Airways and Intubation

Endotracheal intubation is the placement of a tube into the trachea to maintain a patent airway in those who are unconscious or unable to maintain their airway for other reasons. Compared to the use of pharyngeal airways (oropharyngeal or nasopharyngeal), benefits of an endotracheal airway include:

- Protection against aspiration and gastric insufflation.
- More effective ventilation and oxygenation.
- Facilitation of suctioning.
- Delivery of anaesthetic and other drugs via the endotracheal tube (ETT).

Previously restricted to the anaesthetic and operating rooms, advances such as rapid sequence induction (RSI) have meant that intubation is often performed in emergency or pre-hospital settings \[1\]. These situations are by their nature high-risk and there is some evidence that pre-hospital endotracheal intubation in adult major trauma patients with head injury actually increases mortality \[2, 3\]. Similarly, there is evidence that the use of advanced airway management in the setting of an out-of-hospital cardiac arrest is associated with adverse outcomes \[4\]. Many confounding variables exist - experience levels, lack of monitoring equipment, difficulties pre-oxygenating patients, etc - and the studies are retrospective; however, benefit should not be assumed.

Intubation is a technique that requires training, experience and regular updating to maintain competence. Anyone attempting it should also be capable of managing any complications that arise. GPs will vary in their ability. Some will have developed a special interest during hospital training and gained postgraduate qualifications; they may even perform regular anaesthetic lists. Others will have an interest in pre-hospital and emergency care and may be involved in BASICS or ATLS to maintain relevant skills. The key principle is not to act beyond your personal level of competence.

Alternatives to intubation

Laryngeal mask airway (LMA)

This is widely used in the UK in more than 50% of surgical patients.

- It consists of an inflatable silicone ring attached diagonally to a flexible cushion filling the space around and behind the larynx, creating a low-pressure seal between the tube and trachea without insertion into the larynx.
- It can be used in an emergency setting by providers not trained in tracheal intubation and is an option in the management of a difficult airway where intubation has been unsuccessful.
- It is not a definitive airway and provides limited protection only from gastric aspiration.
- It is becoming increasingly available on hospital resuscitation trolleys and is recommended in the latest ALS guidelines, given the ease of insertion and reduction in interruption of chest compressions \[5\].
- There is presently a lack of safety and outcome data on the use of LMAs \[5, 6\].

Oesophageal tracheal Combitube® (ETC)

The ETC is a double lumen tube combining an oesophageal tube with closed distal end linked by a short connection to a conventional tracheal tube.

- It is designed for blind insertion and placement is determined by examination and auscultation, with cuffs being able to be adjusted according to whether the trachea or oesophagus has been intubated.
- It has been used amongst first responders in North America successfully \[7\] but its use in the pre-hospital setting can also be associated with serious complications such as aspiration pneumonitis, pneumothorax and oesophageal rupture \[8\].
Tracheostomy
A tracheostomy provides direct access to the trachea by surgically making an opening in the neck. See separate Tracheostomy article.

Cricothyroidotomy
See separate Cricothyroidotomy article.

Indications\[9\]
- The patient is unable to protect their airway:
  - Loss of reflexes - eg, obtunded or Glasgow Coma Score (GCS) less than 8.
  - Relaxation of muscles - eg, hyperthermia.
  - Risk of aspiration from the stomach, blood or secretions.
- Loss of airway patency or potential for obstruction - eg, burns, epiglottitis.
- Prophylactically:
  - High risk of losing airway protection or patency - eg, local neck haematoma or airway burns.
  - To control the airway - eg, pre-transfer, clinical deterioration expected, uncooperative patient needing urgent investigations or treatment.
- Inadequate ventilation:
  - Treatment of hypercapnia - eg, severe chronic obstructive pulmonary disease, head injury.
  - Selective lung ventilation - eg, massive haemoptysis, bronchopulmonary fistula.
- Inability to oxygenate the patient:
  - For example, where there is severe acute respiratory distress syndrome or severe carbon monoxide (CO) toxicity.
- Drug delivery: a rare indication - eg, surfactant in a neonate.

Contra-indications\[9\]

Relative contra-indications
- Neck immobility or increased risk of neck trauma (eg, rheumatoid arthritis or suspected cervical spine injury) - this is not a true contra-indication; it just makes intubation more difficult. Consider fibre-optic intubation if available.
- Anticipated 'difficult' airway - unsuccessful intubation may lead to further difficulties, especially if anaesthetic drugs have been given. In this scenario it is best to continue bag and mask ventilation (if possible) and obtain immediate senior help, or use of other airway adjuncts or consider awake intubation.

Absolute contra-indications (will necessitate a surgical airway or nasal intubation)
- Total upper airway obstruction.
- Total loss of facial/oropharyngeal landmarks.
- Inability to open the mouth (eg, scleroderma or surgical wiring).
**Procedure**[9, 10]

| Monitoring equipment | • Pulse oximeter  
|                      | • BP gauge  
|                      | • Cardiac monitor      |

| Oxygenation equipment | • Oxygen source and tubing, including nasal prongs  
|                       | • Face mask  
|                       | • Anaesthesia bag or ambu-bag                          |

| Suction equipment | • Check tubing  
|                   | • Check lid  
|                   | • Check pressure                          |

| Pre-medication and induction equipment | • Intravenous (IV) access  
|                                       | • Review possible contra-indications to drugs  
|                                       | • Draw up and label all pre-medication, induction and paralytic agents |

| Intubation equipment | • Laryngoscopes with handles and blades of different sizes and shapes (curved/straight) - to estimate laryngoscope blade size, holding the blade next to the patient's face, the blade should reach between the lips and larynx  
|                     | • Check the light source is working and tighten the light bulb  
|                     | • ETTS of different sizes  
|                     | • Inflate the ETT cuff to check for leakage  
|                     | • Means of securing the tube in place                          |

| Equipment for checking tube position | • Stethoscope  
|                                     | • Carbon dioxide (CO₂) detector or end-tidal CO₂ monitor  
|                                     | • CXR |

**Consider the following**

1. **Predict problems in advance: 'LEMON' and 'MOANS' are useful**

**LEMON** is a useful mnemonic for a difficult laryngoscopic view:

- **Look** externally for any obvious impairment - eg, obesity, pregnancy, congenital/acquired deformity.
- **Evaluate** 3-3-2 rule with patient fingers, ie, mouth opening (3), mento-hyoid distance (3) and hyoid-thyroid cartilage distance (2).
- **Mallampati** - tongue/mouth size:
  - I - pillars/palate/uvula fully visible.  
  - II - uvula partially visible.  
  - III - only base of uvula visible.  
  - IV - none of the three visible.  

- **Obstruction** - (obstructive sleep apnoea, epiglottis, mass).
- **Neck mobility** - (rheumatoid arthritis, cervical spine collar).

Anticipate difficult intubations and seek experienced assistance in advance of the intubation attempt if possible.
MOANS provides information regarding how difficult the mask seal is likely to be:

- Mask seal
- Obstruction
- Age
- No teeth
- Stiff lungs

2. Preparation: consider ‘SOAPME’ for RSI

- Suction
- Oxygen
- Airways
- Positioning
- Monitors
- End tidal CO₂ monitoring

Always have a back-up plan in case things do not go according to plan.

- Pre-oxygenate with 100% oxygen via a well-fitting mask. Consider use of nasal prong O₂ (apnoeic diffusion oxygenation).
- Consider pre-medications to counteract side-effects of intubation, although there is little evidence for muscle relaxants, opioids and atropine.
- RSI can be used if conscious or unconscious.

3. Patient position

- The patient should be aligned without lateral deviation of the head or neck.
- The head should be extended on the neck with a pillow under the occiput. If cervical spine trauma is suspected, have an assistant provide in-line immobilisation.
- The neck should be flexed to approximately 15° on the chest.
- Try to keep the external auditory meatus and sternal notch in the same horizontal plane (except infants or when cervical spine injury is present or suspected).

NB: in infants aged under 2 years, the occiput naturally extends the head and the chin alone needs lifting into the neutral position. In older children a ‘sniffing’ position should be used.

4. Preventing gastric aspiration

Always assume in an emergency setting that a patient has a full stomach carrying the risk of regurgitation and inhalation of gastric contents. If possible, liquid contents of the stomach are removed with a nasogastric or orogastric tube.

Cricoid pressure is applied from the time of loss of consciousness until a secure airway is in place. Pressure is applied directly in midline on the cricoid cartilage, using tips of the thumb and index finger while possibly applying counter-pressure from the back of the neck. This occludes the oesophagus, again with the aim of reducing gastric aspiration, although the evidence for this is disputed[11, 12]. BURP manoeuvre may be useful and stands for ‘backward, upward, rightward pressure’; it helps to view the larynx.

5. Intubation procedure (with induction of anaesthesia and paralysis)

This will follow administration of an induction agent (may be intravenous or inhalational or a combination of both (eg, propofol and sevoflurane) and a muscle relaxant (eg, atracurium or suxamethonium).

Intubation attempts should not last for longer than 30 seconds.

- Begin by keeping your right hand free - it will be needed to open the mouth, control the head and to use suction, etc. Inspect the mouth for loose teeth or for dentures to be removed. Suction any secretions or vomitus. Once a satisfactory view of the airway is available, the ETT should be handled.
- Hold the laryngoscope in the left hand and the ETT in the right and introduce the laryngoscope over the right side of the tongue, sweeping the tongue to the midline. If using a Miller straight blade on the laryngoscope then the tip does not go into the vallecula (between the epiglottis and the base of the tongue).
- Position the tip of the blade in the vallecula and lift upwards and away from yourself until the glottis is visualised.
- Exert traction along the axis of the handle - do not use the teeth or gums as a fulcrum, as this will result in damage to teeth and/or gums.
- Introduce the ETT into the right corner of the mouth, passing it through the vocal cords with the cuff positioned and subsequently inflated just beyond the cords.
- Ventilate with high-concentration oxygen (air is initially used in neonates) secure the ETT.
- The following will help assess tube position:
  - Directly observing the ETT pass through the vocal cords.
  - Fogging of the tube on ventilation.
  - Looking for symmetrical chest movement.
  - Listening over apices and bases of lungs and stomach for equal breath sounds and no gastric breath sounds.
  - End-tidal CO₂ monitor attached to ETT.
- Following successful intubation, ongoing sedation, with or without muscle relaxation, is required.

**Troubleshooting**

Consider DOPE:

- Dislodged tube
- Obstructed tube
- Pneumothorax
- Equipment failure

Checklists are commonly used by emergency teams.

**Complications**

**Laryngoscopy**

- Mechanical:
  - Damage to teeth, lips, gums or other soft tissues.
  - Oedema of tissues (usually the result of multiple intubation attempts).
  - Coughing, laryngospasm, bronchospasm, vomiting (with a risk of aspiration).
  - Hyperextension cervical injury.
  - Temporomandibular joint dislocation.

- Physiological:
  - Cardiovascular responses - hypotension, hypertension, tachyarrhythmias, bradyarrhythmias in children.
  - Respiratory responses - coughing, laryngospasm, bronchospasm.
  - Raised intracranial pressure.
  - Hypoxaemia/hypercarbia - especially with difficult intubation or prolonged attempts.

**Tracheal intubation**

- Failed intubation and hypoxaemia:
  - Can ventilate with a mask - seek senior help, defer intubation or consider an alternative.
  - Can't ventilate - call for urgent assistance; if bag and mask ventilation is maintaining oxygen saturations above 90% and there is adequate time, consider other options, such as the use of a bougie to guide ETT placement, or alternatives such as the use of LMA or Combitube® or fibre-optic induction or, if not, cricothyroidotomy. See example of a failed airway algorithm [14].
- Misplaced intubation - oesophageal or right mainstem intubation.
- Obstruction - kinking of ETT, cuff over-inflation or herniation, presence of blood, mucus or foreign body.
- Mechanical damage - to pharynx, larynx, vocal cords, trachea, or oesophagus (including oesophageal dissection and perforation).
- Aspiration and post-intubation pneumonia.
- Pneumothorax.

### Nasal intubation, LMA and surgical airways
These also have their own complications, largely trauma to the airway or surrounding structures.

### Avoiding problems
LEMON is a useful mnemonic for a difficult laryngoscopic view as discussed above.

Anticipate difficult intubations and seek experienced assistance in advance of the intubation attempt if possible.

### Further reading & references
- **British Association for Immediate Care - BASICS**
- **Sen A; Best Evidence Topics (BETS) review of current evidence - Prehospital endotracheal intubation in adult major trauma patients with head injury; BestBETs, May 2005**
- **Adult Advanced Life Support; Resuscitation Council (UK) Guidelines (2015)**
- **Endotracheal intubation by direct laryngoscopy; American Thoracic Society**
- **Endotracheal intubation; Family Practice Notebook**

### Disclaimer:
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