effective ventilations and chest compressions, the outcome is unlikely to be altered by the use of drugs, although these should be considered. The decision to stop resuscitation should be taken by the most senior healthcare worker present, and the reason for the decision should be clearly documented.

Explain sensitively to the parents that the infant has died. The infant should then be handled in accordance with cultural preference and practice.

Documentation
It is important to keep accurate records of the steps taken during resuscitation. The reason for any decision must be clearly documented, including the decision to start and end resuscitation. This is important irrespective of the immediate outcome of the resuscitation effort. As with any documentation, keep to the facts and make a complete record of all the steps taken, their timing, and the impact that they had on the infant’s progress.

Remember to sign and date the record.

Vitamin K prophylaxis against haemorrhagic disease of the newborn
Following resuscitation/stabilisation, all newborn infants should receive vitamin K 1 mg IM. Vitamin K is given to prevent haemorrhagic disease of the newborn (HDN), which may cause significant bleeding and even death. The IM route is preferred as it provides a depot over many weeks. Similarly, neonates requiring surgery, those with birth trauma, preterm infants and those exposed in utero to maternal medication that is known to interfere with vitamin K are at especially high risk of bleeding and must be given vitamin K 1 mg IM. This is often forgotten in the rush to get the infant to the nursery.

Resuscitation guidelines algorithm
As discussed earlier, all resuscitation guidelines are based on the international evidence-based science agreed in 2010 at the International Liaison Committee on Resuscitation. The algorithm shown in Figure 3.2.5 summarises the recommendations in the text.

Suggested reading


3.3 Clinical care of the infant in the early months of life

Prematurity and low birth weight
- A *low-birth-weight infant* is one weighing less than 2.5 kg at birth. Low birth weight may be attributable to preterm delivery or intrauterine growth restriction.
- A *preterm infant* is one born before 37 completed weeks have elapsed since the first day of the last menstrual period (259 days). Most preterm infants are born after 32 weeks’ gestation.
- A *small-for-gestational age (SGA) infant* is one whose birth weight falls below the 10th percentile on a birth weight centile chart.

Probably at least 25% of SGA infants are just constitutionally small by virtue of maternal weight, and not secondary to poor placental perfusion. The mean birth weight of infants born to mothers 4 feet 10 inches (147 cm) tall is about 500 grams less than that of infants born to mothers 6 foot 0 inches (183 cm) tall. This discrepancy increases to about 1 kg if extremes of mid-pregnancy weight are also taken into account.

- *Intrauterine growth restriction (IUGR)* refers to a slowing of fetal growth velocity. Most but not all IUGR infants are SGA at birth. Some IUGR infants are just wasted.
- A *large-for-gestational age (LGA) infant* is one whose birth weight is greater than the 90th percentile on a birth weight centile chart.

For most clinical purposes it is sufficient to classify infants as ‘low birth weight’, ‘preterm’ or ‘small-for-gestational age’.

Assessing gestational age
Sometimes a mother cannot recall the date of her last menstrual period. The infant’s gestational age can then be assessed to within ± 2 weeks based on a combined physical and neurological score (see Table 3.3.1). Wasted infants underscore on physical criteria.
### TABLE 3.3.1 Ballard's scoring system for gestational assessment

<table>
<thead>
<tr>
<th>Sign</th>
<th>Physical criteria score</th>
<th>Neurological criteria score</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
<th>–1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin</td>
<td>Sticky, friable, transparent</td>
<td>Gelatinous, red, translucent</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>–1</td>
<td></td>
</tr>
<tr>
<td>Lanugo</td>
<td>None</td>
<td>Sparse</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>–1</td>
<td></td>
</tr>
<tr>
<td>Plantar surface</td>
<td>Heel–toe 40–50 mm: –1  40 &lt; 50 mm: –2</td>
<td>Faint red marks</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>–1</td>
<td></td>
</tr>
<tr>
<td>Breast</td>
<td>Imperceptible</td>
<td>Flat areola, no bud</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>–1</td>
<td></td>
</tr>
<tr>
<td>Eye/ear</td>
<td>Lids fused loosely: –1  lightly: –2</td>
<td>Slightly curved pinna; soft</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>–1</td>
<td></td>
</tr>
<tr>
<td>Genitals (male)</td>
<td>Scrotum flat, smooth</td>
<td>Testes in upper canal, rare</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>–1</td>
<td></td>
</tr>
<tr>
<td>Genitals (female)</td>
<td>Clitoris prominent and labia flat</td>
<td>Labia majora and minora</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>–1</td>
<td></td>
</tr>
<tr>
<td>Total physical maturity score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes on calculating the scores:**

**Posture:** With the infant supine and quiet, score as follows:
- Arms and legs extended = 0
- Slight or moderate flexion of hips and knees = 1
- Moderate to strong flexion of hips and knees = 2
- Legs flexed and abducted, arms slightly flexed = 3
- Full flexion of arms and legs = 4.

**Square window:** Flex the hand at the wrist. Exert pressure sufficient to get as much flexion as possible. The angle between the thumb and the anterior aspect of the forearm is measured and scored:
- > 90° = –1
- 90° = 0
- 60° = 1
- 45° = 2
- 30° = 3
- 0° = 4.
**Arm recoil:** With the infant supine, fully flex the forearm for 5 seconds, then fully extend by pulling the hands and release. Score the reaction:
- Remains extended 180°, or random movements = 0
- Minimal flexion, 140–180° = 1
- Small amount of flexion, 110–140° = 2
- Moderate flexion, 90–100° = 3
- Brisk return to full flexion, < 90° = 4.

**Popliteal angle:** With the infant supine and the pelvis flat on the examining surface, the leg is flexed on the thigh and the thigh is fully flexed with the use of one hand. With the other hand the leg is then extended and the angled scored:
- 180° = –1
- 160° = 0
- 140° = 1
- 120° = 2
- 100° = 3
- 90° = 4
- < 90° = 5.

**Scarf sign:** With the infant supine, take the infant’s hand and draw it across the neck and as far across the opposite shoulder as possible. Assistance to the elbow is permissible by lifting it across the body. Score according to the location of the elbow:
- Elbow reaches or nears level of opposite shoulder = –1
- Elbow crosses opposite anterior axillary line = 0
- Elbow reaches opposite anterior axillary line = 1
- Elbow reaches midline = 2
- Elbow does not reach midline = 3
- Elbow does not cross proximate axillary line = 4.

**Heel to ear:** With the infant supine, hold the infant’s foot with one hand and move it as near to the head as possible without forcing it. Keep the pelvis flat on the examining surface. Score as shown in Table 3.3.1 above.

After assigning the score for the physical and neurological criteria, the sum of the two scores is then used to assess the gestation based on Table 3.3.2.

### TABLE 3.3.2 Assessment of gestation from total score

<table>
<thead>
<tr>
<th>Total score</th>
<th>Gestational age (weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>–10</td>
<td>20</td>
</tr>
<tr>
<td>–5</td>
<td>22</td>
</tr>
<tr>
<td>0</td>
<td>24</td>
</tr>
<tr>
<td>5</td>
<td>26</td>
</tr>
<tr>
<td>10</td>
<td>28</td>
</tr>
<tr>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>20</td>
<td>32</td>
</tr>
<tr>
<td>25</td>
<td>34</td>
</tr>
<tr>
<td>30</td>
<td>36</td>
</tr>
<tr>
<td>35</td>
<td>38</td>
</tr>
<tr>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>45</td>
<td>42</td>
</tr>
<tr>
<td>50</td>
<td>44</td>
</tr>
</tbody>
</table>

**Low birth weight and/or preterm infants**

**Infants with birth weight in the range 2.25–2.5 kg**
- These infants are normally strong enough to start feeding themselves. They need to be kept warm and closely observed for infection, but otherwise no special care is required.

**Infants with birth weight in the range 1.75–2.25 kg**
- These infants sometimes need extra care, but can normally stay with their mothers to receive feeding and warmth, especially if skin-to-skin contact can be maintained. Close monitoring by a healthcare worker is required.
- Feeds can be started within 1 hour of delivery. Many of these infants will be able to suck and can be breastfed. Those who cannot breastfeed should be given expressed breast milk with a cup. When the infant is sucking well from the breast and gaining weight on a daily basis, they can be weaned off cup feeds.
- These infants should be reviewed at least twice a day to assess their feeding ability, fluid intake and the presence of any danger signs (see Box 3.3.1 below), including signs of serious bacterial infection. Such problems will necessitate close monitoring in a neonatal nursery (if available) in a similar way to the very low birth weight. The risk of keeping the child in hospital (including hospital-acquired infections) should be considered.

**Infants with birth weight below 1.75 kg**
- These infants are at risk of hypothermia, apnoea, hypoxaemia, sepsis, feed intolerance and necrotising enterocolitis. The smaller the infant, the greater these risks. All infants with a birth weight below 1.75 kg should be admitted to a special care or neonatal intensive care unit (if available).

**Other treatments for low-birth-weight and/or preterm infants**

**Oxygen**

Oxygen should be administered via nasal cannulae, nasal prongs or a head box if there are signs of respiratory distress, such as moderate to severe recession (preterm infants may show mild recession with normal breathing), and definitely in the presence of cyanosis. **Pulse oximetry to measure oxygen saturation is a vital part of oxygen usage in the preterm infant.** Retinopathy of prematurity (ROP), previously known as retrolental fibroplasia, which leads to lifelong blindness in many cases, is caused by high blood levels of oxygen saturation in the preterm infant. There is no good evidence for the optimum oxygen saturation for preterm infants. On the one hand it is important to avoid hypoxia, which would lead to brain damage, as the infant is likely to have respiratory problems from surfactant deficiency, and on the other hand unrestricted oxygen may cause ROP, which would lead to blindness. Current advice is that the infant born at or before 32 weeks’ gestation or weighing less than 1500 grams at birth should have a target oxygen saturation of 86–92%, which is higher than the oxygen saturation to which the fetus is exposed in utero.

**Prevention of hypothermia**

To prevent hypothermia, nurse the infant in skin-to-skin contact between the mother’s breasts (‘kangaroo care’).
or clothed in a warm room, or in an incubator. A hot water bottle wrapped in a towel can be useful for keeping the infant warm if no power for heating is available, but take care not to burn the infant. Aim for an auxiliary temperature of 36.0–36.5°C, with the feet warm and pink. When the mother is asleep or if she is ill, a clean incubator can be used. Incubators should be washed with disinfectant between infants, and should be of a basic design that can be used appropriately by the staff available.

**Fluids**

It is best to give fluids enterally. However, if the infant is not well enough (e.g., due to severe respiratory distress), give IV fluids (see Section 3.4). Initially, consider giving approximately 2–4 mL of expressed breast milk every 1 to 2 hours through a nasogastric tube. This can be adjusted depending on the weight and the amount of IV fluids that the infant is receiving. With increasing age and weight gradually increase the volume and timing of each feed (the maximum time interval between feeds should not exceed 4 hours). The total fluid intake of enteral feeds plus IV fluids per 24 hours should adhere to the following fluid management guidelines:

- 60 mL/kg on day 1
- 80–90 mL/kg on day 2
- 100–120 mL/kg on day 3
- 120–150 mL/kg on day 4
- 150–180 mL/kg thereafter.

Some infants can be fed with a cup. Use only expressed breast milk if possible. If 2–4 mL per feed is tolerated (i.e., there is no vomiting, abdominal distension, or gastric aspirates of more than half the feed) the volume can be increased by 1–2 mL per feed each day. Ideally, aim to have feeding established in the first 5 to 7 days so that the IV fluids can be tapered off. Reduce or withhold feeds if signs of poor tolerance occur. As the infant grows, recalculate the feed volume based on the higher weight. Feeds may be increased over the first 2 weeks of life to 150–180 mL/kg/day based on a 3- to 4-hourly feeding pattern.

**How to give gastric feeds (see also Section 8.5 on gastric tube management)**

Place the baby's lips on the breast even though he or she is unable to suck or attach before each feed. Place expressed breast milk (EBM) in the syringe. Only use fresh milk or milk that has been stored in a refrigerator, and that has not been out of the fridge for more than 1 hour in a hot climate. Check that the tube is in the stomach before every feed or administration of enterally given drugs. Also check that there is not more than 10% of the previous feed in the stomach by gentle aspiration using a 2- or 5-mL syringe. Connect the syringe containing EBM and remove the plunger, giving the milk by gravity over 10–15 minutes per feed. Only if the feed does not flow in should you gently push with the plunger for a few seconds only to get it started. Never push the whole feed in. Observe the infant closely during the feed for signs of respiratory distress that might be due to lung aspiration. Replace the tube every 7 days, or sooner if it is blocked.

Give enteral feeds only if there is no abdominal distension or tenderness, bowel sounds are present, meconium has been passed, and there is no apnoea, low aspirates, no vomiting and adequate stool output.

**TABLE 3.3.3 Guide to volumes of each feed given every 3–4 hours at different infant weights**

<table>
<thead>
<tr>
<th>Total (mL/kg/day)</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
<th>Day 6</th>
<th>Day 7</th>
<th>Day 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.25–1.4 kg</td>
<td>60</td>
<td>80</td>
<td>100</td>
<td>120</td>
<td>140</td>
<td>150</td>
<td>160</td>
<td>170</td>
</tr>
<tr>
<td>1.5–1.9 kg</td>
<td>10</td>
<td>15</td>
<td>18</td>
<td>20</td>
<td>22</td>
<td>24</td>
<td>25</td>
<td>26</td>
</tr>
<tr>
<td>2.0–2.4 kg</td>
<td>15</td>
<td>17</td>
<td>19</td>
<td>21</td>
<td>23</td>
<td>25</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td>≥2.5 kg</td>
<td>20</td>
<td>22</td>
<td>25</td>
<td>27</td>
<td>30</td>
<td>32</td>
<td>35</td>
<td>35</td>
</tr>
</tbody>
</table>

**Blood glucose levels**

Check blood glucose levels every 6 hours until enteral feeds are established, and immediately if there are any danger signs of infection.

**Infection or feed intolerance**

Observe carefully and constantly for infection or feed intolerance.

**Apnoea**

Monitor for apnoea, ideally with a pulse oximeter (which are now affordable and available in many resource-limited countries), supplemented by close visual monitoring of the infant by the mother or a close relative.

**Discharge and follow-up of low-birth-weight infants**

Discharge when:

- no danger signs (see Box 3.3.1), including signs of serious infection
- the infant is gaining weight (at least 20 grams per day for 3 consecutive days) on breastfeeding alone

**TABLE 3.3.3** Guide to volumes of each feed given every 3–4 hours at different infant weights

<table>
<thead>
<tr>
<th>Blood glucose levels</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
<th>Day 6</th>
<th>Day 7</th>
<th>Day 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>60–80</td>
<td>120</td>
<td>140</td>
<td>150</td>
<td>160</td>
<td>170</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80–100</td>
<td>20</td>
<td>22</td>
<td>24</td>
<td>25</td>
<td>26</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100–120</td>
<td>15</td>
<td>17</td>
<td>19</td>
<td>21</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>120–150</td>
<td>20</td>
<td>22</td>
<td>25</td>
<td>27</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>150–180</td>
<td>25</td>
<td>28</td>
<td>30</td>
<td>35</td>
<td>40</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**BOX 3.3.1 Danger signs associated with infection in the neonate**

**Common danger signs**

- Infant feeding less well than before.
- Infant lying quietly and making few spontaneous movements.
- Hypothermia or fever > 38°C.
- Capillary refill time > 3 seconds.
- Respiratory rate ≥ 60 breaths/minute.
- Indrawing of the lower chest wall when breathing, or grunting.
- Cyanosis.
- History of a convulsion.

**Less common but important signs**

- Low respiratory rate (< 20 breaths/minute) or apnoea.
- Jaundice.
- Abdominal distension.
Low-birth-weight infants should be given all scheduled immunisations by the time of discharge from the health facility or soon after.

Counsel the parents before discharge on:
- exclusive breastfeeding
- keeping the infant warm
- the danger signs that necessitate seeking care (see Table 3.3.4), plus advice on when to return for healthcare
- basic life-saving manoeuvres to use in the event of an emergency, particularly mouth-to-mouth and nose ventilation if prolonged apnoea occurs.

Low-birth-weight infants should be followed up at regular intervals following discharge for weighing, assessment of feeding, and assessment of general health until they have reached 2.5 kg in weight.

**TABLE 3.3.4 Danger signs for parents of discharged newborns**

<table>
<thead>
<tr>
<th>Danger sign</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convulsions</td>
<td>Infant refuses feeds</td>
</tr>
<tr>
<td>ANY bleeding</td>
<td>Minor diarrhoea or vomiting</td>
</tr>
<tr>
<td>Severe diarrhoea or vomiting</td>
<td>Minor breathing problems</td>
</tr>
<tr>
<td>Infant appears unresponsive</td>
<td>Infant is less active/interested</td>
</tr>
<tr>
<td>Severe breathing problems</td>
<td>Infant feels abnormally hot</td>
</tr>
<tr>
<td>Infant feels cold</td>
<td>Jaundice</td>
</tr>
</tbody>
</table>

**Enteral feeding for the newborn infant in hospital**

**Type of milk**

Breast milk will provide the nutrients required by almost all infants. However, for preterm infants the following supplements are needed:

**Vitamin D supplementation**

Term breastfed infants generally do not need extra vitamin D. However, this is only true if the mother has an adequate vitamin D status. Maternal vitamin D deficiency during pregnancy and lactation is common in resource-limited countries, contributing to the low vitamin D content of breast milk. Newborn infants of mothers who have dark skin or wear concealing clothes are also at greater risk of vitamin D deficiency at birth.

Large amounts of calcium and phosphorus are transferred from the mother to the infant during the last 3 months of pregnancy, helping the infant’s bones to grow. Therefore a preterm infant may not receive sufficient amounts of calcium and phosphorus for this purpose. Vitamin D helps the body to absorb calcium from the intestines and kidneys. Very preterm infants require adequate vitamin D supplements. Liver problems such as cholestasis and prolonged use of diuretics or steroids may also cause problems with blood calcium levels.

Therefore, without further supplementation, preterm and also some full-term breastfed infants may be at risk of vitamin D deficiency. This risk may be minimised either by supplementing the mother with large amounts of vitamin D (4000 IU/day) during pregnancy and lactation, or by supplementing the infant directly (400 IU/day) during the period of lactation.

**Phosphorus supplements**

These may be needed in the case of very small infants, who can become hypophosphataemic (i.e. with plasma phosphorus levels of < 1.5 mmol/litre). If untreated, this may result in metabolic bone disease. The addition of a concentrated phosphorus salt (50 mg/kg/day of phosphorus) to feeds will prevent this. Adding 0.05 mL/kg of a 4 mmol/mL phosphorus solution to each of eight feeds per day will give 50 mg/kg/day of supplemental dietary phosphorus.

**Vitamin A supplementation**

In resource-limited countries, vitamin A supplementation of the newborn infant reduces mortality. Preterm infants are at high risk of vitamin A deficiency. This important subgroup of our infant population is not only born with inadequate body stores of vitamin A, but is also often unable to tolerate routine oral supplementation. Vitamin A supplementation programmes significantly reduce infant mortality as well as the incidence of xerophthalmia, respiratory infection, and morbidity from gastrointestinal disease. Oral supplementation of 4000 IU/kg/day has been recommended for very-low-birth-weight (VLBW) (< 1500 grams at birth) infants from establishment of full enteral feeding until discharge from the neonatal unit. Supplementing term newborn infants with vitamin A (100 000 IU as a single dose) within 48 hours of birth reduces infant mortality by almost 25%, with those of low birth weight deriving the greatest benefit. Alternatively, a single dose of 200 000 units can be given to all postpartum mothers within 6 weeks of delivery, when the likelihood of pregnancy is very low, and when infants benefit most from the presence of vitamin A in breast milk.

**Vitamin K**

All neonates should be given vitamin K 1 mg IM within 1 hour of birth. Those who require surgery, those with birth trauma, those who are preterm and those exposed before birth to maternal medication (that can interfere with vitamin K) are at high risk of bleeding and must be given vitamin K. If the need for surgery only becomes apparent some time after birth, we suggest that a repeat dose should be given before surgery.

**Multivitamin preparation**

A multivitamin preparation (preferably containing adequate vitamins A and D) for preterm infants may be commenced from 3 weeks of age. A supply of vitamin D (4000 IU/day) is particularly important for bone mineralisation.

**Iron supplements**

Iron supplements for preterm infants are usually commenced from about 6 weeks of age. Preterm infants have reduced iron stores compared with term infants, especially if the umbilical cord is clamped early. The daily dietary iron supplementation is 2–4 mg/kg of elemental iron, up to a maximum of 16 mg/day.
Breast milk banking

The WHO recommends that low-birth-weight babies who cannot be fed their own mother's breast milk should receive donor milk. The high maternal mortality and morbidity in low-income countries mean that there are many infants who cannot be put to the breast within a few hours of birth, and donor milk is suitable for them. In addition, there is evidence that human donor milk reduces the incidence of severe infection and necrotising enterocolitis (NEC) in low-birth-weight babies, compared with formula milk.

It is possible to establish safe donor milk banks in resource-limited settings, provided that there is a microbiology laboratory able to process donor samples, and a power supply to keep the banked milk frozen. A nurse or other staff member must be trained in good hand hygiene, and the importance of labelling and storage. Only simple equipment is needed.

Milk can be collected from lactating mothers who are known to have tested negative to HIV and syphilis, and are non-smokers. Ideally they have also been screened for hepatitis infections. Milk is collected by hand expression under supervision (as ‘drip milk’ is lower in calories than expressed milk). A 1-mL aliquot from each donor’s sample is sent to the microbiology lab. If colony-forming organisms are grown, the whole sample is discarded. Milk can be stored in a refrigerator while awaiting the microbiology results.

Milk is pasteurised by heating for 30 minutes at 62.5°C, and then cooled and frozen. Pasteurised frozen milk can be stored for up to 6 months from the date of collection. Supplementary formula feeding for the infants of mothers who cannot provide breast milk, or whose mothers have died, may be needed after discussion with the infant’s carers.

Fluid and electrolyte management for the neonate in hospital

When giving fluid or blood intravenously, best practice is to use an in-line infusion chamber/burette to avoid fluid overload.

Fluid requirements

Body water content is high at birth and urine output is low for the first few days. Therefore giving large volumes of fluid in the first few days may make an infant oedematous and worsen any respiratory disease. A simple general rule is to start an ill newborn infant who cannot take enteral fluids (breast milk) on 60 mL/kg/day IV as 10% dextrose solution, increasing in daily steps of 20–30 mL/kg/day to a maximum of 140–180 mL/kg/day. However, in a small-for-gestational-age infant it may be necessary to begin with 70–90 mL/kg/day in order to meet the glucose requirements.

Ideally, use a 100-mL paediatric intravenous burette where 60 drops = 1 mL and therefore 1 drop/minute = 1 mL/hour.

So for an infant weighing 1.8 kg on day 1: 1.8 × 60 = 108 mL.

In each hour the fluid will be 108 ÷ 24 = 4.5 mL, which corresponds to 9 drops every 2 minutes.

The rate of insensible water loss (mainly through the skin) is high in some circumstances, particularly in infants under 29 weeks’ gestation or when an overhead heater is used, the infant should not be covered, and the heater output must be adjusted in direct response to the infant’s skin temperature (typically achieved by a continuous temperature probe servo system). Alternatively, a plastic bag over the infant’s body from the neck down can help to preserve heat.

In the first week of life, high rates of insensible water loss will be reflected by high rates of weight loss (more than 10% of birth weight), and often an increase in the plasma sodium concentration to 150 mmol/litre or higher. If either occurs, the infant is dehydrated and fluid intake should be increased by 30 mL/kg/day. When nursing a low-birth-weight infant under an overhead heater, it is advisable to add an extra allowance of 30 mL/kg/day right from the start (i.e. start on day 1 at 90 mL/kg/day rather than 60 mL/kg/day).

Note, however, that even 30 mL/kg/day might not be enough to meet the insensible losses of a very preterm infant (29 weeks or less) under a radiant heater. Such infants are much better nursed in closed incubators.

In very-low-birth-weight infants, enteral feeds should be advanced slowly in 20–30 mL/kg/day increments. Infants who are being enterally fed but who are unable to breastfeed can be given expressed breast milk by orogastric tube or cup. A general plan for fluid enhancement is as follows:

- day 1: 60 mL/kg/day
- day 2: 85 (range 80–90) mL/kg/day
- day 3: 110 (range 100–120) mL/kg/day
- day 4: 135 (range 120–150) mL/kg/day
- day 5 and thereafter: 165 (range 150–180) mL/kg/day.

Monitor the fluid intake by weighing the infant daily and recording the frequency of urine output.

To weigh the baby, first place a blanket in the scales, set them to zero and then place the baby naked in the scales and cover the infant with the blanket to keep them warm. Fluid intake may need to be adjusted frequently to maintain fluid balance. Urine output can be monitored by measuring the difference between wet nappies (diapers) and a dry one using accurate scales. Generally expect at least eight wet nappies in a 24-hour period. Look out for signs of fluid overload (oedema) or dehydration. If possible measure the plasma electrolytes, but remember that these cannot be interpreted without information on body weight and urine output.

Electrolyte requirements when giving IV fluids

Sodium requirements

Infants over 48 hours of age need some sodium supplementation in a dose of 2–3 mmol/kg/day. This can most easily be given by adding 20 mL/kg of normal saline (0.9%) to the daily requirement of 10% glucose to make up the

Fluid and electrolyte management for the neonate in hospital

When giving fluid or blood intravenously, best practice is to use an in-line infusion chamber/burette to avoid fluid overload.

Fluid requirements

Body water content is high at birth and urine output is low for the first few days. Therefore giving large volumes of fluid in the first few days may make an infant oedematous and worsen any respiratory disease. A simple general rule is to start an ill newborn infant who cannot take enteral fluids (breast milk) on 60 mL/kg/day IV as 10% dextrose solution, increasing in daily steps of 20–30 mL/kg/day to a maximum of 140–180 mL/kg/day. However, in a small-for-gestational-age infant it may be necessary to begin with 70–90 mL/kg/day in order to meet the glucose requirements.

Ideally, use a 100-mL paediatric intravenous burette where 60 drops = 1 mL and therefore 1 drop/minute = 1 mL/hour.

So for an infant weighing 1.8 kg on day 1: 1.8 × 60 = 108 mL.

In each hour the fluid will be 108 ÷ 24 = 4.5 mL, which corresponds to 9 drops every 2 minutes.

The rate of insensible water loss (mainly through the skin) is high in some circumstances, particularly in infants under 29 weeks’ gestation or when an overhead heater (radiant warmer) rather than an incubator is used. Helpful measures for reducing insensible water loss in such cases include the following:

- Place the infant from below the neck in a clean plastic bag to maintain humidity. Maintaining humidity helps to keep very premature infants warm by reducing evaporative heat loss.
- Clothe the infant, or wrap the body below the head with bubble wrap or aluminium kitchen foil (with the shiny side facing inward towards the infant).
- When an overhead heater is used, the infant should not be covered, and the heater output must be adjusted in direct response to the infant’s skin temperature (typically achieved by a continuous temperature probe servo system). Alternatively, a plastic bag over the infant’s body from the neck down can help to preserve heat.

In the first week of life, high rates of insensible water loss will be reflected by high rates of weight loss (more than 10% of birth weight), and often an increase in the plasma sodium concentration to 150 mmol/litre or higher. If either occurs, the infant is dehydrated and fluid intake should be increased by 30 mL/kg/day. When nursing a low-birth-weight infant under an overhead heater, it is advisable to add an extra allowance of 30 mL/kg/day right from the start (i.e. start on day 1 at 90 mL/kg/day rather than 60 mL/kg/day).

Note, however, that even 30 mL/kg/day might not be enough to meet the insensible losses of a very preterm infant (29 weeks or less) under a radiant heater. Such infants are much better nursed in closed incubators.

In very-low-birth-weight infants, enteral feeds should be advanced slowly in 20–30 mL/kg/day increments. Infants who are being enterally fed but who are unable to breastfeed can be given expressed breast milk by orogastric tube or cup. A general plan for fluid enhancement is as follows:

- day 1: 60 mL/kg/day
- day 2: 85 (range 80–90) mL/kg/day
- day 3: 110 (range 100–120) mL/kg/day
- day 4: 135 (range 120–150) mL/kg/day
- day 5 and thereafter: 165 (range 150–180) mL/kg/day.

Monitor the fluid intake by weighing the infant daily and recording the frequency of urine output.

To weigh the baby, first place a blanket in the scales, set them to zero and then place the baby naked in the scales and cover the infant with the blanket to keep them warm. Fluid intake may need to be adjusted frequently to maintain fluid balance. Urine output can be monitored by measuring the difference between wet nappies (diapers) and a dry one using accurate scales. Generally expect at least eight wet nappies in a 24-hour period. Look out for signs of fluid overload (oedema) or dehydration. If possible measure the plasma electrolytes, but remember that these cannot be interpreted without information on body weight and urine output.

Electrolyte requirements when giving IV fluids

Sodium requirements

Infants over 48 hours of age need some sodium supplementation in a dose of 2–3 mmol/kg/day. This can most easily be given by adding 20 mL/kg of normal saline (0.9%) to the daily requirement of 10% glucose to make up the
total daily fluid volume needed. This gives approximately 3 mmol of sodium per kg.

Adding sodium is open to many errors. Ready-made neonatal fluids are available in some countries, and may be used to avoid this problem in some situations. The sodium requirements of very preterm infants may be much higher, as urinary sodium losses may approximate 10 mmol/kg/day in those of 29 weeks’ gestation or less.

Sodium can be commenced on the third day of life (after 48 hours) in infants receiving intravenous fluids, but if there is respiratory distress it is wise to wait until the diuresis associated with recovery begins (this is often delayed until the third or fourth day of life).

**Potassium requirements**

Potassium supplementation in a dose of 1–2 mmol/kg/day will meet requirements and can be provided by adding potassium chloride to a 10% glucose fluid. If IV potassium is given, the plasma potassium concentration must be monitored daily. Potassium can be added to fluids but this should be done very carefully. Remember that too much IV potassium can be fatal. The concentration of KCl in peripheral IV solutions should never exceed 40 mmol/litre. Do not add KCl until the urine output is well established.

Remember that it is best to give potassium and calcium supplements orally, unless very low serum values are identified.

**Glucose requirements**

Infusing glucose at the following rates will match the normal hepatic glucose output and therefore maintain the blood glucose concentration at an acceptable level:

- Term infant: 3–5 mg/kg/minute
- Preterm, appropriate weight for gestation: 4–6 mg/kg/minute
- Small for gestational age: 6–8 mg/kg/minute

A solution of 10% glucose at 60 mL/kg/day will give 4 mg (0.22 mmol) glucose/kg/minute.

These infusion rates provide minimal glucose requirements to maintain a normal blood glucose level, but higher rates will be required for growth. Consider hyperinsulinism as a cause of the problem if an infant requires higher rates of infusion to maintain normoglycaemia. Always use 5% or ideally 10% glucose/dextrose for peripheral IV infusions; an umbilical venous catheter will be needed if high glucose requirements or limits on fluid volume necessitate a more concentrated solution which will be damaging to thin peripheral veins.

**Composite maintenance fluid**

An alternative way to make a simple composite maintenance fluid is by adding the following to give a total volume of 100 mL:

- 1/5 dextrose saline (0.18% normal saline with 5% dextrose) = 71 mL
- 7.4% KCl = 2 mL
- 10% calcium gluconate = 2 mL
- 25% dextrose = 25 mL
- Total volume = 100 mL

Each 100 mL of the above solution would contain dextrose 10%, KCl 2 mEq, Ca 2 mEq and sodium 2.5–3 mmol. Any such mixture must be prepared under sterile conditions.

Remember that KCl should not be added until urine output is well established.

**Drug use in the newborn infant**

Relatively few drugs are needed to deal with most common neonatal emergencies.

The IV route should be used if the infant is already being given IV fluids, as this will reduce the amount of pain to which the child is subjected. There are dangers associated with rapid administration or breaking into an existing IV line, leading to an increased risk of sepsis. Erecting an IV line merely to administer drugs also risks exposing the child to dangerous fluid overload, unless a syringe pump can be used to control the rate at which fluid is infused.

**Common emergency problems that require hospital care in the first month of life**

Many emergencies can be prevented by attention to good feeding practices, providing adequate warmth and preventing infection. The more preterm or low birth weight the infant, the more likely it is that the following complications will occur:

- feeding difficulties
- poor temperature control, especially hypothermia
- infection – prevention and early recognition and safe management are essential
- polycythaemia
- respiratory distress and apnoeic attacks
- bleeding
- jaundice and neonatal anaemia
- reduced conscious level and seizures, including hypoglycaemia
- surgical problems.

**Feeding difficulties**

Infants born after 34 weeks are generally mature enough to suck and swallow well, but may be less demanding of feeds than term infants. Attention to the following can help all newborn infants, especially those born preterm, to establish breastfeeding:

- Encourage early and prolonged skin contact.
- Encourage small frequent feeds by waking the infant every 2 to 3 hours and putting them to the breast.
- If the infant will not latch on and suck, the mother can be encouraged to express breast milk and offer it to the infant by cup and/or spoon or if not accepted by orogastric or nasogastric tube.
- If an otherwise well infant on breast milk feeds is experiencing inadequate growth, an inadequate milk supply may be the problem. There are several possible causes for this, which can usually be identified by listening to the mother and then watching the infant feed. A relaxed mother will have a good ‘let-down’ reflex which gives the infant the more calorie-rich hind milk as well as the fore milk. The mother can tell when she has ‘let down’ by a tingling feeling in her breasts, and the infant starts to swallow rapidly. The infant must latch on properly for feeding to be successful, and this may need some assistance from the midwife. The best way to increase the milk supply for a hungry infant who is not thriving is to increase the feed frequency. Breast milk works on
a demand-and-supply system, so the more the infant demands, the more the breast supplies. If the infant is not feeding vigorously enough to increase the milk supply, the mother should express milk after feeding and give it to the infant as described above.

- Avoid giving formula or breast milk by bottle. A small feeding cup (about the size of a medicine measuring cup, with a smooth rim) or a spoon can be used to feed the infant.
- Give expressed breast milk via orogastric or nasogastric tube if the infant is too unwell to suck or drink from a cup.
- As the infant becomes stronger, encourage a transition to demand breastfeeding.

**Feeding problems**

- Ingested meconium/blood. Infants who have swallowed a lot of meconium or blood before birth may retch and appear distressed after birth. Such problems almost always settle within a few hours without any intervention.
- Uncoordinated feeding. Infants born before 32 weeks’ gestation often have difficulty sucking and swallowing in a coordinated way. Most will initially need some tube feeds. They are not likely to start gaining weight until they are taking at least 120 mL/kg of milk a day. Infants need to be fed regularly at least once every 4 hours, day and night. Breast milk can be supplemented with formula milk at this time if donor milk is not available. However, every effort needs to be made to sustain the mother’s lactation by expression and by keeping the mother in hospital to be near her infant.
- Regurgitation. Hurried frequent feeding may cause regurgitation. A poorly developed cough reflex can cause the infant to inhale milk into the lung, resulting in possible pneumonitis and even pneumonia. Newborn infants benefit from frequent small feeds every 2 to 3 hours. Feeds should be increased gradually over the first 3 to 5 days of life. Patience is required. Dehydration (and the risk of hypoglycaemia) need to be monitored, and can be prevented during this period by giving supplemental gastric or IV fluids so that total fluid intake (i.e. taking the gastric/IV and the oral intake together) does not fall below 120 mL/kg per day.
- Feeding tubes. Tube feeding is the best option for infants who have not yet developed a coordinated suck and swallow reflex. Nasogastric tubes are popular, easier to secure and less easily pushed out by the infant’s tongue, but they can almost completely block one nostril, significantly increasing the work of breathing. Therefore orogastric tubes are preferred if respiratory distress is present. Alternatively, a fine-bore nasogastric tube can be left in place and changed as required (up to a maximum of 7 days). Small frail infants should be handled as little and as gently as possible, and can be left lying undisturbed in their cots during a tube feed so long as the head end of the cot is elevated 25 cm.

**Temperature control and hypothermia prevention and treatment**

Hypothermia can be due to a cold environment, but remember that starvation or serious infection can present as hypothermia.

Normal temperatures for newborn infants are 36.5–37.5°C (axillary) if measured over 3 minutes, and lower (around 36.0–36.5°C) if measured over at least 1 minute. Rectal thermometers are difficult to use and can be dangerous. If the trunk is cold, the infant is almost certainly hypothermic.

Use a low-reading digital thermometer, not a mercury thermometer. If the axillary temperature is less than 32°C, hypothermia is severe; if it is in the range 32–35.9°C the infant has moderate hypothermia. If the infant’s temperature does not register on the normal thermometer, assume that they have hypothermia.

Hypothermia can be prevented by the following measures:

- Dry the infant well immediately after birth and place them in skin-to-skin contact with the mother. This is especially important for low-birth-weight infants who do not have other complications. For those with medical problems, warm the infant by skin-to-skin care. If there are adequate resources and staff, an overhead radiant heater or an air-heated incubator (set at 35–36°C) can be used.
- “Kangaroo care” (skin-to-skin contact with the mother between her breasts and covered with a blanket) is the most effective method for all infants, especially for those of low-birth-weight. Randomised trials in both well-resourced and resource-limited countries have shown significant advantages to this technique for the infant and the mother, including an increased prevalence of breastfeeding, a reduced incidence of apnoea and a reduced risk of infection. Take care when examining the infant not to allow the temperature to fall (ideally room temperature in the hospital ward should be higher than 25°C).
- A cot heated with a hot-water bottle with the top screwed in tightly and wrapped in a clean towel can be just as effective if the above are not available. Ordinary domestic radiant heaters or electrical blower type heaters can also be effective.
- Cover the infant’s head with a warm woollen hat and dress them in warm, dry clothes. Keeping the nappy dry is also very helpful.
- Avoid overheating by monitoring the axillary temperature 4- to 6-hourly.
- Feed the infant 2- to 3-hourly, and continue with 4-hourly feeds during the night.
- Avoid washing the infant before they are 24 hours of age.
- Do not leave the infant where there are any draughts.
- The infant should sleep either with or next to the mother during the night.

The development of incubators earlier in the twentieth century significantly reduced the mortality of preterm infants, but they are expensive, and require regular maintenance, thorough cleaning and sufficient numbers of trained staff. The nursing of infants in incubators is covered by standard texts, but Table 3.3.5 gives the settings from which to start, adjusting the incubator temperature up or down to maintain the infant’s axillary temperature at 36.0–36.5°C.
organisms vary from one part of the world to another.

During labour and delivery. The most frequently observed organisms acquired by vertical transmission from mother to infant are Gram-positive cocci, especially group B beta-haemolytic streptococcus, other streptococcal species, *Staphylococcus* and *Enterococcus*. Rarely *Listeria monocytogenes* is isolated from newborn infants with sepsis, especially when there are foodborne epidemics.

**Prevention of neonatal infection**

A newborn infant with risk factors for infection (membranes ruptured more than 18 hours before delivery, mother with fever > 38°C before delivery or during labour, or foul-smelling/purulent amniotic fluid) should be treated with prophylactic antibiotics (ampicillin and gentamicin IM or IV) for at least 2 days. After 2 days the infant should be reassessed and treatment continued if there are signs of sepsis (or a positive blood culture).

Simple measures that can prevent infection in the newborn include the following:

- **Ensure a clean delivery environment** for the mother and infant, including disinfectant cream for all maternal vaginal examinations (e.g. Hibitane cream).
- **Good cord care**: the WHO recommends that the cord be kept clean and dry. It should not be covered. Local applications of creams, ointments, etc. are generally not required except in high-risk settings, where application of an antiseptic is recommended. An antiseptic solution or cream such as 4% chlorhexidine has recently been shown to reduce omphalitis and resulting neonatal mortality. It should be applied immediately after birth and for several days thereafter if possible, preferably after every nappy change. Similarly, there is extensive successful experience with the application of surgical spirit or iodine solution to the cord.
- **Exclusive breastfeeding**.
- **Strict procedures for hand washing** or the use of hand sprays or hand rubs for all staff and for families before and after handling infants.
- **Not using water for humidification** in incubators (where *Pseudomonas* can easily colonise).
- **Cleaning incubators with an antiseptic before use** (if skin-to-skin mother care is not possible).
- **Strict sterility for all invasive procedures**.
- **Sterile injection practices**.
- **Remove intravenous drips** when they are no longer necessary.
- **Keep invasive procedures (e.g. blood sampling, unnecessary IV cannulation) to a minimum**, only undertaking them when they are essential.

**Early-onset sepsis (first 72 hours)**

Early-onset sepsis usually occurs as a result of bacteria acquired by vertical transmission from mother to infant during labour and delivery. The most frequently observed organisms vary from one part of the world to another. Gram-negative enteric bacteria (especially *Escherichia coli* and *Klebsiella* species) predominate in many regions. Gram-positive cocci are also common, and include group B beta-haemolytic streptococcus, other streptococcal species, *Staphylococcus* and *Enterococcus*. Rarely *Listeria monocytogenes* is isolated from newborn infants with sepsis, especially when there are foodborne epidemics.

**Maternal risk factors for early-onset sepsis**

These include the following:

- maternal fever (especially 38°C or higher) before delivery or during labour
- pre-labour rupture of membranes
- prolonged rupture of membranes (18 hours or longer)
- preterm labour
- maternal bacteriuria during pregnancy (including *E. coli* and group B beta-haemolytic streptococcus)
- prior infected infant (group B beta-haemolytic streptococcus).

Early-onset sepsis in the newborn usually results from bacteria acquired from the mother at or shortly before delivery. These infants mostly present with respiratory distress, and have bacteraemia or pneumonia. However, vaginal cultures cannot be used to determine the choice of antibiotics when treating the symptomatic newborn.

**Late-onset sepsis**

Organisms are less likely to reflect those of the maternal genital tract, although the same pathogens may be identified in infants presenting from home. The most common infections are focal ones such as conjunctivitis, omphalitis, skin infections and meningitis. A circumcision wound can also be the site of serious infection.

In the hospital setting, infection is more commonly due to nosocomial pathogens, including coagulase-negative staphylococci, *Gram-negative enteric bacteria* (e.g. *Klebsiella oxytoca*, *Klebsiella pneumoniae*, *Enterobacter cloacae*), *Staphylococcus aureus*, *Pseudomonas* species, streptococcal species and *Enterococcus*. Fungal sepsis must also be considered. Investigate as for early-onset sepsis, with the inclusion of a lumbar puncture and suprapubic urine for analysis and culture if indicated, and treat empirically with parenteral broad-spectrum antibiotic therapy directed towards the most commonly encountered pathogens for the particular nursery. Once cultures are positive, therapy can be directed accordingly. (For details of treatment of sepsis, see Section 3.4.)

**Laboratory evaluation of the unwell infant**

In an infant who is generally unwell with no clinically obvious infective focus, the following investigations should be performed:

- **Blood culture (about 1 mL of venous blood)**: This should be obtained from a peripheral vein after preparing

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**TABLE 3.3.5 Incubator temperature guidelines**

<table>
<thead>
<tr>
<th>Weight of baby (grams)</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4 and subsequently</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1200</td>
<td>35.0°C</td>
<td>34.0°C</td>
<td>34.0°C</td>
<td>33.5°C</td>
</tr>
<tr>
<td>1200–1500</td>
<td>34.0°C</td>
<td>34.0°C</td>
<td>33.5°C</td>
<td>33.5°C</td>
</tr>
<tr>
<td>1500–2500</td>
<td>33.5°C</td>
<td>33.0°C</td>
<td>32.0°C</td>
<td>32.0°C</td>
</tr>
<tr>
<td>&gt; 2500</td>
<td>33.0°C</td>
<td>32.5°C</td>
<td>31.0°C</td>
<td>30.5°C</td>
</tr>
</tbody>
</table>
the skin with an antibacterial wash such as povidone-iodine and/or 70% ethanol or isopropyl alcohol. Blood culture is the gold standard for neonatal sepsis, but it is not 100% sensitive. The sensitivity may be further reduced if intrapartum antibiotics were administered to the mother antenatally. The results can be assessed at 48 hours.

- White blood cell and differential cell count are not helpful in most situations.
- Chest X-ray: This may be helpful if there are any respiratory signs, but not if it means taking the infant to another department in the hospital. A portable chest X-ray is ideal.
- Lumbar puncture if indicated: cytology, chemistry, Gram stain and culture. Not routinely done on all infants with suspected infection unless there are neurological signs.
- C-reactive protein (CRP): This is an inexpensive and useful test which may take 12 hours to become positive after the onset of an infection if it is present.
- Blood glucose concentration.
- Serum bilirubin concentration: if the infant appears jaundiced.
- Surface cultures (ear canal, umbilical stump) and gastric aspirate cultures: these do not correlate with either the likelihood of sepsis or the causative agent in septic infants. These cultures should not be obtained.
- Midstream or suprapubic aspirate of urine for culture: this procedure is of little value in the infant with suspected sepsis shortly after birth, but may be positive in infants with new-onset symptoms later in the first week (± 3 days). A urinary tract infection should always be considered in neonates with late-onset sepsis.

In seriously sick infants with suspected sepsis, priority should be given to the structured ABC approach, while simultaneously obtaining a blood culture followed by prompt administration of antibiotics. Other tests, such as a lumbar puncture if needed (see above), can be performed once the infant is stable and antibiotics have been started. (For details of treatment of sepsis, see Section 3.4.)

Infants who are vulnerable to maternal factors

The infant of a diabetic mother

If a diabetic mother is poorly controlled, her infant may be large for gestational age, putting him or her at risk of slow progress in labour and perhaps shoulder dystocia. At birth, the infant, although large, behaves in a similar manner to a preterm infant. There is a major risk of hypoglycaemia, caused by the intrarutine over-stimulation of the infant pancreas to produce abnormally high levels of insulin. The infant must be monitored at least hourly for hypoglycaemia in the first 6 hours, and should then be monitored 4-hourly for hypoglycaemia, which should be treated as described above with an infusion of 10% dextrose. The infant of a diabetic mother has immature lung maturation and is liable to surfactant deficiency (see Section 3.4), poor feeding and jaundice, Polycythaemia is also more likely.

The infant of a mother who is dependent on alcohol or drugs of addiction

These infants have been exposed to significant levels of narcotic drugs or alcohol in utero, causing an increased risk of congenital abnormalities and of abnormal neurological development and behaviour during childhood. Soon after birth they may show hyper-irritability and convulsions, requiring treatment and gradually reducing sedation as they are 'weaned off' the addictive drugs to which they have been exposed. These infants are also at risk of having been exposed to bloodborne viruses such as HIV and hepatitis B and C.

Birth injuries

Swellings around the head

- The commonest is a caput succedaneum, which is oedematous tissue over the occiput present after a vaginal delivery. This usually resolves within a few days and is of no consequence, requiring no intervention.
- A cephalhaematoma is a lateral (sometimes bilateral) fluctuant swelling, well circumscribed by the sutures. It does not cross the midline and anatomically represents a sub-periosteal haemorrhage. There may be an associated skull fracture, but neither this nor the swelling itself usually needs treatment. The only important complication can be worsening of jaundice as the blood is degraded and reabsorbed. Never aspirate blood from a cephalhaematoma, as this can cause a serious infection.
- A subaponeurotic haemorrhage (bleeding between the skull periosteum and the scalp aponeurosis) is the least common but most dangerous scalp swelling. It represents haemorrhage beneath the aponeurosis of the scalp. Onset and progression is often insidious, with progressive pallor due to significant haemorrhage. The bogggy swelling of the head, extending from above the eyes to the occiput, may only be noticed after the infant has developed hypovolaemic shock. The infant may develop bruising behind the ears and around the eyes. This must be recognised early, as these infants often need urgent transfusion. Injection of vitamin K should be given.

Nerve palsies

- Facial nerve palsies are sometimes associated with forceps delivery. They usually resolve within a few days, requiring little intervention.
- Brachial plexus trauma may follow shoulder dystocia or a difficult breech delivery, and reflects traction injury to the upper roots of the brachial plexus. The arm is flaccid and the wrist flexed. This can most clearly be demonstrated by eliciting an asymmetric Moro reflex. Look for signs of respiratory distress, as the phrenic nerve on the same side is sometimes affected. An X-ray should be obtained to exclude a pseudoparesis associated with clavicular fracture or syphilitic ostetis. The humerus should also be included in the X-ray to rule out humeral fractures, which may occasionally be present. Most brachial plexus palsies resolve within 3 to 4 weeks of delivery, but rarely they can be permanent. Once fractures have been ruled out, the mother can be shown how to perform passive movements to reduce the possibility of joint contractures developing. Refer
3.4 Neonatal illnesses and emergencies

Sepsis in the neonate
Recognising and treating neonatal infection
Bacterial sepsis (septicaemia) in the newborn infant may present with any number of subtle non-specific changes in activity or physical findings. A change in feeding pattern, vomiting, irritability, pallor, diminished tone and/or decreased skin perfusion is suggestive of neonatal infection. Other presenting physical findings may include lethargy, apnoea, tachypnoea, cyanosis, petechiae or early jaundice. There may be fever, but this is not common, especially with bacterial infections occurring in the first week. However, temperature instability with hypothermia may be seen. Abnormal glucose homeostasis (hypoglycaemia or hyperglycaemia) and/or metabolic acidosis are commonly associated findings. Infants, especially preterm infants, are very prone to infection and can become ill very rapidly once infection takes hold. Antibiotic treatment is only likely to work if started early, but the recognition of early infection is not easy. A WHO study showed that more than a third of all deaths in the first month of life in most resource-limited countries were caused by infection. It also found that more than 80% of these infants, when first seen, had one or more of the following eight danger signs associated with infection in the neonate:
- Infant feeding less than well than before
- Infant lying quiet and making few spontaneous movements
- Low respiratory rate (< 20 breaths/minute) or apnoea
- Jaundice
- Abdominal distension
- Skin infections.

All neonates with signs of sepsis need immediate hospital admission if they are not already there, and must be treated with IV antibiotics for at least 10 days after blood and other appropriate cultures have been taken.

Ampicillin (or penicillin) plus gentamicin are the first-line drugs to be used. Consider adding cloxacillin or flucloxacillin if there are signs suggesting that *Staphylococcus aureus* is a cause (e.g. skin pustules, abscesses, omphalitis). Blood cultures are ideal although not always possible before starting antibiotics. If the infant does not respond within 48 hours, consider changing the antibiotic. If there is a possibility of meningitis, risk of resistance or Gram-negative organisms, a third-generation cephalosporin such as cefotaxime or ceftriaxone should also be added.

Further reading

Fractures
The most common types are skull and clavicular fractures. These usually require no specific treatment. However, significant skull fractures must be evaluated for intracranial bleeding. There should also be consideration of whether the injury is a birth-associated one or a subsequent inflicted injury perpetrated by a caregiver.

Common external congenital abnormalities
Talipes equinovarus
Talipes equinovarus is a fixed inversion and flexion deformity of the foot at the ankle, in which the foot cannot easily be put in a normal position. It is helpful to note that this form of fixed talipes is usually associated with the presence of a groove on the medial aspect of the foot. Treatment is required. The foot should be splinted and strapped in the position closest to normal, and an orthopaedic surgeon's advice must be sought (see Section 5.17). Whenever talipes is present, be sure to examine the hips carefully for evidence of developmental dysplasia (also known as ‘congenital dislocation of the hip’). It is also important to examine the back for a spinal defect and evidence of neurological deficit.

The common variation (positional talipes) where the foot can easily be brought into the normal position does not require treatment.

Extra digits
These are very common. It is important to distinguish a simple skin tag from a true extra digit containing bone or cartilage. The latter may be associated with other congenital anomalies, particularly of the heart, spine, kidney or gut. Skin tags are inherited and are of cosmetic significance only. Skin tags are often held by only a thin pedicle of tissue, which can be ligated at the base, usually causing the tag to fall off a few days later.

Supernumerary nipples and pre-auricular skin tags
These are often found and are of cosmetic concern only. No intervention is required.