Equipment for airway management

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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

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

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

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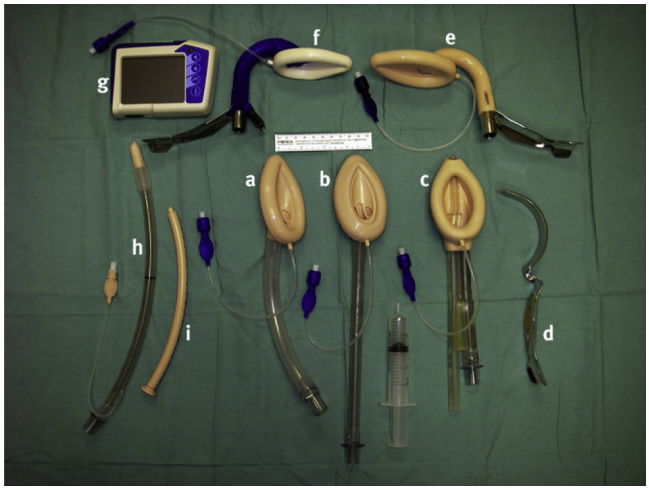

Figure 1 Supraglottic airway devices. (**a**) classic Laryngeal Mask Airway (cLMA); (**b**) flexible Laryngeal Mask Airway (fLMA); (**c**) ProSeal Laryngeal Mask Airway (PLMA™); (**d**) spatula for insertion of PLMA™; (**e**) Intubating Laryngeal Mask Airway (ILMA™); (**f**) CTrach™; (**g**) Screen for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