Chapter 8

Resuscitation of the baby at birth

Objectives

On successfully completing this topic, you will be able to:

- understand the important physiological differences in the newly born baby
- understand the equipment used for resuscitation at birth
- understand how to assess the baby at birth
- understand how to resuscitate the baby at birth
- understand additional measures for special situations

Introduction

The resuscitation of babies at birth is different from the resuscitation of all other age groups, and knowledge of the relevant physiology and pathophysiology is essential. However, the majority of newly born babies will establish normal respiration and circulation without help. Ideally, someone trained in newborn resuscitation should be present at all deliveries. It is advisable that those who attend deliveries attend courses such as the Newborn Life Support Course, organised by the Resuscitation Council (UK), the European Resuscitation Council or the Neonatal Resuscitation Programme, organised by the American Academy of Pediatrics. However, some babies are born in unexpected places such as A&E departments. For these situations it is important that clinicians have an understanding of the differences in resuscitating a baby at birth.

Normal physiology

At birth the baby must change, often within a matter of moments, from an organism with fluid-filled lungs whose respiratory function is carried out by the placenta to a separate being whose air-filled lungs can successfully take over this function. Preparation for this begins during labour, when the fluid-producing cells within the lung cease secretion and begin re-absorption of that fluid. Delivery by caesarean section before the onset of labour may slow the clearance of pulmonary fluid from the lungs.

During vaginal delivery some lung fluid, perhaps 35 ml in a term baby, is expelled by passage through the birth canal. In a healthy baby the first spontaneous breaths may generate a negative pressure of between – 30 cm H_2O and –90 cm H_2O which aerates the lungs for the first time. This pressure is 10–15 times greater than that needed for later breathing but is necessary to overcome the viscosity of the fluid filling the airways, the surface tension of the fluid-filled lungs and the elastic recoil and resistance of the chest wall, lungs and airways. These powerful chest movements cause fluid to be displaced from the airways into the lymphatics and circulation.

After delivery, a healthy term baby usually takes its first breath within 60–90 seconds of clamping or obstructing the umbilical cord. Separation of the placenta and clamping of the cord leads to the onset of hypoxia, which is initially a major stimulant to start respiration. Physical stimuli such as cold air or physical discomfort may also provoke respiratory efforts.

In a 3-kg baby up to 100 ml of fluid is cleared from the airways following the initial breaths, a

process aided by full inflation and prolonged high pressure on expiration, i.e. crying. The effect of the first few breaths is to produce the baby's functional residual capacity. Neonatal circulatory adaptation commences with the detachment of the placenta, but lung inflation and alveolar distension releases mediators, which affect the pulmonary vasculature as well as increase oxygenation.

Pathophysiology

Our knowledge of the pathophysiology of fetal asphyxia is based on pioneering animal work in the early 1960s. The results of these experiments, which followed the physiology of newborn animals during acute, total, prolonged asphyxia and subsequent resuscitation are summarised in Figure 8.1.

When the placental oxygen supply is interrupted, the fetus attempts to breathe. Should these attempts fail to provide an alternative oxygen supply – as they will inevitably fail to do so in utero – the baby will lose consciousness. If hypoxia continues, the respiratory centre becomes unable, through lack of sufficient oxygen, to continue initiating breathing and the breathing stops, usually within 2–3 minutes (primary apnoea, Figure 8.1).

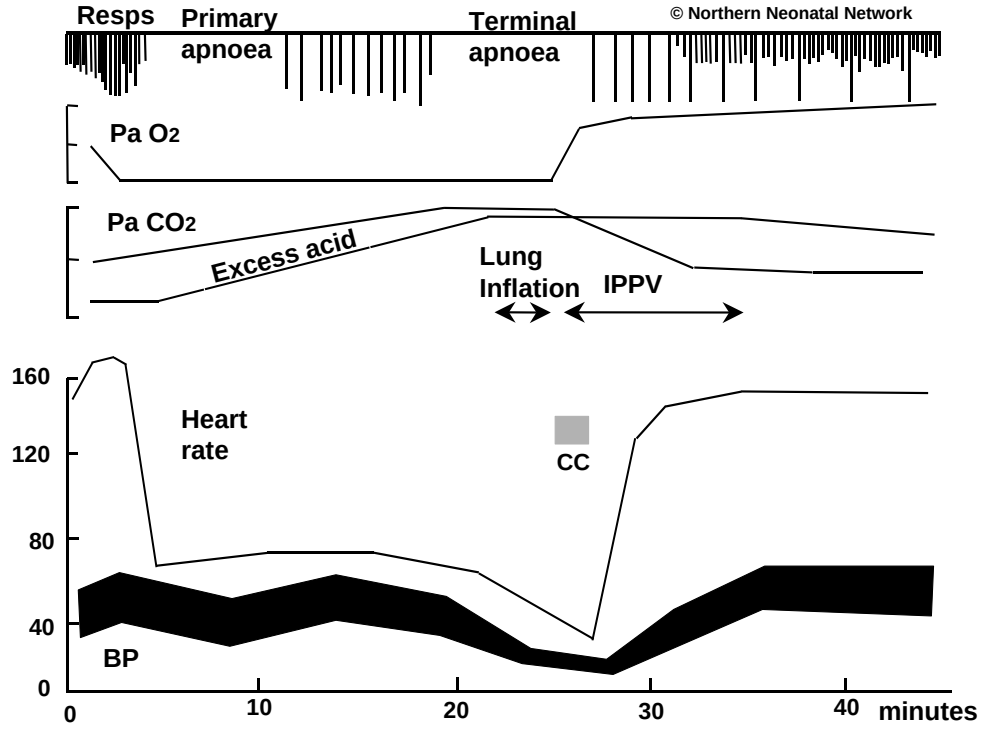

Figure 8.1. Response of a mammalian fetus to total, sustained asphyxia started at time 0.

Fetal bradycardia ensues but blood pressure is maintained, primarily by peripheral vasoconstriction and diversion of blood away from non-vital organs, and also by an increased stroke volume. After a latent period of apnoea (primary), primitive spinal centres, no longer suppressed by neural signals from the respiratory centre, exert an effect by initiating primitive gasping breaths. These deep spontaneous gasps are easily distinguishable from normal breaths as they only occur 6–12 times per minute and involve all accessory muscles in a maximal inspiratory effort. After a while, if hypoxia continues, even this activity ceases (terminal apnoea). The time taken for such activity to cease is longer in the newly born baby than in later life, taking up to 20 minutes.

The circulation is almost always maintained until all respiratory activity ceases. This resilience is a feature of all newborn mammals at term, largely due to the reserves of glycogen in the heart. Resuscitation is therefore relatively easy if undertaken before all

respiratory activity has stopped. Once the lungs are inflated, oxygen will be carried to the heart and then to the brain provided the circulation is still functional (Figure 8.2). Recovery will then be rapid. *Most* infants who have not progressed to terminal apnoea will resuscitate themselves if their airway is patent. Once gasping ceases, however, the circulation starts to fail and these infants are likely to need more extensive resuscitation (Figure 8.3).

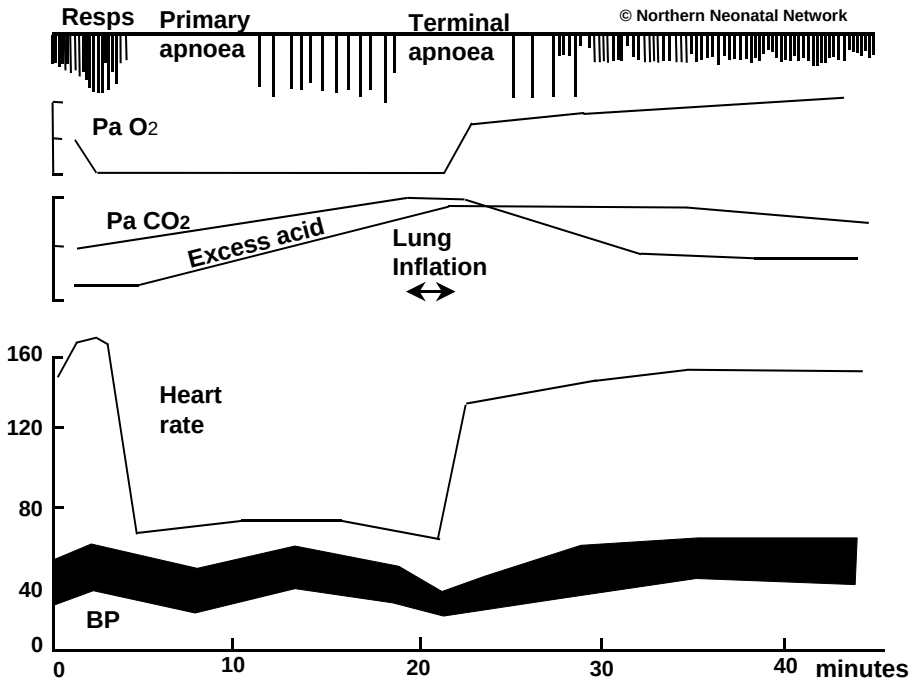

Figure 8.2. Effects of lung inflation and a brief period of ventilation on a baby born in early terminal apnoea but before failure of the circulation (Reproduced with permission from the Northern Neonatal Network)

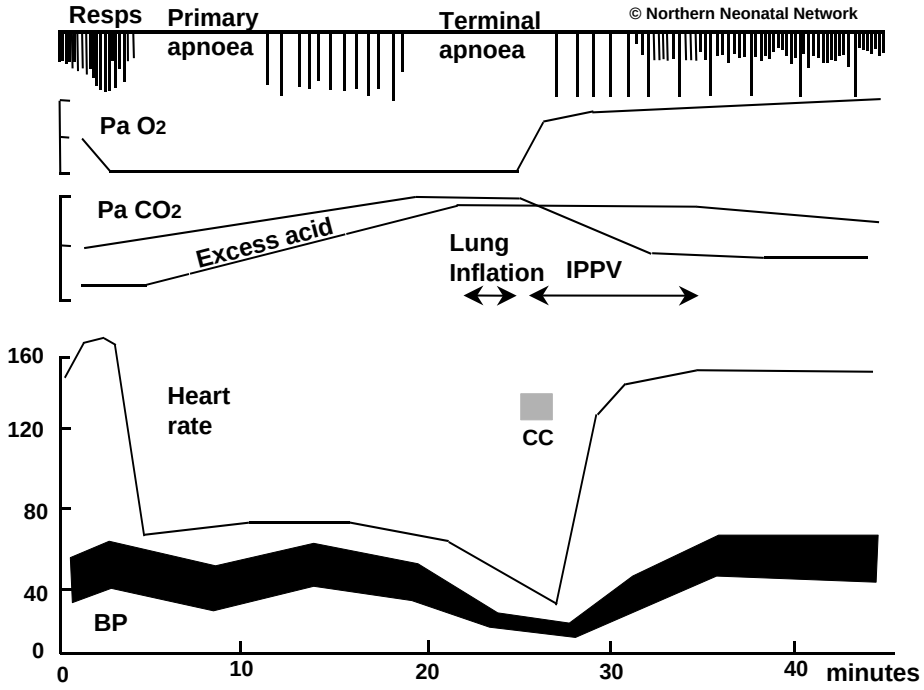

Figure 8.3. Response of babies born in terminal apnoea. In this case lung inflation is not sufficient because the circulation is already failing. However, lung inflation delivers air to the lungs and then a brief period of chest compressions (CC) delivers oxygenated blood to the heart which then responds.(reproduced with permission from the Northern Neonatal Network)

Equipment

For many newborn babies, especially those born outside the delivery room, the need for resuscitation cannot be predicted. It is therefore useful to plan for such an eventuality. Equipment, which may be required to resuscitate a newborn baby is listed in Table 8.1. This will vary between departments; however, most babies can be resuscitated with a flat surface, warmth, knowledge and a way to deliver air or oxygen at a controlled pressure.

Table 8.1. Equipment for newborn resuscitation

- A flat surface
- Radiant heat source and dry towels (or suitable plastic bags for preterm infants)
- Suction with catheters at least 12 Fr
- Face masks
- Bag-valve-mask or T piece w pressure limiting device
- Source of air and/or oxygen
- Oropharyngeal (Guedel) airways
- Laryngoscopes with straight blades, 0 and 1
- Nasogastric tubes
- Cord clamp
- Scissors
- Tracheal tubes sizes 2.5 to 4.0 mm
- Umbilical catheterization equipment
- Adhesive tape
- Disposable gloves
- Plastic bag for preterm babies
- Saturation monitor/stethoscope

Strategy for assessing and resuscitating a baby at birth

Resuscitation is likely to be rapidly successful if begun before the baby has become so anoxic that all potential for respiratory activity has vanished. Babies in primary apnoea can usually resuscitate themselves if they have a clear airway. As you do not know whether a newborn, apnoeic baby is in primary or secondary apnoea you must develop a graded approach that will work in either situation. Always start by drying and covering the baby to prevent it from getting cold and then proceed as far as it is necessary down the following list:

- Call for help
- Start the clock or note the time
- Dry, and cover the baby
- Assess the situation

- Airway
- Breathing
- Chest Compressions
- (Drugs)

Call for help

Ask for help if you expect or encounter any difficulty or if the delivery is outside the labour suite

Start clock

If available, or note the time of birth

At birth

- There is no need to rush to clamp the cord, particularly if the baby appears well. Unless the baby is clearly in need of immediate resuscitation, wait for at least one minute from the complete delivery of the baby before clamping the cord. Keep the baby warm during this time
- Dry the baby quickly and effectively. Remove the wet towel and wrap in a fresh dry warm towel. (For very small or significantly preterm babies it is better to place the wet baby in a food grade plastic bag – and later under a radiant heater)
- During this period it is possible to assess the baby and decide whether any intervention is going to be needed
- Then clamp and cut the cord

If the baby is thought to need assistance then this becomes the priority. This may mean that the cord needs to be clamped in order to deliver that assistance.

Keep the baby warm

Dry the baby off immediately and then wrap in a dry towel. A cold baby has increased oxygen consumption and cold babies are more likely to become hypoglycaemic and acidotic. They also have an increased mortality. If this is not addressed at the beginning of resuscitation it is often forgotten. Most of the heat loss is caused by the baby being wet and in a draught – hence the need to dry the baby and then to wrap the baby in a dry towel. Babies also have a large surface area to weight ratio; thus heat can be lost very quickly. Ideally, delivery should take place in a warm room, and an overhead heater should be switched on. However, drying effectively and wrapping the baby in a warm dry towel is the most important factor in avoiding hypothermia. A naked wet baby can still become hypothermic despite a warm room and a radiant heater, especially if there is a draught. Make sure that the head is covered as it represents a significant part of the baby's surface area (see "Pre-Term Babies")

Assessment of the newborn baby

Whilst keeping the baby warm make an initial assessment by assessing:

• Respiration	(rate and quality)		**Airway and Breathing**
• Heart rate	(fast, slow, absent)	}	
• Colour	(pink, blue, pale)		
• Tone	(unconscious, apnoeic babies are floppy)		**Circulation**

Unlike resuscitation at other ages, it is important to assess fully in order that one can judge the success of interventions. This is most true of heart rate and breathing which guide further resuscitative efforts. However a baby who is white and shut down peripherally is more likely to be acidotic and a baby who is atonic is likely to be unconscious. Subsequent assessments

should focus on breathing and heart rate.

Respiration

Most babies will establish spontaneous regular breathing sufficient to maintain the heart rate above 100 beats/min and to improve the skin colour within 3 minutes of birth. If apnoea or gasping persists after drying, intervention is required.

Heart rate

In the first couple of minutes, auscultating at the cardiac apex is the best method to assess the heart rate. Palpating peripheral pulses is not practical and cannot be recommended. Palpation of the umbilical pulse can only be relied upon if it is $\geq$ 100 beats/min. A rate less than this should be checked by auscultation if possible or by a saturation monitor using Masimo (or similar) technology if available. A saturation monitor applied to the right hand or wrist can give an accurate reading of heart rate and saturations within 90 seconds of application (see later). An initial assessment of heart rate is vital because an increase in the heart rate will be the first sign of success during resuscitation.

Colour

Attempting to judge oxygenation by assessing skin colour is unreliable but it is still worth noting the baby's colour at birth as well as whether, when and how it changes. Very pale babies who remain pale after resuscitation may be hypovolaemic as well as acidotic.

If the baby has good tone, a good heart rate and is making respiratory effort then further help is unlikely to be needed.

Using a saturation monitor will allow a rapid assessment of heart rate and saturation within 90 seconds of application. Oxygen saturation levels in healthy babies in the first few minutes of life may be considerably lower than at other times.

Acceptable pre-ductal SpO_2
2 min 60%
3 min 70%
4 min 80%
5 min 85%
10 min 90%

This assessment will categorise the baby into one of the three following groups:

1. *Regular respirations, heart rate fast (more than 100 beats/min) pink, good tone.* These are healthy babies and they should be kept warm and given to their mothers. The baby will remain warm through skin-to-skin contact with the mother under a cover and may be put to the breast at this stage.
2. *Irregular or inadequate respirations, heart rate slow (less than 100 beats/min), blue, normal or reduced tone.* If gentle stimulation (such as drying) does not induce effective breathing, the airway should be opened and, if necessary, cleared. If the baby responds then no further resuscitation is needed. If there is no response, if necessary, progress to lung inflation.
3. *Apnoeic, or heart rate slow (less than 100 beats/min) or absent, blue or pale, floppy.*

Whether an apnoeic baby is in primary or secondary apnoea (Figure 8.1) the initial management is the same. Open the airway and then inflate the lungs. A reassessment of

any heart rate response then directs further resuscitation. Reassess the heart rate and respiration at regular intervals throughout.

Apnoea, low or absent heart rate, pallor and floppiness together suggest terminal apnoea. However, initial management of such babies is unchanged but resuscitation may be prolonged

After assessment, resuscitation follows:

- Airway
- Breathing
- Circulation
- With the use of drugs in a few selected cases

Airway

The baby should be positioned with the head in the neutral position (see Figure 8.4 and Chapter 4). The newborn baby's head has a large, often moulded occiput, which tends to cause the neck to flex when the baby is supine on a flat surface. However, overextension may also collapse the newborn baby's pharyngeal airway, leading to obstruction. A 2cm folded towel and placed under the neck and shoulders may help to maintain the airway in a neutral position and a jaw thrust may be needed to bring the tongue forward and open the airway especially if the baby is floppy (Figure 8.5). Visible secretions may be removed by gentle suction with a paediatric Yankauer or 12–14-Fr suction catheter, although these rarely cause airway obstruction. Blind deep pharyngeal suction should not be performed as it may cause vagally induced bradycardia and laryngospasm. Suction, if it is used, should not exceed –
-100 mmHg (9·8 kPa). The presence of thick meconium (see below) in a non-vigorous baby is the only indication for considering visualisation of the oropharynx and immediate suction.

Meconium aspiration

Meconium-stained liquor (light green tinge) is relatively common and occurs in up to 10% of births. Happily, meconium aspiration is a rare event. Meconium aspiration usually happens in term infants in utero before delivery. A large randomised trial has shown no advantage to suctioning the airway whilst the head is on the perineum and this may delay resuscitation. This practice is, therefore, no longer recommended if the baby is vigorous, a randomised trial has shown that suctioning of the trachea at any time offers no advantage either and no specific action (other than drying and wrapping the baby) is needed.

If the baby has absent or inadequate respirations, a heart rate <100 beats/min or hypotonia, inspect the oropharynx with a laryngoscope and aspirate any particulate meconium seen using a wide-bore catheter. If intubation is possible and the baby is still unresponsive, aspirate the trachea either using the tracheal tube as a suction catheter. However, if intubation cannot be achieved immediately, clear the oropharynx and start mask inflation. If, while attempting to clear the airway, the heart rate falls to less than 60 beats/min then stop airway clearance, give aeration breaths and start ventilating the baby.

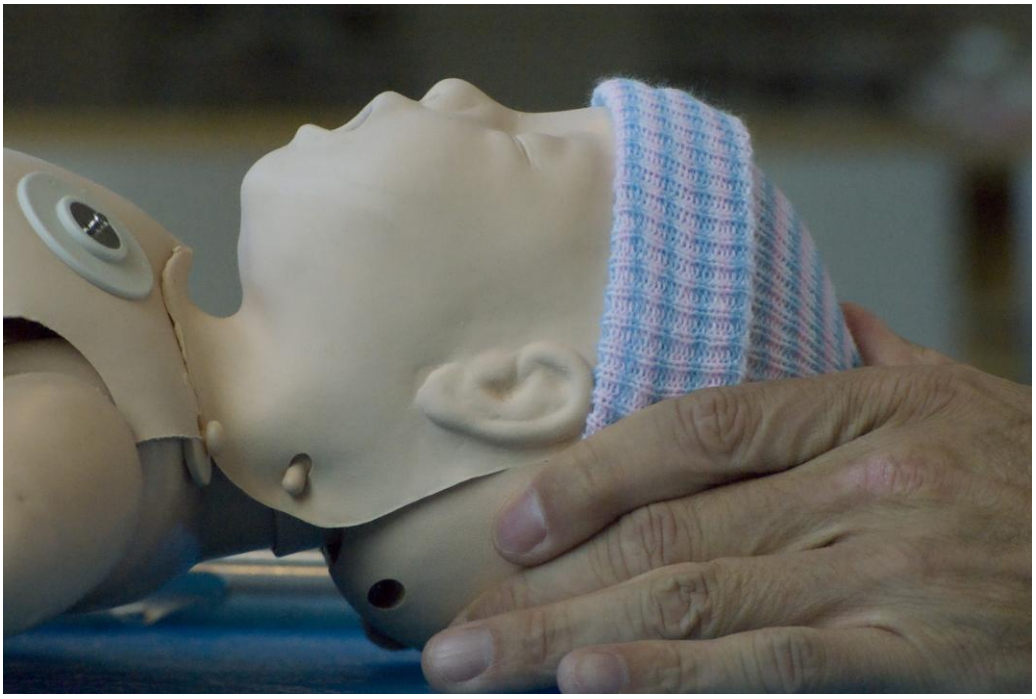

Figure 8.4. Chin lift in infants

Figure 8.5. Jaw thrust

Breathing (aeration breaths and ventilation)

The first five breaths in term babies should be 'inflation' breaths in order to replace lung fluid in the alveoli with air. These should be 2-3 second sustained breaths using a continuous gas supply, a pressure limiting device and a mask. Use a transparent, circular soft mask big enough to cover the nose and mouth of the baby. If no such system is available then a 500-ml self-inflating bag and a blow-off valve set at 30–40 cmH_2O can be used (Figure 8.6). This is especially useful if compressed air or oxygen is not available.

The chest may not move during the first 1–3 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 per minute. Therefore, reassess the heart rate after

delivery of the first 5 breaths. It is safe to assume the chest has been inflated successfully if the heart rate responds. In fluid-filled lungs, breath sounds may be heard even when the lung is not aerated.

Once the chest is inflated and the heart rate has increased or the chest has been seen to move then ventilation should be continued at a rate of 30–40 per minute. Continue ventilatory support until regular breathing is established. Where possible, start resuscitation of the baby at birth with air. There is now good evidence for this in term babies and oxygen toxicity is a real concern with premature babies. Use of the supplemental oxygen should be guided by pulse oximetry with reasonable levels listed in the box above and on the algorithm.

If the heart rate has not responded then check for chest movement rather than auscultation as in fluid-filled lungs, breath sounds may be heard without lung inflation. Go back and check airway opening manoeuvres and repeat the inflation breaths.

Figure 8.6. Bag and mask ventilation

Circulation

If the heart rate remains slow or absent, despite adequate ventilation for 30 seconds as shown by chest movement, then chest compressions should be started. Chest compressions will help to move oxygenated blood from the lungs to the heart and coronary arteries. The blood you move can only be oxygenated if the lungs have air in them. Cardiac compromise is always the result of respiratory failure and can only be effectively treated if effective ventilation is occurring.

The most efficient way of delivering chest compressions in the neonate is to encircle the chest with both hands, so that the fingers lie behind the baby and the thumbs are apposed on the sternum just below the inter-nipple line (Figure 8.8). Compress the chest briskly, *by one third of its depth*. In newborn babies, current advice is to perform three compressions for each ventilation breath (3:1 ratio).

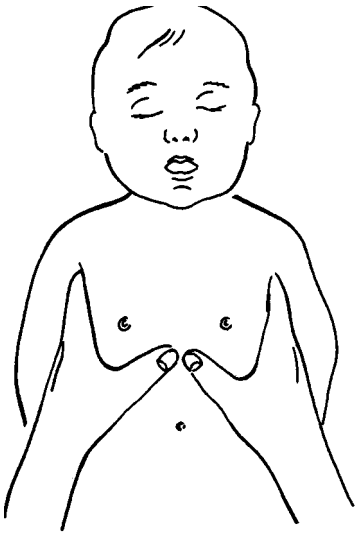

Figure 8.8. Infant chest compression: hand-encircling technique

The purpose of chest compression is to move oxygenated blood or drugs to the coronary arteries in order to initiate cardiac recovery. Thus there is no point in starting chest compression before effective lung inflation has been established. Similarly, compressions are ineffective unless interposed by ventilation breaths of good quality. Therefore, the emphasis must be upon *good-quality breaths*, followed by effective compressions. Simultaneous delivery of compressions and breaths should be avoided, as the former will reduce the effectiveness of the breaths. It is usually only necessary to continue chest compressions for about 20-30 seconds before the heart responds with an increase in heart rate. Once the heart is above 60 beats/min and rising, chest compression can be discontinued. Maintain ventilations until effective breathing or mechanical ventilation is established.

Drugs

If after adequate lung inflation and cardiac compression the heart rate has not responded, drug therapy should be considered. However, the most common reason for failure of the heart rate to respond is failure to achieve lung inflation, and there is *no point* in giving drugs unless the airway is open and the lungs have been inflated. Airway and breathing must be reassessed as adequate before proceeding to drug therapy. Venous access will be required via an umbilical venous line, because ideally drugs should be given centrally. The outcome is poor if drugs are required for resuscitation.

Adrenaline

The alpha-adrenergic effect of adrenaline increases coronary artery perfusion during resuscitation, enhancing oxygen delivery to the heart. In the presence of profound unresponsive bradycardia or circulatory standstill, 10 micrograms/kg (0·1 ml/kg 1:10000) adrenaline may be given intravenously. Further doses of 10–30 micrograms/kg (0·1–0·3 ml 1:10000) may be tried at 3–5-minute intervals if there is no response. The tracheal route cannot be recommended, as there is insufficient data. However, if it is given via the tracheal route it is likely that doses of at least 50 micrograms/kg will be required to achieve a similar effect to intravenous. Such an unproven administration should not compromise airway and breathing management or obtaining umbilical access.

Bicarbonate

Any baby who is in terminal apnoea will have a significant metabolic acidosis. Acidosis depresses cardiac function. Bicarbonate 1-2 mmol/kg (2-4 ml/kg of 4·2% solution) may be

used to raise the pH and enhance the effects of oxygen and epinephrine.
Bicarbonate use remains controversial and it should only be used in the absence of discernible cardiac output despite all resuscitative efforts or in profound and unresponsive bradycardia.

Glucose

Hypoglycaemia is a potential problem for all stressed or asphyxiated babies. It is treated using a slow bolus of 2.5 ml/kg of 10% glucose intravenously, and then providing a secure intravenous glucose infusion at a rate of 100 ml/kg/day of 10% glucose. BM stix are not reliable in neonates when reading less than 5 mmol/l.

Fluid

Very occasionally hypovolaemia may be present because of known or suspected blood loss (antepartum haemorrhage, placenta or vasa praevia, unclamped cord) or it may be secondary to loss of vascular tone following asphyxia. Volume expansion, initially with 10 ml/kg, may be appropriate. Normal saline can be used; alternatively Gelofusine has been used safely and if blood loss is acute and severe, non-cross-matched O-negative blood should be given immediately. Albumin cannot be recommended. However, most newborn or neonatal resuscitations do not require fluid unless there has been known blood loss or septicaemic shock.

Naloxone

This is not a drug of resuscitation. Occasionally a baby *who has been effectively resuscitated* – is pink, with a heart rate of over 100 beats/min – may not breathe spontaneously or adequately because of the possible effects of maternal opiates. If respiratory depressant effects are suspected the baby should be given naloxone intramuscularly (200 micrograms in a full term baby). Smaller doses of 10 micrograms/kg will also reverse the sedation but the effect will only last a short time (20 minutes IV or a few hours IM). Intravenous naloxone has a half-life shorter than opiates, and there is no evidence to recommend intra-tracheal administration.

Response to resuscitation

The first indication of success will be an increase in heart rate. Recovery of respiratory drive may be delayed. Babies in terminal apnoea will tend to gasp first as they recover before starting normal respirations (Figure 8.3). Those who were in primary apnoea are likely to start with normal breaths, which may commence at any stage of resuscitation.

Tracheal intubation

Most babies can be resuscitated using a mask system. Swedish data suggests that if this is applied adequately, only 1:500 babies may actually need intubation. However, tracheal intubation only remains the gold standard in airway management if it is performed perfectly. It is especially useful in prolonged resuscitations, pre-term babies and meconium aspiration. It should be considered if mask ventilation has failed, although the most common reason for failure with mask inflation is poor positioning of the head with consequent failure to open the airway.

The technique of intubation is the same as for infants and is described in Chapter 20. A normal full-term newborn usually needs a 3·5 mm tracheal tube, but 4·0- 3·0- and 2·5 mm tubes should also be available.

Tracheal tube placement must be assessed visually during intubation and in most cases will be confirmed by a rapid response in heart rate on ventilating via the endotracheal tube. If in doubt exhaled CO2 detection will correctly identify most correctly sited tubes in the presence of any cardiac output. Detection of exhaled carbon dioxide should be used to confirm tracheal tube placement

Special cases

Pre-term babies

Unexpected deliveries outside delivery suites are more likely to be premature. Premature babies are more likely to get cold (higher surface area to mass ratio), and more likely to become hypoglycaemic (fewer glycogen stores). There are now several trials, which support the use of plastic bags placed over babies of <29 weeks gestation or <1000g before drying in order to keep warm. The babies should then be placed under radiant heat (see box below). The effectiveness of this technique without the radiant heater has not been tested in trial.

Table 8.2. Guidelines for use of plastic bags for pre-term babies (<29 weeks) at birth

1. Pre-term babies born below 29 completed weeks' gestation may be placed in plastic bags or wrap for temperature stability during resuscitation. They should remain in the bag until they are on the NICU and the humidity within their incubator is at the desired level. It is a way of preventing evaporative heat loss and cannot replace incubators etc. Neither should it replace all efforts to maintain a high ambient temperature around babies outside delivery suites.
2. At birth the baby should not be dried, but should be slipped straight into the prepared plastic bag or wrapping. There is no need to wrap in a towel so long as this is done immediately after birth. This gives immediate humidity. The plastic bag only prevents evaporative heat loss – once in the bag the baby should be placed under a radiant heater.
3. Suitable plastic bags are food-grade bags designed for microwaving and roasting. They should be large. The bag is prepared with a V cut in the closed end. Purpose made bags and wraps are also available.
4. The bag should cover the baby from the shoulders to the feet, with the head protruding through the V-cut. This is most easily performed if the hand is placed through the V, the head placed in the hand, and the bag drawn back down over the baby
5. The head will stick out of the V-cut and will be dried as usual and resuscitation commenced as per standard guidelines. A hat should be placed over the head if practical to further reduce heat loss.
6. The standard resuscitation would be carried out without any limitations of access, but if the umbilicus is required for any access then a hole can be made above the area and the desired intervention done
7. The bag should not be removed unless deemed necessary by the registrar or consultant.
8. After the transfer to a neonatal unit and stabilising ventilation if required, the baby's temperature should be recorded. The bag is only removed when the incubator humidity is satisfactory, and further care provided as per nursing protocols

The more premature a baby the less likely it is to establish adequate respirations. Preterm

babies (less than 32 weeks gestation) are likely to be deficient in surfactant especially after unexpected or precipitate delivery. The surfactant, secreted by pneumocytes in the alveolar epithelium, reduces alveolar surface tension and prevents alveolar collapse on expiration. Small amounts of surfactant can be demonstrated from about 20 weeks' gestation, but a surge in production occurs at 30–34 weeks. Surfactant is released at birth due to aeration and distension of the alveoli. The half-life of the surfactant is approximately 12 hours. Production is reduced by hypothermia (<35 °C), hypoxia and acidosis (pH <7·25). In babies born before 32 weeks, one must anticipate a lack of surfactant. The effort of respiration will be increased, although the musculature will be less developed. They may require help to establish prompt aeration and ventilation, and may subsequently require exogenous surfactant therapy.

The lungs of pre-term babies are more fragile than those of term babies and thus are much more susceptible to damage from over-distension. Therefore, it is appropriate to start with a lower inflation pressure of 2·0–2·5 kPa (20–25 cmH_2O) but do not be afraid to increase this to 30 cm H_2O if there is no heart rate response.

It should be noted that very obvious chest wall movement in premature babies of less than 28 week' gestation may indicate excessive and potentially damaging tidal volumes.

Premature babies are more susceptible to the toxic effects of hyperoxia. Using a pulse oximeter to monitor both heart rate and oxygen saturation in these babies from birth makes stabilisation much easier. Exposing babies at birth to high concentrations of oxygen can have significant adverse longer term effects. Ranges of pre-ductal oxygen saturation found in the first few minutes of life in well preterm infants are increasingly being reported however, normal values in well babies born before 32 weeks gestation are based upon small numbers. Therefore, at present, additional oxygen should not be given if the oxygen saturation from the right arm or wrist is above the values below:

Time from birth	Acceptable (25th centile) preductal saturation (%) under 32 weeks gestation
2 min	60
3 min	70
4 min	80
5 min	85
10 min	90

Saturation monitoring

Pulse oximetry gives a quick and relatively accurate display of both heart rate and oxygen saturation which can be easily seen by all involved in the resuscitation. This is particularly useful when stabilising significantly preterm babies or when tempted to give additional oxygen to any baby. Once the oximeter is switched on, a reading can be obtained a few seconds faster if the probe is first attached to the right hand or the wrist of the baby and only then connected to the machine. Once the heart rate is displayed it is likely that this will be more accurate than other commonly used methods of assessing heart rate.

Actions in the event of poor initial response to resuscitation

1. Check airway and breathing.
2. Check for a technical fault.
   (a) Is mask ventilation effective? Observe movement.
   (b) Is the tracheal tube in the trachea? Auscultate both axillae, listen at the mouth for a large leak, and observe movement. Use an exhaled $C0_2$ detector to ensure tracheal tube position.
   (c) Is the tracheal tube in the right bronchus? Auscultate both axillae and

observe movement.
(d) Is the tracheal tube blocked? If there is doubt about the position or patency of the tracheal tube re-place it. Use an exhaled $C0_2$ detector.
(e) Is a longer inflation time required?
(f) If starting in air increase the oxygen concentration? This is least likely to be a cause, although if monitoring saturations it could be a cause for slow increase.

3. Does the baby have a pneumothorax? This occurs spontaneously in up to 1% of new-borns, but those needing action in the delivery unit are exceptionally rare. Auscultate the chest for asymmetry of breath sounds. A cold light source can be used to transilluminate the chest – a pneumothorax may show as a hyper-illuminating area. If a tension pneumothorax is thought to be present clinically, a 21-gauge butterfly needle should be inserted through the second intercostal space in the mid-clavicular line. Alternatively, a 22-gauge cannula connected to a three-way tap may be used. Remember that you may well cause a pneumothorax during this procedure. (Chapter 22)
4. Does the baby remain cyanosed despite breathing with a good heart rate? There may be a congenital heart malformation, which may be duct-dependent (Chapter 9), or a persistent pulmonary hypertension.
5. If, after resuscitation, the baby is pink and has a good heart rate but is not breathing effectively, it may be suffering the effects of maternal opiates. Naloxone 200 micrograms IM may be considered, this should outlast the opiate effect.
6. Is there severe anaemia or hypovolaemia? In case of large blood loss, 20 ml/kg O-negative blood or a volume expander should be given.

Birth outside the delivery room

Whenever a baby is born unexpectedly, the greatest difficulty often lies in keeping it warm. Drying and wrapping, turning up the heating and closing windows and doors are all important in maintaining temperature. Special care must be taken to clamp and cut the cord to prevent blood loss.
Hospitals with accident and emergency departments should have guidelines for resuscitation at birth, summoning help and post-resuscitation transfer of babies born within the department.

Babies born unexpectedly, outside hospital, will be at greater risk of being pre-term and of getting cold. However, the principles of resuscitation are identical to the hospital setting. Transport will need to be discussed according to local guidelines.

Discontinuation of resuscitation

The outcome for a baby with no detectable cardiac output for more than 10 minutes of is likely to be very poor. Stopping resuscitation early, or not starting resuscitation at all, may be appropriate in situations of extreme prematurity (<23 weeks), birth weight of <400 g, or in the presence of lethal abnormalities such as anencephaly or confirmed trisomy 13 or 18. Resuscitation is nearly always indicated in conditions with a high survival rate and acceptable morbidity. Such decisions should be taken by a senior member of the team, ideally a consultant in consultation with the parents and other team members.

Communication with the parents

It is important that the team caring for the newborn baby informs the parents of the progress whenever possible. This is likely to be most difficult in unexpected deliveries so prior planning to cover the eventuality may be helpful. Decisions at the end of life must involve the parents whenever possible. All communication should be documented after the event.

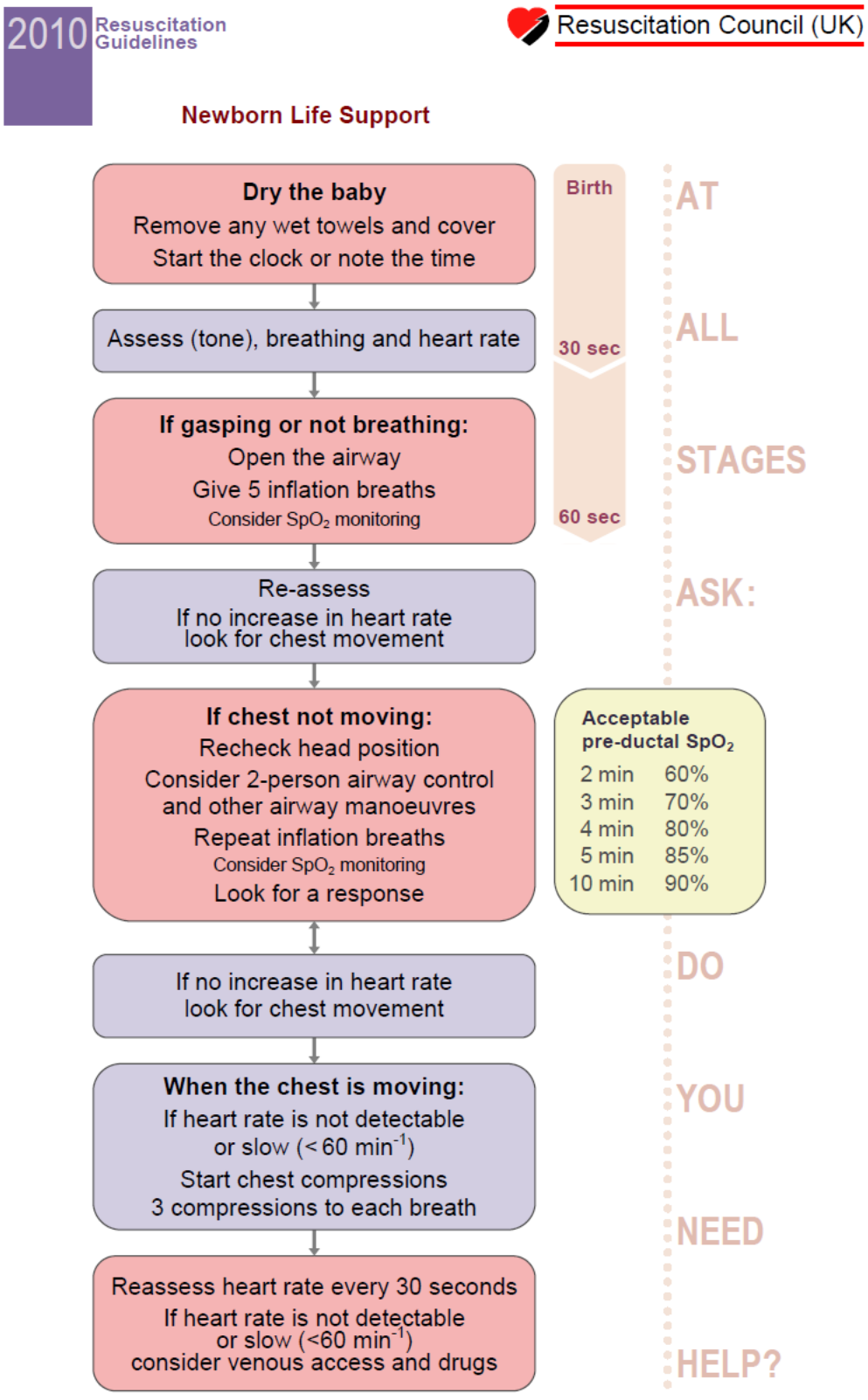

Figure 8.7 Newborn Resuscitation Algorithm
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