The following data should be recorded in the notes of every newborn baby.

**Baby’s name (if given at the time)**

**Mother’s data**
- Name, address, date of birth, and any identifying number
- Parity and previous obstetric history
- Blood group
- First day of last menstrual period
- Results of any antenatal serology (e.g. rubella, syphilis, rhesus titres, HIV status)
- Illness during the pregnancy
- Drugs taken during the pregnancy
- Family history of any illnesses

**Father’s data**
- Full name, address and date of birth
- Family history of any illnesses

**Labour and delivery data**
- Time of onset: whether induction of labour or spontaneous
- Time membranes ruptured and any other known risk factors for infection (see below)
- Duration of first and second stage of labour
- Drugs given to the mother in labour
- Presentation and mode of delivery
- Full details of any resuscitation for baby or mother
- Time, dose, route of administration and full generic name of any drugs given to the mother

**Baby data**
- Temperature shortly after delivery, to document adequate thermoregulation
- Birth weight
- Head circumference (best measured after 24 hours when moulding has subsided)
- Length (ideally)
- Full physical examination, noting any abnormalities or evidence of birth trauma detected
- Details of dose, preparation and route of administration of any drugs given at delivery (e.g. vitamin K)
- If not already given, ensure that vitamin K 1 mg IM is administered

**Follow-up home visits**
Trials in South Asia have shown that three home visits in the first week of life (starting on the day of birth) by trained healthcare workers can reduce neonatal mortality by 30–60%. During their visits, the healthcare workers promote essential newborn care, examine babies for danger signs, and treat or refer when appropriate, counsel the families in how to recognise danger signs and emphasise the importance of prompt referral when they are identified.

The WHO and UNICEF recommend that skilled healthcare workers (nurses or midwives) should undertake these visits, but in many settings this is not possible. Volunteers have also been trained to do this, and recently the effectiveness of this has been shown in Ghana, where a fall in neonatal mortality followed two home visits during pregnancy and three visits in the first week of life.

**Further reading**

### 3.2 Resuscitation of the newly born

**Introduction**

Respiratory changes at birth in a healthy term infant

- During life in utero, the infant’s lungs are full of lung tissue fluid. The fluid is removed during labour and at birth by the following mechanisms:
  - at the onset of labour, lung fluid production stops
  - as labour progresses, re-absorption of lung fluid occurs
  - about 35 mL of fluid are expelled from the lungs as a result of thoracic compression during vaginal delivery
  - the first breaths generate relatively high pressures to inflate the lungs, which has the effect of pushing this fluid into the circulation. These first breaths establish the infant’s functional residual capacity.
- Surfactant is produced in the alveoli to prevent them collapsing completely during expiration.

- Production starts slowly at 20 weeks’ gestation, and increases rapidly from 30–34 weeks and thereafter.
- Surfactant production is reduced by hypothermia, hypoxia and acidosis.

Caesarean section is associated with delayed clearance of pulmonary fluid, and reduces the initial functional residual capacity.

Most infants breathe well and do not need active ‘resuscitation’ at birth. Simply drying the infant with a warm dry sheet/towel will in most cases stimulate a cry from the infant thus expanding the lungs (see Section 3.1). Attempts to clear the airway, to stimulate breathing, or to give facial oxygen are unnecessary. Therefore routine airway suctioning is not needed. Most infants make all the circulatory adjustments required at birth without external intervention as the lungs expand. All that the birth attendant has to do
is to optimise the conditions needed for these changes to occur smoothly.

Around 5% of infants do not breathe spontaneously after delivery. However, breathing can be started in almost all these infants by correctly applying bag-and-mask ventilation. With lung inflation there is an immediate and easily detectable rise in heart rate. It may be difficult to identify the infant’s pulse rate by palpation at any site, so the best way to determine the heart rate is to listen over the chest with a stethoscope.

Far less commonly, infants are born cyanosed, shocked, limp and hypotonic. Around 1% do not respond to bag-and-mask ventilation, and need further help with advanced resuscitation.

**Resuscitation at birth**

**Equipment needed for resuscitation**

The following equipment is needed:

- Two clean dry towels.
- A firm working surface.
- Heat and light source.
- Sterile gloves.
- Sterile scissors.
- Sterile cord clamps.
- Food-grade plastic wrapping (cling film).
- Clock.
- Soft well-fitting face masks (size 0/1 and 00).
- A self-inflatable bag.
- A source of oxygen.
- A pressure-limiting device at 30cmH₂O if T-piece is used.
- A stethoscope.
- A laryngoscope, with straight blades size 0 and 1, and spare bulbs.
- A set of endotracheal tubes (2.5, 3.0, 3.5 and 4.0mm) with adaptors to fit the inflation system.
- An endotracheal stylet.
- An umbilical venous catheter (or use a sterile feeding tube).
- A pulse oximeter (if available).
- A roll of zinc oxide tape for name-band.
- Syringes: 1 mL, 5 mL, and 10 mL.
- Emergency drugs: 1 in 1000 adrenaline plus sterile water for dilution to make 1 in 10,000.
- Ringer-lactate or Hartmann’s solution, plasma expander or blood in the case of hypovolaemia due to fetal bleeding (see below) may occasionally be required and would use the umbilical vein route. The intra-osseous route is also now being used, either using a purpose-made needle and drill set or by using a venepuncture needle and the medial side of the tibial bone, below the growth plate (see Section 8.N). For a discussion of drugs, see below.

**Timing**

A clock will help you to document the duration of resuscitation and the timing of interventions.

**Circulatory access and drugs**

An umbilical vein catheter may be used to administer drugs, but it is important to note that infants who require drugs during resuscitation have poorer outcomes and are at increased risk of death and long-term neurological sequelae. Ringer-lactate or Hartmann’s solution, plasma expander or blood in the case of hypovolaemia due to fetal bleeding (see below) may occasionally be required and would use the umbilical vein route. The intra-osseous route is also now being used, either using a purpose-made needle and drill set or by using a venepuncture needle and the medial side of the tibial bone, below the growth plate (see Section 8.N). For a discussion of drugs, see below.

**Additional equipment**

A heat and light source is needed plus food-grade plastic wrapping for infants under 32 weeks’ gestation.

An oxygen source is helpful but not essential for infants who need advanced resuscitation.

A pulse oximeter can be of help in monitoring the improvement in oxygenation and detecting the occasional infant with sub-clinical cyanosis requiring further intervention or evaluation for cardiac or pulmonary disease. It is also useful to prevent hyperoxia when oxygen is used in resuscitation, especially in the preterm infant.

A roll of zinc oxide tape half an inch wide can be used to make a simple name band for infants not delivered in their own homes. Take six inches of this tape, write the date and the mother’s name at one end, turn the last two inches of the other end back on itself (so the tape does not stick to the skin), and then turn this into a simple bracelet round the child’s wrist. Ensure that the bracelet is loosely fitting to avoid a tourniquet effect.

**Guidelines from the 2010 International Liaison Committee on Resuscitation (ILCOR)**

The main changes that have been made to the Neonatal Life Support (NLS) guidelines relevant to resource-limited countries are as follows:

- The use of food-grade plastic wrapping (cling film) is recommended to maintain body temperature in very small preterm infants.
- Ventilatory resuscitation may be started with air. However,
where possible, additional oxygen should be available if there is no rapid improvement in the infant's condition.

- Adrenaline should be given by the IV route, as standard doses are likely to be ineffective if given via a tracheal tube.
- If there are no signs of life after 20 minutes of continuous and adequate resuscitation efforts, discontinuation of resuscitation may be justified.

Sequence of actions during resuscitation of the newborn

There are agreed guidelines from the 2010 International Liaison Committee on Resuscitation (ILCOR). The sequence below and that of ‘Helping Infants Breathe’ are both practical applications of these principles.

First call for help

Start the clock or note the time. Keep the infant dry and warm and assess their breathing and heart rate.

- Infants are born small and wet. They get cold very easily, especially if they remain wet and in a draughty. Whatever the problem, dry the infant well, including the head. Remove the wet towel, and wrap the infant in a dry towel. It is helpful if the towels are warm.
- There is good evidence that for very preterm infants (30 weeks’ gestation or earlier), placing the infant under a radiant heater after drying, and immediately covering the head and body, apart from the face, with clean plastic wrapping, is the most effective way of keeping these very small infants warm during resuscitation.

- Drying the infant immediately after delivery will provide significant stimulation during which colour, tone, breathing and heart rate can continue to be observed.

- It is important to monitor the infant’s breathing. Observing the colour, heart rate and tone helps to document the infant’s condition and assess their response to resuscitation.

- Reassess these observations regularly (particularly the heart rate), every 30 seconds or so, throughout the resuscitation process. The first sign of any improvement in the bradycardic infant will be an increase in heart rate.

- A healthy infant may be born blue but will have good tone, will cry within a few seconds of delivery, will have a good heart rate (the heart rate of a healthy newborn infant is about 120–150 beats/minute) and will rapidly become pink during the first 90 seconds or so. An ill infant will be born pale and floppy, not breathing, and with a slow or very slow heart rate.

- The heart rate of an infant is best judged by listening to the chest with a stethoscope. It can also sometimes be felt by palpating the base of the umbilical cord, but a slow rate at the cord is not always indicative of a truly slow heart rate, and, if the infant is not breathing, must not delay the immediate application of lung inflations. In addition, if the infant is not breathing, feeling for peripheral pulses is potentially harmful as it delays the onset of life-saving lung inflations. If a stethoscope is not available, you can listen to the heart by placing your ear on the infant’s chest or using a Pinard’s stethoscope.

Airway: Keep the airway open

- Before the infant can breathe effectively the airway must be open.

- The best way to achieve this in an infant who is not breathing well is to place the infant on their back with the head in the neutral position (i.e. with the neck neither flexed nor extended). Most newborn infants will have a relatively prominent occiput, which will tend to flex the neck if the infant is placed on their back on a flat surface. This can be avoided by placing some support using a folded nappy or cloth under the shoulders of the infant, but be careful not to overextend the neck.

- If the infant is floppy it may also be necessary to apply chin lift or jaw thrust.

The best way to stabilise an infant’s condition at birth is to ensure that the upper airway remains unobstructed. The child will then have little difficulty in drawing air into its lungs for itself when it takes its first spontaneous gasp or cry. Unfortunately, books often talk of the need to keep the airway ‘clear’, giving the false impression that the infant is going to find it difficult to breathe unless all the fluid and mucus is first sucked out of the way. There is no evidence that this is ever necessary unless the infant is meconium stained or does not breathe well. Moreover, blind deep suction of the nose or mouth can stimulate the vagus nerve, leading to bradycardia, apnoea and laryngospasm.

However, the upper airway of any infant who is born limp and hypotonic certainly needs to be opened and maintained in just the same way as the airway of any other unconscious patient. In an unconscious patient, pharyngeal tone decreases even more than it does during sleep, causing the upper airway to narrow or close. When such a patient is laid on their back the tongue also falls back, further obstructing the airway. There are three key ways to counter this:

1. Hold the head in the neutral position and
2. Support the chin or
3. Push the jaw forward.

Because of moulding, most infants have quite a prominent occiput at birth. Lying supine (on their back) on a flat surface, the neck becomes flexed, and the airway becomes obstructed. Exactly the same thing can happen if the neck is over-extended. The aim is to ensure that the head is in a ‘neutral’ position – a posture most easily achieved by placing a small (2 cm high) pad under the infant’s shoulders.

It is important that all healthcare workers who conduct deliveries are taught how to open the airway correctly.
the perineum has dramatically reduced the incidence of meconium aspiration syndrome (MAS) and death. There is subsequently no need for further suctioning after birth if the infant breathes well.

**What to do if the trachea appears to be blocked**

If the infant is born through meconium and is unresponsive (or ‘not vigorous’) at birth, the oropharynx should be inspected and cleared of meconium. If intubation skills are available, the larynx and trachea should also be cleared under direct vision. If meconium has entered the trachea, resuscitation here is only possible if the accumulated debris can be immediately removed. The easiest way to do this is to pass an endotracheal tube and then remove the debris by direct suction to the endotracheal tube. Sometimes the meconium debris is so large that it cannot be sucked through the tube. The tube can then be removed and replaced with a clean tube to clear the remaining obstructive material. Suction may also make it easier to see the larynx during intubation. Giving mask ventilation for the infant who is not breathing before the meconium has been cleared (as above) may force the meconium deeper into the lungs.

**Breathing**

- If the infant is not breathing adequately give five inflation breaths as soon as possible (unless the baby is very preterm, in which case such breaths may injure immature lungs: give ordinary ventilation breaths in this situation). Until now the infant’s lungs will have been filled with fluid. Aeration of the lungs in these circumstances is best with slow inflations at pressures of about 30 cmH₂O with the bag and mask; these are called ‘inflation breaths’. These initial ventilation breaths should last 2–3 seconds each. The aim is to mimic the initial breaths taken by a normal infant to open the airways, remove lung fluid and achieve its functional residual capacity.
- If the heart rate was below 100 beats/minute initially then it should rapidly increase as oxygenated blood reaches the heart. If the heart rate does increase then you can assume that you have successfully aerated the lungs and there is adequate tissue oxygenation. If the heart rate increases but the infant does not start breathing, then continue to provide regular ventilation breaths at a rate of about 30–40 breaths/minute until the infant starts to breathe.
- The chest may not move during the first one or two breaths as fluid is displaced. Adequate ventilation is usually indicated by either a rapidly increasing heart rate or a heart rate that is maintained at more than 100 beats/minute. Therefore reassess the heart rate after delivery of the first five breaths. It is safe to assume that the chest has been inflated successfully if the heart rate improves. Once the chest has been seen to move and the heart rate has increased, ventilation should be continued at a rate of 30–40 breaths/minute. Continue ventilatory support until regular breathing is established.
- If the heart rate does not increase following inflation breaths, then either you have not aerated the lungs or the infant needs more than lung aeration alone. By far the most likely possibility is that you have failed to aerate the lungs effectively. If the heart rate does not increase, and the chest does not passively move with each inflation breath, then you have not aerated the lungs.
Under these circumstances consider the following:
- Are the infant’s head and neck in the neutral position?
- Do you need jaw thrust?
- Do you need a second person’s help with the airway or to squeeze the bag? A relative or ward orderly can be shown immediately how to effectively squeeze the self-inflating bag while you ensure that the mask is held firmly and in the best position on the face over the mouth and nose with the airway open.
- Is there an obstruction in the oropharynx (laryngoscope and suction under direct vision)?

Bag-and-mask inflation of the lung

Having positioned the infant correctly it is then usually quite easy to use a self-inflating bag and mask to provide inflations.

Remember that the infant cannot breathe through the bag-valve-mask system, so do not leave the mask sealed to the face and expect the infant to breathe from the bag. The valve between the bag and the mask prevents this. When the infant is breathing, remove the mask and watch closely to ensure that adequate breathing continues.

Most infants will respond to bag-and-mask ventilation by gasping and then starting to breathe on their own without further support. If this does not happen, it is still easy to confirm that lung aeration has been achieved, because the heart rate will rise reliably and consistently above 100 beats/minute. If lung aeration has been achieved and the infant still has a slow heart rate, proceed to support the circulation (C). If oxygen is available, applying this through the bag and medical mask may also help.

It is essential that the skills of correct bag-and-mask ventilation are taught to all healthcare workers who conduct deliveries. This is best done on a mannequin. Correct bag-and-mask ventilation is the single most important skill needed to provide active resuscitation.

There is good evidence that most infants can be resuscitated using mask resuscitation without any need for tracheal intubation. However, in certain situations (e.g. infants less than 1000 g not responding to inflation, prolonged bag-and-mask ventilation with no spontaneous breathing, etc.) infants require early intubation, so the equipment and the skill to intubate should be available.

Deciding whether to use air or 100% oxygen for resuscitation of the newborn

Concern about the possible injurious effects of excess oxygen, particularly in preterm infants, and the apparent effectiveness of air in a number of randomised controlled human studies of resuscitation at birth, have resulted in a change in guidelines.

There is evidence to suggest that air is safer for initial resuscitation. However, where possible, it is recommended that additional oxygen should be available for use if there is not a rapid improvement in the infant’s condition. Equally, hypoxia should be avoided, especially in the preterm infant. If a pulse oximeter is available this can be done. Try to keep the SaO$_2$ between 88% and 95%.

When to cut and clamp the cord in an infant who needs resuscitation at birth

There are advantages to delaying clamping of the cord for 2 minutes after birth to allow placental transfer of blood to the infant (see above). However, it is important to ensure that by doing this there is no harm to the mother (e.g. if she needs resuscitation) or to the infant (e.g. if they require resuscitation). Usually the umbilical cord is clamped and cut immediately if the infant needs to be moved for active resuscitation.

Mouth-to-mouth resuscitation

Most current guidelines on neonatal care steer clear of discussing the role of mouth-to-mouth resuscitation. The risk of HIV infection or hepatitis has further fuelled that reluctance. However, there is no doubt that this can be a very effective way of reviving an apparently lifeless infant in the absence of equipment. Remember the following:
- Keep the upper airway open by optimising the position of the head and neck as described above.
- Cover the infant’s nose and mouth with your mouth (or cover the mouth of a big infant and just pinch the nose).
- Use the pressure you can generate with your cheeks, and try to aerate the lungs by slow inflations for 2–3 seconds.
- Only use as much air for each breath as you can keep in your cheeks (i.e. do not ‘blow’ air into the infant, but just small puffs).
- Watch for chest movement, and allow time for lung recoil.
- Once the chest starts to move, sustain what has been achieved with 20–25 artificial breaths/minute.

Checking progress before moving on

- If the heart rate has not risen to over 100 beats/minute after the five initial breaths or within 30 seconds of adequate ventilation, something is wrong. The most likely problem is that you have not successfully ventilated the infant. Never move on to deal with the issues covered under letter C of the resuscitation alphabet until you are quite sure you have achieved objectives A and B. To do so is quite futile. Chest compression will never restore the circulation until the blood being massaged from the lung to the heart contains oxygen.
- Look to see whether the chest moves each time you apply mask pressure. Movement should not be difficult to see once the first few breaths have aerated the lungs. It is usually easier to judge success with your eyes than with a stethoscope. In a newborn, breath sounds can be heard when only the airway is being aerated, so are not a good way to judge ventilatory success.
- Check that the infant’s head is well positioned. Check chin support and jaw thrust, and that the mask is correctly applied with no air leaks. Ask a second person to help you position the infant optimally and provide inflations by squeezing the bag while you hold the airway open and the mask in place.
- Few infants need support with their breathing once their lungs have been aerated. Most will gasp, cry or breathe just as soon as an attempt is made to get air into the lungs, and then continue breathing adequately.
- However, a few may benefit from further support if they do not start to breathe regularly, or only gasp occasionally. Some may have suffered severe hypoxia in utero, and a few may be drowsy because of drugs given to the mother during labour. Check that the heart rate remains normal (above 100 beats/minute) and that there is no central cyanosis (best judged by looking at the colour of the tongue).
- Try to assess whether there is hypoxemia (cyanosis...
or SaO2 less than 90% with a pulse oximeter), if the infant’s breathing remains laboured and irregular or if the child’s colour remains blue. Give oxygen then if it is available, preferably with SaO2 monitoring. Hyaline membrane disease, meconium aspiration syndrome, pneumonia or transient tachypnoea of the newborn are most likely.

Other possibilities include:
- intra-partum pneumonia (common)
- diaphragmatic hernia
- pneumothorax
- pulmonary hypoplasia (possibly associated with a skeletal or renal abnormality)
- cyanotic congenital heart disease (although this usually takes a little time to appear)
- persistent fetal circulation.

- If breathing requires continuous support it is important to try and reduce mask inflation pressures to little more than half of what was needed to aerate the lung in the first place. It is easy to over-ventilate an infant with healthy lungs and to wash out so much of the carbon dioxide that normally provides the main stimulus to breathing that all such activity stops for a while. There is also increasing evidence that sustained over-ventilation can seriously reduce cerebral blood flow.

**Endotracheal intubation**

As discussed earlier, most infants who need resuscitation can be managed with bag-valve-mask intubation. However, occasionally endotracheal intubation is required, but this must be done by someone skilled and practised in the technique. It is most likely to be required for prolonged resuscitation, in meconium aspiration, and in preterm infants with surfactant deficiency. A straight-bladed laryngoscope is preferred, and tube sizes are around 3.5 mm for a term infant and 2.5 mm for a preterm infant. Sizes larger and smaller than these should be available.

**Preterm infants**

- Infants with surfactant deficiency may have difficulty in expanding their lungs, and in developing a normal functional residual capacity at birth.
- However, the preterm lung is quite a delicate structure with relatively little elastic support, and any use of undue pressure or excessive ventilation during resuscitation can damage the lungs.

While an inspiratory pressure of 30 cmH2O may well be necessary to begin aerating the lungs at birth, the pressure should be reduced as rapidly as possible to a level that ensures that the chest is moving adequately. The key aim must be to conserve such surfactant as already exists by sustaining the lung’s functional residual capacity (an objective best achieved by providing at least 5 cmH2O of positive end-expiratory pressure (PEEP)). Aim to achieve this consistently throughout transfer to the nursery. This can be achieved using nasal prongs (nasal PEEP), thus avoiding endotracheal intubation altogether (see Section 8.2).

**Circulation: chest compressions**

- Most infants needing help at birth will respond to successful lung inflation with an increase in heart rate followed quickly by normal breathing. Chest compression should be started only when you are sure that the lungs are being aerated successfully.
- If the heart rate remains very slow (less than 60 beats/minute) or absent following 60 seconds of ventilation with good chest movements, start chest compressions.
- In infants, the most efficient method of delivering chest compressions is to grip the chest in both hands in such a way that the two thumbs can press on the lower third of the sternum, just below an imaginary line joining the nipples, with the fingers over the spine at the back. This can only be done if there is a second operator ventilating the lungs (see Figure 3.2.4).
- If you are alone, the two-thumb method is not possible, as ventilations also need to be provided. In this situation, use the first two fingers of one hand to depress the lower sternum, while the other hand holds the mask in place. Then move the hand from the sternum to squeeze the bag.
- Compress the chest quickly and firmly, reducing the antero-posterior diameter of the chest by about one-third.
- Because oxygenation is such an important part of neonatal resuscitation, the recommended ratio of compressions to inflations in newborn resuscitation is 3:1.
- Chest compressions move oxygenated blood from the lungs back to the heart and out into the ascending aorta. From there the two coronary arteries will then quickly deliver oxygen to the failing anoxic heart muscle. It is important to allow enough time during the relaxation phase of each compression cycle for the heart to refill with blood, at the same time ensuring that the chest is inflating with each breath.

**FIGURE 3.2.4** Two-thumb compression of the chest, with a second operator ventilating the lungs, here using a T-piece as an alternative to bag and mask.

- The rate of chest compressions is around 120/minute. However, with pauses for ventilation, the actual number of compressions is less than 120/minute.

**Drugs**

Rarely inflation of the lungs and effective chest compression will not be sufficient to produce adequate circulation and perfusion in infants. In these circumstances, drugs may be helpful. However, drugs are needed only if there is no significant cardiac output despite effective lung inflation and chest compression.

Very few drugs have proved to be of benefit in such circumstances. The drugs used are adrenaline (1:10000) and dextrose (10%). Drugs are best delivered via an umbilical venous catheter. In those where IV access is not possible, the intra-osseous route may be used. Each injection of a
drug should be followed with a bolus of $2-3\text{mL}$ of Ringer lactate or Hartmann’s solution. Unfortunately, most of the infants in whom cardiac output only returns after such treatment require specialist neonatal care (often with mechanical ventilation) and do not survive to discharge. Most of those who do survive later develop profound disabling spastic quadriplegia.

Where the cause of the child’s terminal apnoea is a sudden and much more abrupt hypoxic event (such as shoulder dystocia or an occasional case of late cord prolapse) these reservations may be less valid. Here there is at least anecdotal evidence that the outlook is much less bleak if the circulation can be restarted.

Acidosis not serious enough to precipitate circulatory standstill (asystole) will nearly always correct itself spontaneously within 90 minutes once the circulation has been restored and the infant starts to breathe for himself or herself.

A potential problem for stressed or hypoxic neonates, so should be given to the infant. Remember that does not reverse the respiratory depressing effects of non-opiate drugs.

Acute blood loss as a cause of circulatory arrest (circulatory volume support)

- Sudden acute blood loss is a rare, but often recognised, cause of acute circulatory collapse. Bleeding from an aberrant placental blood vessel (vasa praevia) or snapped umbilical cord can rapidly lead to hypovolaemic death. The response to a rapid generous infusion of any IV fluid can be equally dramatic. Speed is of the essence. Circulatory collapse probably does not occur until the infant has lost 30–40\text{mL/kg} of blood, but 20\text{mL/kg} of Ringer-lactate or Hartmann’s solution will usually reverse the immediate critical hypovolaemia rapidly. The initial intravenous fluid bolus should be $10\text{mL/kg}$ of Ringer-lactate or Hartmann’s solution or blood group O Rh-negative blood (if immediately available). This can be repeated once if there is no or only minimal response. A similar response can be achieved with plasma, albumin or some artificial plasma-expanding agent (e.g. gelatine). A packed red cell transfusion using group-specific or group O Rh-negative duly cross-matched blood can be given later to correct the associated anaemia.

Apart from these specific indications, fluid should not be used during neonatal resuscitation. There is no evidence to suggest benefit from routine use, which only compounds the problem of fluid balance that can develop over the next 2 to 3 days if severe intrapartum stress causes secondary renal failure.

Environment

This is always at risk of being overlooked, but it should be the first issue to receive attention in all infants, before and at birth.

- A clean, warm and well-lit environment for resuscitation is the objective in all cases. It only takes a few seconds to dry the infant and provide a clean dry blanket for warmth. The room in which delivery takes place should also be clean, warm and free of draughts.

- Small infants in particular rapidly become cold, especially if left wet, which can be lethal. Enclosing the trunk and the limbs in a clear plastic drape or bag (plus a woolen cap if available) can greatly reduce evaporative heat loss. Indeed, infants born more than 10 weeks early have skin that is so thin that it is not really ‘waterproof’. This will cause excessive evaporative heat loss to persist for several days after birth.

Family

- The mother’s needs come first if you are on your own. Most infants are quite good at looking after themselves, once they are breathing and wrapped. If possible keep the infant with the mother.

- If you are not on your own, things become much easier. The ‘ABC’ summary really only comments on the care that should be given to the infant. Remember that...
parents need to be told what is happening. They will fear the worst, more so if the infant was only taken away from them even for a few minutes at birth for stabilisation or resuscitation.

- If you tell the parents that their infant needed ‘resuscitation’ at delivery, they may well start to think that their child was in the process of dying. That might make you feel that you have done something useful, and it may make the parents very grateful. However, it will also make them feel that something must have gone ‘wrong’ during delivery, and it may lead them to worry that their child could be ‘brain-damaged’ as a result. The words that we use matter. Parents can easily read meanings into them that we never intended.

- Write down what you see and do, distinguishing fact from opinion and making no assumption as to the causation. Use adjectives with great care and do not make judgemental comments on the actions of others. Document everything.

**Poor response to resuscitation**

If the infant either fails to respond or shows a poor response to resuscitation, the most likely problem is inadequate oxygenation. The following steps should be considered:

- Check the airway and ventilation.

  - Check for technical faults if using equipment.
  - Is the oxygen attached?
  - Is the airway blocked?
  - Is the endotracheal tube in the correct place?

- Re-examine the chest to see if a pneumothorax has developed. This is not common, but may cause a problem. Drain a tension pneumothorax with a small cannula over needle (21 gauge) in the second intercostal space in the mid-clavicular line. This should be followed by the insertion of a chest drain (see Section 8.3).

- Consider the possibility of a congenital heart lesion if the infant remains cyanosed despite breathing and having a good heart rate.

- Consider the possibility of maternal opiates or sedation, such as diazepam or phenobarbitone, if the infant is pink, well perfused, but requires assisted ventilation.

- Shock, caused by acute blood loss, should respond to a rapid bolus of 10–20 mL/kg of O-negative blood.

- Consider the possibility of hypoglycaemia.

**Stopping resuscitation**

Even with the most effective resuscitation, not all infants will survive.

If the infant has been without a cardiac output after 20 minutes of resuscitation and does not respond despite

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**NOTES**

The number of heart beats/minute does not have to be exact.

The health worker should identify the rate as being FAST (>100), SLOW (<100) or VERY SLOW (<60 or undetectable).

The healthy neonate has a rapid heart rate, normally > 100

If the heart rate is < 100, this indicates hypoxia.

If the heart rate is < 60 or undetectable, the baby without adequate resuscitation is likely to die or develop brain injury.

**FIGURE 3.2.5** Algorithm for resuscitation of the baby at birth.
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
World Health Organization, London School of Hygiene and Tropical Medicine, Save the Children et al. (2011) Neonatal mortality levels for 193 countries in 2009 with trends since 1990: a systematic analysis of progress, projections and priorities. PLoS Medicine, 8, e1001080.

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 feet 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.