the foot up towards the leg and hold it in position with one hand, placing a finger between the top of the foot and leg.
– Puncture the skin (1 to 2 mm deep) firmly with a lancet:
  • Aim toward the lateral or medial side of the heel (see Figure 7).
  • Avoid the toes and the soles of the feet as there is a risk of increased pain, haematoma and osteomyelitis.
  • Alternate sampling sites each time.

![Figure 7 - Site for heel prick](image)

– Wipe off 2 first drops of blood if sampling for haemoglobin measurement.
– Collect the blood into the tube or apply required volume onto reagent strip or fill HemoCue cuvette.

– Once finished, apply gentle pressure to the puncture site with a dry cotton wool ball for several minutes to prevent bruising.
– Dispose of sharps in the appropriate container.
– Remove gloves and perform hand hygiene.

### 3.6 Intramuscular injections

#### Indications

Intramuscular (IM) administration of vaccinations or medications.

#### Equipment

– Antiseptic solution
– Large bore needle for withdrawing medication from ampoule (19G)
– Sterile needle (23G, 26G – or use the smallest possible needle)
– Syringe (1 or 2 mL)
– Dry cotton wool ball
– Sharps container
– Oral sugar solution (see Chapter 8, Section 8.1)

#### Technique

– Check the correct patient, drug, dose, time and route of administration.
– Draw the medication into the syringe using a large bore needle.
– Change to injection needle (23G or 26G).
– Administer oral sugar solution for pain relief.
– Position the neonate.
– Perform hand hygiene.
– Cleanse the injection site with water for vaccinations or with antiseptic solution for medication (to avoid risk of abscess and other infections).
– Select site for injection: the upper, outer thigh is the preferred site of injection in neonates. For IM vaccinations in neonates, use the anterolateral aspect of the thigh (quadriceps muscle). Never inject into the gluteal or deltoid muscle (arm).
– Place your forearm across the neonate’s pelvis and secure the thigh between your thumb and forefinger.
– Position the leg so that the hip and knee is flexed to relax the muscle.
– Pierce the skin at a 90° angle and aspirate to ensure the needle is not in a blood vessel.
– Slowly inject the medication (over 5 seconds) to minimise neonatal discomfort.
– Remove the needle and check for bleeding. Apply cotton wool ball if necessary.
– Dispose of sharps in the appropriate container.
– Document administration of vaccination or medication in the health record.

#### Precautions

– Minimise pain:
  • Use a sharp needle of the smallest diameter that allows fluid to flow freely (26G if < 2500 g; 23G if ≥ 2500 g).
  • Use minimum volume for injection (≤ 1 mL if < 2500 g and ≤ 2mL if ≥ 2500 g).
  • Administer oral sugar solution before carrying out procedure.
Appendix 4. Blood transfusion

Blood transfusions in neonates carry significant risk and the patient should be carefully monitored throughout the procedure. For suspected acute transfusion reactions, immediately stop the transfusion and call the medical officer.

Indications
To give an immediate increase in oxygen delivery to the tissues. Consider transfusion in the following circumstances:
– Haemoglobin (Hb) < 8 g/dL in term neonates or < 7 g/dL in preterm neonates
– Hb < 10 g/dL with associated clinical signs of intolerance of anaemia (tachypnoea, tachycardia)
– Acute blood loss with cardiovascular compromise

Exchange transfusions (for haemolytic diseases) is not recommended for settings where it cannot be performed correctly and safely. Refer where possible.

Safety Rules
– Blood should be compatible with both the neonate’s and the mother’s ABO and Rh group until 4 months of age (see compatibility rules in Table 1). Do not use blood from the mother.
  • In case of transfusion with ABO non-identical blood, give packed red blood cells (PRBC) without plasma to avoid transfusing donor’s potential haemolysins (acquired IgG anti-A and/or anti-B antibodies of high titre)⁴.
  • For acute haemorrhage at birth, transfuse O Rh negative PRBC obtained by centrifugation or sedimentation.
  • In case of haemolytic disease due to ABO incompatibility, transfuse O Rh compatible PRBC obtained by centrifugation or sedimentation.
– In malaria endemic areas: use blood that has been screened negative for malaria due to the potential higher vulnerability of neonates. In life-threatening emergencies, unscreened or malaria RDT positive blood may be used and the neonate treated with anti-malarials at the end of the transfusion.
– In life-threatening emergencies, if only syphilis-positive blood is available, treat with benzathine penicillin G IM: 50 000 IU/kg at completion of transfusion.
– Do not inject medications into blood units.
### Table 1 - Compatibility rules for neonates

<table>
<thead>
<tr>
<th>Neonate</th>
<th>Mother</th>
<th>Blood to transfuse</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>A, B or O</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>A or AB</td>
<td>A (or O)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B or O</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>B or AB</td>
<td>B (or O)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A or O</td>
<td>O</td>
<td></td>
</tr>
<tr>
<td>AB</td>
<td>AB</td>
<td>AB, A, B (or O)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>A (or O)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>B (or O)</td>
<td></td>
</tr>
<tr>
<td>Rh +</td>
<td>Rh +</td>
<td>Rh +</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rh –</td>
<td>Rh –</td>
<td>If Direct Coombs test negative in neonate, possible to give Rh +</td>
</tr>
<tr>
<td>Rh –</td>
<td>Rh +</td>
<td>Rh –</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rh –</td>
<td>Rh –</td>
<td></td>
</tr>
</tbody>
</table>

If mother’s blood group unknown: give O group blood

If mother’s Rh unknown: give Rh – blood

### Transfusion procedure

- Refer for comprehensive guidance to the guide *Blood transfusion*, MSF, 2018.
- Use packed or sedimented blood that has been collected in the last 10 days. Blood stored for longer than this may contain dangerously high levels of potassium.
- Each 3 mL/kg of PRBC should increase the Hb level by 1 g/dL. The normal order for a neonate is:

| packed red blood cells (PRBC) IV: 15 mL/kg over 3 hours (rate should not exceed 5 mL/kg/hour) OR whole blood IV: 20 mL/kg over 4 hours (rate should not exceed 5 mL/kg/hour) |

- Perform a bedside ABO compatibility test just before starting the transfusion.
- If concerned about fluid overload, make sure there are 2 PRBC units from the same donor in stock; transfuse 10 mL/kg from the first unit, and 5 to 10 mL/kg of the second unit on the following day.
- It is difficult to achieve low flow rates (< 3 to 5 drops/minute) as small adjustments are difficult and the catheter may get blocked, in which case the transfusion may need to be administered intermittently in aliquots. Use 0.9% sodium chloride to keep the vein open between aliquots.
- If there is severe anaemia and the patient is clinically compromised, the transfusion may be given more rapidly over the first 30 minutes, then reduced to normal rate once stabilised.
- Use small blood units (30 to 50 mL) to avoid discarding unused blood. If possible, keep 2 units from the same donor in case the neonate requires a second transfusion.
- Consider the volume of the tubing (generally 16 to 18 mL). This is particularly important when transfusing small volumes.

---

*a* Note: blood transfusion can be given via an electrical syringe or an infusion pump. See the guide *Blood transfusion*, MSF, 2018.
Stop any other IV infusions through the same line. Withhold feeding the neonate until after the first 15 minutes of the transfusion.

Furosemide is not routinely given to neonates for blood transfusions. It should be used only in cases of suspected fluid overload.

**Monitoring**

Throughout the transfusion monitor:

- Infusion rate and IV site every 15 to 30 minutes (1 mL of blood = 15 drops)
- Vital signs (temp, RR, HR, O2 saturations) every 15 minutes for the first hour then every 30 minutes
- Signs of fluid overload: liver size and oedema every 30 minutes
- Urine output (normal 1 to 4 mL/kg/hour) every hour
- Blood glucose level every 2 hours

**After the transfusion**

- Continue breastfeeding or IV fluids.
- Check Hb after 24 hours (earlier if there is poor clinical response, on-going oxygen requirement or jaundice).

**Management of acute transfusion reactions**

In case of a suspected reaction to the transfusion:

- Stop the transfusion.
- Recheck that the correct blood unit has been given to the correct neonate.
- Notify the medical officer: check temperature, vital signs, signs of shock, respiratory distress, urticaria, red urine (haemoglobinuria).

**Acute haemolytic transfusion reaction**

Triggered by an antigen-antibody reaction causing intravascular haemolysis with fever and haemoglobinuria. It causes destruction of transfused red cells. Signs of shock may be present.

- Stop the transfusion.
- Check Hb and take an EDTA blood sample to check the colour of plasma. With intravascular haemolysis, the plasma is pink.
- Attention to hydration: manage signs of shock with 10 mL bolus of 0.9% sodium chloride or Ringer Lactate over 20 minutes (to be repeated as necessary up to a maximum of 3 boluses in total). Ensure good hydration with IV fluids.

**Febrile non-haemolytic reaction (FNHR)**

Involves ≥ 1 °C rise in temperature and may be related to the transfusion or due to other pathology.

- Ensure the patient is not suffering from an acute haemolytic reaction.
- Consider the possibility of neonatal sepsis or malaria and treat accordingly.
- If other vital signs are normal, continue transfusion at a slower rate (maximum 4 hours).
- Manage fever:

  paracetamol PO: 10 mg/kg single dose

- If repeated FNHR in neonates requiring multiple transfusion, consider for subsequent transfusions:

  dexamethasone IV: 0.05 mg/kg as a premedication
  Plus
  prednisolone PO: 1 mg/kg immediately following the transfusion
**Allergic reaction**

Urticarial reactions are characterised by flushing and hives. Anaphylaxis (stridor, wheeze, circulatory collapse) is uncommon. In the case of anaphylaxis, stop the transfusion and administer:

| **epinephrine** (adrenaline) | IM: 0.01 mL/kg of undiluted solution (1 mg/mL = 1:1000) or 0.1 mL/kg of a diluted solution (0.1 mg/mL = 1:10 000) |

**Fluid overload**

Rapid increases in blood volume may lead to circulatory overload characterised by oedema, tachypnoea and chest crackles. Stop the transfusion and administer:

| **furosemide** | IV: 0.5 to 1 mg/kg slow IV |

Once stabilised, if transfusion is still indicated, continue at a slower rate. For repeated transfusions, there is a risk of hypocalcaemia. If the neonate is in shock, has hypotension or is convulsing, administer **calcium gluconate** IV: 0.5 mL/kg of 10% solution as slow IV.
Appendix 5. Common drug doses

Table 1 - Dosages for common antibiotics

<table>
<thead>
<tr>
<th>Drug</th>
<th>Route</th>
<th>Dose per kg and frequency of administration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Body weight &lt; 2 kg</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 to 7 days</td>
</tr>
<tr>
<td>Ampicillin</td>
<td>IV</td>
<td>50 mg/kg every 12 hours</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Meningitis:</em> 100 mg/kg every 12 hours</td>
</tr>
<tr>
<td>Benzylpenicillin&lt;sup&gt;a&lt;/sup&gt;</td>
<td>IV</td>
<td>25 mg/kg every 12 hours</td>
</tr>
<tr>
<td>Cefotaxime</td>
<td>IV</td>
<td>50 mg/kg every 12 hours</td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>IV, IM</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Meningitis:</em> 100 mg/kg every 24 hours</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>IV</td>
<td>5 mg/kg every 12 hours</td>
</tr>
<tr>
<td>Cloxacillin</td>
<td>IV</td>
<td>50 mg/kg every 12 hours</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50 mg/kg every 8 hours</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>IV</td>
<td>3 mg/kg every 24 hours</td>
</tr>
<tr>
<td>Metronidazole</td>
<td>IV</td>
<td><em>Loading dose:</em> 15 mg/kg, then after 24 hours, 7.5 mg/kg every 12 hours</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Use for meningitis only if cefotaxime is not available.
<table>
<thead>
<tr>
<th>Drug</th>
<th>Route</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aciclovir</td>
<td>IV</td>
<td>20 mg/kg every 8 hours</td>
</tr>
</tbody>
</table>
| Caffeine citrate    | IV, PO| Loading dose: IV: 20 mg/kg  
Maintenance dose: PO or IV: 5 mg/kg once daily. Increase to 10 mg/kg once daily if no response (see Table 5). |
| Diazepam            | IV    | diazepam emulsion for injection  
• 0.1 to 0.3 mg/kg by slow IV injection (3 to 5 minutes) every 1 to 4 hours depending on the severity and the persistence of the spasms as long as the RR is ≥ 30.  
• If despite hourly diazepam the spasms persist, start a continuous infusion of diazepam with an electric syringe driver: 0.1 to 0.5 mg/kg/hour (2.4 to 12 mg/kg every 24 hours). Start with 0.1 mg/kg/hour and if symptoms persist, increase by 0.1 mg/kg/hour as long as RR is ≥ 30.  
• If in spite of 0.5 mg/kg/hour symptoms persist, the dose can be increased up to 0.8 mg/kg/hour as long as the RR ≥ 30. |
| Epinephrine (adrenaline) | IV    | Caution* Vial (1 mg/mL): dilute 1 mL (whole vial) in 9 mL of 0.9% NaCl to obtain a diluted solution of 0.1 mg/mL (1:10 000).  
0.01 mg/kg = 0.1 mL/kg of a diluted* solution |
| Elemental iron      | PO    | 4.5 mg once daily                                                    |
| Fluconazole         | IV    | 0 to < 14 days: 6-12 mg/kg every 72 hours  
14 to 28 days: 6-12 mg/kg every 48 hours |
| Furosemide          | IV    | Slow IV injection: 0.5 to 1 mg/kg every 12 to 24 hours             |
| Morphine            | IV, PO| PO (immediate release): 0.1 to 0.4 mg/kg every 4 hours  
IV: 0.05 to 0.1 mg/kg, slow IV (over 3 to 5 minutes), every 4 to 6 hours |
<table>
<thead>
<tr>
<th>Drug</th>
<th>Route</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naloxone</td>
<td>IV, IM</td>
<td>Respiratory depression at birth due to maternal morphine: 0.1 mg/kg. May be repeated if necessary to completely reverse effect of opioid. Morphine induced respiratory depression in neonate: 0.01 mg/kg every 2 to 3 minutes as needed until resolution of respiratory depression while maintaining analgesic effect.</td>
</tr>
<tr>
<td>Nystatin</td>
<td>PO</td>
<td>100 000 IU 4 times daily</td>
</tr>
<tr>
<td>Paracetamol</td>
<td>PO, IV</td>
<td>PO: 10 to 15 mg/kg every 6 to 8 hours (or as required) (max. 60 mg/kg/day). IV: 7.5 mg/kg every 6 hours (or as required) if PO route not possible (max. 30 mg/kg/day).</td>
</tr>
<tr>
<td>Phenobarbital</td>
<td>IV, IM, PO</td>
<td>First dose: 20 mg/kg slow IV infusion (diluted) over 20 to 30 minutes May be given IM (undiluted) if no IV access. Repeat dose of 10 mg/kg may be administered 15 to 30 minutes after first dose (if administered by IV infusion) or 60 minutes after first dose (if administered by IM injection). Max. total loading dose = 40 mg/kg. Maintenance dose: 5 mg/kg IV or PO every 24 hours</td>
</tr>
<tr>
<td>Phenytoin</td>
<td>IV</td>
<td>20 mg/kg slow IV infusion over 20 to 30 minutes Never IM.</td>
</tr>
<tr>
<td>Phytomenadione (vitamin K1)</td>
<td>IV, IM</td>
<td>Prevention: IM &lt; 1500 g: 0.5 mg single dose ≥ 1500 g: 1 mg single dose</td>
</tr>
<tr>
<td>Potassium chloride</td>
<td>PO</td>
<td>1 mmol/kg 2 times daily</td>
</tr>
</tbody>
</table>
Dissolve 60 mg *artesunate* powder for injection in 1 mL 5% sodium bicarbonate. Then dissolve further according to route (IV or IM).

For IV *artesunate*: Then add 5 mL of 0.9% sodium chloride to the vial → Obtain 6 mL of solution containing 10 mg/mL of artesunate for IV injection.

For IM *artesunate*: Then add 2 mL of 0.9% sodium chloride to the vial → Obtain 3 mL of solution containing 20 mg/mL of artesunate for IM injection.

### DOSING of ARTESUNATE

<table>
<thead>
<tr>
<th>Artesunate</th>
<th>Dose</th>
<th>Timing</th>
<th>Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>First dose</td>
<td>3 mg/kg</td>
<td>On admission</td>
<td>Slow IV (3 to 5 minutes) OR slow IM in anterior thigh if IV not possible</td>
</tr>
<tr>
<td>Second Dose</td>
<td></td>
<td>At 12 hours</td>
<td></td>
</tr>
<tr>
<td>Third Dose</td>
<td></td>
<td>At 24 hours</td>
<td></td>
</tr>
<tr>
<td>Subsequent doses</td>
<td></td>
<td>Once daily for 6 days</td>
<td></td>
</tr>
</tbody>
</table>

### Dosing for IV injection: artesunate solution 10 mg/mL

Use a 1 mL syringe graduated in 0.01 mL when the dose required is less than 1 mL

<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>Dose (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to &lt; 1.5</td>
<td>0.5</td>
</tr>
<tr>
<td>1.5 to &lt; 2</td>
<td>0.6</td>
</tr>
<tr>
<td>2 to &lt; 3</td>
<td>0.9</td>
</tr>
<tr>
<td>3 to &lt; 4</td>
<td>1.2</td>
</tr>
<tr>
<td>4 to &lt; 5</td>
<td>1.5</td>
</tr>
</tbody>
</table>

### Dosing for IM injection: artesunate solution 20 mg/mL

<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>Dose (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to &lt; 1.5</td>
<td>0.2</td>
</tr>
<tr>
<td>1.5 to &lt; 2</td>
<td>0.3</td>
</tr>
<tr>
<td>2 to &lt; 3</td>
<td>0.5</td>
</tr>
<tr>
<td>3 to &lt; 4</td>
<td>0.6</td>
</tr>
<tr>
<td>4 to &lt; 5</td>
<td>0.8</td>
</tr>
</tbody>
</table>

### Dosing for rectal artesunate (if IV/IM NOT available)

<table>
<thead>
<tr>
<th>Weight</th>
<th>50 mg rectal capsule</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5 kg</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 4 - Artemisinin based combination therapy (ACT) dosing
ACT is once daily for 3 days.

### artesunate-amodiaquine (AS-AQ)
*Available formulations, soluble in water in 3 minutes*

Dilute 1 tablet of AS-AQ (25 mg AS/67.5 mg AQ base) into 2 mL of water for injections or filtered water.

Dose: 4 mg/kg AS; 10 mg/kg AQ x 1

<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>Dose (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 – 1.1</td>
<td>0.3 mL once daily</td>
</tr>
<tr>
<td>1.2 – 1.3</td>
<td>0.4 mL once daily</td>
</tr>
<tr>
<td>1.4 – 1.5</td>
<td>0.5 mL once daily</td>
</tr>
<tr>
<td>1.6 – 1.7</td>
<td>0.5 mL once daily</td>
</tr>
<tr>
<td>1.8 – 1.9</td>
<td>0.6 mL once daily</td>
</tr>
<tr>
<td>2.0 – 2.4</td>
<td>0.7 mL once daily</td>
</tr>
<tr>
<td>2.5 – 2.9</td>
<td>0.9 mL once daily</td>
</tr>
<tr>
<td>3.0 – 3.4</td>
<td>1.0 mL once daily</td>
</tr>
<tr>
<td>3.5 – 3.9</td>
<td>1.2 mL once daily</td>
</tr>
<tr>
<td>4.0 – 4.4</td>
<td>1.3 mL once daily</td>
</tr>
<tr>
<td>4.5 – 4.9</td>
<td>1.5 mL once daily</td>
</tr>
</tbody>
</table>

### artemether-lumefantrine (AL)

Dilute 1 dispersible tablet of AL (20 mg artemether/120 mg lumefantrine) into 10 mL of water for injections or filtered water.

Dose: 2 to 4 mg/kg artemether; 12 to 24 mg/kg lumefantrine x 2

<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>Dose (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0 - 2.4</td>
<td>2.2 mL 2 times daily</td>
</tr>
<tr>
<td>2.5 - 2.9</td>
<td>2.8 mL 2 times daily</td>
</tr>
<tr>
<td>3.0 - 3.4</td>
<td>3.2 mL 2 times daily</td>
</tr>
<tr>
<td>3.5 - 3.9</td>
<td>3.8 mL 2 times daily</td>
</tr>
<tr>
<td>4.0 - 4.4</td>
<td>4.2 mL 2 times daily</td>
</tr>
<tr>
<td>4.5 -5.0</td>
<td>4.8 mL 2 times daily</td>
</tr>
</tbody>
</table>
Caffeine citrate

*Loading dose*
IV: 20 mg/kg

*Maintenance dose*
PO or IV: 5 mg/kg once daily. Increase to 10 mg/kg once daily if no response.

If tachycardia, vomiting or irritability the dose should be reduced or postponed. Administer only in a hospital setting.

**Table 5** - Caffeine citrate dosing according to weight (solution 10 mg/mL of caffeine citrate)

<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>Loading dose (PO or IV)</th>
<th>Maintenance dose (PO or IV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8</td>
<td>1.6 mL</td>
<td>0.4 mL</td>
</tr>
<tr>
<td>0.9</td>
<td>1.8 mL</td>
<td>0.5 mL</td>
</tr>
<tr>
<td>1</td>
<td>2.0 mL</td>
<td>0.5 mL</td>
</tr>
<tr>
<td>1.1</td>
<td>2.2 mL</td>
<td>0.6 mL</td>
</tr>
<tr>
<td>1.2</td>
<td>2.4 mL</td>
<td>0.6 mL</td>
</tr>
<tr>
<td>1.3</td>
<td>2.6 mL</td>
<td>0.7 mL</td>
</tr>
<tr>
<td>1.4</td>
<td>2.8 mL</td>
<td>0.7 mL</td>
</tr>
<tr>
<td>1.5</td>
<td>3.0 mL</td>
<td>0.8 mL</td>
</tr>
<tr>
<td>1.6</td>
<td>3.2 mL</td>
<td>0.8 mL</td>
</tr>
<tr>
<td>1.7</td>
<td>3.4 mL</td>
<td>0.9 mL</td>
</tr>
</tbody>
</table>
Appendix 6. Fortification of breast milk with breast milk fortifiers

Background
Low and very low birth weight neonates have a high demand of nutrients for normal growth. Some of these neonates are unable to gain appropriate weight on breast milk alone. These neonates should receive expressed breast milk that is fortified with a breast milk fortifier (BMF). The fortifier adds protein, calories and micronutrients.

Indication
BMF should be added to all feeds for neonates:
– With a birth weight < 2000 g AND
– Who are at least one week of age AND
– Receive all their fluid needs by enteral intake and at least partially by alternative feeding methods (cup/spoon, double suctioning, tube feeding) AND
– Who are gaining less than 15 g/kg/day on three consecutive days on adequate amounts of breast milk.
If breast milk amounts are not adequate, attention should be given to increasing maternal breast milk production.

The product: Nutrilon BMF® from Nutricia
The BMF comes in 2.2 g sachets. The correct way of fortifying the expressed breast milk is producing a maximum 4% solution.
– Add one sachet (2.2 g) of BMF to 50 mL of expressed breast milk to make a 4% solution; or
– Add half a sachet (1.1 g) of BMF to 50 mL of expressed breast milk to make a 2% solution; or
– Add half a sachet (1.1 g) of BMF to 25 mL of expressed breast milk to make a 4% solution.
When the neonate is taking 80 to 100 mL/kg/day of breast milk and tolerating it well, add the fortifier as a 2% solution for all feeds.
After 48 hours of good tolerance, add fortifier as a 4% solution for all feeds.
Continue to increase milk up to 160 to 180/mL/kg/day as long as the neonate tolerates the volume well.

Administration rules
– BMF is restricted to hospital use. Do not give to mothers to administer at home.
– BMF is added to the expressed breast milk directly before the feed.
– Mixing fortifier and milk is done by a nurse or nurse assistant, respecting standard hygiene practices of milk preparation. Stir milk and BMF with a spoon.

Procedure for mixing BMF with expressed breast milk
– Check the amount of breast milk that is prescribed by the clinician and assist the mother to express the amount of breast milk required.
– Add the contents of one sachet (2.2g) to every 50 mL of warm breast milk (approx. 37°C).
  If less milk volume is available, reduce the amount of powder accordingly to avoid over concentration. If less than one sachet is being used, weigh the powder with a laboratory scale if available, in strictly hygienic conditions.
– Swirl gently until powder is dissolved completely.
Monitoring
– If the neonate shows signs of intestinal intolerance (painful and swollen abdomen, vomiting), stop fortification of milk.

Duration of fortification
Add the BMF to expressed breast milk as long as the neonate requires alternative feeding methods. The neonate will suck more and more milk from the breast directly, and this milk does not need to be fortified – do not express breast milk only for fortification. As breastfeeding increases, fortification will be gradually weaned.
Appendix 7. Daily fluid requirements

7.1 Daily fluid volumes for enteral feeding only

Birth weight ≥ 2500 g

<table>
<thead>
<tr>
<th></th>
<th>Total (mL/kg/day)</th>
<th>Breast milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>60</td>
<td>8 x 23 mL</td>
</tr>
<tr>
<td>D2</td>
<td>80</td>
<td>8 x 30 mL</td>
</tr>
<tr>
<td>D3</td>
<td>100</td>
<td>8 x 38 mL</td>
</tr>
<tr>
<td>D4</td>
<td>120</td>
<td>8 x 45 mL</td>
</tr>
<tr>
<td>D5</td>
<td>140</td>
<td>8 x 53 mL</td>
</tr>
<tr>
<td>D6</td>
<td>160</td>
<td>8 x 60 mL</td>
</tr>
<tr>
<td>D7</td>
<td>160-180</td>
<td>8 x 60-68 mL</td>
</tr>
<tr>
<td>D8 and after</td>
<td>160-200*</td>
<td>8 x 60-75 mL</td>
</tr>
</tbody>
</table>

* Up to 220 mL/kg may be given, if necessary for growth.

Birth weight 2000 g to < 2500 g

<table>
<thead>
<tr>
<th></th>
<th>Total (mL/kg/day)</th>
<th>Breast milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>60</td>
<td>8 x 17 mL</td>
</tr>
<tr>
<td>D2</td>
<td>80</td>
<td>8 x 23 mL</td>
</tr>
<tr>
<td>D3</td>
<td>100</td>
<td>8 x 28 mL</td>
</tr>
<tr>
<td>D4</td>
<td>120</td>
<td>8 x 34 mL</td>
</tr>
<tr>
<td>D5</td>
<td>140</td>
<td>8 x 40 mL</td>
</tr>
<tr>
<td>D6</td>
<td>160</td>
<td>8 x 45 mL</td>
</tr>
<tr>
<td>D7</td>
<td>160-180</td>
<td>8 x 45-51 mL</td>
</tr>
<tr>
<td>D8 and after</td>
<td>160-200*</td>
<td>8 x 45-56 mL</td>
</tr>
</tbody>
</table>

* Up to 220 mL/kg may be given, if necessary for growth.

Birth weight 1500 g to < 2000 g

<table>
<thead>
<tr>
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<th>Total (mL/kg/day)</th>
<th>Breast milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>60</td>
<td>8 x 13 mL</td>
</tr>
<tr>
<td>D2</td>
<td>80</td>
<td>8 x 18 mL</td>
</tr>
<tr>
<td>D3</td>
<td>100</td>
<td>8 x 22 mL</td>
</tr>
<tr>
<td>D4</td>
<td>120</td>
<td>8 x 26 mL</td>
</tr>
<tr>
<td>D5</td>
<td>140</td>
<td>8 x 31 mL</td>
</tr>
<tr>
<td>D6</td>
<td>160</td>
<td>8 x 35 mL</td>
</tr>
<tr>
<td>D7</td>
<td>160-180</td>
<td>8 x 35-39 mL</td>
</tr>
<tr>
<td>D8 and after</td>
<td>160-200*</td>
<td>8 x 35-44 mL</td>
</tr>
</tbody>
</table>

* Up to 220 mL/kg may be given, if necessary for growth.
Appendix 7

Birth weight 1250 g to < 1500 g

Neonates with a birth weight < 1500 g should receive 10% glucose in a continuous infusion for the first 48 hours due to the high risk of necrotising enterocolitis with introduction of early enteral feeding. Trophic feeds of 10 mL/kg/day should be started on D1 only if the neonate is clinically stable (i.e. without severe respiratory distress or signs of shock).

The following tables are provided as a last resort – when it is impossible to administer a continuous infusion. Expressed breast milk and 10% glucose are administered simultaneously by mouth.

<table>
<thead>
<tr>
<th></th>
<th>Total (mL/kg/day)</th>
<th>Breast milk</th>
<th>10% glucose</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>80</td>
<td>12 x 5 mL</td>
<td>12 x 4 mL</td>
</tr>
<tr>
<td>D2</td>
<td>100</td>
<td>12 x 7 mL</td>
<td>12 x 4 mL</td>
</tr>
<tr>
<td>D3</td>
<td>120</td>
<td>12 x 10 mL</td>
<td>12 x 4 mL</td>
</tr>
<tr>
<td>D4</td>
<td>140</td>
<td>12 x 14 mL</td>
<td>12 x 2 mL</td>
</tr>
<tr>
<td>D5</td>
<td>160</td>
<td>12 x 18 mL</td>
<td>–</td>
</tr>
<tr>
<td>D6</td>
<td>160-180</td>
<td>12 x 18-21 mL</td>
<td>–</td>
</tr>
<tr>
<td>D7</td>
<td>160-200</td>
<td>12 x 18-23 mL</td>
<td>–</td>
</tr>
<tr>
<td>D8 and after</td>
<td>160-200*</td>
<td>12 x 18-23 mL</td>
<td>–</td>
</tr>
</tbody>
</table>

* Up to 220 mL/kg may be given, if necessary for growth.

Birth weight 1000 g to < 1250 g

<table>
<thead>
<tr>
<th></th>
<th>Total (mL/kg/day)</th>
<th>Breast milk</th>
<th>10% glucose</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>80</td>
<td>12 x 5 mL</td>
<td>12 x 3 mL</td>
</tr>
<tr>
<td>D2</td>
<td>100</td>
<td>12 x 7 mL</td>
<td>12 x 3 mL</td>
</tr>
<tr>
<td>D3</td>
<td>120</td>
<td>12 x 10 mL</td>
<td>12 x 3 mL</td>
</tr>
<tr>
<td>D4</td>
<td>140</td>
<td>12 x 14 mL</td>
<td>12 x 2 mL</td>
</tr>
<tr>
<td>D5</td>
<td>160</td>
<td>12 x 18 mL</td>
<td>–</td>
</tr>
<tr>
<td>D6</td>
<td>160-180</td>
<td>12 x 18-21 mL</td>
<td>–</td>
</tr>
<tr>
<td>D7</td>
<td>160-200</td>
<td>12 x 18-23 mL</td>
<td>–</td>
</tr>
<tr>
<td>D8 and after</td>
<td>160-200*</td>
<td>12 x 18-23 mL</td>
<td>–</td>
</tr>
</tbody>
</table>

* Up to 220 mL/kg may be given, if necessary for growth.

7.2 Daily fluid volumes for IV and enteral feeding

The following charts provide a guide to determine how much IV fluid and feeds to give sick and LBW neonates. If a neonate is not tolerating the prescribed amount of oral feeds, decrease the oral feeds and increase the IV fluids, ensuring the total fluid volume is correct for the neonate’s age and weight. Do not exceed 150 mL/kg/day of IV fluid.

The fluid of choice for D1 and D2 is 10% glucose (G10%). From D3 the fluid of choice is 1/5 0.9% sodium chloride (NaCl 0.9%) + 4/5 10% glucose (G10%).

Feeds should be increased gradually each day, as tolerated, and IV fluids reduced accordingly, with the aim of stopping IV fluids as quickly as possible. For neonates with a birth weight > 2000 g the following tables correspond to IV fluid volumes of 60 – 50 – 40 then 30 mL/kg/day between D1 to D4 and enteral volumes of 10 – 30 – 60 – 80 – 100 – 120 mL/kg/day between D1 to D6.
### Birth weight ≥ 3500 g

<table>
<thead>
<tr>
<th></th>
<th>Total (mL/kg/day)</th>
<th>IV (mL/day)</th>
<th>IV (mL/hr)</th>
<th>Breast milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>70</td>
<td>210</td>
<td>9</td>
<td>8 x 4 mL</td>
</tr>
<tr>
<td>D2</td>
<td>80</td>
<td>175</td>
<td>7</td>
<td>8 x 13 mL</td>
</tr>
<tr>
<td>D3</td>
<td>100</td>
<td>140</td>
<td>6</td>
<td>8 x 26 mL</td>
</tr>
<tr>
<td>D4</td>
<td>110</td>
<td>105</td>
<td>4</td>
<td>8 x 35 mL</td>
</tr>
<tr>
<td>D5</td>
<td>100</td>
<td>0</td>
<td>–</td>
<td>8 x 44 mL</td>
</tr>
<tr>
<td>D6</td>
<td>120</td>
<td>0</td>
<td>–</td>
<td>8 x 53 mL</td>
</tr>
<tr>
<td>D7+</td>
<td>160-180</td>
<td>0</td>
<td>–</td>
<td>8 x 70-79 mL</td>
</tr>
</tbody>
</table>

### Birth weight 3000 g to < 3500 g

<table>
<thead>
<tr>
<th></th>
<th>Total (mL/kg/day)</th>
<th>IV (mL/day)</th>
<th>IV (mL/hr)</th>
<th>Breast milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>70</td>
<td>192</td>
<td>8</td>
<td>8 x 4 mL</td>
</tr>
<tr>
<td>D2</td>
<td>80</td>
<td>160</td>
<td>7</td>
<td>8 x 12 mL</td>
</tr>
<tr>
<td>D3</td>
<td>100</td>
<td>128</td>
<td>5</td>
<td>8 x 24 mL</td>
</tr>
<tr>
<td>D4</td>
<td>110</td>
<td>96</td>
<td>4</td>
<td>8 x 32 mL</td>
</tr>
<tr>
<td>D5</td>
<td>100</td>
<td>0</td>
<td>–</td>
<td>8 x 40 mL</td>
</tr>
<tr>
<td>D6</td>
<td>120</td>
<td>0</td>
<td>–</td>
<td>8 x 48 mL</td>
</tr>
<tr>
<td>D7+</td>
<td>160-180</td>
<td>0</td>
<td>–</td>
<td>8 x 64-72 mL</td>
</tr>
</tbody>
</table>

### Birth weight 2500 g to < 3000 g

<table>
<thead>
<tr>
<th></th>
<th>Total (mL/kg/day)</th>
<th>IV (mL/day)</th>
<th>IV (mL/hr)</th>
<th>Breast milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>70</td>
<td>165</td>
<td>7</td>
<td>8 x 3 mL</td>
</tr>
<tr>
<td>D2</td>
<td>80</td>
<td>138</td>
<td>6</td>
<td>8 x 10 mL</td>
</tr>
<tr>
<td>D3</td>
<td>100</td>
<td>110</td>
<td>4.5</td>
<td>8 x 21 mL</td>
</tr>
<tr>
<td>D4</td>
<td>110</td>
<td>83</td>
<td>3.5</td>
<td>8 x 28 mL</td>
</tr>
<tr>
<td>D5</td>
<td>100</td>
<td>0</td>
<td>–</td>
<td>8 x 34 mL</td>
</tr>
<tr>
<td>D6</td>
<td>120</td>
<td>0</td>
<td>–</td>
<td>8 x 41 mL</td>
</tr>
<tr>
<td>D7+</td>
<td>160-180</td>
<td>0</td>
<td>–</td>
<td>8 x 55-62 mL</td>
</tr>
</tbody>
</table>

### Birth weight 2000 g to < 2500 g

<table>
<thead>
<tr>
<th></th>
<th>Total (mL/kg/day)</th>
<th>IV (mL/day)</th>
<th>IV (mL/hr)</th>
<th>Breast milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>70</td>
<td>135</td>
<td>6</td>
<td>8 x 3 mL</td>
</tr>
<tr>
<td>D2</td>
<td>80</td>
<td>113</td>
<td>5</td>
<td>8 x 8 mL</td>
</tr>
<tr>
<td>D3</td>
<td>100</td>
<td>90</td>
<td>4</td>
<td>8 x 17 mL</td>
</tr>
<tr>
<td>D4</td>
<td>110</td>
<td>68</td>
<td>3</td>
<td>8 x 23 mL</td>
</tr>
<tr>
<td>D5</td>
<td>100</td>
<td>0</td>
<td>–</td>
<td>8 x 28 mL</td>
</tr>
<tr>
<td>D6</td>
<td>120</td>
<td>0</td>
<td>–</td>
<td>8 x 34 mL</td>
</tr>
<tr>
<td>D7+</td>
<td>160-180</td>
<td>0</td>
<td>–</td>
<td>8 x 45-51 mL</td>
</tr>
</tbody>
</table>
**LBW neonates**

For LBW neonates weighing between **1500 g to < 2000 g**, feeds should be advanced more cautiously. For neonates < 2000 g, the following table corresponds to IV fluid volumes of 60 – 60 – 60 – 60 then 40 mL/kg/day between D1 to D5 and enteral volumes of 10 – 20 – 40 – 60 – 80 – 100 – 120 – 140 then 160 - 180 mL/kg/day between D1 to D9.

**Birth weight 1500 g to < 2000 g**

<table>
<thead>
<tr>
<th></th>
<th>Total (mL/kg/day)</th>
<th>IV (mL/day)</th>
<th>IV (mL/hr)</th>
<th>Breast milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>70</td>
<td>105</td>
<td>G10%</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8 x 2 mL</td>
<td></td>
</tr>
<tr>
<td>D2</td>
<td>80</td>
<td>105</td>
<td>G10%</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8 x 4 mL</td>
<td></td>
</tr>
<tr>
<td>D3</td>
<td>100</td>
<td>105</td>
<td>1/5 NaCl 0.9%+ 4/5 G10%</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8 x 9 mL</td>
<td></td>
</tr>
<tr>
<td>D4</td>
<td>120</td>
<td>105</td>
<td>1/5 NaCl 0.9%+ 4/5 G10%</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8 x 13 mL</td>
<td></td>
</tr>
<tr>
<td>D5</td>
<td>120</td>
<td>70</td>
<td>1/5 NaCl 0.9%+ 4/5 G10%</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8 x 18 mL</td>
<td></td>
</tr>
<tr>
<td>D6</td>
<td>100</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8 x 22 mL</td>
<td></td>
</tr>
<tr>
<td>D7</td>
<td>120</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8 x 26 mL</td>
<td></td>
</tr>
<tr>
<td>D8</td>
<td>140</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8 x 31 mL</td>
<td></td>
</tr>
<tr>
<td>D9+</td>
<td>160-180</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8 x 35-39 mL</td>
<td></td>
</tr>
</tbody>
</table>

**VLBW neonates**

All VLBW neonates < **1500 g** should be given **10% glucose** as a continuous infusion from D1. Trophic feeds of 10 mL/kg/day on D1 should be started if the neonate is clinically stable (i.e. without severe respiratory distress or signs of shock). Aim to commence trophic feeds as soon as possible, within 6 to 12 hours after birth. Note this volume of trophic milk is an extra amount and not included in the total daily volume.

For neonates < 1500 g, the following tables correspond to IV fluid volumes of 80 – 100 – 100 – 100 – 80 – 50 then 30 mL/kg/day between D1 to D8 and enteral volumes of 10 – 10 – 20 – 40 – 60 – 80 – 100 – 120 - 140 – 160 then 180 - 200 mL/kg/day between D1 to D11.

**Birth weight 1250 g to < 1500 g**

<table>
<thead>
<tr>
<th></th>
<th>Total (mL/kg/day)</th>
<th>IV (mL/day)</th>
<th>IV (mL/hr)</th>
<th>Breast milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>80</td>
<td>110</td>
<td>G10%</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12 x 1 mL</td>
<td></td>
</tr>
<tr>
<td>D2</td>
<td>110</td>
<td>135</td>
<td>G10%</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12 x 1 mL</td>
<td></td>
</tr>
<tr>
<td>D3</td>
<td>120</td>
<td>135</td>
<td>1/5 NaCl 0.9%+ 4/5 G10%</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12 x 2 mL</td>
<td></td>
</tr>
<tr>
<td>D4</td>
<td>140</td>
<td>135</td>
<td>1/5 NaCl 0.9%+ 4/5 G10%</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12 x 5 mL</td>
<td></td>
</tr>
<tr>
<td>D5</td>
<td>160</td>
<td>135</td>
<td>1/5 NaCl 0.9%+ 4/5 G10%</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12 x 7 mL</td>
<td></td>
</tr>
<tr>
<td>D6</td>
<td>160</td>
<td>110</td>
<td>1/5 NaCl 0.9%+ 4/5 G10%</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12 x 9 mL</td>
<td></td>
</tr>
<tr>
<td>D7</td>
<td>150</td>
<td>68</td>
<td>1/5 NaCl 0.9%+ 4/5 G10%</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12 x 11 mL</td>
<td></td>
</tr>
<tr>
<td>D8</td>
<td>150</td>
<td>41</td>
<td>1/5 NaCl 0.9%+ 4/5 G10%</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12 x 14 mL</td>
<td></td>
</tr>
<tr>
<td>D9</td>
<td>140</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12 x 16 mL</td>
<td></td>
</tr>
<tr>
<td>D10</td>
<td>160</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12 x 18 mL</td>
<td></td>
</tr>
<tr>
<td>D11+</td>
<td>180-200*</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12 x 20-23 mL</td>
<td></td>
</tr>
</tbody>
</table>

* Up to 220 mL/kg may be given, if necessary for growth.
### Birth weight 1000 g to < 1250 g

<table>
<thead>
<tr>
<th></th>
<th>Total (mL/kg/day)</th>
<th>IV (mL/day)</th>
<th>IV (mL/hr)</th>
<th>Breast milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>80</td>
<td>96</td>
<td>G10%</td>
<td>4</td>
</tr>
<tr>
<td>D2</td>
<td>110</td>
<td>120</td>
<td>G10%</td>
<td>5</td>
</tr>
<tr>
<td>D3</td>
<td>120</td>
<td>120</td>
<td>1/5 NaCl 0.9%+ 4/5 G10%</td>
<td>5</td>
</tr>
<tr>
<td>D4</td>
<td>140</td>
<td>120</td>
<td>1/5 NaCl 0.9%+ 4/5 G10%</td>
<td>5</td>
</tr>
<tr>
<td>D5</td>
<td>160</td>
<td>120</td>
<td>1/5 NaCl 0.9%+ 4/5 G10%</td>
<td>5</td>
</tr>
<tr>
<td>D6</td>
<td>160</td>
<td>96</td>
<td>1/5 NaCl 0.9%+ 4/5 G10%</td>
<td>4</td>
</tr>
<tr>
<td>D7</td>
<td>150</td>
<td>60</td>
<td>1/5 NaCl 0.9%+ 4/5 G10%</td>
<td>3</td>
</tr>
<tr>
<td>D8</td>
<td>150</td>
<td>36</td>
<td>1/5 NaCl 0.9%+ 4/5 G10%</td>
<td>2</td>
</tr>
<tr>
<td>D9</td>
<td>140</td>
<td>0</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>D10</td>
<td>160</td>
<td>0</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>D11+</td>
<td>180-200*</td>
<td>0</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

* Up to 220 mL/kg may be given, if necessary for growth.
Appendix 8. Management of gastric residuals

Gastric residual volume does not need to be assessed routinely. However, if there are signs of feed intolerance (vomiting, distended or tender abdomen, bloody stools), checking the gastric residual immediately before the next feed is recommended (see Appendix 3.1).

Procedure

– Use a small volume syringe (preferably 5 mL) for checking residuals and aspirate gently.

Aspirate is green, bloody, dirty, or fetid and volume ≥ 3 mL/kg

• Throw away aspirate.
• Stop enteral feeding.
• Carry out a complete clinical exam* and formulate differential diagnosis.
• According to suspected diagnosis, see Chapter 3, Section 3.5.2 and Section 3.5.6 for further management.

Aspirate is green, bloody, dirty, or fetid and volume < 3 mL/kg

• Throw away aspirate.
• Withhold feed and monitor glycaemia until the next feed is due.
• Carry out a complete clinical exam* and act according to findings.
• Re-evaluate aspirate before the next feed.
• In case of persistence, see Chapter 3, Section 3.5.2 and Section 3.5.6, otherwise restart feeds as prescribed.

Aspirate is clear with small amount of red or black blood

• Throw away aspirate.
• Carry out a complete clinical exam* and act according to findings.
• Continue feeds as prescribed.
• Re-evaluate aspirate before the next feed.
• In case of persistence, see Chapter 3, Section 3.5.3.

Aspirate is clear and volume < 3 mL/kg

• Return aspirate via O/NGT slowly.
• Give feed as prescribed.
• Re-evaluate the aspirate before the next feed.
• Continue increasing feeds as per feeding plan if volume remains < 3 mL/kg.

Aspirate is clear and volume ≥ 3 mL/kg

• Return aspirate via O/NGT slowly
• Give feed as prescribed minus the volume of the gastric aspirate
• Re-evaluate the aspirate before the next feed
• Continue feeds as prescribed but do not increase feed volume until aspirate < 3 mL/kg.

* Clinical exam should include palpation and auscultation of the abdomen, inspection of stool, active search for signs of infection, observation and interpretation of vital signs.

– Stop checking gastric residuals when there are no longer any signs of feed intolerance and gastric residuals have been normal (< 3 mL/kg and clear) for at least 2 days.
Appendix 9. Neonatal ARV prophylaxis for PMTCT

Low risk HIV exposed neonates

- Mother has been on ART for more than 4 weeks prior to deliverya.

Start nevirapine (NVP) syrup once daily as soon as possible after birth for 6 weeks.

Table 1 - ARV prophylaxis for low risk neonate

<table>
<thead>
<tr>
<th>Birth weight</th>
<th>NVP (10 mg/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2 kg and &gt; 35 weeks gestation</td>
<td>2 mg/kg once daily</td>
</tr>
<tr>
<td>2 to &lt; 2.5 kg</td>
<td>10 mg once daily</td>
</tr>
<tr>
<td>≥ 2.5 kg</td>
<td>15 mg once daily</td>
</tr>
</tbody>
</table>

High risk HIV exposed neonates

High risk include:
- Mother received less than 4 weeks of ART at the time of delivery, or
- Mother on ART but with a documented antenatal viral load of > 1000 copies/mL, or
- Mother with incidental HIV infection during pregnancy or breastfeedingb, or
- Mother identified as HIV positive for the first time at delivery or during the breastfeeding period.

Start combination ARV prophylaxis as soon as possible after birth.

Simplified ARV prophylaxis regimen for high risk neonates

From birth to 6 weeks, give one quarter of \textit{AZT/3TC/NVP} dispersible FDC two times daily. Teach the parents or caregiver how to use a cutter to obtain 4 equal parts.

Then at 6 weeks, switch to nevirapine PO: 25 mg once daily for 6 weeks.

Table 2 - Simplified ARV prophylaxis for high risk neonatesc

<table>
<thead>
<tr>
<th>Age</th>
<th>60 mg AZT/30 mg 3TC/50mg NVP tablet</th>
<th>NVP 10 mg/mL syrup or 50 mg tablet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth to 6 weeks</td>
<td>¼ tab x 2</td>
<td>–</td>
</tr>
<tr>
<td>6 to 12 weeks</td>
<td>–</td>
<td>2 mL syrup or ½ tab x 1</td>
</tr>
</tbody>
</table>

\textit{a} Treatment success is best defined by maternal viral load < 1000 just before delivery and/or during pregnancy and breastfeeding.

\textit{b} Defined as a new HIV diagnosis in a pregnant or breastfeeding woman with a previous negative test during pregnancy.

\textit{c} This simplified prophylactic regimen has not been formerly evaluated yet but has been discussed with WHO experts who recognize the importance of simplicity for success.
Standard WHO recommended (2016) ARV prophylaxis regimen for high risk neonates\textsuperscript{d}

Where available, give NVP and AZT combined regimen from birth to 12 weeks. Adjust dose according to birth weight for LBW neonates receiving ARV prophylaxis at or around birth.

Table 3 - WHO recommended ARV prophylaxis for high risk neonates

<table>
<thead>
<tr>
<th>Birth weight or age</th>
<th>NVP 10 mg/mL syrup or 50 mg tablet</th>
<th>AZT 10 mg/mL syrup or 60 mg tablet</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2 kg and &gt; 35 weeks gestation\textsuperscript{e}</td>
<td>2 mg/kg x 1</td>
<td>4 mg/kg x 2</td>
</tr>
<tr>
<td>2 to &lt; 2.5 kg</td>
<td>1 mL syrup x 1</td>
<td>1 mL syrup x 1</td>
</tr>
<tr>
<td>≥ 2.5 kg Birth to 6 weeks</td>
<td>1.5 mL syrup x 1</td>
<td>¼ tab or 1.5 mL syrup x 1 or NVP alone</td>
</tr>
<tr>
<td>6 to 12 weeks</td>
<td>½ tab or 2 mL syrup x 1</td>
<td>1 tab x 2 or NVP alone</td>
</tr>
</tbody>
</table>

- If this is too complicated for the mother, choose the simplified one above.
- If appropriate formulations are not available, give NVP alone for 12 weeks.

For the mother: start ART as soon as possible. If HIV infection is confirmed during labour, administer first dose of ART and continue treatment for life. Ensure proper counselling is done after delivery.

\textsuperscript{d} To be used if this is national recommendation.
\textsuperscript{e} Note: Very preterm neonates will need further reduced doses.
Appendix 10. Ballard score and growth charts

10.1 Ballard score for assessment of gestational maturity
10.2 Growth charts

10.2.1 Fenton growth charts

Girls
Boys
10.2.2 WHO growth charts

[Diagram of WHO growth charts for girls from birth to 2 years, showing percentiles for weight and age.]
References Appendices


Atlas of neonatal skin and congenital conditions

The photos used in this annex are for illustrative purposes only and should not be taken in isolation to make a diagnosis. The clinical condition of the neonate must be taken into account.

**Figure A-1 and Figure A-2**: Erythema toxicum neonatorum
Lesions are characterised by a central whitish to yellowish papule surrounded by a ring of erythema, mainly over the trunk.

**Figure A-3**: Milia
White papules that commonly occur on the face.
Figure A-4: Miliaria crystallina
Small vesicles on the scalp, face and trunk without inflammation resulting from superficial sweat retention.

Figure A-5 and Figure A-6: Transient pustulosis
Lesions are characterised by superficial pustules that rupture easily leaving a spot of hyperpigmentation. There is no surrounding erythema.
**Figure A-7: Neonatal acne**

Erythematous pustules, mainly over the cheeks, but also other areas of the face and scalp.

**Figure A-8: Salmon patch (naevus simplex)**

Midline capillary malformations often seen on the forehead, eyelids, nape of neck. They are more common in Caucasian babies.
Figure A-9: Mongolian blue spot (dermal melanocytosis)
A common benign bluish skin pigmentation occurring frequently in Polynesian, Asian and Mediterranean babies. The lumbosacral region and buttocks are the most common sites.

Figure A-10: Vitiligo
Skin depigmentation condition. Patches of lighter skin appear commonly on the hands, face and feet, but can ultimately affect any area of the body.
Figure A-11 and Figure A-12: Lamellar ichthyosis (collodion neonate)
Inherited skin condition. Neonates are born with a tight clear film (collodion membrane) covering their skin which sheds after a few days or weeks. Generalised erythema follows and the skin becomes dry, flaky and scaly.
Figure A-13, Figure A-14, Figure A-15: Infantile haemangioma (strawberry naevus)
Benign vascular tumour that can occur anywhere on the body and appears as a red or purplish protruding mass. Most lesions involute spontaneously and do not require specific treatment, unless they are causing functional impairment such as obstruction to airway or vision.
Figure A-16: Oral candidiasis (thrush)
Caused by the fungus *Candida albicans* and presents with white patches on the tongue, gums, cheeks or palate. Thrush may cause pain and difficulty feeding.

Figure A-17: Diaper dermatitis (nappy rash)
Typically there is erythema in the perineum, buttocks and skin folds. Superimposed infection with *Candida albicans* is common.
**Figure A-18:** Diaper dermatitis with superimposed *Candida albicans* infection
Extensive erythema of the perineum, abdomen and skin folds with desquamation and satellite lesions.

**Figure A-19:** Bullous impetigo
Superficial vesicles progress rapidly to enlarging, flaccid bullae with sharp margins and no surrounding erythema. It is caused by the toxin producing *Staphylococcus aureus*. 
**Figure A-20: Mastitis**

Infection of the nipple by *Staphylococcus aureus*. Usually presents with unilateral tender, erythematous, swollen breast which may develop into an abscess.

**Figure A-21: Ecthyma gangrenosum**

This rare, systemic infection is characterised by the appearance of multiple erythematous vesicles or bullae which ulcerate and become necrotic. There may be tissue destruction in severe cases.
Figure A-22: Staphylococcal Scalded Skin Syndrome (SSSS)
Generalised erythema is followed by superficial blistering of the skin which desquamates giving the skin a scalded appearance, like a burn.

Figure A-23: Neonatal necrotising cellulitis
Necrotising soft tissue infection affecting the skin only.
**Figure A-24:** Neonatal necrotising fasciitis  
Necrotising soft tissue infection involving subcutaneous tissues and fascia.

**Figure A-25 and Figure A-26:**  
Neonatal necrotising myositis  
Necrotising soft tissue infection extending to, and involving muscle.
**Figure A-27:** Neonatal necrotising soft tissue infection (depth unclear)
Necrotising soft tissue infection with complete dehiscence of flap of scalp. Impossible to determine depth of infection from isolated photograph.

**Figure A-28:** Herpes simplex virus (HSV)
Vesicular lesions develop at the end of the first week or into the second week of life. Grouped vesicles are seen, often in a linear distribution if affecting the limbs.

**Figure A-29:** Congenital syphilis
Lesions are variable and may occur anywhere on the body, but are more prominent on the palms and soles, perioral and anogenital areas. Classically there are vesiculobullous lesions with later desquamation.
Local signs of omphalitis include purulent or foul-smelling discharge from the umbilical stump, periumbilical erythema, oedema and tenderness. Possible complications include disseminated disease and necrotising fasciitis.

A sac-like protrusion of the brain and covering membranes through an opening in the skull. Encephalocoele is part of a spectrum of congenital malformations known as neural tube defects.
**Figure A-32: Omphalocoele**

A midline defect of variable size at the site of the cord insertion. It is covered by a membrane of peritoneum with Wharton’s jelly between the two layers, and contains abdominal contents. Ascites may be present and associated anomalies are common.

**Figure A-33: Umbilical hernia**

These are common in neonates and may become prominent with crying or straining. They do not require treatment.
Anorectal malformations (imperforate anus) are birth defects in which there are abnormalities of the anus and rectum of varying severity, ranging from fairly minor lesions to complex anomalies. Neonates may present with failure to pass meconium after birth, or a physical examination may reveal absence of the anus (as in this photo) or a misplaced anal opening.

The extra digit is found on the ulnar side of the hand. When the digit is attached only by a small skin bridge it can be tied off with a suture at the base of the peduncle.
References Atlas

Glossary

**Chorioretinitis**: uveal tract inflammation of the eye.

**Haemorrhagic disease of the newborn (HDN)**: bleeding in the neonatal period resulting from poor blood clotting as a result of vitamin K deficiency. Vitamin K deficiency is common in neonates as they are born with a low level of vitamin K and their immature liver cannot effectively use vitamin K.

**Patent ductus arteriosus (PDA)**: failure of closure of ductus arteriosus soon after birth that can result in cardio-respiratory problems in the neonate. The ductus arteriosus is a blood vessel connecting the aorta and pulmonary artery during the foetal period, which is essential for foetal blood circulation. As part of the physiological transition to adapt from intra- to extra-uterine life, the ductus arteriosus should close within minutes up to few days after birth. Incomplete closure of the ductus arteriosus results in left-to-right shunting. A small PDA may be asymptomatic and may only be picked up incidentally on routine clinical examination. Large PDAs with significant shunting results in left ventricular volume overload and dysfunction. Without correction, this progressively increases pulmonary arterial pressure, presenting clinically in heart failure or eventually cyanosis. Persistent pulmonary hypertension of newborn (PPHN): results when pulmonary vascular resistance stays high after birth leading to right-to-left shunting in the circulatory system. Clinical presentation is usually with cyanosis and respiratory distress that may be severe and require respiratory support.

**Pulmonary surfactant**: a lipoprotein complex (phospholipoprotein) formed by type II alveolar cells in the lungs which increases lung compliance, facilitating lung inflation and thereby reducing the work of breathing. Preterm neonates lack pulmonary surfactant. To prevent and treat respiratory distress due to surfactant deficiency in preterm neonates, pulmonary surfactants derived from animal lungs can be administered soon after birth.

**Rickets**: is a condition in children with softening and weakening of the bones resulting in clinical features such as bowing of the legs, frontal bossing (prominent forehead or square skull), growth stunting and thickening of the costochondral joints (seen as ‘lumps’ on the ribs). Children can have bone pain and are suffer from fractures. Rickets primarily results from vitamin D deficiency which causes poor bone mineralisation affecting the growth plates and structure of the bone. Vitamin D supplementation starting in the neonatal period, especially for high risk children, is recommended to prevent rickets.
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