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Introduction

The aim of the Scottish Neonatal Resuscitation Training Course is to provide participants with the knowledge and skills to perform basic resuscitation of the newborn baby within a safe simulated clinical environment.

As a result of undertaking the course, participants will be able to:

- Develop an understanding of the physiological processes that can lead to the need for resuscitation of the newborn.
- Practise the immediate care of babies requiring resuscitation at birth
- Acquire practical experience in using neonatal resuscitation equipment.

The course material is based on information provided by the International Liaison Committee on Resuscitation (ILCOR) and takes into account the guidelines produced, both in their original form [1], and subsequent updates in 2005 [2] and 2010 [3].

Although the course provides participants with the theory and skills to undertake resuscitation of the newborn, it does not guarantee competence in the clinical environment. It is the responsibility of candidates’ line managers to ensure that personnel are competent before they are expected to perform resuscitation unsupervised.

References:

Chapter 1

The physiological basis of resuscitation at birth

Why are newborn infants different?

There are several differences between resuscitation in newborn babies and those at any other age:

1. In adults, collapse is usually a primary cardiac event (most commonly due to arrhythmia or asystole due to myocardial infarction) whereas in infants and children the problem initially tends to be a respiratory one. The journey through the birth canal is by adult standards a relatively hypoxic experience as each contraction causes significant interruption of gaseous exchange. The heart of a newborn baby can continue to beat for approximately 20 minutes at a time when normal breathing, and the reserve system of gasping, have ceased.

2. Newborn babies are well adapted to hypoxic stress. Glycogen reserves in the myocardium and the ability of the brain to utilise alternative fuels mean that the newborn baby can withstand longer periods of hypoxia than an adult.

3. Antenatally the lungs are filled with fluid and this can affect aeration at birth. Term babies have 100-120 ml of fluid in their lungs. A small amount is squeezed out during the vaginal birth process but most is absorbed into the interstitial lymphatics.

4. Chest compressions are easier and can be more effective than in adults – the newborn chest has a compliant cartilaginous ribcage and the heart size is relatively larger than in the adult.

5. Chest compression in adults aims to maintain adequate tissue perfusion of both heart and brain, whereas in newborn babies the resuscitator is mainly trying to move oxygenated blood from the lungs to the myocardium.
**Physiology of acute perinatal asphyxia**

The data shown in the diagrams below were derived from animal studies performed in the 1960s and 1970s and outline the response of a mammalian fetus subjected to total hypoxia. Data were obtained by delivering the fetus in such a way that the uterus did not contract, the fetus was prevented from breathing and the fetoplacental circulation was then obstructed. Although we cannot be entirely sure, it is thought that the human fetus behaves in a similar fashion and that the whole process, from insult to death, takes about 20 minutes in the fetus or indeed in the newborn human baby *who receives no effective resuscitation*.

The hypoxic insult may begin before, during or after birth – for simplicity the following description is that of a fetus *in utero* but the sequence equally applies to a newborn baby whose breathing is obstructed.

**Respiratory activity**

With the onset of acute hypoxia the fetus begins to breathe more deeply and more rapidly. The arterial oxygen concentration – already much lower in the fetus than the adult – falls rapidly and the fetus loses consciousness. Within a few minutes the respiratory centre is unable to function due to lack of oxygen and the fetus enters a period known as *primary apnoea*.

If hypoxia continues, the fetus remains in primary apnoea for 5 to 10 minutes, after which primitive spinal reflexes (normally suppressed by higher breathing centres) begin to cause shuddering whole body ‘agonal’ gasps at a rate of approximately 12 per minute. Drugs and anaesthetics can increase the duration of primary apnoea so that these gasps appear later, however they can also reduce the duration of the gasping period. Once this gasping stops, the fetus enters a second phase of apnoea called ‘*secondary apnoea*’ or ‘*terminal apnoea*’, and without intervention at this stage the outcome is death.

The only way to tell whether a newborn baby was in ‘primary’ or ‘terminal’ apnoea is by assessment of the response to resuscitation. Almost all those in ‘primary’ apnoea will start with regular breathing (+/- a few gasps) whereas those resuscitated from ‘terminal’ apnoea will invariably gasp first and do so for some time before regular respiration is established.

**Heart rate and blood pressure**

There is often a small increase in heart rate before the heart rate falls to around half its normal rate. The fall in heart rate is probably mediated through the vagus nerve, but this slower rate is then maintained in the presence of hypoxia by anaerobic metabolism. The myocardium utilises the glycogen stores that have been laid down
during the last trimester. Anaerobic metabolism is far less efficient at producing energy than aerobic metabolism; therefore the heart rate is necessarily slower.

Blood pressure is well maintained until the terminal stages of the hypoxic process. The relative slowing of the heart allows for a greater time for the ventricles to fill in diastole, and the stroke volume actually increases. At the same time vasoconstriction occurs in non-vital organs such as the skin thereby preserving the blood supply to those organs important for immediate survival. Thus the skin looks very pale and feels cool.

**Blood gases**

As stated above oxygen falls rapidly from already low levels (4-5 kPa [30-37 mmHg] *in utero* versus 8-12 kPa [60-90 mmHg] in the adult) and unless the fetoplacental circulation or breathing is restored then this remains low. Carbon dioxide increases from the time of interruption of the fetoplacental circulation causing a *respiratory acidosis*. The anaerobic metabolism produces lactic acid, which, after an initial period of buffering, leads to a *metabolic acidosis*. Thus, an affected fetus can have a severe mixed respiratory and metabolic acidosis.

**Resuscitation and recovery**

The problem faced by resuscitators is that the fetus can be born at any stage along this timeline. A baby who is not breathing within a minute or two after delivery could have reached any of the arrows in the diagram below. More importantly the initial assessment of each of these babies would be essentially the same - the baby would be apnoeic (this would only occur between gasps for the baby at arrow 2), be blue +/- pale and have a slow heart rate.

*Figure 1*: Babies can be born at any point after the initial hypoxic event. The babies born at the points marked above will at first sight be indistinguishable - they will not be breathing (number 2 will be if in between the gasps), blue/white and have a slow heart rate.
A baby born at the time indicated by the first arrow will be able to ‘resuscitate’ itself in air provided the airway is open. After a continuing period of apnoea the gasps will occur. If these are successful in aerating the lungs the oxygenated blood will be transported to the coronary arteries and myocardium. The heart rate then increases. In turn there will be greater oxygen carried to the rest of the body and the respiratory centre. Once this begins to function again regular breathing occurs and gasps are suppressed.

A similar sequence of events will occur with a baby born at the time indicated by the second arrow, but recovery may be a bit slower. **The key event in both situations (and indeed in any resuscitation) is aeration of the lungs and this requires an open airway.**

The baby born at arrow three would die without intervention and may die in spite of these interventions. Effective lung inflation may, however, be enough to produce recovery provided there is a functional circulation to transfer oxygenated blood to the myocardium.

![Graph](https://via.placeholder.com/150)

**Figure 2:** The baby born in 'terminal apnoea' cannot resuscitate itself. The resuscitator must open the airway and get oxygen (or air) to the lungs.
If the period of hypoxia is prolonged then the situation may have progressed to the stage where the circulation is no longer functioning and oxygenated blood is not delivered to the heart despite adequate aeration of the lungs. In this situation recovery can still occur if a brief period of cardiac compression (CC) is used to deliver the oxygenated blood to the heart (see below). This is interspersed with ventilation until the heart rate recovers in which case the cardiac compression can be discontinued allowing ventilation alone until the onset of regular respiratory activity.

Figure 3: If getting oxygen to the lungs is insufficient to resuscitate the baby, the resuscitator must move on to the next step of the algorithm.

Almost all babies who are going to respond to resuscitation will have responded by this stage. Only about 0.1% of newborn babies actually need drugs and the outcome in these babies is usually poor.
Summary

- Newborn babies are well adapted to recover from temporary hypoxia.
- They respond to hypoxia by shutting down the circulation to all but the vital organs.
- They have a ‘safety net’ of gasping and several organs, like the heart and brain, are able to utilise alternative fuel sources increasing their resilience to hypoxia.
- Babies in primary apnoea and the gasping phase could ‘resuscitate’ themselves provided they have an open airway but we cannot distinguish these babies at birth from those in terminal apnoea. Personnel who work with newborn babies should have a strategy that will cope equally well in either situation. Such a strategy focuses on assessment, airway management, aeration of the chest and chest compressions, and is described in the next sections of this manual.
Chapter 2

Initial steps and assessment of the newborn

The environment

As part of the preparation of the environment for resuscitation, it is helpful if you have time to read the maternal notes and talk to the midwife or obstetrician. This may identify situations where additional assistance will be required. If the baby is very preterm, if a multiple birth is anticipated or if there is thick meconium staining, ask for assistance from someone who can intubate.

Introduce yourself to the parents and explain to them why you are there. There may be time for them to ask questions and these should be answered as honestly as possible.

The temperature of the room is important. Babies have a large surface area and they are wet. They lose heat easily. Generally a temperature that is comfortable for the labouring woman will be cold for a newborn baby. Make sure that doors and windows are closed and that a heater is on. **Ensure that anything that the baby will touch has been pre-warmed. This is especially important if the delivery is preterm. Special circumstances and thermal care are discussed on later sections.**

Check that the equipment you require is available and ready for use. Ensure that air and oxygen supply is available and that pressure limits are set appropriately. Do not assume the baby will require supplementary oxygen till after initial assessment and any immediate resuscitation. Check that the suction apparatus works and that a suction catheter is attached.

**Consider if you will need help and how long it will take to arrive.** Even very experienced and competent individuals may sometimes require the assistance of
another pair of hands. It is far better to anticipate a problem and request help and find that it is not needed than to find yourself with a small sick baby and out of your depth.

If a baby is being born out of hospital or if the labour room is some distance from the Neonatal Unit, then transport must be considered. A mobile Resuscitaire or portable incubator (and someone who knows how to use it) may be required. For out of hospital births, an ambulance may need to be arranged. Be aware of any arrangements for calling assistance (e.g. from midwives or from the ambulance service and the limitations of calling these).

Before the baby is born:

- Ascertain the gestational age of the baby
- Whether there is one or more babies
- Whether there has been meconium staining of the liquor
- Whether there has been any CTG or other signs of fetal distress
- Whether concerns about fetal wellbeing occurred in the antenatal period.

This will help you decide what level of assistance you may require.

**Preventing heat loss**

All babies should have measures undertaken to prevent hypothermia. Most term babies will be dried with warm towels. This can be done while the baby is with its mother.

Remove any wet towel as this too can contribute to heat loss. Rewrap the baby in a warm dry towel or blanket, plus a hat if available or Skin-to-skin care (placing the baby on the mother's abdomen or chest) can also be used to keep the baby warm if the baby does not require further assistance.

Avoid overheating term infants as the management of severe hypoxic ischaemia may involve passive cooling or therapeutic hypothermia

**Preventing heat loss (preterm infants)**

Small preterm babies < 28 weeks are particularly vulnerable to heat loss and special precautions may be required. Very small or compromised babies should be taken to the prewarmed resuscitaire as soon as the cord is cut. They may also have their wet bodies enclosed in a food grade plastic bag or wrap to neck level and placed under a radiant heat source to prevent excessive heat loss at birth. This bag should be transparent to allow assessment and remain in place until the baby is safely transferred to a warmed and humidified incubator on the neonatal unit. A hat should
also be put on. Delivery rooms should be at least 26°C for infants<28 weeks gestation.

**If a radiant warmer is not available the preterm baby should be completely dried, before being placed in a polythene bag as above and further warming measures initiated.**

**Initial assessment**

When the baby is born or when you arrive, start the clock or note the time. This will guide you in relation to reassessment and response to interventions.

During this process, check:

**Colour**

Observe the baby's lips, tongue and trunk. Most babies are blue when they are born. However, they gradually become centrally pink once they establish respirations. This can take several minutes. In darker skinned babies, the lips and tongue are the best indicator of cyanosis. Pale babies may lack an effective circulation - either because they have poor cardiac output or because they have a low circulating blood volume. Progression to the next step after the initial evaluation is now directed by the simultaneous assessment of 2 vital characteristics, heart rate and respirations. The use of a third assessment—that of colour is now replaced by oximetry assessment of oxyhaemoglobin saturation. Except where no saturations monitor is available, colour should still be used.

**Tone**

Is the baby well flexed or like a 'rag doll'? Floppy babies - especially those who are pale - should be considered as being in difficulty and in need of immediate resuscitation.

**Breathing**

Note the presence, rate and pattern of breathing. This is best done visually. A baby who is not breathing regularly needs help. Look for gasping. This is where the breathing movements are irregular, with all the accessory muscles of respiration being used. A baby who is gasping should be assumed to be close to developing terminal apnoea and needs immediate assistance to establish regular breathing.

**Heart rate**

The heart rate should be above 100 beats per minute. A heart rate below 60 beats per minute in an apnoeic neonate will not provide an effective circulation. The pulse may be palpated at the base of the umbilical cord or on the precordium. If it cannot be felt or if it seems slow, then it should be checked with a stethoscope.
A prompt increase in heart rate remains the most sensitive indicator of effective resuscitation. Of the clinical assessments, auscultation of the heart is the most accurate, with palpation of the umbilical cord less so. This may be noted before chest movement can be seen. Heart rate should remain the primary vital sign by which to judge the need for and efficacy of resuscitation. Auscultation of the precordium should remain the primary means of assessing heart rate. There is a high likelihood of underestimating heart rate with palpation of the umbilical pulse, but this is preferable to other palpation locations.

After making an initial assessment, the need for intervention should be established and should be carried out according to the algorithm. Call for help if needed

**Pulse Oximetry**

For babies who require ongoing resuscitation or respiratory support or both, the goal should be to use pulse oximetry. The sensor should be placed on the baby’s right hand or wrist (pre-ductal) before connecting the probe to the instrument. Because of concerns about the ability to consistently obtain accurate measurements, pulse oximetry should be used in conjunction with and should not replace clinical assessment of heart rate during newborn resuscitation.
**Initial steps in resuscitation**

**Stimulation**

Drying the baby may stimulate it to start breathing. Slapping and pinching the baby is not necessary. If the baby does not respond to this intervention, then further steps are required.

**Position**

The airway can be opened by placing the baby’s head in the neutral position (Figure 4).

![Neutral position](image)

*Figure 4:* The natural position for the baby’s head to adopt on a flat surface is flexion (owing to the large occiput). In their anxiety (or sometimes as a result of prior experience in adult resuscitation) resuscitators can over-extend the head. Instead the ‘neutral’ position is required with the plane of the face parallel to the work surface.

Excessive flexion or extension of the neck can block the airway. It is more common for the airway to be blocked because of poor pharyngeal tone, than because of obstruction due to blood, secretions or meconium.

Even if opening the airway does not produce an immediate response, it is important to maintain the neutral position **at all times** to ensure the effectiveness of other supplementary airway management manoeuvres (e.g. jaw thrust, guedel airways).
**Meconium**

Meconium is a mixture of gastric secretions, bile salts, mucus, vernix, lanugo, blood, pancreatic enzymes, free fatty acids and squamous cells. It is normally passed during the first few postnatal days. If a fetus is subjected to ‘stress’ such as hypoxia or infection then it may pass meconium *in utero*. Meconium staining of amniotic fluid probably occurs in up to 15% of pregnancies. The most severe condition associated with meconium passage *in utero* – the meconium aspiration syndrome – occurs in 2-5% of deliveries through meconium stained liquor. In this there is a double insult of the meconium and a severe hypoxic insult resulting in gasping (and therefore the inhalation of the meconium) as well as damage to other organs such as heart, kidneys, brain, etc.

If there is meconium staining of the liquor, additional steps may be required.

Suction of the nose and mouth before the shoulders are delivered and the head is on the perineum does not alter outcome in severe meconium aspiration syndrome and can no longer be recommended.

If the baby is crying, then suction should not be attempted as it is likely to do more harm than good. A crying baby has, by definition, a clear airway.

If the baby is not breathing, help should be summoned. If you have the skill, intubate the baby with an endotracheal tube (ideally with a meconium aspirator attached – see diagram) and use this to suck out the trachea. If you are unable to intubate, call for assistance from someone who has the skill. While waiting for them to arrive, suck out the oropharynx then the nares under direct vision with a wide bore suction catheter or a yankers and then provide intermittent positive pressure ventilation as described in the next chapter.

![A meconium aspirator. This is designed to be attached to an endotracheal tube to allow it to be connected to suction tubing. Occlusion of the side-hole (as on the right) allows suction to be applied as the ET tube is withdrawn.](image-url)
In the event that assistance is not immediately available and you cannot intubate:

- Clear the upper airways (nose and mouth) as much as possible
- Prevent heat loss by drying and covering the baby
- Open the airway as described above
- Start positive pressure ventilation with the lowest pressure that achieves chest expansion
  - Proceed with the standard approach to resuscitation as required based on repeated assessment of response

This may result in meconium being pushed into the lungs but this is better than doing nothing at all. **If you do not do anything the baby will die.**
Chapter 3

Providing assistance with breathing

Use observation to assess if the baby is making breathing efforts. If the baby is not breathing, or is gasping or has a heart rate of less than 100 beats per minute, then intermittent positive pressure ventilation (IPPV) will be required.

**Start ventilating with air**, adding oxygen if there is no improvement in heart rate (guided by pulse oximetry) after several minutes of effective ventilation.

**Select the appropriate size mask**

![Figure 5: The correct mask should fit across the bridge of the nose (avoiding the eyes), cover both nose and mouth and reach the tip of the chin. Incorrectly positioned masks also increase the likelihood of leak of the positive pressure air/oxygen.](image)

The mask should cover mouth, nose and tip of the chin, but not the eyes. The mask should have a deformable edge so that an even pressure is applied around the entire circumference of the mask.

Ensure there is a clear airway. Check the position. Check if suction to the mouth and nose is required.
Position yourself at the head or side of the resuscitaire. If you are right handed you will hold the mask with your left hand and use your right to operate the bag. It is vital that the baby is positioned so that you can observe the rise and fall of the chest as you ventilate the baby. Concentrate on chest movement rather than watching the manometer, if you are using one.

**Using the bag and mask**

The mask should be placed so it covers the nose and mouth. The mask is held on the face with the thumb, index, and/or middle finger holding the firm part of the mask (Figure 6). The ring and 5th fingers bring the chin forward to maintain the airway. If using an anatomically shaped mask the pointed end should be over the nose (the different types of masks are discussed in the Appendix). Do not allow your fingers or parts of your hand to rest on the baby’s eyes.

![Figure 6](image)

*Figure 6:* When holding the mask on the face using the thumb and index finger, the other fingers support the jaw and if necessary apply jaw thrust. The picture on the left shows a round Laerdal silicone mask with a deformable rim, the picture on the right shows a 'pear-shaped' anatomical face mask.

**Delivering a breath**

You want to demonstrate a noticeable rise and fall of the chest with ventilation. In order to achieve this, higher pressures (30cm H₂O) or sustained inflation breaths (breaths of 2-3 second duration) may be required initially for term infants and pressures of 20-25cm H₂O for preterm infants. The type of bag you are using will influence this practice. T-pieces and flow inflating devices make delivering sustained pressure easier; it is more difficult to achieve with self inflating bags (500mls) and may be impossible with smaller volume (250ml) bags. Ventilation of the newborn can be performed effectively with a flow-inflating bag, a self-inflating bag, or a pressure-limited T-piece resuscitator.

You should watch carefully for chest movement. If there is none, or it is insufficient, you can consider increasing the pressure and/or inflation time. In theory inflation breaths are only necessary for 4 or 5 breaths. Check the heart rate – sometimes the first sign of successful resuscitation will be a rise in the heart rate.
Suggested pressures for newborn babies are:

<table>
<thead>
<tr>
<th>Condition</th>
<th>Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial breath after delivery (term or near-term infants)</td>
<td>30 cm H₂O</td>
</tr>
<tr>
<td>Normal lungs later breaths</td>
<td>15 - 20 cm H₂O</td>
</tr>
<tr>
<td>Diseased or immature lungs</td>
<td>20 - 40 cm H₂O</td>
</tr>
</tbody>
</table>

**Rate**

During the initial stages of neonatal resuscitation breaths should be delivered at a rate that allows the resuscitator to see the chest move. ILCOR guidelines suggest a rate of 30 – 60 breaths per minute, if you are using longer inflation breaths, this rate will necessarily be slower.

**Assessing the effectiveness of ventilation**

Improvement is shown by three signs:

- Increasing heart rate
- Spontaneous breathing.
- Improving colour

As the baby’s heart rate increases towards normal you should continue ventilating at a rate of 30-60 breaths. **If you have an improving heart rate then there is adequate chest movement – you do not necessarily have to see chest movement in all cases.** This is especially important in preterm babies where over-inflation due to vigorous ventilation manoeuvres can cause lung damage and is a risk factor for subsequent chronic lung disease. Always try to prevent over-inflation by regularly checking the heart rate and monitoring chest movement.

Check for bilateral chest movement. The baby should be observed continuously and reassessed every 30 seconds. When the heart rate stabilises above 100, the rate and pressure of ventilation can be gradually reduced while you continue to stimulate the baby to breathe.
Air or 100% oxygen

Use of Supplementary oxygen
In term infants receiving resuscitation at birth with positive pressure ventilation, evidence now suggests that it is best to begin with air rather than 100% oxygen. If despite effective ventilation there is no increase in heart rate or if oxygenation (guided by oximetry) remains unacceptable, use of a higher concentration of oxygen should be considered. Because many preterm babies of <32 weeks’ gestation will not reach target saturations in air, blended oxygen and air may be given judiciously and ideally guided by pulse oximetry. Both hyperoxaemia and hypoxaemia should be avoided. If a blend of oxygen and air is not available, resuscitation should be initiated with air.

Prolonged ventilation
If a baby requires mask inflation for longer than 5 minutes then consideration should be given to the passage of an orogastric tube. This is because air or oxygen is forced into the oropharynx where it can enter the oesophagus as well as the trachea. Distension of the stomach and intestines can interfere with ventilation and may also cause regurgitation of gastric contents.
Chapter 4

Troubleshooting ventilation

If the heart rate is not increasing and there is no chest movement then it is necessary to review what you are doing and to consider additional manoeuvres.

If the chest is not rising it may be due to one or more of the following:

- The seal of the facemask is incomplete
- The airway is blocked
- Not enough pressure is being given
- The device may be faulty.

The seal of the facemask is incomplete

If you hear or feel air escaping around the mask reposition and reapply the mask to the face and try and form a better seal. If you find difficulty keeping the mask in place without a leak then ask for help if available.

*Do not press down hard on the baby's face - this may push the jaw back and cause the tongue to obstruct the airway.*

Blocked airway

- Check the position of the baby’s head (the commonest reason for failure of ventilation)
- Check the mouth, oropharynx and nose for secretions
- Consider jaw thrust or insertion of a guedel airway
- Consider if the equipment is functioning effectively.
**Position**

Check that the baby's head is still in the neutral position. A small roll of towel placed under the baby’s shoulders may help the baby maintain this position.

**Consider using jaw thrust**

The jaw thrust manoeuvre may also be necessary - particularly in floppy babies. This involves pushing the jaw forwards by applying pressure to the angle of the jaw. It can be done as a single handed manoeuvre while the other hand operates the self inflating bag or T-piece (Figure 7).

*Figure 7:* The single hand jaw thrust. Note that the fingers are placed on the bony part of the chin avoiding the fleshy area.
The single hand jaw thrust takes a bit of practice to achieve. An alternative, if there are two people, is that one person can perform jaw thrust with two hands (Figure 8) while holding the head in a neutral position and maintaining a seal with the mask, while the other person operates the self inflating mask or occludes the T-piece.

Figure 8: Hand and finger positions for the two-person jaw thrust. The mask is held on the face by the person doing the jaw thrust using the thumbs; the jaw is brought forward using the fingers.

**Consider using an airway**

If there is only one resuscitator a guedel airway could be used.

Figure 9: Guedel airways come available for neonates in 3 sizes – 000, 00 and 0. A size 1 may be appropriate for larger babies.
A guedel airway may also be useful in some orofacial abnormalities such as a cleft palate or Pierre Robin sequence where the lower jaw is smaller than normal and for hypotonic infants. The airway is sized by holding the flange in the middle of mouth and aligning it along the lower jaw. The other end of the airway should reach the angle of the jaw.

Figure 10: Sizing the guedel airway prior to insertion – the airway should measure from the middle of the mouth to the angle of the jaw

The airway is inserted by slipping it over the tongue and it should be inserted in the same way as it is expected to remain.

**Not enough pressure**

Increase the pressure. If you have a pressure manometer briefly note the required pressure to make the chest rise. If using a bag with pop off valve, increase the pressure until the valve actuates. Increase the peak limiting pressure if using a T-piece device. (You may need to increase the flow rate to 10 litres/minute to achieve this.)

Observe chest movement continuously as high pressure inflation may pose a risk for air leak if lung compliance or face mask seal suddenly improves.
If the baby does not improve?

Call for additional help and check the following:

- Is the chest movement adequate?
- Visually check for adequacy of chest expansion and listen with a stethoscope for equal air entry
- Do you have a good seal with the facemask?
- Is the airway blocked? This could be due to:
  - Incorrect head position
  - Glossoptosis (tongue falling back)
  - Secretions in the nose, mouth or pharynx
- Is the ventilation equipment working properly?
- Are you using enough pressure?
- Have you increased the oxygen concentration (e.g. from air to 40% before increasing further to 100%)?
  - Is air and/or oxygen flowing through the ventilation device?
  - If using a self-inflating bag is the O₂ reservoir attached?
  - If using an air or O₂ cylinder - is it empty?
- Is air in the stomach interfering with chest expansion?

Summary

- The position of the baby’s head is important.
- Equipment should be checked before use and when used it should be used correctly.
- Assessment of the effectiveness of all manoeuvres should be done every 30 seconds.
- The first sign of improvement is usually an increase in the heart rate.
Chapter 5

Chest compressions

Chest compressions or external cardiac massage, consist of rhythmic compressions of the sternum that

- Compress the heart between the sternum and the spine
- Increase the intrathoracic pressure
- Circulate blood to the vital organs.

Starting chest compressions

After administering effective positive-pressure ventilation (determined by good chest movement and breath sounds) with air or an air oxygen mixture, the baby should be reassessed. If the heart rate remains below 60 beats per minute and not improving, chest compressions coordinated with continued positive pressure ventilation are indicated.

If the heart rate is 60 beats per minute but improving it may be sufficient to give a further 30 seconds of ventilation breaths and then reassess.

There is absolutely no point in commencing chest compressions, if you are not adequately ventilating the baby. All you will be doing is circulating deoxygenated blood and wasting time which should be spent concentrating on establishing effective ventilation. The baby who does not respond to assisted ventilation is rare and the most likely reason for failure of the heart rate to increase in response to positive pressure ventilation is that you have not succeeded in adequately ventilating the lungs.

Before starting chest compressions check:

- Is the head positioned correctly?
- Is the airway clear?
- Are you using the correct size of mask?
- Is there a good seal between the face mask and the baby's face?
- Is your equipment connected to an air/oxygen supply?
- Are you generating good chest movement and breath sounds?
Your aim, with chest compressions is to compress the heart between the sternum and the spine. This will have the effect of compressing the heart, but more importantly will increase the intrathoracic pressure. This will move blood forward into the coronary arteries. During the relaxation phase, the heart will refill with blood. The relaxation phase should be slightly longer than the compression phase to allow enough time for the heart to refill with blood. Ideally two operators will be required - one to compress the chest and one to continue ventilation.

The person performing chest compressions must have access to the chest and be able to position their hands correctly. The person assisting ventilation should be positioned at the baby’s head to achieve an effective seal between the mask and the baby’s face, and be in a good position to watch for effective chest movement.

Ideally you should recruit additional help at this point in case more extensive resuscitation is required and to assist with reassessments.

**Techniques for chest compressions**

There are two different techniques for performing chest compressions.

These techniques are:

- Two-hand technique
- Two-finger technique.

Each technique has advantages and disadvantages.

Some evidence in the literature suggests the two-hand technique may offer some advantages in generating peak systolic and coronary perfusion pressure, and therefore this is the preferred technique.

For both techniques you must have:

- Firm support for the back
- Good position of the thumbs / fingers on the chest wall
- Adequate depth of chest compression
- Synchronised rate of chest compression.
The two-hand technique (also called the thumb technique)

The two-hand (thumb) technique is accomplished by encircling the torso with both hands and placing the thumbs on the lower third of the sternum and the fingers under the newborn. The thumbs can be placed side by side or, on a small baby or for large thumbs, one over the other. The thumbs will be used to compress the sternum, while the fingers provide the support for the back. The thumbs should be flexed at the first joint and pressure applied vertically to compress the heart between the sternum and the spine. Care must be taken not to squeeze the chest (ribs) with your whole hand during compression.

![Figure 11: Two hand (thumb) technique for chest compressions (towels, etc., removed for clarity)](image)

The two-hand (thumb) technique has some restrictions. It is more difficult to perform effectively if the baby is large or your hands are small. It makes access to the umbilical cord more difficult if medications become necessary.

The two-finger technique

The tips of the middle finger and either the index or ring finger of one hand are used for compressions. The two fingers are positioned over the lower third of the sternum, perpendicular to the chest and downward pressure is applied with the fingertips. The other hand should be used to support the baby’s back so that the heart is more effectively compressed between the sternum and the spine. When compressing the chest only the two fingertips should rest on the chest and pressure should be applied vertically. There should be no lateral pressure over the ribs.
Figure 12: Two finger technique for chest compressions (towels, etc., removed for clarity).

How much pressure do you use to compress the chest?

A compression depth of approximately one-third of the depth of the chest should be achieved. Compressions should be delivered smoothly. The thumbs or fingertips should be kept in contact with the sternum at all times. The compression phase should be slightly shorter than the relaxation phase. This offers theoretical advantages for blood flow in the newborn.

Rate of chest compressions and co-ordination with assisted ventilation

It is mandatory that chest compressions are accompanied by positive pressure ventilation. However, you should avoid doing the two simultaneously, since one will decrease the efficacy of the other. The two must be co-ordinated, with one ventilation interposed after every third compression, for a total of 30 breaths and 90 compressions per minute.

The person doing the compressions should count “One-and-two-and-three-and breathe-and” while the person ventilating delivers a breath during “breathe-and”. Passive exhalation occurs during the downward stroke of the next compression. One cycle will consist of three compressions plus one ventilation, and should take approximately 2 seconds. However, the effectiveness of both the ventilation and the chest compression is more important than delivering the exact amount of “events” in a one-minute period.
**Stopping chest compressions**

After approximately 30 seconds of well co-ordinated chest compressions and ventilation, you should re-assess the newborn baby. If you can feel the pulse at the base of the cord, you will not need to stop ventilation to assess the condition of the baby. Otherwise, you will need to stop both chest compressions and ventilation for a few seconds to allow you to check for a heart beat.

If the heart rate is now above 60 beats per minute and improving, then you can discontinue chest compressions, but continue positive pressure ventilation at a rate of 40–60 per minute.

Once the heart rate rises above 100 beats per minute and the baby begins to breathe spontaneously, you should slowly withdraw positive pressure ventilation, and once stable, move the baby to a neonatal unit for ongoing care.

**If the baby is not responding**

While you are administering chest compressions, you should ask yourself the following questions:

**Check list**

- Is the head positioned correctly?
- Is the airway clear?
- Are you using the correct size of mask?
- Is there a good seal between the face mask and the baby's face?
- Is your equipment connected to an effective air/oxygen supply?
- Are you generating good chest movement and breath sounds?
- Are you delivering effective, well co-ordinated chest compressions?

Very occasionally, babies will require “advanced” techniques of resuscitation, e.g. if the heart rate remains below 60 beats per minute despite effective well co-ordinated chest compressions and positive pressure ventilation. If the baby is not responding, call for help sooner rather than later.

**Reassessment**

The baby should be reassessed after every 30 seconds or after every intervention to assess its effectiveness. Look for a change in colour, tone, breathing and heart rate. Remember that the first response to effective resuscitation may be an increase in heart rate. If there is chest movement but no change in the heart rate, check that lung ventilation is really effective before moving on to chest compressions.
Chapter 6

Ongoing care

Discontinuing resuscitation

Once the baby is able to maintain its own respirations, positive pressure ventilation should be withdrawn. The baby can be given to the parents to hold but should be observed carefully.

If the baby is responding to resuscitation but is not able to maintain effective ventilation, then positive pressure ventilation will need to be continued and the baby will need to be transferred to the Special Care Baby Unit. Transport will be required.

If the baby is not responding to resuscitation and there is no effective cardiac output, then a decision to discontinue resuscitation will need to be considered. This will usually be carried out by a senior member of staff and then only after at least ten minutes of effective resuscitation. If there is any uncertainty about the decision, resuscitation should be continued while the decision is referred to more senior staff. In some areas, locally agreed protocols will be in place and these should be followed. Try to ensure parents are informed that the baby is not responding to resuscitation before discontinuing so they can understand what has been done and why the decision is being made.
Chapter 7

Communication

Documentation should be written as soon as possible after the event. It should be accurate and legible and should contain information about the timing of events and assessments, observations, interventions and outcomes (NMC 2009). The records should contain facts, not opinions. For example, stating that the baby was apnoeic is a fact. However, writing that the baby has birth asphyxia is an opinion – and one that the resuscitator is not in a position to make.

If there is sufficient help allocate a scribe to record times, observations and actions as they happen. Read and confirm these and countersign them with any additional notes.

It is essential to note the condition of the baby at birth or when you arrived. Write down what you did and when you did it. Describe the baby’s response to your actions. Note the first time the baby’s heart rate exceeded 100 beats per minute. Describe the pattern of breathing. Did gasping precede the onset of regular breathing? Note at what time the baby started to breathe regularly. Remember to sign and date the entry and print your name. If you have noted down observations on bits of paper, these are part of the records and should be kept along with the notes.

It is important to communicate with the parents as they are likely to be anxious about their baby. They should have the opportunity to hold their baby – even if it is necessary to transfer the baby to a Neonatal Unit. The parents should be given information about the care that the baby has received and the condition of the baby. A useful way of ensuring that parents understand what has been said to them is to ask them to repeat back what you have told them. Parents whose first language is not English should have access to an interpreter. The use of family members to deliver information can result in the transmission of inaccurate information and breach patient confidentiality. Document what you said to the parents and their response in the case notes.
Appendix – Equipment

Types of face-mask

A number of different face-masks are available commercially. If they are to be used to deliver positive pressure ventilation then they should form a good seal with the baby’s face during use. The Rendell-Baker face-mask (Figure 13) is designed for spontaneously breathing patients and that gas escapes around the mask, they are therefore unsuitable for newborn resuscitation.

![Rendell-Baker facemasks](http://www.icrc.org/emergency-items/)

Suitable facemasks for positive pressure ventilation come in two main shapes – round or ‘anatomical’. Round facemasks are usually made of silicone and have a broad deformable flange which acts as a sealing surface against the baby’s face (Figure 14).

![Laerdal® Silicone facemask](image)

Some bag-valve-mask systems, e.g. the Ambu® Baby Resuscitator, also have round facemasks but in this case the mask is made of rigid plastic with an inflatable cushioned edge. ‘Anatomical’ facemasks are a variant of this but are pear shaped (Figure 15).
Figure 15: Anatomical facemask (with removable attachments to allow anaesthetist to secure the mask to the face – not needed during resuscitation). The mask is rigid plastic with an inflatable cushioned rim. It is important that the mask cushion is inflated to form an even pressure on the baby’s face but still deformable, if over-inflated the mask will become rigid and make it more difficult to achieve a seal.

The shape of the mask is probably unimportant; round and ‘anatomical’ facemasks are equally effective when applied properly and a good seal is obtained. Obtaining a good seal is an operator-dependent technique and it is this that needs to be checked if air is felt to leak around the mask.

Types of resuscitation devices available

There are three “systems” available to you. You may have to use more than one type in your working practice and it is therefore useful to know about all three. You must ensure that you know the details of and practice with the one you are most likely to use. The three systems are as follows:

Self-inflating bag (e.g. Laerdal, Ambubag)

The self-inflating bag, as the name implies, inflates automatically without a compressed gas (oxygen) source.

The T-piece (e.g. Tom Thumb, Neopuff®)

The T-piece is the generic term for a gas driven system that operates by thumb occlusion. The pressure delivered is set by the operator and the exact amount delivered with each breath. Like the flow inflating bag it requires a gas source to operate.

The pressure can be controlled via a ‘blow off’ valve or manometer. Manometer control is the preferred method as it provides better control of inflation times and pressures.

A number of alternative pressure limited T-piece systems are available:

- Incorporated in the Hill-ROM infant radiant warmer/Draegar resuscitaire
- As a stand-alone rail mounted ‘Tom Thumb’ device (Viamed Ltd.)
The Neopuff® which can be found either as a stand-alone device or incorporated within Fisher & Paykell resuscitaires.

**Flow-inflating bag**

The flow-inflating bag is collapsed when not in use, and it looks like a deflated balloon. It inflates only when oxygen is forced into the bag and the opening of the bag is sealed, as when the mask is placed tightly on a baby’s face. Its inflation and function are dependent on a compressed gas (oxygen) source.

**Advantages and disadvantages of these devices**

<table>
<thead>
<tr>
<th>Method</th>
<th>Self-inflating bag</th>
<th>T-piece device</th>
<th>Flow-inflating bag</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td>Works without a bottled or piped gas source</td>
<td>Can pre-set delivery pressure</td>
<td>Can deliver 21 - 100% O₂</td>
</tr>
<tr>
<td></td>
<td>Can deliver between 21 - approx. 95% O₂ depending on gas supply</td>
<td>Can deliver 21 - 100% O₂</td>
<td>Can deliver free flow O₂</td>
</tr>
<tr>
<td></td>
<td>Usually has a blow-off valve to limit pressure</td>
<td>Can be used for free flow O₂</td>
<td>Good seal easily determined</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Some types offer PEEP as well as inspiratory pressure</td>
<td></td>
</tr>
<tr>
<td><strong>Disadvantages</strong></td>
<td>Cannot reliably give free flow O₂</td>
<td>Requires a bottled or piped gas source</td>
<td>Requires a bottled or piped gas source</td>
</tr>
<tr>
<td></td>
<td>Re-inflates without a good seal</td>
<td></td>
<td>Requires a tight seal</td>
</tr>
<tr>
<td></td>
<td>Requires a reservoir to deliver higher amounts of O₂</td>
<td></td>
<td>May not have a blow-off valve</td>
</tr>
</tbody>
</table>

**Self-inflating bags**

This is the simplest method to use. The pressure delivered to the baby is dictated primarily by how hard the bag is squeezed with some limitation of the pressure by a blow-off valve.

As the bag re-expands following compression, gases are drawn into the bag through a one way valve that may be located at either end of the bag, depending on the design. The mix of the gas (and thus oxygen concentration) depends on the
presence of an oxygen supply and whether or not a reservoir bag is attached. The 500 ml bag should be used for neonatal resuscitation.

Every self-inflating bag has an oxygen inlet, which is usually located near the air inlet. The oxygen inlet allows oxygen tubing to be attached.

The patient outlet is where the gas (oxygen and/or air mixture) exits from the bag to the baby and where the mask attaches.

Paediatric (and that includes infant) self-inflating bags have a valve assembly positioned between the bag and patient outlet – these are not found on adult bags and it is important to ensure that your bag does not have an adult patient outlet attached to an infants/paediatric sized bag. The exact set up of these valves varies depending on the bag used. It is important to familiarise yourself with the bag you will use so that if necessary you could put the valve assembly together. When the valve is squeezed the valve opens and oxygen/air is released to the patient. When the bag re-inflates (during the exhalation cycle) the valve is closed. This prevents the patient’s exhaled air entering the bag and being re-breathed.

Some self-inflating bags have a site to attach a pressure manometer. Note that the manometer must be attached or the hole plugged to allow the bag to operate.

Self-inflating bags generate a peak inspiratory pressure (PIP) when the bag is being squeezed but unlike the other systems discussed below there is no positive end expiratory pressure (PEEP) when the bag is not squeezed. This is not thought to be an important factor in resuscitating babies at term, but PEEP may limit lung damage in resuscitation of preterm babies with immature lungs.
How do you control oxygen in a self-inflating bag?

In term infants receiving resuscitation at birth with positive pressure ventilation, it is best to begin with air rather than 100% oxygen. If despite effective ventilation there is no increase in heart rate or if oxygenation (guided by oximetry) remains unacceptable, use of a higher concentration of oxygen should be considered. Without additional oxygen the self-inflating bag will deliver air (21% oxygen).

By connecting the self-inflating bag to an oxygen source allows higher levels of oxygen to be delivered to the baby. The exact amount depends on whether or not a reservoir bag is used.

If a reservoir bag is not used whenever the bag reinflates after being squeezed, air will be drawn into the bag through the air inlet. Therefore, even though you have 100% O₂ flowing into the bag this is diluted by the air drawn in each time the bag reinflates. As a result the concentration of oxygen actually delivered to the baby is probably 30-40%.

Oxygen concentrations of 90-100% can be achieved by using an O₂ reservoir. An O₂ reservoir is usually a bag placed over the bag’s air inlet; this fills during the squeezing of the bag and allows ~100% O₂ to collect at the air inlet. So when the bag reinflates, instead of air being drawn into the bag there is ~100% O₂. There are different types of reservoir available but they all perform the same function. Some are simple closed bags, others have open ends (e.g., a length of corrugated tubing) and others have a valve that allows some air to enter the reservoir.

Self-inflating bags are generally thought not to be suitable for delivering free-flow O₂ because of the one-way valve near the patient outlet. This is not quite accurate; the self-inflating bag cannot be used to reliably deliver free-flow O₂ by being held close to the baby’s face. With high flow rates of O₂ it is possible to achieve high concentrations of O₂ near the patient outlet; however, this may vary from one self-inflating bag to another and between bags from different manufacturers.

How do you control pressure in a self-inflating bag?

The pressure delivered by a self-inflating bag does not depend on the flow of gas entering the bag. When you seal the mask on the baby’s face there will be no change in the inflation of a self-inflating bag.
The amount of pressure and volume delivered with each breath depends on the following three factors:

1. **How hard (and to some extent how quickly) the operator squeezes the bag.**
2. **Any leak that may be present between the mask and baby’s face.**
3. **The set point of the pressure-release valve (and the inertia within this system).**

You should always test the self-inflating bag before use to see if the valve is working. This is done by squeezing the bag with the mask applied to a firm surface (Figure 18). You should be able to hear the valve being released.

**Figure 18:** Testing the blow-off (safety) valve of a self-inflating bag. The pressures at which these valves blow off are pre-set by the manufacturers and can vary even among bags made by the same manufacturer.

If the blow-off valve does not make a noise when the bag is squeezed vigorously, check:

- Is there a crack or leak in bag? - you cannot generate a high pressure
- Are all the valves present? - remember adult bags do not contain blow-off valves, make sure you don’t have one of these parts attached to your infant or paediatric bag
- Is the blow-off valve stuck in the closed position?

**If there is a problem with any of the above; obtain a new self-inflating bag. Do not attempt to use a faulty piece of equipment as injury can occur to both you and/or the baby.**
**T-pieces**

These come in different guises depending on the manufacturer (see Figures 19 and 20). In all cases the pressures are set by the operator. All systems deliver a peak inspiratory pressure (PIP) when the operating valve is occluded by the operator’s finger. The pressure is set by the operator before starting resuscitation and this remains the same from breath to breath until the operator makes a change. Some systems can additionally deliver positive end expiratory pressure (PEEP) or Continuous Positive Airways Pressure (CPAP); other systems can deliver “breaths” automatically (essentially they become a ventilator).

![Figure 19: The T-piece system. A number of manufacturers have begun fitting these to their resuscitaires.](image)

This is the ‘Tom Thumb’ available from Viamed Ltd., 15 Station Road, Cross Hills, Keighley, West Yorkshire (see [http://www.viamed.co.uk/products/resus/infant_resus.htm](http://www.viamed.co.uk/products/resus/infant_resus.htm))

The system is essentially an oxygen supply, a pressure control valve with manometer, and a T-piece attached to the face mask.

![Figure 20: This is the Fisher & Paykell Neopuff® (see [http://www.fphcare.com/neonatal/resuscitation.asp](http://www.fphcare.com/neonatal/resuscitation.asp)) which can be found as a stand-alone unit or may be incorporated into their resuscitaires.](image)
T-piece systems essentially consist of:

- A variable flow control
- A peak pressure control
- An end expiratory control (available on some models only)
- A manometer
- An oxygen / air blender (available on some models only)
- Auto vent (available on some models only)
- Gas flow (on/off)
- Auxiliary gas.

The principle of operation of the different systems is the same. The set pressure (30 cm H₂O in term infants) is delivered to the patient for as long as the hole in the delivery set is occluded by the operator's finger (Figure 21). When the hole is released the pressure falls to zero (or to the preset PEEP if this feature is available). In order to achieve adequate inflation the flow rate is set between 5 and 10 litres (usually 6). The T-piece needs a gas supply. The concentration of oxygen depends on the availability of both compressed air and compressed oxygen supplies. A blender allows the operator to choose oxygen concentrations between 21% and 100%.

The T-piece can deliver free flowing oxygen to the spontaneously breathing infant if required.

Figure 21: Operation of the T-piece is as simple as occluding the hole with your thumb. You can then concentrate on correct positioning of the mask and holding the head in the neutral position.

Poor diagram - overextended and mask not held in place
How do you control the oxygen and pressure in a T-piece?

The concentration of oxygen within a T-piece system is entirely dependent on the gas supply. If there is only a supply of compressed oxygen the T-piece will deliver 100% oxygen only. Only if there are supplies of both compressed air and oxygen with a blender (Figure 22) can the oxygen levels be adjusted.

![Figure 22: An example of an oxygen blender – in this case a BIRD Low Flow MicroBlender (VIASYS Healthcare Inc.)](image)

The inspiratory pressure delivered by the T-piece device is set by the pressure control valve. This should be clearly marked on all systems. Normally this would be at 30 cm H₂O for term babies, but can be adjusted in the case of preterm babies. Check the pressure as described below before using the device on a baby.

Normally the flow rate should be set to 6 litres/minute – this should be sufficient for most cases. If the pressure control is at maximum and required pressure is not reached the flow rate can be increased.

Where positive end expiratory pressure is required and a PEEP valve is present (for example as found on the Fisher & Paykell Neopuff®), adjust this until the PEEP is 4-5 cm H₂O (figure 23).

![Figure 23: The PEEP valve (found on Fisher & Paykell Neopuff® is a screw top valve that can be opened or closed by the operator. The more tightly the top is closed the higher the PEEP.](image)

Caution should be exercised as the PEEP depends on the closure of this valve AND the flow of gas in the circuit. Too high PEEP levels can be detrimental to the baby.
Testing the T-piece device

Set the flow of gas to 6 litres/minute. Test the circuit by making a seal in the palm of your hand or by using a rubber test lung if one is available (Figure 24). Set the PIP to 30 cm H₂O (for term babies) by adjusting the pressure control. Once set, the pressure delivered with each breath will remain the same until the operator adjusts the pressure control or if there is a leak in the circuit.

**Figure 24:** To check the pressure in a T-piece system, occlude all exits to the T using your thumb and either a rubber lung as shown here or the palm of your hand. You can then adjust the controls to achieve the desired pressure.

If you do not achieve the required pressures, check:

- Is the gas supply on?
- Is your circuit correctly assembled?
- Have you adequately sealed the outlet with your palm or the test lung?
- Is there a leak somewhere in the circuit?
- If it does not work, then discard the device and use a different method of delivering pressure.
Flow-inflating resuscitation bags

Flow-inflating bags (Figure 25), like T-piece systems, require a gas source to work. However they can be used to deliver free flowing 100% O₂. There are several different types on the market – the way in which flow is controlled is the main difference between these.

![Figure 25: The flow-inflating bag consists of the following:
1. A gas inlet - the concentration of oxygen depends on the type of gas(es) used and whether a blender is available
2. A patient outlet to allow the facemask (or endotracheal tube) to be fitted
3. A flow-control valve to adjust the pressures
4. A pressure manometer site so that the operator can see what pressures are being delivered](image)

Gas from either the mains or a cylinder enters the bag via a small inlet designed to fit oxygen tubing. The inlet can be at either end of the bag depending on the brand. As you want to give air for the initial resuscitation there must be an air supply as well as an ‘oxygen’ supply and the gases blended to give the desired concentration of oxygen guided by pulse oximetry.

The blended gas (21–100% O₂) exits the bag at the patient outlet when a mask is attached to the bag. The flow control valve provides an adjustable leak that allows the operator to regulate the pressure in the bag when a seal is created by holding the mask firmly on the baby’s face.

Many flow-inflating bags allow a pressure manometer to be attached thus enabling monitoring of peak inspiratory pressure (PIP) and positive end expiratory pressure (PEEP). This attachment is usually close to the patient outlet. If the bag has a pressure manometer port, the manometer must be attached, or the attachment site plugged, otherwise the bag will not work.
The bag will not work if:

- There is no gas supply
- There is a leak in the system - this can be due to:
  - An incomplete seal around the facemask
  - A tear in the bag
  - The flow control being open too wide
  - The pressure manometer is not attached or it’s port is not occluded (if a manometer is not being used).

**Using the flow-inflating bag**

Adjust the flow of incoming gas to 5–10 litres. Test the circuit by making a seal with the palm of your hand. Adjust the flow control valve so there is a 5 cm H₂O pressure when not squeezed and 30 cm H₂O when squeezed.

If you cannot achieve the required pressures, check:

- Is there a good seal with the facemask?
- Is there a crack or tear in the bag?
- Is the flow control open too wide?
- Is the pressure manometer attached (or its port occluded to prevent leak)?
- Is the gas supply working and the tubing attached?
- Squeeze the bag at 40-60 times per minute. If it does not fill rapidly enough increase flow rate of gas.

**If all else fails - get a new bag.**
Further reading

The two most commonly used textbooks for newborn resuscitation are:

The following is a selection of various papers that show the ILCOR guidelines and the science behind them:

The following are some of the papers that look at some of the changes between the 2005 and 2010:

The following papers look critically at different aspects of newborn resuscitation equipment:

Other references:
Nursing and Midwifery Council Guidelines for Records and Record Keeping (2009)
http://www.nmc-uk.org/

Acknowledgements

Figures 1, 2, 3, 6 - 9 and 12 - 15 have been reproduced with kind permission of Dr Sam Richmond, Chairman of the Newborn Life Support (NLS) course sub-committee, Resuscitation Council (UK).
Newborn Life Support

**Dry the baby**
Remove any wet towels and cover
Start the clock or note the time

Assess (tone), breathing and heart rate

**If gasping or not breathing:**
Open the airway
Give 5 inflation breaths
Consider SpO2 monitoring

Re-assess
If no increase in heart rate
look for chest movement

**If chest not moving:**
Recheck head position
Consider 2-person airway control
and other airway manoeuvres
Repeat inflation breaths
Consider SpO2 monitoring
Look for a response

If no increase in heart rate
look for chest movement

When the chest is moving:
If heart rate is not detectable
or slow (<60 min⁻¹)
Start chest compressions
3 compressions to each breath

Reassess heart rate every 30 s
If heart rate is not detectable
or slow (<60 min⁻¹)
consider venous access and drugs

Acceptable* pre-ductal SpO2
2 min 60%
3 min 70%
4 min 80%
5 min 85%
10 min 90%

AT
ALL
STAGES
ASK:
DO
YOU
NEED
HELP?