⚠ Oxygen administration

Theory

This is the administration of supplementary oxygen when tissue oxygenation is impaired.

The aim is to achieve adequate tissue oxygenation (without causing a significant ↓ in ventilation and consequent hypercapnia or oxygen toxicity) while minimizing cardiopulmonary workload.

▶ Oxygen is a drug with a correct dosage and side effects, which, when administered correctly, may be life saving.

The primary responsibility for oxygen prescription lies with the hospital medical staff. It is good practice to record the following:

- Whether delivery is continuous or intermittent
- Flow rate/percentage used
- What SaO_2 should be

When to treat

- Tissue hypoxia is difficult to recognize, as clinical features are nonspecific. They include altered mental state, dyspnea, cyanosis, tachypnea, arrhythmias, and coma.
- Treatment of tissue hypoxia should correct any arterial hypoxemia (cardiopulmonary defect or shunt, e.g., PE, pneumonia, asthma), any transport deficit (anemia, low cardiac output), and the underlying causes.

▶ Remember, SaO_2/PaO_2 can be normal when tissue hypoxia is caused by low cardiac-output states.

Equipment

See 🕮 p. 546.

Procedure

- Explain what is happening to the patient and ask their permission.
- Choose an appropriate oxygen delivery device (see next page).
- Choose an initial dose:
  - Cardiac or respiratory arrest: 100%
  - Hypoxemia with $PaCO_2$ <40 mmHg: 40–60%
  - Hypoxemia with $PaCO_2$ >40 mmHg: 24% initially
- Decide on the acceptable level of SaO_2 or PaO_2 and titrate oxygen accordingly.
- If possible, try to measure a PaO_2 in room air prior to giving supplementary oxygen. (This is not absolutely necessary, especially if the patient is in severe respiratory distress or is hypoxic.)
- Work with nursing staff, respiratory therapist, or outreach services for support in setting up equipment.
- Apply the oxygen and monitor via oximetry (SaO_2) and/or repeat ABGs (PaO_2) in 30 minutes.
- If hypoxemia continues, the patient may require respiratory support either invasively or noninvasively—consult with a respiratory specialist.
- Stop supplementary oxygen when tissue hypoxia or arterial hypoxemia has resolved.

Hints

- Only 10% of patients with COPD are susceptible to CO_2 retention with oxygen therapy. Use Venturi-style masks and monitor closely.
- Think about what is normal for the individual.

Oxygen administration equipment

The method of delivery will depend on the type and severity of respiratory failure, breathing pattern, respiratory rate, risk of CO_2 retention, need for humidification, and patient compliance.

Each oxygen delivery device (Fig. 18.16) comprises an oxygen supply, flow rate, tubing, interface 9 humidification. (Humidification should be used for patient comfort, presence of thick tenacious secretions, or flows >4 L/min.)

Nasal cannulas

These direct oxygen via two short prongs up the nasal passage They

- Can be used for long periods of time.
- Prevent rebreathing.
- Can be used during eating and talking.

Local irritation, dermatitis, and nose bleeding may occur, and rates of above 4 L/min should not be used routinely.

Low-flow oxygen masks

These deliver oxygen concentrations that vary depending on the patient's minute volume. At these low flow rates there may be some rebreathing of exhaled gases (they are not sufficiently expelled from the mask).

Fixed performance masks

These achieve a constant concentration of oxygen independent of the patient's minute volume.

The masks contain Venturi barrels where relatively low rates of oxygen are forced through a narrow orifice, producing a greater flow rate that draws in a constant proportion of room air through several gaps.

Partial and non-rebreather masks

Masks such as these have a reservoir bag that is filled with pure oxygen and depend on a system of one-way valves that prevent mixing of exhaled gases with the incoming oxygen.

The concentration of oxygen delivered is set by the oxygen flow rate.

High-flow oxygen masks

Masks or nasal prongs generate flows of 50–120 L/min using a high-flow regulator to mix air and oxygen at specific concentrations.

These masks are highly accurate, as delivered flow rates will match a high respiratory rate in patients with respiratory distress. It should always be used with humidification.

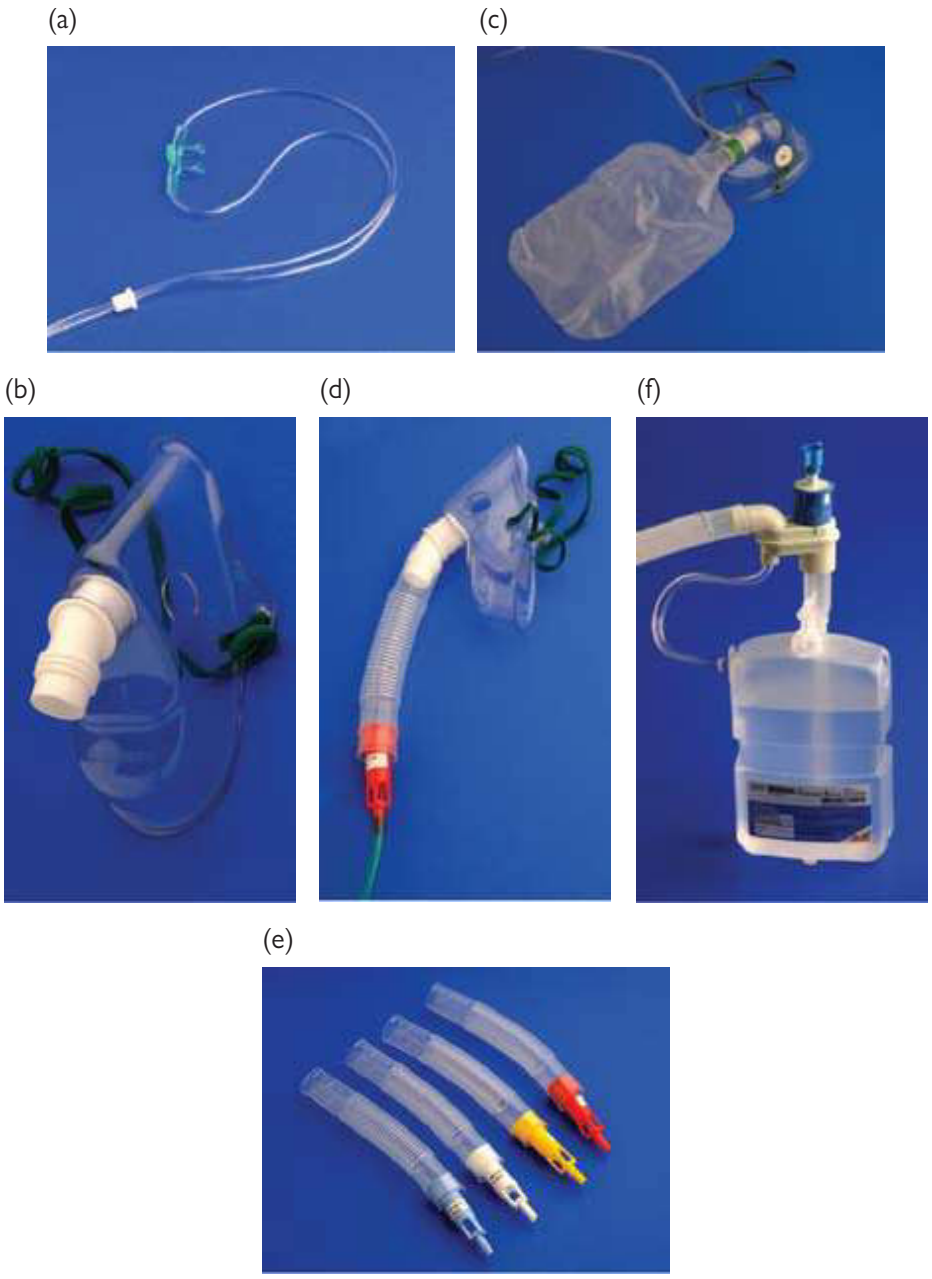

Fig. 18.16 (a) Nasal cannula. (b) Low-flow/variable-concentration mask. (c) Non-rebreather mask. (d) Mask with Venturi valve attached. (e) Selection of Venturi valves. (f) Humidification circuit.

▶ Basic airway management

Theory

An inadequate airway (Box 18.4) leads rapidly to hypoxemia and, if uncorrected, brain damage and death. Endotracheal intubation remains the gold standard for securing an airway and protecting the patient from aspiration (Box 18.5).

Airway management without intubation is an important skill to master and consists of the use of one or more of the following: triple maneuver, face masks, oropharyngeal and nasopharyngeal airways, laryngeal masks, and other supraglottic devices, e.g., Combitube. It may be carried out when intubation equipment or skills are unavailable, if intubation is difficult, or on a patient with a partially obstructed airway.

Urgency is an important factor in planning and securing an airway in the most appropriate manner. This will depend on risk of vocal cord injury, degree of patient cooperation, anatomy of airway, equipment at hand, and your own experience.

Before you start

▶ Think about simple positioning and the recovery position of the patient, especially for airway protection alone.

Assess for airway obstruction:

- LOOK (into mouth and for chest or abdominal movement)
- LISTEN (snoring, gurgling, wheezing)
- FEEL (expired air)

▶ Complete airway obstruction is *silent*.

Make sure that you have the following:

- Oxygen tubing
- Suction equipment
- Ambu-bag
- Rebreather bag

Hints

- A fully conscious, talking patient is able to maintain his or her own airway and needs no further assessment.

❗ Do not use a head tilt or chin lift in suspected cervical spine injury, except as a last resort.

Airway maneuvers

The following techniques are performed with the patient lying supine, and all aim to open the airway with simple physical maneuvers. These are

Box 18.4 Common causes of airway obstruction

- Tongue (due to unconciousness)
- Soft tissue swelling (trauma, tumor)
- Foreign material (blood, vomit)
- Direct injury
  - Secretions
  - Bronchospasm

Box 18.5 Secure airways

A secure airway may be necessary in patients with the following:
- Apnea
- Glasgow Coma Scale <9/15
- High aspiration risk
- Respiratory failure
- Unstable mid-face trauma
- Airway injuries

useful as a first step in managing a patient with a compromised airway and are used in conjunction with an oxygen mask. They are also useful in situations where no airway devices are available.

If unsuccessful, you should go on to use additional equipment.

Head tilt

Place your hands around the patient's forehead and tilt backward to achieve upper cervical extension (Fig. 18.17).

Chin lift

- This is usually used with the head tilt.
- Place the tips of the index and middle fingers of your right hand under the front of the patient's mandible.
- Lift up, pulling the mandible anteriorly (Fig. 18.18).

Jaw thrust

- Use this maneuver if there is suspicion of an injury to the cervical spine. This is a two-handed technique.
- Holding the patient from behind, place the fingers of both hands behind the angle of the mandible.
- Lift the mandible with these fingers while using your thumbs to displace the chin downward, opening the mouth (Fig. 18.19).

▶ Hint

❗ Do not use a head tilt or chin lift in a patient with (or suspected to have) cervical spine injuries.

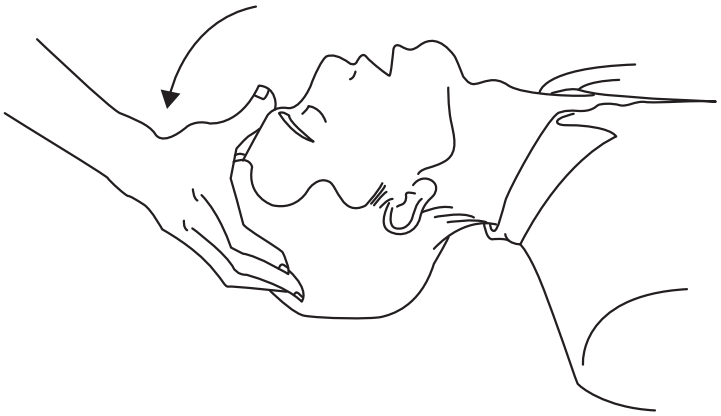

Fig. 18.17 Performing a head tilt.

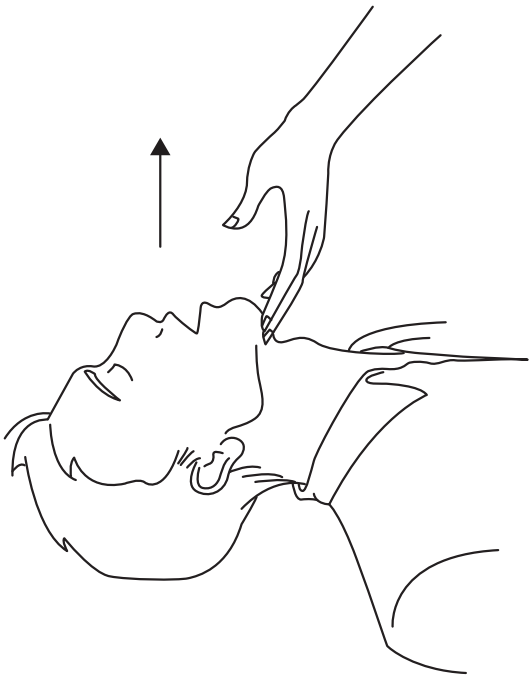

Fig. 18.18 Performing a chin lift.

Fig. 18.19 Performing a jaw thrust.

Airway devices

Face masks

► Use the smallest-fitting mask to fit over the mouth and nose.

This is a simple mask that is fitted over the nose and mouth. You may use an airway to aid ventilation or to clear any obstruction.

One-hand technique

- Place your thumb and index finger on the mask in a *C* shape (see Fig. 18.20).
- Grasp the jaw with the remaining fingers, pulling face into the mask.

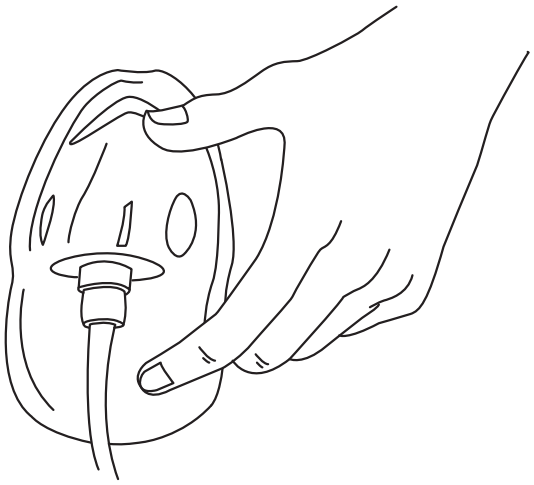

Fig. 18.20 Use of a face mask, one-handed technique.

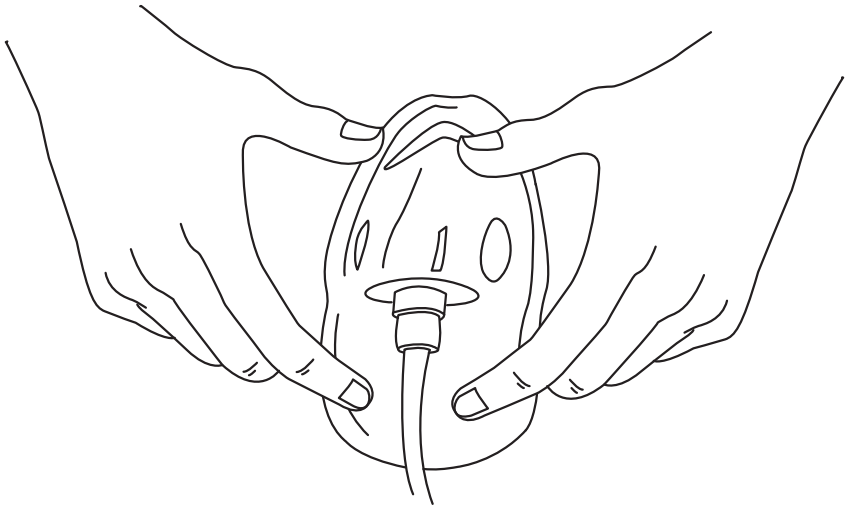

Fig. 18.21 Use of a face mask, two-handed technique.

Two-hand technique

- Place your thumbs on either side of the nasal portion of the mask.
- Use your index fingers to support the body of the mask.
- Use your other fingers to lift the jaw and extend the neck (Fig. 18.21).

Oropharyngeal airway

► Use this when the patient is semiconscious.

This device consists of a flange (limits depth of insertion), bite portion (teeth of patient rest against this), and curved body (follows curvature of the tongue), which has a lumen allowing passage of air and suction.

Different sizes are available and are color coded. The correct size is determined by measuring the airway against the distance between the corner of the mouth and the angle of the jaw (Figs. 18.22 and 18.23).

Fig. 18.22 Oropharyngeal airways.

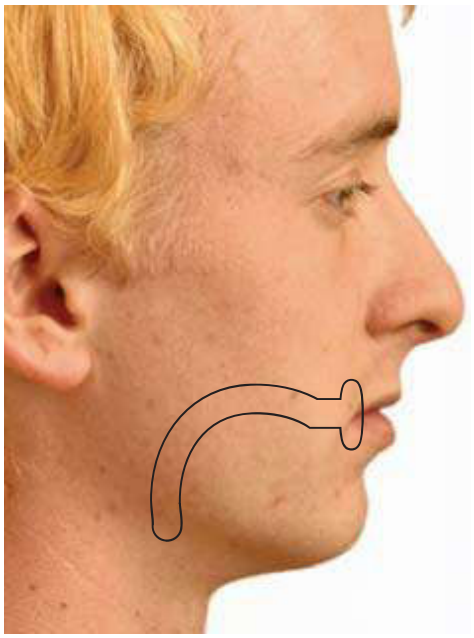

Fig. 18.23 Chose size of the oropharyngeal airway by measuring from the patient's teeth to the angle of the mandible.

Technique

- Lubricate and insert the airway upside down.
- Once it is well into the mouth rotate 180° and advance to full position.
  - Alternatively, hold the tongue down and forward with a tongue depressor until the airway is in place.

- Check for no gagging, snoring, or vomiting and that air is moving in and out.

- Use a size 10/12/14 catheter for suction, if required.

Nasopharyngeal airway

▶ This is tolerated better than the oropharyngeal airway in alert patients.

This device consists of a flange (limits depth of insertion). The pharyngeal end has a bevel to facilitate nontraumatic insertion and a curved body with lumen allowing passage of air and suction. Some airways come without an adequate flange, so a safety pin is used at the nasal end to prevent the airway from falling back into the nose (see Fig. 18.24).

Different sizes are available. Determine the correct size by comparing with the distance between the nostril and the tragus (see Fig. 18.25).

Technique

- The wider nostril is traditionally chosen, but most airways are beveled for introduction into the left nostril.
- Lubricate airway and pass directly into the nasal passage, passing along the floor of the nose or aiming for the back of the opposite eyeball.
- Use a size 10/12 catheter for suction, if required.

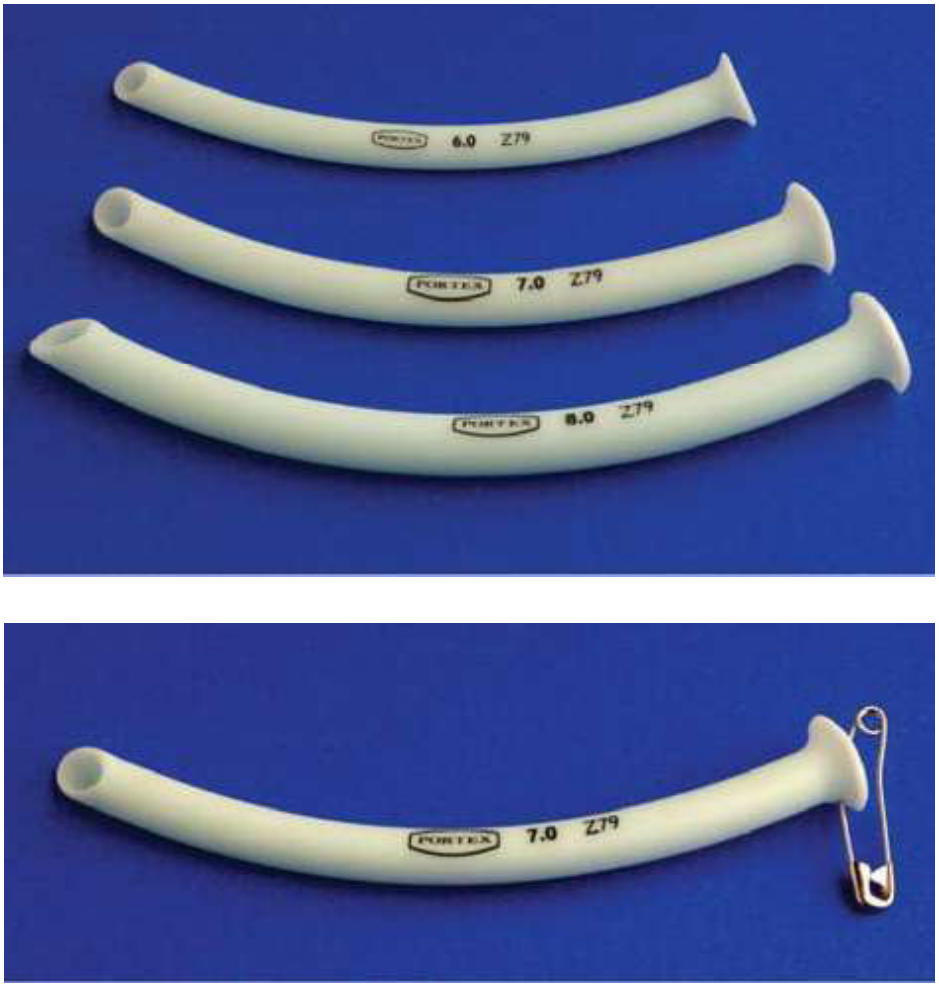

Fig. 18.24 Nasopharyngeal airways.

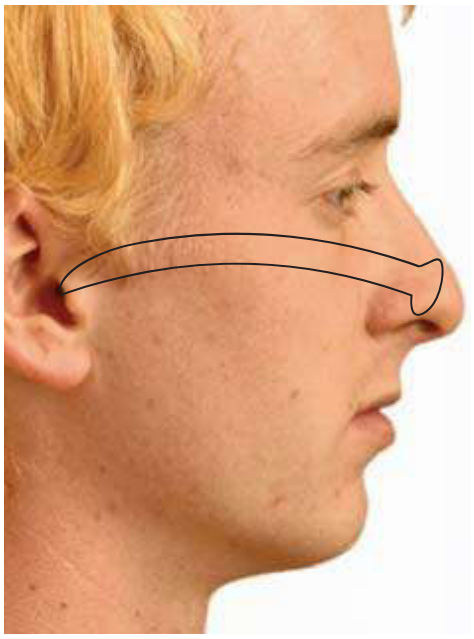

Fig. 18.25 Chose size of the nasopharyngeal airway by measuring from the patient's nostril to the tragus.

Laryngeal mask airway (LMA)

This consists of a tube with an inflatable cuff designed to seal around the laryngeal opening (Fig. 18.26). The patient must be deeply unconscious.

Technique

- Maintain oxygenation by bag and mask.
- Deflate the cuff of the LMA using a 20 mL syringe.
- Lubricate the outer cuff with aqueous gel. This part will not be in contact with the larynx.
- The patient should be in a supine position with head and neck in alignment.
- Stand behind the patient or, if this is not possible, from the front.
- Hold the tube like a pen and pass it into the mouth with the distal aperture facing the feet of the patient.
- Push back over the tongue while applying the tip to the surface of the palate until it reaches the posterior pharyngeal wall.
- The mask is then pressed backward and down until it reaches the back of the hypopharynx and resistance is felt.
- The black line on the tube should be aligned with the nasal septum.
- Inflate the cuff with usually 20–30 mL of air.
- The tube should lift out of the mouth slightly; the larynx is pushed forward if it is in the correct position.
- Attach breathing circuit and gently ventilate patient with 100% oxygen.
- Confirm correct placement by auscultating the chest in the axillary regions and observe for bilateral chest movement.
- Insert a bite block or oropharyngeal airway alongside the tube and secure the airway with the tape or tie provided.

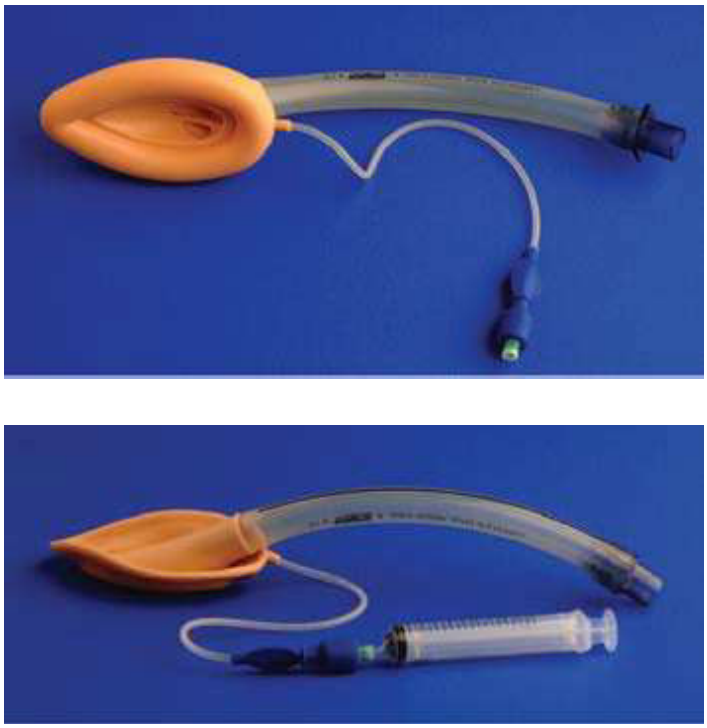

Fig. 18.26 A laryngeal mask airway.

Tracheostomy management

Theory

A *tracheostomy* is an opening in the anterior wall of the trachea below the larynx that can facilitate ventilation and respiration.

A *mini-tracheostomy* is a narrow-diameter, cuffless tube inserted into the trachea, through which a catheter can be passed to stimulate a cough and/or suction. This is not a method for protecting the airway or delivering any kind of ventilatory support except emergency oxygen therapy.

Tracheostomy may be performed if the need for an endotracheal tube is prolonged, to facilitate weaning, to identify an inability to maintain or protect an airway, and to secure and clear an airway.

Patients may have a permanent tracheostomy in place or even a stoma. These often do not need humidification or suction unless the patient is acutely ill.

Equipment

Tracheostomy tube

The tracheostomy tube may be stitched in or secured around the neck and is either single or double lumen (has an inner tube that can be removed for cleaning). The tubes are either fenestrated or nonfenestrated.

Fenestrated tubes allow the passage of air and secretions into the mouth. These are good for weaning.

Humidification

Heated humidification is used for the short term and is the gold standard. A heat moisture exchanger is used for patients with minimal secretions or who are mobile.

Procedures

Open suction

The aim is to remove secretions and prevent blockages in the tracheostomy tube, bronchial obstruction, and alveolar collapse.

- Use a catheter with diameter no more than one 1/2 the internal tracheotomy diameter. [(Size of outer diameter) – 2 x 2 = x; e.g., 8.0 mm – 2 x2 = 12].
- Negative pressure should be 100–150 mmHg.
- Wear gown, gloves, and protective eyewear.
- Attach a sterile catheter to suction equipment, ensuring a good seal, and leave most of the packaging in place.
- Place under the nondominant arm.
- Put a clean, disposable glove on the dominant hand and do not touch anything other than the catheter tip.
- Pull the packaging away with the nondominant hand.
- Open the suction port.
- Introduce the tip of the catheter into the tracheostomy tube with the dominant hand gently but quickly.
- Depth of insertion should be 0.5–1.0 cm beyond the end of the tracheostomy tube (about 1/3 the length of catheter).

- Insert until the patient coughs.
- Withdraw the tip 0.5 cm and apply suction.
- Continue to withdraw slowly and continuously.
- Close the suction port and discard the glove and catheter.

▶ Suction should last no more than 10 seconds.

▶ Allow sufficient time between passes for recovery.

- Repeat until secretions are cleared.
- After suction, ensure that the patient is reconnected to respiratory support and oxygen and that oxygen levels are returned to normal.

Tube occlusion

- Call for help.
- Reassure the patient.
- Ask the patient to cough, or attempt to clear secretions via suction.
- Remove the inner cannula and replace it with a new one.
- If there is no inner cannula, deflate the cuff and administer oxygen facially, instill 2–5 mL 0.9% saline, and suction to try to clear blockage.
- If you are unable to clear the blockage, a total tube change may be required (try using a smaller size, if necessary).
- If tube insertion fails, then consider mask-to-stoma ventilation (consider suction via stoma).

▶ If respiration stops all together, initiate the proper code, call for anesthesia service, inflate the cuff, and manually ventilate using a catheter mount and rebreather or Ambu-bag.

Swallowing assessment

This should be performed by the appropriate practitioner (e.g., radiologist or speech and language therapist).

- Sit the patient up.
- Suction via tracheotomy prior to cuff deflation.
- *Deflate* cuff fully, if possible, or to maximum degree that the patient can tolerate.
- Ensure that there is an appropriate inner cannula in place.
- Give the patient *sips* of water from a teaspoon and follow the procedure explained on 📖 p. 289.
- Intermittently check for voice quality (ask the patient to say "ah" or count out loud).
- Stop if the patient deteriorates, fatigues, shows signs of persistent coughing or aspiration on suction, or has a persistently "wet" voice.

Hints

- Practice techniques before needing them in an emergency.
- Stridor is a good indication that an airway is partially blocked.
- Always remember to humidify oxygen in tracheostomy patients.

▶▶ Endotracheal (ET) intubation

Theory

There are three main indications for tracheal intubation: relieving airway obstruction, protecting the airway from aspiration, and facilitating artificial ventilation of the lungs.

▶ Remember, if you are inexperienced in this technique, never perform tracheal intubation unsupervized.

▶ In an emergency situation, it is safer to bag and mask the patient or use a laryngeal mask airway if one is available and await assistance.

Equipment

- Laryngoscope (check bulb)—usually size 3 is adequate
- Selection of ET tubes (size 7 in most women and size 8 in most men)
- Sterile lubricant
- 20 mL syringe for cuff inflation
- Tape to tie tube in place
- Rigid stilette or gum-elastic bougie
- Self-inflating bag and oxygen supply
- Stethoscope for confirming correct position of tube
- Suction apparatus with a wide-bore, rigid suction end (Yankauer)

Procedure

- In the awake patient, introduce yourself, confirm the patient's identity, explain the procedure, and obtain verbal consent.
- Wash your hands and put on a pair of gloves.
- Pre-oxygenate the patient with a high concentration of oxygen for a minimum of 15 seconds.

▶ Remember, intubation must take no longer than 30 seconds.

- Position the neck such that it is distally extended and proximally slightly flexed, with a small pillow underneath the head—an exaggeration of the normal cervical lordosis.

▶ If a cervical injury is suspected, the head and neck should be maintained in neutral alignment.

- Stand at the head of the bed and open the mouth.
- Inspect for loose dentures or foreign material—remove any if present.
- Hold the laryngoscope in the left hand and look down its length as you insert.
- Slide the scope into the right side of the mouth until the tonsillar fossa comes into view.
- Now move the blade to the left so that the tongue is pushed into a midline position.
- Advance blade, following the posterior edge of the soft palate until the uvula comes into view.
- Advance blade over the base of the tongue, and the epiglottis should pop into sight.
- With blade positioned between the epiglottis and base of the tongue (vallecula), apply traction in the line of the handle of the laryngoscope.

  - This movement should lift the epiglottis and expose the V-shaped glottis behind.
- Once the triangular-shaped laryngeal inlet is in view, position the ET tube between the vocal cords so that the tube is just distal to them.
  - Use mark on the tube above the cuff to indicate correct position.
  - This is around 21 cm in a female and 22 cm in a male.
- If difficulty is experienced passing ET tube into the larynx, pass a gum-elastic bougie first and then try passing a lubricated ET tube over this.
- Once the ET tube is in position, inflate the cuff while ventilating through the ET tube with a self-inflating bag (Fig. 18.27).
- Verify correct positioning of the tube by observing chest movement and auscultate at the sides of the chest in the mid-axillary line (both sides of the chest should move equally, and you should hear breath sounds at both lung bases).
- Secure the ET tube with a tie.
- Obtain a chest X-ray to confirm the tube position. The ET tube has a radio-opaque line within it.
- Document the details of the procedure in the patient notes.

Important note

▶ The insertion of the ET tube should take no more than 30 seconds from start to finish. If 30 seconds pass and the tube is not in the correct position, remove all the equipment and bag/mask ventilate the patient until you are ready to try again.

Some complications of ET intubation

- Trauma to teeth, airway, larynx, or trachea
- Aspiration
- Airway obstruction
- Tube misplacement
- Hypoxia from prolonged attempts
- Tracheal stenosis (late complication)

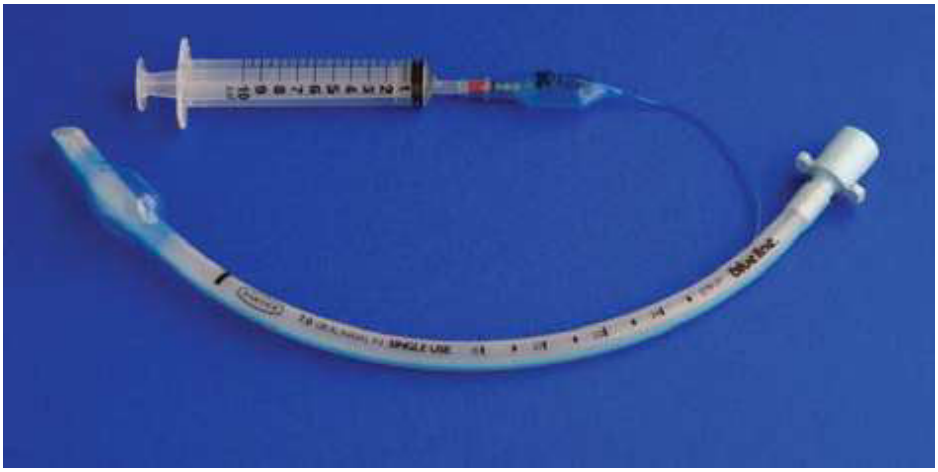

Fig. 18.27 ET tube with attached syringe. The cuff has been inflated to demonstrate.

Noninvasive ventilation (NIV)

Theory

NIV is the application of positive pressure ventilatory support via a facial or nasal interface and not via an airway (ET tube, tracheostomy) (see Box 18.6 for setup). NIV should be operated only by trained staff in an appropriate area. It may be used in acute conditions in the hospital or in chronic conditions at home.

Patients need to be spontaneously breathing, maintaining their airway (i.e., conscious), and compliant. It is not a substitute for mechanical ventilation unless this has been decided as the ceiling of treatment.

Pressures are usually documented in cmH_2O (rather than mmHg), and it is good practice that the decision of maximal pressure to be used is documented in the medical notes so that if a patient continues to deteriorate, the intensivist, pulmonologist, or anesthesiologist has an appropriate management strategy in place.

Contraindications

These include undrained pneumothorax and pulmonary hemorrhage. It is good practice to review a recent chest X-ray to rule these out before beginning.

Cautions

These comprise bullae, unstable cardiovascular system, abscess, facial trauma, basal skull fracture, recent bronchial or esophageal surgery, persistent vomiting, and high bronchial tumor.

CPAP

Continuous **P**ositive **A**irways **P**ressure (CPAP) maintains a single pressure continuously throughout both inspiratory and expiratory phases.

It is used in the treatment of type I respiratory failure (obstructive sleep apnea and cardiopulmonary edema, and occasionally in pulmonary embolus, pneumonia, and weaning from ventilation).

BiPAP

Bilevel **P**ositive **A**irways **P**ressure (BiPAP) ventilation uses different pressures on expiration (EPAP) and on inspiration (IPAP). Higher EPAP increases functional residual capacity (FRC), while higher IPAP augments tidal volume. The system is normally pressure driven but can be volume driven.

It is used in the treatment of type II respiratory failure (i.e., hypoventilation, chronic neuromuscular conditions, and exacerbations of COPD).

Box 18.6 Setting up NIV

This is not something that the inexperienced provider will be expected to do. The following is a brief guide that should allow you to understand what is involved.

CPAP

Equipment

- Mask, head strap, positive end-expiratory pressure (PEEP) valves (5–7.5–10 cmH_2O)
- Circuit, safety pop-off/blow-off valve
- High-flow generator for oxygen and air
- Heated humidification

Procedure

- Explain the procedure to the patient and obtain verbal consent.
- Use measuring templates to assess appropriate-size interface and minimize air leaks.
- Set oxygen and flow rate and ensure that the PEEP valve opens a small distance only and never fully closes.
- Start with a low pressure and slowly increase for patient comfort and to gain compliance.
- Aim to reduce the work of breathing.
- Continuously monitor ABG/SaO_2, heart rate, and BP. Watch for abdominal distension.

BiPAP

Equipment

- Mask (facial/nasal), prongs, full face mask, head strap
- Circuit, exhalation port
- Entrained oxygen, if required
- Heated humidification
- Ventilator (NIPPV1/2/3, Breas, BiPAP vision)

Procedure

- Explain the procedure to the patient and obtain verbal consent.
- Use measuring templates to assess appropriate-size interface and minimize air leaks.
- Start with low pressures and slowly increase for patient comfort and to gain compliance. (Trial data in COPD is based on pressures of 20/5.)
- Setting inspiratory and expiratory times will need to be continuously reassessed, as respiratory rate will change over time.
- Initially aim to match the patient's own ventilatory pattern, but eventually aim to ↓ respiratory rate and ↑ tidal volume/flow using the minimal pressures possible.
- Monitor ABG/SaO_2, heart rate, and BP at 1 and 4 hours. Watch for abdominal distension.