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8.3 Breathing procedures

Emergency needle thoracocentesis
This procedure is used for the rapidly deteriorating patient who has a life-threatening tension pneumothorax (see Section 7.3.A). If this technique is used in a patient who does not have a tension pneumothorax, there is a 10–20% risk of producing a pneumothorax or causing damage to the lung, or both. In such cases, immediate insertion of a chest drain is mandatory. Patients who have undergone
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this procedure should ideally have a chest radiograph, and may require chest drainage if they subsequently need assisted ventilation.

**Minimum equipment**
- Swabs for disinfecting the skin.
- Large over-the-needle IV cannula (16-gauge, but 20- to 22-gauge in preterm infants).
- 20-mL syringe.

**Procedure (see Figure 8.3.1)**

1. Identify the second intercostal space in the mid-clavicular line on the side of the pneumothorax (the opposite side to the direction of tracheal deviation and the same side as the hyper-resonance).
2. Swab the chest wall with surgical preparation solution or an alcohol swab.
3. Attach the syringe to the over-the-needle IV cannula, ideally via a three-way tap.
4. Insert the cannula vertically into the chest wall, just above the rib below to avoid blood vessels, aspirating all the time.
5. If air is aspirated, remove the needle, leaving the plastic cannula in place.
6. Tape the cannula in place and proceed to chest drain insertion as soon as possible.

**Complications**
These include the following:
- local cellulitis
- local haematoma
- pleural infection
- empyema
- pneumothorax.

**Insertion of a chest drainage tube**

In a trauma emergency that requires a chest drainage tube, fluid resuscitation through at least one large calibre IV cannula, and monitoring of vital signs should be ongoing. Usually the patient will be receiving oxygen through a face mask with a reservoir.

Chest drain placement should be performed using the open technique described here, as this minimises lung damage. In general, the largest size of drain that will pass between the ribs should be used.

**FIGURE 8.3.1** Position for inserting over-the-needle cannula for thoracocentesis.

1. Swab the chest wall with surgical preparation or an alcohol swab.
2. Attach the syringe to the over-the-needle IV cannula, ideally via a three-way tap.
3. Insert the cannula vertically into the chest wall, just above the rib below to avoid blood vessels, aspirating all the time.
4. If air is aspirated, remove the needle, leaving the plastic cannula in place.
5. Tape the cannula in place and proceed to chest drain insertion as soon as possible.

**Complications**
These include the following:
- local cellulitis
- local haematoma
- pleural infection
- empyema
- pneumothorax.

**FIGURE 8.3.2** Sites for chest drain: 4th or 5th intercostal space in the anterior or mid-axillary line.

**Procedure**

1. Consider using analgesia or sedation in a small or apprehensive child.
2. Wash your hands and arms to the elbows, and wear a mask, surgical hat (bonnet), sterile gown and sterile surgical gloves.
3. Decide on the insertion site (usually the fourth or fifth intercostal space in the anterior or mid-axillary line) on the side with the pneumothorax (see Figure 8.3.2).
4. Swab the chest wall with surgical preparation or an alcohol swab.
5. Use local anaesthetic if the child is conscious. Morphine (100 micrograms/kg IV over 10 minutes) should also be given if the child is conscious, but in the preterm infant who is not ventilated this may precipitate apnoea. Facilities to provide bag-and-mask ventilation and/or intubation should be immediately available, together with staff trained in their use.
6. Make a 2- to 3-cm skin incision along the line of the intercostal space, immediately above the rib below to avoid damage to the neurovascular bundle which lies under the inferior edge of each rib.
7. Using artery forceps, bluntly dissect through the subcutaneous tissues just over the top of the rib below, and puncture the parietal pleura with the tip of the forceps.
Diagnostic procedure

Tapping the chest for diagnostic tests in pleural effusions or empyema

Consider giving the child analgesia or light anaesthesia with ketamine.

- Wash your hands and put on sterile gloves.
- Lie the child on their back.
- Clean the skin over the chest with an antiseptic solution (e.g. 70% alcohol).
- Select a point in the mid-axillary line (at the side of the chest) just below the level of the nipple (fifth intercostal space; see Figure 8.3.2).
- Inject about 1 mL of 1% lignocaine into the skin and subcutaneous tissue at this point.
- Insert a needle or needle-over-catheter through the skin and pleura, and aspirate to confirm the presence of pleural fluid. Withdraw a sample for microscopy and other tests and place it in a container.
- If the fluid is clear (straw-coloured or brownish), pull out the needle or catheter after withdrawing enough fluid to relieve distress, and put a dressing over the puncture site. Consider a differential diagnosis of tuberculosis (see Section 6.1.N).
- If the fluid is thin pus or cloudy (like milk), leave the catheter in place so that you can draw out more pus several times a day. Make sure that you seal the end of the catheter so that no air can get in.
- If the fluid is thick pus which cannot pass easily through the needle or catheter, insert a chest tube as described above.

Non-invasive respiratory support (see Section 1.25)

Respiratory support is needed when the patient fails to sustain adequate ventilation despite treatment of the respiratory condition. Respiratory failure may result from any of the following:

- respiratory illnesses
- severe shock
- coma
- convulsions
- meningo-encephalitis
- neuromuscular disorders
- raised intracranial pressure (e.g. from trauma).

Infants and young children are more likely to progress to respiratory failure because:

- they are more susceptible to infection
- their airways are smaller
- their thoracic cage is more compliant
- their ribs are (nearer) horizontal
- their respiratory muscles are more prone to fatigue.

Women and girls who are pregnant are also more susceptible to respiratory failure. They have reduced immune function, an expanding abdominal mass which impairs lung expansion, and are more prone to gastro-oesophageal reflux and aspiration of gastric contents.

As respiratory failure progresses, it will ultimately lead to cardiorespiratory arrest and death. Thus recognition of the severity of the conditions that lead to respiratory failure, followed by appropriate treatment, will reduce morbidity and mortality.

**Signs** that indicate the adequacy of breathing include the following:

- intercostal, sub-costal and supra-ternal recession
- respiratory rate
- inspiratory and expiratory noises

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9 Put a gloved finger into the incision and clear the path into the pleura. This will not be possible in infants or small children, in which case continue to use the artery forceps.

10 Advance the chest drain tube (use the largest size that can comfortably pass between the ribs) into the pleural space without the trocar in place, but using the artery forceps to help to guide it into the pleural cavity if necessary. Pass about 3 cm and then connect to the underwater seal. Ideally advance the chest drain tube into the pleural space during expiration.

11 Ensure that the tube is in the pleural space by looking for fogging of the tube during expiration.

12 Ensure that all of the drainage holes of the chest drain tube are inside the chest.

13 Connect the chest drain tube to an underwater seal. Check that the tube is in the right place by observing intermittent bubbling of the water in the drainage bottle.

14 Secure the tube using a suture passed through the skin at the incision site (after ensuring that adequate local anaesthetic has been administered) and tied around the tube.

15 Cover the puncture site in the chest wall with a sterile dressing, and tape the chest tube to the chest wall.

16 Obtain a chest radiograph if at all possible.

If the chest drainage tube is satisfactorily positioned and working, occasional bubbles will pass through the underwater seal. The water level in the tube may also rise and fall slightly with the respiratory cycle.

**Complications of chest drainage tube insertion**

- Dislodgement of the chest drain tube from the chest wall or disconnection from the drainage bag.
- Drainage bag elevated above the level of the chest, and fluid flowing into the chest cavity, unless there is a one-way valve system.
- Chest drain tube kinking or blocking with blood clot.
- Damage to the intercostal nerve, artery or vein. This might convert a pneumothorax to a haemopneumothorax, or result in intercostal neuritis or neuralgia.
- Damage to the internal thoracic artery if the puncture is too medial, resulting in haemopneumothorax.
- Incorrect tube position, inside or outside the chest cavity.
- Infection of pleural fluid (e.g. thoracic empyema).
- Laceration or puncture of interthoracic or abdominal organs. This can be prevented by using the finger technique before inserting the chest tube.
- Leaking drainage bag.
- Local cellulitis.
- Local haematoma.
- Mediastinal emphysema.
- Persistent pneumothorax from a large primary defect; a second chest tube may be required.
- Subcutaneous emphysema (usually at the tube insertion site).
use of accessory muscles
- adequacy of breath sounds and chest expansion
- heart rate
- skin colour
- mental status.

To help to assess the development of respiratory failure, it is necessary to assess changes in the above clinical signs. In the following situations, however, these signs are less useful because there is absent or decreased effort of breathing:
1. with fatigue or exhaustion (e.g. after prolonged respiratory effort)
2. with loss of cerebral drive from raised intracranial pressure, poisoning or encephalopathy
3. in children with neuromuscular disease.

In these cases, pay more attention to the chest expansion, heart rate, skin colour, mental status and, if available, \( \text{SaO}_2 \) measurement.

Pulse oximetry is of additional value to measure the arterial oxygen saturation through the skin (\( \text{SpO}_2 \) or \( \text{SaO}_2 \)). Values of \( \text{SpO}_2 \) of less than 92–94% in air (at sea level; see Section 1.13 for values at high altitude) are abnormal, and would warrant at least initial treatment with additional inspired oxygen. Values of less than 95% when the child is in oxygen are low, but even values of more than 95% in oxygen may be associated with significant hypoventilation. It is essential to remember that, in respiratory failure, normal \( \text{SaO}_2 \) while receiving additional inspired oxygen is likely to be associated with significant hypoventilation or intra-pulmonary shunting. Measurement of transcutaneous, end-expired or blood carbon dioxide levels will confirm this.

### TABLE 8.3.1 Modes of respiratory support for different conditions

<table>
<thead>
<tr>
<th>Mode of support</th>
<th>Interface with patient</th>
<th>Level of nursing care</th>
<th>Associated medical treatment</th>
<th>Clinical use</th>
<th>Examples of conditions treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-flow high-humidity oxygen</td>
<td>Nasal cannulae</td>
<td>Home, ward, HD</td>
<td>Nil</td>
<td>To provide a flow above the patient’s needs, that helps to wash out dead space, and improves comfort and clearance of the airways. It may provide mild CPAP</td>
<td>Bronchiolitis, post-operative, chronic lung disease of prematurity</td>
</tr>
<tr>
<td>Continuous positive airways pressure</td>
<td>Nasal cannulae or nasopharyngeal tube</td>
<td>High dependency (HD)</td>
<td>Sedation or analgesia may be needed</td>
<td>To keep upper and lower airways patent and maintain adequate lung volume (oxygenation)</td>
<td>Neonatal respiratory distress syndrome, bronchiolitis</td>
</tr>
<tr>
<td>Intermittent positive pressure ventilation (IPPV)</td>
<td>Nasal mask or pillows, face mask (NIPPV)</td>
<td>Intensive care (IC)</td>
<td>Sedation or analgesia may be needed</td>
<td>To treat hyperventilation (raised CO₂) when airway control and clearance are adequate</td>
<td>Extreme upper airway obstruction before, instead of after extubation</td>
</tr>
<tr>
<td>Endotracheal tube</td>
<td>IC</td>
<td>Anaesthesia for intubation, Sedation or analgesia will be needed</td>
<td>To treat hyperventilation when clearance and/or support of airway(s), or close control of ventilation needed</td>
<td>Procedures or surgery requiring anaesthesia, Severe respiratory illnesses, raised intracranial pressure</td>
<td>Brainstem/high spinal injury or neuromuscular disease</td>
</tr>
<tr>
<td>Tracheostomy</td>
<td>Home to IC</td>
<td>ENT surgical procedure</td>
<td>Long term ventilation where day and night support needed</td>
<td>Bronchiolitis and other severe lower respiratory infections, especially where the nose is blocked by secretions</td>
<td>Brainstem/high spinal injury or neuromuscular disease</td>
</tr>
<tr>
<td>Continuous negative extrathoracic pressure (CNEP)</td>
<td>Chamber or jacket</td>
<td>Home to IC</td>
<td>Nil</td>
<td>To keep lower airways patent and maintain adequate lung volume</td>
<td>Bronchiolitis (e.g. apnoea of prematurity, neuromuscular disease)</td>
</tr>
<tr>
<td>Intermittent negative pressure ventilation (INEP or INPV)</td>
<td></td>
<td></td>
<td></td>
<td>To treat hyperventilation where airway control and clearance are adequate or maintained by CPAP</td>
<td>Central hypoventilation (e.g. apnoea of prematurity, neuromuscular disease)</td>
</tr>
</tbody>
</table>

Shaded areas denote those that require a lower dependency of care (e.g. that have been used in the home setting), but may be useful in acute conditions.

Bold type denotes high-risk situations in which CPAP may be ineffective and intubation may be required.
When respiratory fatigue is severe, oxygenation is poor or deteriorating, or carbon dioxide levels are raised, respiratory support should be used, if available. The various forms of respiratory support are outlined in Table 8.3.1, along with their indications.

**Notes on the use of positive pressure ventilation**

1. Monitoring of patient status and airway or mask pressures is necessary when undertaking any form of respiratory support (see below).
2. Positive airway pressure involves a flow of air or other gas mixture to the patient’s airways. This flow may be continuous (as in CPAP) or intermittent (as in IPPV). It may vary with inspiration and expiration (as in BiPAP), or to accommodate the leaks or variable compliance of ventilator tubing, airways or lung units.
3. Mask ventilation can be well tolerated by children, but it may be more difficult for infants and young children to tolerate appliances on their face.
4. In the presence of excess airway secretions or an open mouth, nasal masks and nasal cannulae may not produce as effective airway pressures as ventilation with tracheal intubation (or relatively higher pressures may be needed for the same effect).
5. The pressures used with masks and cannulae may be higher than those used with tracheal intubation, because of the greater potential for air leaks and other volume loss in compliant upper airway structures.
6. Infants and young children will sometimes tolerate masks and cannulae only with the use of sedation, in which case close monitoring of respiratory failure must be undertaken in case full intubation and ventilation is needed.
7. Endotracheal intubation should be undertaken with rapid sequence drug or gaseous induction, and subsequent analgesia, anxiolysis and sedation should be provided.
8. Positive pressure ventilation administered through an endotracheal tube must be accompanied by adequate humidity of the inspired gases.
9. Oxygen may be administered either using a built-in mixer in the ventilator, or by entraining a supply in the ventilator tubing nearer to the patient.
10. Positive pressure ventilators should be able to provide manipulation of either the pressure or volume administered, and the time intervals for inspiration and expiration. There should be alarms for failure to cycle, and for excessive pressure and/or volume administered.

**Continuous positive airway pressure (CPAP)**

CPAP has several effects on the airway and lungs of the preterm and full-term infant. These include prevention of alveolar collapse, increased functional residual capacity (FRC), and splinting of the airway. It is therefore of most value when used early in the course of respiratory disease (i.e. before too much alveolar collapse has taken place). Several units around the world use it successfully as first-line ventilatory support in even the smallest infants (< 750 grams birth weight).

**Indications for CPAP**

These include the following:

- signs of significant respiratory distress (tachypnoea, recession, grunting, nasal flare)
- diseases with low FRC (respiratory distress syndrome, transient tachypnoea of the newborn, pulmonary oedema)
- meconium aspiration syndrome
- apnoea and bradycardia of prematurity
- tracheomalacia.

**Requirements**

- Low-resistance delivery system.
- Large-bore tubing.
- Short wide connection to patient.
- Consistent and reliable pressure generation.
- Appropriate snug-fitting nasal cannulae.
- Well-positioned and secured nasal cannulae.
- Prevention of leaks, mainly via the mouth, with a chinstrap.
- Optimally maintained airway.
- Ideally warmed humidified gas.
- Prevention of neck flexion or over-extension with a neck roll.
- Regular suction to remove secretions.
- Meticulous and consistent technique.

**Monitoring**

- Continuous heart and respiratory rate monitoring.
- Continuous pulse oximetry, ideally pre-ductal.
- Blood gas measurements. These need not be done regularly in the stable baby with low oxygen needs unless they are required in order to assess the degree of metabolic acidosis, but in those with high oxygen requirements (FiO2 > 40%) or in the unstable baby they should be checked regularly via an arterial line.

**Complications**

- Nasal septum erosion/necrosis: this is a result of ill-fitting nasal cannulae, and can be avoided by the fitting of snug, but not tight, cannulae (blanching of the overlying skin suggests that the cannulae are too large) which are held firmly in place to prevent rubbing as the child moves.
- Pneumothorax: all methods of artificial ventilation are associated with this problem. However, the more effective the CPAP is the less the work of breathing and therefore the lower the risk of pneumothoraces should be. Any pneumothorax that does occur should be drained appropriately. It is inappropriate to discontinue the CPAP.
- Gastric distension from swallowed air: this is important and is easily overcome by the venting of any such air via an open orogastric tube.
**Insertion and securing of nasal cannulae and administration of CPAP**

**FIGURE 8.3.3** Securing nasal cannulae for giving continuous positive airway pressure (CPAP) in a baby. A special bonnet is used from which tapes hold the pipe carrying the air/oxygen mixture to the nasal cannulae to the forehead and a separate tape above the mouth to ensure the cannulae do not come out of the nasal passages.

**FIGURE 8.3.4** Simplified diagram of Hudson continuous positive airway pressure (CPAP). The gas flow is adjusted until a continuous trail of bubbles starts to appear in the water bottle, which is at the same height as the baby. This generates a CPAP of +5 cmH₂O.

When the child is inside the chamber, the breathing rate falls, the effort of breathing is reduced, and thus less energy is needed for breathing.

**Indications**
- Respiratory failure due to lung problems:
  - bronchiolitis
  - other causes of acute respiratory infection where the nasal airway is blocked and nasal CPAP is not possible.
- Respiratory failure due to weakness of respiratory muscles:
  - poliomyelitis.

**Advantages**

**Continuous negative extra-thoracic pressure**

Continuous negative extra-thoracic pressure (CNEP) is a method by which sub-atmospheric pressure is applied to the outside of a child’s chest by nursing them in a specially designed chamber. The patient’s head is kept outside the chamber, thereby allowing the nose, mouth and all the airways into the lungs to remain at atmospheric pressure. As a result of this pressure difference, the chest is expanded and air is encouraged to enter the lungs. Areas of lung that were previously poorly inflated may be expanded, and this allows more chance for recovery from the lung disease.

The use of CNEP depends upon continued breathing efforts by the child to move air into and out of the lungs.

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- Respiratory failure due to lung problems:
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  - poliomyelitis.

**Advantages**

- The absence of airway invasion:
  - avoids trauma to the airways
  - reduces the need for suctioning
  - lowers the risk of introducing infection into the lungs
  - is more comfortable for the patient, so there is less need for sedation.

- Less complex equipment:
  - can be managed on a general ward or at home
  - is not difficult for healthcare workers and parents to learn how to use
  - means that there is less utilisation of intensive care resources
  - is quick to institute, not requiring medical or anaesthetic staff.

- Physiological (compared with positive pressure) ventilation:
  - does not increase pulmonary vascular resistance
  - is less likely to significantly reduce cardiac output
  - enhances lung perfusion, as well as ventilation.

**Disadvantages**

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  - is less likely to significantly reduce cardiac output
  - enhances lung perfusion, as well as ventilation.

**Disadvantages**

The use of CNEP depends upon continued breathing efforts by the child to move air into and out of the lungs.
inspiration may be increased, thus exacerbating pre-existing upper airway obstruction. Respiratory support may need to be interrupted for short periods.

- This means it is less suitable where the need for support to ventilation is critical and continuous
- It is also not suitable if the patient’s own ventilatory efforts are inadequate to remove carbon dioxide.

Maintenance of body temperature in newborn infants may require specific attention.

**Components of negative pressure system**

**The chamber**

For low-birth-weight infants the chamber is built on to an incubator base incorporating a cabinet and heater, the latter providing servo-controlled circulation of hot air into the interior of the chamber. Particular features of the chamber shown in Figure 8.3.5 include the following:

1. Release for the head section
2. Rods upon which the head section slides out away from the chamber base
3. Headbox
4. Latex rubber neck seal fixed on to the arch of the lid
5. Gas strut hinges
6. Foam gasket or cuff on the porthole
7. Porthole for infusions, monitoring leads, etc.
8. Footplate to support the infant when the chamber is tilted up
9. Compressible rubber strips below which leads, etc. can enter the chamber
10. Tubing to the pressure monitor.

**The neck seal**

This is a piece of latex rubber with a circular hole 2–5 cm in diameter, situated near the bottom end. This is fitted around the infant’s neck overlying the neck protector.

**The neck protector**

This is a piece of two or four thicknesses of ribbed cotton tubular stockinet. Two holes cut in the sides allow this to be fitted like a polo-necked vest over the infant.

**The suction unit**

This incorporates an electrical fan with a valve which provides variable levels of continuous suction. The valve is adjustable by a pressure control knob. A suction hose connects from the suction unit to the base of the chamber.

**The pressure monitor**

This can be a simple calibrated U-tube containing coloured alcohol or other fluid, or a more sophisticated pressure monitor.

**Safety**

1. Special care must be taken not to trap the fingers or toes when closing the lid.
2. To avoid damaging the monitor leads, these must pass either (1) through the diaphragm at the base of the chamber, or (2) between a rubber strip at the foot end of the chamber and a second rubber strip on the lower edge of the lid. The monitor leads will be damaged and pressure lost if they are brought out through the sides of the chamber between the unprotected Perspex edge of the lid and the rubber seal on the base.

**Care of infants who are receiving CNEP**

**Feeding**

While receiving negative pressure, the patient would not usually be fed orally. Feeds should be given via a nasogastric tube, and this tube should be clamped off when not in use. Do not leave the tube open to air or the stomach may become distended.

If the baby develops problems with abdominal distension, the stomach should not be left on free drainage in the conventional way. Either frequent aspiration of the stomach contents should be performed, with the tube clamped off in the intervening time, or the end of the tube can be put through the neck seal (in between the silicone gel and the vest) and the tube left on free drainage inside the chamber.

If the baby’s clinical condition allows this, they may be taken out of the chamber at regular intervals for breastfeeding or cup feeds.

**Procedures**

Most procedures, such as re-siting of an IV line, can be performed while the infant is receiving negative pressure.
When the arms are inserted through the portholes, sub-atmospheric pressure can be maintained by the close-fitting cuffs around the forearms.

Excessive body movement may occur during sudden loss of negative pressure when the porthole is opened or the arm removed from the cuff. This may be quite disruptive to the baby. Therefore it is preferable to minimise the number of times this occurs by taking into the chamber all the items which are needed for the procedure. When the cuffs or gaskets become soiled or torn, they must be replaced immediately.

Neck care
Pay particular attention to the patient’s neck, observing it for soreness frequently, at 6- to 8-hourly intervals if possible when the patient is turned. It is important to ensure that all the layers of the neck seal are in place and that the latex does not come into contact with the baby’s skin. It is not necessary to replace the neck seal components unless they are soiled or damaged. If they are in place for a prolonged period, especially in the case of a newborn preterm baby whose skin may scale and shed, it is probably better to wash and dry the neck at regular intervals when the clinical condition allows, preventing colonisation by skin commensal bacteria.

It is also important to frequently check the neck to ensure that the latex does not become too tight if the baby becomes oedematous. If this happens it is important to replace the latex with a larger size.

Controlling body temperature
The important principle to follow in the control of body temperature of babies who are receiving negative pressure is the prevention of hypothermia, rather than its treatment. Due to convective and radiant heat loss the baby is much more likely to cool rapidly and be more difficult to warm up than in the conventional incubators.

Plastic sheeting or bubble wrap may be placed over the infant’s body to create a ‘micro-environment’.

An overhead radiant heater may be used as an additional heat source over the headbox or chamber.

Management of problems that may arise

Inadequate pressure

- Excess leak at neck:
  - Stack the latex into the arch in the lid.
  - Move the baby upwards.
  - Reposition the latex.
  - Double the thickness of stockinet collar under the latex.
  - Use latex with a smaller hole (if a large leak is present).
- Excess leak between chamber and base of chamber:
  - Tighten the quick-release lid and base catches.
  - Replace the rubber strip gasket around the chamber base.
- Excess leak at the portholes:
  - Renew the cuffs or foam gaskets.
  - Tighten or secure the iris diaphragm porthole.
- Inadequate suction pressure:
  - Check that the hose is plugged in at both ends.
  - Check that the access hole for suction inside the chamber is not blocked (e.g. by the sheet).
  - Check the pressure achieved by the suction unit after directly occluding the hose at the end.

Unsettled baby

- Baby breathing too hard:
  - There may be an inadequate negative pressure.
  - Check for upper airway obstruction.
  - Check for stridor, tracheal tug and carbon dioxide retention.
  - A different method of respiratory support may be needed.
- Anxiety:
  - Give reassurance and/or sedation to make the baby comfortable.
- Sore neck:
  - Check the neck and treat sore areas to relieve discomfort.

Abdominal distension

- Air swallowing:
  - Close the nasogastric tube.
  - Undertake more frequent suction or free drainage inside the chamber.

Cold baby

- Excess leak:
  - See the section on ‘Inadequate pressure’.
- Cold environment:
  - Provide an overhead heater.
  - Humidify the chamber.
  - See the guidelines on temperature.

Problem: neck soreness

- Pressure or contact allergy:
  - Ensure that at the neck seal there is at least a fourfold thickness of stockinet between the latex and the skin.
  - If the latex is stretched too tightly, the baby may be suspended at the neck. Release and pleat it as described above.
  - The hole in the latex may be too small, so revise it if necessary.

Inadequate oxygen in the headbox

- Excess leak at the neck:
  - See the section on ‘Inadequate pressure’.
- Inadequate oxygen:
  - Seal the top and sides of the headbox (e.g. with cling film).
  - Adjust the flow and/or concentration.
  - Two supplies of high-flow humidified 100% oxygen may be needed to provide a high concentration in the headbox.

Physiotherapy for suppurative lung diseases

Therapy for bronchiectasis, cystic fibrosis and other conditions with excess airway secretions is described here.

Postural drainage

This is positioning to allow drainage by gravity from lung segments to central airways.

For infants, use a maximum of five positions in 10 minutes, progressing in older children to two to three positions in up to 30 minutes.
FIGURE 8.3.7 Positions for postural drainage.
Upper lobe
- Apical segments: sitting (1).
- Posterior segments: prone, one pillow below the affected side (2).
- Anterior segment: supine (3).

Middle lobe/lingual
- Chest tipped 15 degrees below the horizontal, lying supine, with a pillow supporting the ipsilateral hip and shoulder (4).

Lower lobe
- Apical segments: prone (5).
- Anterior basal: chest tipped 20 degrees below the horizontal, lying supine (6).
- Lateral basal: chest tipped 20 degrees below the horizontal, lying on the unaffected side (7).
- Posterior basal: chest tipped 20 degrees below the horizontal, lying on the unaffected side (8).

Figure 8.3.7 shows all of these positions in sequence.

Equipment
Carer’s lap (in the case of an infant), otherwise bean bags, pillows or a tilted bed.

Adjuncts to postural drainage
The following may be combined with postural drainage:
- chest clapping: done over the area to be cleared with a cupped hand
- chest shaking: fine manual shaking in line with rib motion during the expiratory phase of breathing
- active cycle of breathing: relaxed tidal breathing, four deep breaths to maximal inspiration with hold, and relaxed expiration. Huff – that is, forced expiration at mid
- to low lung volumes with the glottis open (as if misting glass), cough to clear secretions, and repeat the cycle until the chest is clear.

Note where bronchoconstriction is an issue:
1. Increase the amount of time spent doing tidal volume breathing.
2. Omit percussion.
3. Increase tidal volume breathing and omit percussion.

Consider the use of inhaled bronchodilators (e.g. salbutamol 200–500 micrograms inhaled through a spacer) (see Section 5.2.B).

Relative contraindications
These include the following:
- raised intracranial pressure
- severe hypertension
- after abdominal surgery
- after major haemoptysis
- pulmonary oedema
- surgical emphysema
- after treatment of tension pneumothorax
- cardiac arrhythmias
- gastro-oesophageal reflux (only omit postures with upper body dependent).

Patient positioning
- To maximise ventilation–perfusion matching (e.g. in pneumonia, asthma, pneumothorax) in self-ventilating patients, position with the better ventilated lung uppermost.
- In severely breathless patients, use sitting with a forward lean, or the recovery position. Use pillows to raise and support the chest if the patient cannot tolerate lying flat.

8.4 Circulatory procedures

Access to and support for the circulation is vital in emergency care, to draw blood samples for diagnosis and monitoring, to infuse fluid to restore circulating volume and improve perfusion, to transfuse blood and to give treatment drugs. This section describes and illustrates many means of access to the circulation, and includes guidance on safe drug and fluid infusion.

Also included are circulatory support procedures such as defibrillation and pericardiocentesis, and techniques for other non-parenteral routes of drug administration, including intramuscular (IM), subcutaneous (SC) and intradermal (ID) injections.

8.4.A Minimising error in drug and fluid administration: giving injections

General points on safety
The information given below is adapted from the Neonatal Formulary, 11th edition (BMJ Books).

1. Drug vials once reconstituted do not contain preservatives or antiseptic. Therefore multiple sampling from them is potentially hazardous.