Equipment for airway management

David R Ball

Learning objectives

After reading the article, you should be able to:
- list the approaches to airway management giving examples of equipment for each
- discuss the types of supraglottic airway devices available, knowing their strengths and weaknesses
- discuss the types of laryngoscopes, tracheal tubes and aids to intubation available

Abstract

Airway management provides gas exchange, protects the lungs from injury and permits treatment. This requires safe, effective and reliable use of equipment, often in combination. A management plan with backup plans is essential, but a sequence of logical plans forming an airway management strategy is better. Correct equipment use needs correct knowledge, skill and attitudes. There are five approaches to airway management in which equipment is used: facemask ventilation with adjuncts, airway clearance with suction or foreign body removal, use of supraglottic airway devices, tracheal intubation with a variety of laryngoscopes (including the flexible fibreoptic bronchoscope) and transtracheal access using cricothyroidotomy or tracheostomy. Tracheal tubes and aids for placement are described.

Keywords Airway; bougie; cricothyroidotomy; flexible fibreoptic bronchoscope; laryngeal mask airway; laryngoscope; optical stylet; tracheal intubation; tracheal tube; tracheostomy

Royal College of Anaesthetists CPD matrix: 1C01, 1C02

Airway management requires safe, effective and reliable equipment use to achieve two goals: provision of gas exchange (i.e. delivery of oxygen to, and removal of carbon dioxide from, the lungs); and *protection* of the lungs from aspiration injury.

Equipment is used as part of an ‘airway management strategy’, a ‘co-ordinated, logical sequence of plans’, a key message from the 4th National Audit Project (NAP4) on emergency airway management.[1]

Airway plans also form the core of the Difficult Airway Society (DAS) guidelines for the management of the unanticipated difficult tracheal intubation.[2]

A successful strategy provides a secure airway and therefore *permits* treatment, either surgery or critical care. This strategy must encompass all phases of airway management, induction, maintenance and recovery. Equipment must be available for both planned and unplanned events and should be *available* at time of need and the practitioner *able* to use it. A balance of *knowledge*, *skill* and *attitude* is needed to achieve *competency*, then *mastery* of use.

Since airway management involves a variety of equipment, often used in sequence, functional compatibility is important (e.g. a tracheal introducer or stylet must fit the chosen tracheal tube). Moreover, all equipment must have standard dimensions when matching is needed (e.g. adoption of standard 15/22 mm connectors to allow connection to breathing systems)

Additionally, all equipment must biologically compatible and be supplied sterile.

A crucial test of success is the detection of expired carbon dioxide, a real-time measure of airway patency. Capnography should be used in all situations were airway equipment is in use.[1]

Occasionally, airway equipment is used together with equipment designed for other uses to achieve a safer outcome. An old example is the use of nasal cannulae to deliver oxygen to an apnoeic patient to extend safe apnoea time during airway management. A more recent application of this technique is the use of nasal high flow oxygen delivered from a humidifier (THRIVE), again to extend apnoea time.

Recently, there has been an increase in the number and types of equipment, especially supraglottic airway devices (SADs) and various laryngoscopes.[3] Often there is little clinical evidence to support their use. In response, DAS has introduced the ‘ADEPT’ scheme for device evaluation, which stipulates that a device be considered for purchase following evaluation of evidence at ‘level 3’, a case series.[4]

The five approaches to airway management

Equipmen is used for each stage:
1. Facemask ventilation using adjuncts.
2. Airway clearance.
3. Supraglottic airway device use (Figure 1).
4. Tracheal access above the vocal cords.
5. Tracheal access below the vocal cords (tracheostomy or cricothyroidotomy).

These approaches may be used alone or in sequence. There is sometimes overlap (e.g. a supraglottic airway can be used for intubation).

Facemask ventilation (FMV) using adjuncts

This brings the practitioner into closest and continual contact with the patient. A facemask consists of a mount (connected to a breathing system *via* an angle piece), body and edge (preformed or inflatable cuff).

Optimal positioning of the patient’s head and neck and keeping mask seal is needed.

Adjuncts include oropharyngeal (Guedel) and nasopharyngeal airways.

The Han grading of FMV[5] is:

0: not attempted

David R Ball FRCA *is a Consultant Anaesthetist at the Dumfries and Galloway Royal Infirmary, Scotland, UK. Conflicts of interest: DRB has received equipment for charity work from Aircraft Medical, Cook Medical, Intavent Direct, Olympus Medical, P-3 Medical, Storz Medical and Trucorp.*

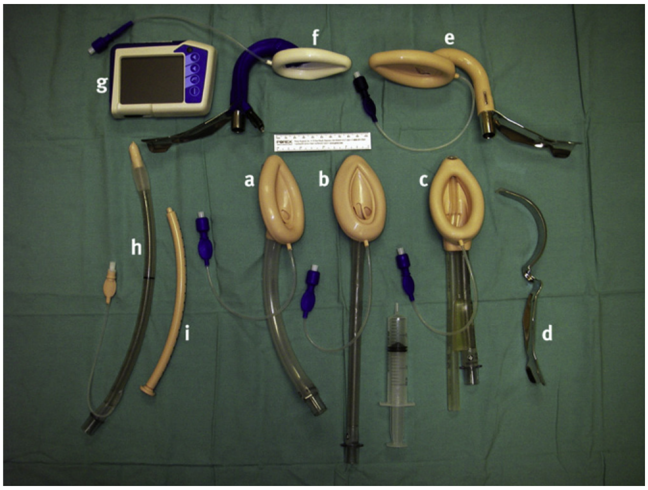

Figure 1 Supraglottic airway devices. (**a**) classic Laryngeal Mask Airway (cLMA); (**b**) flexible Laryngeal Mask Airway (fLMA); (**c**) ProSeal Laryngeal Mask Airway (PLMA™); (**d**) spatula for insertion of PLMA™; (**e**) Intubating Laryngeal Mask Airway (ILMA™); (**f**) CTrach™; (**g**) Screen for Ctrach™.

1: ventilated by mask
2: ventilated, adjuncts needed
3: ventilated, difficult (two-handed, adjuncts needed)
4: impossible.

Airway clearance

Blood, secretions or debris is cleared with suction apparatus. Oropharyngeal suction is usually done with a Yankauer sucker. This can have a side port to digitally control flow. Softer tracheal catheters are also used and also for nasopharyngeal suction.

Debris and foreign bodies can be removed with forceps, using a laryngoscope for illumination. Care must be taken to prevent pushing the debris further inwards.

Supraglottic airway devices (SADs)

These occupy the middle ground between FMV and intubation regarding anatomy, security and invasiveness. All are inserted blindly. There are over 15 devices, single-use or reusable. It is presently uncertain which is clinically superior.

A simple classification is into *first-* or *second*-generation devices. First-generation devices provide an airway with a low pressure (<20 cm water) seal. Second-generation devices are variously modified to provide a greater seal pressure, drainage of gastric content or reduce dental damage.

LMA classic (cLMA): has unrivalled clinical use in over 500 million patients. It is made of silicone, having an airway tube with connector, inflatable cuff (mask) and a tube for cuff inflation. The bowl of the mask has a grille to prevent intrusion of tongue or epiglottis. The cuff extends inferiorly to upper oesophagus, bilaterally to the pyriform fossae and superiorly to tongue base. A seal is formed by cuff inflation to <60 cm water. Manometers can measure this, but pilot balloon palpation is useful. Nitrous oxide diffuses into the cuff, increasing pressure; increased pressure from this or other mechanism commonly causes sore throat and rarely recurrent laryngeal, hypoglossal or lingual nerve damage.

It is available in 8 sizes with selection based on patient weight (sizes 1–6 with 1.5 and 2.5) and may be reused 40 times.

Concerns about possible prion transfer led to the recommendation for and development of single use devices in the UK but there are no reports of prion transfer by this route and no prions found in 63,000 tonsil specimens examined.

There are four uses:

- *Elective anaesthesia*: with spontaneous or controlled ventilation to 20 cm water.
- *Rescue airway device*: when FMV or intubation is difficult, worsening or failed (Plan C of the DAS guidelines).
- *Intubating conduit*: when intubation is difficult, a cLMA can be used to aid passage of a flexible fibreoptic bronchoscope. (Plan B of the DAS guidelines). The intubating LMA (ILMA) is designed for this.
- *Tracheal tube exchange*: occasionally a tracheal tube is removed and replaced by an LMA to allow a smoother emergence from anaesthesia with reduced risk of coughing and straining. This ‘bridge to extubation’ or Bailey manoeuvre, can be useful in the recovery of neurosurgical and maxillofacial patients.

Limitations of the first-generation devices include:

- *Aspiration risk*: there is no separation of airway and digestive pathways and reflux of gastric content into the bowl and the lungs is possible.
- *Low compliance chest*: in obesity, high ventilatory pressures (>20 cm water) may result in gas leak and/or gastric insufflation.
- *Periglottic pathology*: impedes placement (e.g. lingual tonsil hypertrophy)

Risk of obstruction by biting during emergence leading to negative pressure pulmonary oedema.

Flexible LMA (FLMA) is a reusable device similar to the cLMA available in sizes 2–5. The airway tube is narrower, longer and wound with spiral wire. This flexibility allows tube positioning without mask dislodgement, useful for head, neck and dental surgery.

Limitations are the same as for the cLMA.

ProSeal™ LMA (PLMA) is the archetypal second-generation device.[6] It has a number of modifications:

- *Cuff*: larger with a posterior extension, allowing higher seal pressures and an insertion pocket on the posterior surface.
- *Bowl*: no grille.
- *Gastric drainage tube*: separate from the airway tube, allowing venting of gastric fluid away from the bowl of the mask, reducing aspiration risk.
- *Airway tube*: containing spiral wire and a silicone bite block.

Sizes 1–5 are available: sizes less than 3 lack a posterior cuff.

This is made of silicone and is reusable (40 times). It has indications for use similar to the cLMA. The higher seal pressure permits ventilation for patients with lower compliance of chest wall (e.g. obesity) or lungs (e.g. fibrosis).The modifications separating the aerodigestive tract plausibly increase safety by reducing aspiration risk, this has not been clinically validated. The PLMA is not advised for use in patients with a ‘full stomach’.

There are three techniques for insertion:

- *Using the index finger*: as for the cLMA, with first time placement of about 90%.
- *Using the spatula*: supplied with the device.
- *Using an introducer*: a lubricated tracheal introducer ('bougie') is placed in the oesophagus, the PLMA™ is threaded along this *via* the drainage tube. This is the most effective technique but is more invasive.

Single-use SADs: Single use avoids the technical and logistical issues of decontamination and sterilization. Medical, commercial and political pressures over presently theoretical risks of transmissible prion disease have driven their introduction. Both first- (e.g. *LMA Unique*™) and second generation (e.g. *LMA Supreme*™, *I-gel*™) are available. There is generally no evidence supporting overall clinical superiority of any device.

Intubating LMA (ILMA): A SAD and conduit for the passage of a tracheal tube. Sizes 3–5 are available, reusable (40 times) or single use. The design features are:

- *Airway tube*: short, wide, curved and rigid with handle.
- *Bowl*: has a moulded tube guide and the grille is replaced by an epiglottic elevator bar.

The ILMA is designed to be used with a dedicated tracheal tube, a spiral wired, 31 cm long cuffed tube with a soft bullet-shaped tip with sizes 6.0–9.0 mm ID. It is either reusable (silicone) or single use, the *Fastrach*™ (Polyvinylchloride).

A *stabilizing rod* is supplied to control tube position when removing the ILMA.

ILMA insertion is blind, achieved with neutral positioning, useful for patients with risks of cervical cord damage. The lubricated tracheal tube (connector removed) is inserted into the airway tube and is guided blindly into the trachea with an 80% first time success. By attaching the connector, inflating the tube cuff and ventilating through the tube, placement is confirmed. To remove the ILMA, the connector is removed, the ILMA cuff deflated and the stabilizing rod is positioned onto the tracheal tube to offset frictional forces of pulling out the ILMA over the tube. The connector is replaced again and tube placement reconfirmed. There is a risk of pushing the tube too far in, or pulling it out.

The original method of ILMA-guided tracheal intubation is 'blind'; an FFOB can be used for visualization.

CTrach™ was an ILMA development with a detachable camera and screen, allowing visualization of the larynx. Technically, this is a form of laryngoscope. It is currently not available.

Tracheal access above the vocal cords

Tracheal access *above* the glottis most usually involves passing a tracheal tube through the vocal cords; most cases are done using a visual technique, with a laryngoscope to view the larynx. (intubation *below* the glottis includes tracheostomy or cricothyroidotomy).

A laryngoscope views the laryngeal inlet, allowing visually guided tracheal intubation. In general, three criteria are needed for success: a view, alignment of the airway axes and space for tube passage.

There are three limitations for all laryngoscopes:

- *blood or secretions* degrade or obscure the view
- *trismus*: The mouth must be able to open sufficiently to accept the device blade and accompanying tracheal tube.
- *training*: effective use requires sufficient practice.

The main types, with examples, are:

- **rigid direct bladed:** standard (straight; *Miller*, curved; *Macintosh*) and modified (*McCoy*)
- **rigid indirect bladed**: using a prism (*Belscope*), mirror (*McMorrow*), fibreoptics (*Bullard*™) or video camera (*MacGrath*™).
- **intubating conduits:** optical (*Airtraq*™) or video camera (*CTrach*™)
- **optical stylets**: rigid (*Bonfils*™), malleable (*Shikani*™)
- **flexible fibreoptic devices**: a fibreoptic laryngoscope is used to view the larynx in ENT practice, but is not used for intubation: the longer flexible fibreoptic bronchoscope (FFOB) is needed, which can also function as a laryngoscope.

Rigid direct bladed laryngoscopes (Figure 2)

Each has a handle containing batteries joined to a blade, straight or curved. Illumination is provided by a lightsource in the blade or fibreoptic bundle transmitting light from a source in the handle. The blade has a *contact* with the handle at a hinge. The

Figure 2 Direct laryngoscopes. (**a**) Macintosh (size 3) laryngoscope with standard handle; (**b**) Macintosh 4 blade; (**c**) Macintosh 5 blade; (**d**) Miller (size 3) laryngoscope with short (stubby) handle; (**e**) Miller 4 (disposable) blade; (**f**) McCoy (size 3) levering laryngoscope; (**g**) Polio blade laryngoscope.

blade has a *spatula*, *flange* and *beak* of varying geometry. Some have modifications, such as a movable tip (*McCoy*).

A view is achieved by transoral insertion of the blade forming a line of sight (LoS) between intubator and larynx and opening the upper airway allows tube passage. Success depends on either:

- *Patient factors*: mouth opening, dentition, neck mobility, airway swellings and contamination with blood, secretions or debris.
- *Practitioner factors*: correct device choice and technique.

Standard blades are essentially devices designed to lift the epiglottis. They are either straight or curved. The *Miller* is the standard *straight* blade, achieving a LoS by passing the beak posterior to the epiglottis, lifting it directly to expose the larynx.

The *Macintosh* is the standard *curved* blade. The beak is placed in the vallecula, antero-inferior traction is applied to the tongue base, tensioning the hyo-epiglottic ligament, lifting the epiglottis indirectly, exposing the larynx. The Cormack and Lehane grading for the laryngeal view is based on Macintosh blade use. Extending this descriptor to views gained by other devices, especially videolaryngoscopes (which can 'see round corners'), leads to confusion.

Macintosh laryngoscopy is the most popular technique and is relatively easy to learn. Trained practioners have a first time success of over 90%. Success is often limited by:

- *Prominent upper teeth*: interfering with the LoS, risking dental damage.
- *Tongue base pathology* (cysts, tumours or lingual tonsils) prevent the beak entering the vallecula.
- *'Anterior larynx'*: the tongue has to be displaced into the mandibular space, out of the LoS. If the space is small, the tongue protrudes posteriorly, obscuring the view.
- *Floppy epiglottis*: this limits curved blade use, especially for infants.

Modified blades for rigid direct laryngoscopy

Polio blade is a curved blade which forms an obtuse (120°) with the handle. Originally used for patients in 'iron lung' ventilators, now used for patients with a small 'sternal space', usually those with large breasts.

Reversed blade: a curved blade, a 'mirror image' version of the Macintosh, designed to displace the tongue rightwards. Useful in patients who are in the right lateral position or who have right sided pyriform fossa masses.

McCoy blade: a Macintosh variant, incorporating a lever-operated movable blade tip to enhance epiglottic displacement, useful when neck movement is limited by injury.

Flexiblade: another curved blade, with a lever flexing the distal half of the blade.

Other direct laryngoscopes: many eponymous blades are available, usually variations on straight or curved blades. They have not shown convincing improvements over standard blades in general use.

Single-use blades were introduced to reduce cross infection. Plastic curved blades were prone to failure in use. Metal blades are available.

Rigid indirect bladed laryngoscopes

These devices achieve a view using a number of principles, either *reflection* (using a prism, mirror or fibreoptics) or *electronic (video)* imaging (videolaryngoscopes). Techniques using the latter are by far the most common in clinical practice.

Reflection with prism: the *Belscope*™ curved blade has a perspex prism in the blade achieving an indirect LoS.

Reflection with mirror: the *McMorrow*™ blade is a curved, hinged blade with a dental mirror, actuated by levers, giving an upside down view.

Reflection with fibreoptics: these devices have a rigid blade, usually curved, with fibreoptic illumination and image transmission and were introduced in the 1990s. e.g. *Bullard*™, *Upsher*™ scopes.

Devices utilizing reflection are not in common use.

Electronic (video) imaging is used by several types of *videolaryngoscope* and is increasingly common. In general, a form of digital camera is housed near the beak of a blade of variable geometry with image transmission to a screen. e.g. *Glidescope*™, *McGrath Series 5*™, *McGrath MAC*™, *CMAC*™, *AP Advance*™ *etc*.

A videolaryngoscope (and also fibreoptic bladed devices) usually provide a laryngeal view and can 'see around the corner'. In general, there is the reduced airway alignment and reduced space for tube passage. The blade is usually protected by a single-use sheath.

One classification is:

- *Obligate videolaryngoscopy*: The blade geometry is such that no direct view is achievable and the user must view the screen. e.g. *Glidescope*™, *McGrath Series 5*™. Usually some form of stylet to curve the tube is needed into a 'hockey stick' configuration. Care must be taken when inserting this into the mouth since there is a 'blind spot' and palatal injury has been described.
- *Optional videolaryngoscopy*: The blade geometry is less acute and the user may choose to view the larynx either directly or indirectly. e.g. *McGrath MAC*™ (*with MAC blade*) These devices allow training from direct to indirect techniques and are useful for teaching airway anatomy.
- *Orienting videolaryngoscopy*: These devices have a guiding channel for the tracheal tube in the airway blade, e.g. *Pentax Airway Scope*™. By selecting a blade sheath with a channel, videoscopes from the other two groups join this set. e.g *McGrath MAC*™ *with X blade*.

There is currently no strong data to recommend which device is generally superior.

Intubating conduits

Optical imaging: the single-use *Airtraq*™ uses illuminated lenses and prisms to display the larynx with an intubating channel.

Electronic imaging: the *CTrach*™ is a modified ILMA with illumination and camera within the bowl. The image is transmitted to a detachable screen. It is unique, allowing simultaneous visualization, ventilation and intubation, but is presently unavailable.

Optical stylets[7]

Rigid stylet: the *Bonfils*™ has fibreoptic illumination and imaging within a 5 mm straight (but distally curved) stylet, over which a tracheal tube is loaded. Intubation can be achieved with minimal neck movement.

Malleable stylet: the *Shikani*™ is similar. The malleable tip risks damage to the fibreoptic components.

Intubation with a flexible fibreoptic bronchoscope (FFOB) (Figure 3)

This versatile device is used for airway inspection, biopsy, toilet and tracheal intubation by oral or nasal routes. This can be done with local or general anaesthesia.

It consists of:

- *Insertion cord*: fibreoptic light and viewing bundles, tip control elements and working (suction) channels.
- *Control body*: handle, control lever, eyepiece, light-guide either from battery or umbilical (cable).

The FFOB is expensive, delicate and needs intense decontamination. Training is needed to master the skills of patient preparation and device use. The main limitations are image loss with blood or secretions, inability of patients to tolerate an awake approach or deficits in practioner skill.

Light-guided intubation

Intubation using transillumination is successful with training. Devices such as the *Trachlight*™, loaded with a tube are inserted blindly into the airway. The quality of the light transmitted through the neck indicates tube placement. This is useful with blood in the airway.

Figure 3 Flexible fibreoptic laryngoscope. (**a**) handle; (**b**) Control lever; (**c**) eyepiece; (**d**) lightsource (battery) or connection for external lightsource (umbilical); (**e**) port for working channel (for suction or instrumentation); (**f**) insertion cord; (**g**) movable tip of insertion cord.

Intubation with a SAD

SAD guided intubation, such as the ILMA is described above.

Tracheal tubes

The tube provides airway patency and protection. Most single-use tubes are polyvinyl chloride and reusable tubes are silicone.

Standard tubes consist of:

- *Connector*: 15 mm external diameter.
- *Tube*: marked with radio opaque line, cm distance markers from the tip, depth marker 3 cm from the tip with information on internal (ID) and external diameters. (When printed, 'Z29-IT' refers to the room number where the decision on biocompatibility, 'Implantation Testing', in rabbit was made).
- *Tip*: with a left-facing bevelled opening. Some have an additional opening, a Murphy eye, to allow ventilation if the main opening is blocked.

Cuffed or uncuffed tubes are available. The cuff is inflated with air via a pilot tube, balloon and self-sealing valve. Cuff pressure should be <30 cm water, measured with a manometer. Nitrous oxide increases pressure by diffusion.

Reinforced tubes: have spiral wire to resist kinking, used for neurosurgery and maxillofacial surgery.

ILMA tubes are described above.

Preformed tubes are moulded to direct the tube away from the operative site for ENT surgery. Examples include *Polar* (north—or south-facing) and *RAE* (Ring, Adair, Elwyn) tubes.

Microlaryngeal tubes are 5 mm ID, soft walled, cuffed tube used for laryngeal procedures.

Laser tubes are ignition resistant, either metal or silicone/metal wrapped, used for laser airway surgery. Some have two cuffs and inflation with saline is advised.

Thoracic surgery tubes are used to isolate each lung. *Double-lumen tubes* have one lumen to enter one mainstem bronchus, the other lies in the trachea. The *Robertshaw* tube (P3 medical) is popular. Single lumen *Bronchial blocking tubes* are used with balloon-tipped guidewires designed as endobronchial blockers. (*Univent*™, *Arndt*™, or *Cohen* ™ tubes)

Subglottic tubes, such as the Hunsaker (Mon-Jet™) and the Jet Catheter (VBM) are narrow catheters designed for laryngeal surgery. They are passed through the glottis and require high-pressure source ventilation (HPSV). A second lumen may be used to measure respiratory pressures or gas composition.

Tracheostomy tubes: are short and curved. Some have an inner cannula for cleaning. Others have an adjustable flange to alter the depth of insertion into the neck.

Aids to tracheal intubation

Stylet: this is a malleable, coated wire rod inserted into a tracheal tube to bend it. When a tight distal curve is formed it is called a 'hockey stick'. The stylet should not protrude beyond the tube orifice.

Tracheal introducer is a guide for intubation when the laryngeal view is incomplete or tube passage is problematic. The standard device is the *Portex Venn*™, (previously the *Eschmann*™ introducer), called a 'bougie'. It is a 60 cm flexible rod with an angled 'coude' tip made of braided polyester with resin coatings. It can be reused six times.

Single-use devices (e.g. *Frova*™) have higher risks of trauma. Adaptors permit HPSV but barotrauma is a risk.

Aintree Intubating Catheter™ is a 56 cm long hollow tube with adaptors for breathing systems and for HPV. It is threaded over a 4.0 mm FFOB or through a SAD into the trachea allowing a tracheal tube (>7.0 mm ID) to be guided over it.

Airway exchange catheters: are long (83 cm) hollow catheters are used for tracheal tube exchange. Adaptors allow for oxygen insufflation or HPSV. The catheter tip must remain in the tracheal lumen; more distal placement risks lung injury, either directly or from barotraumas with administered oxygen.

Retrograde intubation equipment: a cannula or extradural needle is used to access the trachea *via* the cricothyroid membrane (CTM). An extradural catheter or guidewire is threaded rostrally leaving the mouth, passed through a tracheal tube or working channel of an FFOB acting as an intubation guide.[8]

Airway management below the glottis: cricothyroidotomy (Figure 4) and tracheostomy[9]

Tracheostomy is done when airway patency or protection *via* the upper airway is not assured. A surgical approach is called 'open'. Percutaneous dilational techniques are most often done within critical care.

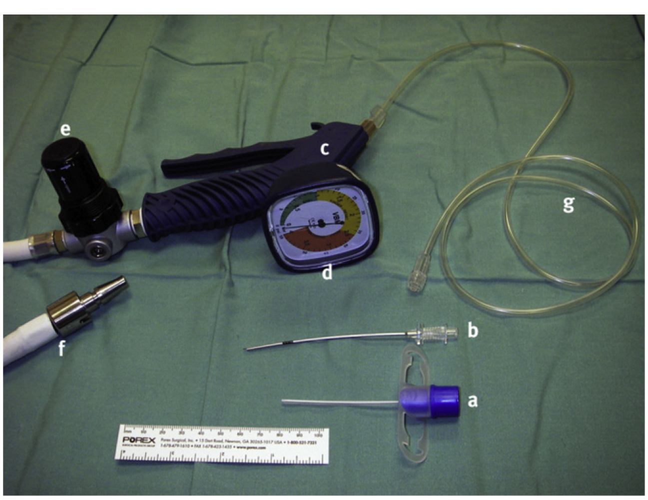

Figure 4 Cricothyroidotomy cannula and jet ventilator. (**a**) cricothyroidotomy cannula (13G *Ravussin*™ type); (**b**) needle for cannula; (**c**) jet ventilator (*Manujet*™); (**d**) pressure gauge (0–4 bar); (**e**) pressure adjusting valve; (**f**) high pressure hose and Schrader valve; (**g**) tubing to connect ventilator to cannula.

Cricothyroidotomy involves airway access through the cricothyroid membrane. This is a temporary technique with conversion to another form of airway control advised, usually within a day or so. There are two groups; advice recommends that both approaches are learned.

***Narrow bore* (<4 mm ID):** a catheter-over-needle (e.g. *Ravussin*™, *Cricath*™) is used. Since there is high flow resistance, HPSV (a jet ventilator, e.g. the *Manujet*™) is needed to ensure efficient gas exchange and the expiratory pathway is *via* the patient's own upper airway. Catheter misplacement, kinking and barotrauma are risks. Oxygenation by insufflation is possible by connecting the cannula *via* tubing to flow metered oxygen, but carbon dioxide is not cleared.

The *Enk Flow Modulator*™ is a single-use device which connects to the cannula and improves delivery of oxygen from flow metered oxygen.

A new device, the *Ventrain*™ has been recently introduced for use with narrow-bore cricothyoid cannulae. The device is a single-use jet ventilator driven from flow metered oxygen and uniquely uses the venturi principle to extract expiratory gas from the narrow-bore cannula. This means that expiration is independent of the patient's upper airway patency and plausibly may increase safety in rescue from dangerous upper airway obstruction. There is currently little data on clinical use.

***Wider bore* (>4 mm ID)**: have lower resistance and gas exchange is achievable with standard breathing systems. The uncuffed *Quicktrach 1*™ is available in three diameters (1.5, 2.0 and 4.0 mm) whilst the 4.0mmID *Quicktrach 2*™ is cuffed. They are designed as for direct percutaneous insertion with a cutting needle with a removable guard to reduce the risk of damage to the posterior laryngeal wall. Another example is the *Portex PTK*™.

The *Melker*™ is available in either uncuffed or a 5.0 mm ID cuffed versions. The latter is part of the *Melker Universal*™ kit. This may be inserted using a wireguided and dilational technique ('Seldinger') or using a scalpel ('Surgical') incision, control of the cut with a tracheal hook followed by tracheal dilation with forceps to allow tube insertion. The *Surgicric*™ is a kit with scalpel, tracheal hook and a 7.0mmID cuffed tube with a moveable flange.

The surgical approach can be used with any tracheal tube of suitable size. Care must be taken to avoid excessive insertion with endobronchial intubation.

The *Minitrach*™ is designed for tracheobronchial toilet, not provision of gas exchange.

Cricothyroidotomy is done in three clinical situations:

- *Procedural*: allowing surgical access in laryngeal surgery.
- *Precautionary*: when airway management is predicted to be difficult, a form of 'insurance policy'.[10]
- '*Perimortem*': when all forms of airway control have failed and is done as a final rescue effort, in the 'Can't Intubate, Can't Ventilate' scenario (better called 'Can't Intubate, Can't Oxygenate'). This is Plan D of the DAS guidelines. NAP4 has shown that in these circumstances the failure rate for narrow bore devices is about 70% and about 45 % for the wider bore.[1] Lack of training and performance anxiety are likely to be major factors. This emphasizes the need for formulation of a safe and effective strategy to reduce the risk of reaching this very dangerous situation. ◆

REFERENCES

1 Royal College of Anaesthetists, Difficult Airway Society. 4th national audit project of the Royal college of anaesthetists and the difficult airway society. Report and findings. March 2011 (accessed 12 January 2015), http://www.rcoa.ac.uk/document-store/nap4-full-report.

2 Henderson JJ, Popat MT, Latto IP, Pearce AC. Difficult airway society guidelines for management of the unanticipated difficult intubation. *Anaesthesia* 2004; **59:** 675–94.

3 Behringer EC, Kristensen MS. Evidence for benefit vs. novelty in new intubation equipment. *Anaesthesia* 2011; **66**(suppl 2)**:** 57–64.

4 Pandit JJ, Popat MT, Cook TM, et al. The Difficult Airway Society 'ADEPT' guidelines on selecting airway devices: the basis of a strategy for equipment evaluation. *Anaesthesia* 2011; **66:** 726–37.

5 Han R, Tremper KK, Kheterpal S, O'Reilly M. Grading scale for mask ventilation. *Anesthesiology* 2004; **101:** 267.

6 Cook TM, Lee G, Nolan JP. The ProSeal™ laryngeal mask airway: a review of the literature. *Can J Anaesth* 2005; **52:** 739–60.

7 Liem EB, Bjoraker DG, Gravenstein D. New options for airway management: intubating fibreoptic stylets. *Br J Anaesth* 2003; **91:** 408–18.

8 Dhara SS. Retrograde tracheal intubation. *Anaesthesia* 2009; **64:** 1094–104.

9 Hamaekers AE, Henderson JJ. Equipment and strategies for emergency tracheal access in the adult patient. *Anaesthesia* 2011; **66**(suppl 2)**:** 65–80.

10 Gerig HJ, Schnider T, Heidegger T. Prophylactic percutaneous transtracheal catheterisation in the management of patients with anticipated difficult airways: a case series. *Anaesthesia* 2005; **60:** 811–5.

FURTHER READING

Mihai R, Blair E, Kay H, Cook TM. A quantitative review and meta-analysis of performance on non-standard laryngoscopes and rigid fibreoptic intubation aids. *Anaesthesia* 2008; **63:** 745–60.

Patel B, Frerk C. Large-bore cricothyroidotomy devices. *Br J Anaesth CEPD Rev* 2008; **8:** 157–60.