3 Pre-oxygenate every child prior to intubation.

4 Introduce the laryngoscope into the right side of the mouth, sweep the tongue to the left, and advance the blade until the epiglottis is seen.
   - Curved blade: advance the blade anterior to the epiglottis, and lift the epiglottis forward by moving the blade away from your own body.
   - Straight blade: advance the blade beneath the epiglottis into the oesophagus, pull back, and the glottis will ‘flip’ into view.
   - Recognise the glottis.
   - Insert the endotracheal tube gently through the vocal cords.
   - Stop at a predetermined length.

5 Confirm that placement is correct.
   - The chest moves up and down with ventilation and equally on both sides.
   - Listen to breath sounds in the axillae and anterior chest wall.
   - Confirm that there are no breath sounds in the stomach.
   - Oxygen saturations do not go down.

6 Secure the tube.

If you are skilled, proceed to nasal intubation. This is best for long-term ventilation, but is contraindicated in base of skull fracture.
   - Fresh gas flow through T-piece circuit to prevent re-breathing $CO_2$.
   - Minute ventilation (MV) is $1000\,\text{mL} + 100\,\text{mL/kg}$.
   - For spontaneous ventilation: $3 \times MV$.
   - For positive pressure ventilation: $1.5 \times MV$.
   - Minute ventilation = rate $\times$ tidal volume.
   - Ventilator rates and tidal volumes (by hand or mechanical).
   - Tidal volume is that which is enough to see the chest expand adequately, or $5–10\,\text{mL/kg}$.

   Rates:
   - neonates: 30–40 breaths/minute
   - infants: 25–30 breaths/minute
   - children: 20 breaths/minute
   - adolescents: 15 breaths/minute.

Further reading

1.25 Non-invasive respiratory support

Introduction
Respiratory support is needed when the patient fails to sustain an adequate airway, oxygenation or ventilation, despite treatment of the condition leading to respiratory failure. Respiratory failure may result from:
   - respiratory illnesses
   - severe shock
   - coma
   - convulsions
   - meningitis-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 airway is smaller
   - their thoracic cage is more compliant
   - their ribs are (nearer) horizontal
   - their respiratory muscles are more prone to fatigue.

Pregnant women and girls 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.

Use of respiratory support
The following clinical signs should be observed when assessing the adequacy or inadequacy of breathing:
   - intercostal, sub-costal and supra-sternal recession
   - respiratory rate
   - inspiratory and expiratory noises
   - 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 clinical signs listed above. In the following situations, however, these signs are less useful because there is absent or decreased work of breathing:
   - in patients with fatigue or exhaustion (e.g. after prolonged respiratory effort)
In those with cerebral depression due to raised intracranial pressure, poisoning or encephalopathy in children with neuromuscular disease.

In these cases, pay more attention to the chest expansion and air entry on auscultation of the chest, heart rate, skin colour, mental status and, if available, SaO₂ measurement.

Pulse oximetry measures the arterial oxygen saturation through the skin (SpO₂ or SaO₂). Values of SpO₂ lower than 94% in air at sea level (for values at high altitude, see Section 5.1.D) are abnormal and would warrant at least initial treatment with additional inspired oxygen. Values of less than 85% in oxygen are very low, but even values greater than 95% in oxygen may be associated with significant hypoventilation. It is essential to remember that, in respiratory failure, even a normal SaO₂ while receiving additional inspired oxygen is likely to be associated with significant hypoventilation or intrapulmonary shunting. Measurement of transcutaneous, end-expired or blood carbon dioxide levels will confirm this.

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 1.25.1, along with their indications.

### TABLE 1.25.1 The various forms of respiratory support, with nursing care and medical treatment required, and examples of relevant conditions treated

<table>
<thead>
<tr>
<th>Mode of respiratory 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 relevant 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 (CPAP)</td>
<td>Nasal cannulae or nasopharyngeal tube</td>
<td>HD</td>
<td>Sedation or analgesia may be needed</td>
<td>To keep the upper and lower airways patent and maintain adequate lung volume (oxygenation)</td>
<td>Neonatal respiratory distress syndrome, bronchiolitis*</td>
</tr>
<tr>
<td></td>
<td>Nasal mask or face mask</td>
<td>Home, ward, HD</td>
<td>Nil</td>
<td></td>
<td>Sleep-related upper airway obstruction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intensive care (IC)</td>
<td>Sedation or analgesia may be needed</td>
<td></td>
<td>Acute upper airway obstruction before, instead of* or after extubation</td>
</tr>
<tr>
<td>Intermittent positive pressure ventilation (IPPV)</td>
<td>Nasal mask or pillows, face mask (NIPPV)</td>
<td>Home to IC</td>
<td>Nil</td>
<td>To treat hypoventilation (raised CO₂) when airway control and clearance are adequate</td>
<td>Chronic (e.g. central, neuromuscular) Acute (e.g. after surgery)</td>
</tr>
<tr>
<td></td>
<td>Endotracheal tube</td>
<td>IC</td>
<td>Anaesthesia for intubation. Sedation or analgesia will be needed</td>
<td>To treat hypoventilation when clearance/support of airway(s), or when close control of ventilation is needed</td>
<td>Procedures or surgery requiring anaesthesia Severe respiratory illnesses, raised intracranial pressure</td>
</tr>
<tr>
<td></td>
<td>Tracheostomy</td>
<td>Home to IC</td>
<td>ENT surgical procedure</td>
<td>Long-term ventilation where day and night support is needed</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 the lower airways patent and maintain adequate lung volume</td>
<td>Bronchiolitis and other severe lower respiratory infections, especially where the nose is blocked by secretions</td>
</tr>
<tr>
<td>Intermittent negative pressure ventilation (INEP or INPV)</td>
<td></td>
<td></td>
<td>To treat hypoventilation where airway control and clearance are adequate or maintained by CPAP</td>
<td>Central hypoventilation (e.g. apnoea of prematurity or neuromuscular disease)</td>
<td></td>
</tr>
</tbody>
</table>

HD, high dependency; IC, intensive care.

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

* High-risk situation, in which CPAP may be ineffective and intubation may be required.
Notes on the use of positive pressure ventilation

1 Monitoring of patient status and either airway or extrathoracic pressures is necessary when undertaking any form of respiratory support except for high-flow, high-humidity oxygen (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 to achieve 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 only tolerate masks and cannulae if sedation is used, in which case close monitoring of respiratory failure must be undertaken in case full intubation and ventilation are needed.

7 Endotracheal intubation should be undertaken with rapid-sequence drug or gaseous induction, and subsequent analgesia, anxiolysis and sedation must 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/volume administered.