Difficult airway management for the anaesthetist

ABSTRACT

This article reviews the key considerations when managing a patient with a difficult airway. The difficult airway may be anticipated from preassessment allowing time for investigations and preparation. Alternatively, the unanticipated difficult airway can present in an emergency situation, or unexpectedly during a routine anaesthetic. The main airway management techniques are discussed with a description of their advantages and limitations. Current guidelines are included that demonstrate how the techniques are incorporated into an overall strategy with a plan A–D when failure occurs. It is critical to progress through such an algorithm in a timely manner to prevent the onset of hypoxia.

A difficult airway can involve difficult mask ventilation, intubation or both (Apfelbaum et al, 2013). Fortunately, serious morbidity from airway complications is rare. In the UK the incidence of airway-related death and brain damage is reported to be 7 per million general anaesthetics (Cook et al, 2011b). Anticipating the difficult airway is a vital skill of the anaesthetist. Once the risk is identified, a plan must be devised to secure the airway in the safest way, as part of an overall strategy to maintain or secure the airway in case of failure. If a method fails there must be seamless transition to the next stage at clearly defined points.

This article explores the airway techniques available to the anaesthetist and their role when planning for and managing a difficult airway. One must be aware of the difference in management of the anticipated (planned procedure) and unanticipated difficult airway (unplanned and usually more time critical).

Presentation

When approaching the anticipated difficult airway, some useful questions include (Crawley and Dalton, 2015; Aintree Difficult Airway Management Course, 2018):

Regarding urgency:

1. How severe is the airway compromise?
2. How much time is available to secure the airway?

Regarding the management plan:

3. At what level(s) of the respiratory tract is the airway compromised?
4. How can the airway be accessed (oral, nasal, transtracheal routes)?
5. Will I be able to
   a. Mask ventilate?
   b. Perform laryngoscopy?
   c. Use a supraglottic airway device?
   d. Intubate the trachea?
   e. Perform front of neck access (transtracheal route)?
6. Should intubation be performed awake?
7. How could the situation deteriorate?
8. Is there a significant risk of aspiration?
9. How will the airway behave at extubation?

A thorough preoperative assessment will determine the need for further help, specialized equipment or advanced airway techniques. It may be crucial to involve the ear, nose and throat surgeons.

A symptoms review may indicate the level and severity of airway obstruction, although not every patient with a difficult airway is symptomatic (*Table 1*).

Obstruction is most common at the level of the larynx. Severely symptomatic patients may have worsening exercise tolerance, orthopnoea and dysphagia. Stridor usually indicates narrowing of the lumen by more than 50% of its diameter. The progression of symptoms is important when considering the urgency of intervention. Patients in extremis with associated hypoxia require time-critical airway intervention that precludes extensive investigations. The most appropriate team and equipment should be gathered at the most suitable location. Theatre is the best environment to manage a difficult airway but a judgement must be made about whether it is safer to bring resources to the patient or undertake a transfer.

Table 1. Site *vs* symptoms

Site	Symptoms
Oropharynx	Snoring, gurgling sounds
Base of tongue or epiglottis	Dysphagia, drooling, stridor
Glottis	Stridor, paroxysmal nocturnal dyspnoea, voice changes
Trachea	Expiratory stridor

From Lynch and Crawley (2018)

Dr J Hews, Specialist Registrar, Department of Anaesthesia, Guy's & St Thomas' NHS Foundation Trust, London SE1 9RT

Dr K El-Boghdadly, Consultant Anaesthetist, Department of Anaesthesia, Guy's & St Thomas' NHS Foundation Trust, London

Dr I Ahmad, Consultant Anaesthetist, Department of Anaesthesia, Guy's & St Thomas' NHS Foundation Trust, London

Correspondence to: Dr J Hews (hewsie33@gmail.com)

Conversely, slow progressing disease may be well compensated for allowing time for planning.

If a mass is present in the neck it should be examined for:

- Consistency
- Mobility
- Tracheal deviation
- Retrosternal extension.

Hard, fixed masses tend to represent cancer. As well as this it may be difficult to perform intubation with distorted anatomy. By contrast, benign soft tissue masses often accommodate a tracheal tube larger than the initial diameter of the lumen. Retrosternal extension may cause difficult access via the transtracheal route. Sternotomy may be required for surgical access.

Masses may impact surrounding structures in the following ways:

- Intraluminal invasion of cancer can cause difficulty passing a tracheal tube
- Recurrent laryngeal nerve damage results in vocal cord palsy
- Cartilage involvement can compromise structural integrity of the airway. Tracheomalacia is the dynamic collapse of the airway, especially with increased airflow, and may become problematic in the postoperative period
- Proximity to blood vessels presents a risk of haemorrhage.

Further growth or changes in clinical presentation should be noted since the last assessment, including any impact on the airway. Previous treatments such as surgery or radiotherapy should also be identified as they can predispose to difficult mask ventilation and intubation.

For infection, the extent and site of swelling helps identify the level of airway compromise. Tracking through fascial planes can affect the airway at any or all levels of the upper respiratory tract. Trismus should be sought, whereby the involvement of the temporomandibular joint causes painful muscle spasm that prevents mouth opening. This can also occur with trauma. Although painful trismus often subsides after induction of anaesthesia and muscle relaxation, improved mouth opening does not reliably follow. The airway management strategy must account for this.

Some further take-home points from the 4th National Audit Project of major airway complications in the UK (Cook et al, 2011b) reported that 40% of airway incidents were associated with acute or chronic disease of the head, neck or trachea. Airway obstruction was present in approximately 70% of cases. Obesity was twice as likely to be present with adverse airway events, especially morbid obesity.

Routine airway assessment: findings suggestive of difficult airway

A standard airway assessment (described elsewhere) is performed for every anaesthetic pre-assessment as a difficult airway may be present with or without co-existing head and neck pathology. During the course of assessment, accessing previous anaesthetic charts provides a good source of information if a difficult airway was encountered. However, a previous easy airway in the context of head and neck pathology does not reliably predict similar conditions subsequently. The Difficult Airway Society also organizes a database of difficult airway patients to whom they issue an airway alert card (Ponnusamy et al, 2018). If a difficult airway is anticipated then alternative forms of anaesthesia should be considered if appropriate, e.g. regional technique.

Investigations

If there is time for investigations these can add valuable information.

Computed tomography or magnetic resonance imaging

Computed tomography or magnetic resonance imaging defines the extent of any lesions and measures the airway diameter at critical points. In an emergency computed tomography is usually used as it is faster and hence less hazardous for a patient with airway compromise to lie flat in the scanner. Magnetic resonance imaging might be available in elective situations and is usually better at imaging soft tissues. Furthermore, software is available that can construct computed tomography imaging into a three-dimensional virtual endoscopy (El-Boghdadly et al, 2017a).

Awake flexible nasendoscopy

Usually performed in ear, nose and throat outpatient clinic, awake flexible nasendoscopy has the added benefit of showing dynamic changes that occur in the airway with respiration.

Ultrasound

Ultrasound scan of the neck can locate the position of the cricothyroid membrane or spaces between tracheal cartilage rings to help plan for front of neck access (Kristensen et al, 2016).

Techniques for managing the difficult airway

There is no specific consensus for management of the anticipated difficult airway, because the skill and experience with different airway techniques varies among anaesthetists (Cook et al, 2011a). The definitive airway is a tracheal tube with its cuff inflated in the trachea. This allows control of ventilatory pressures, gas exchange and protection from pulmonary aspiration. However, it is not always necessary to secure the airway at the level of the trachea and using a supraglottic airway device, or even facemask ventilation, may be suitable depending on the nature of the surgery and patient characteristics.

Facemask ventilation

Facemask ventilation is a skill that should not be underestimated. If there is difficulty managing the airway using other techniques facemask ventilation is a rescue for maintaining oxygenation. Facemask ventilation is the usual technique for anaesthetic induction.

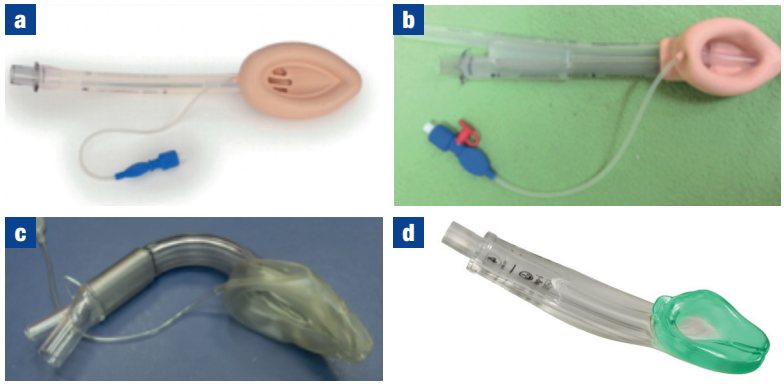

Figure 1. **a.** LMA laryngeal mask Classic (Teleflex Medical, Morrisville, NC, USA). **b.** ProSeal LMA laryngeal mask (Teleflex Medical, Morrisville, NC, USA). **c.** LMA laryngeal mask Supreme (Teleflex Medical, Morrisville, NC, USA). **d.** i-gel (Intersurgical, Wokingham, UK). From Kwanten and Madhivathanan (2018).

Decreased consciousness, whether from anaesthesia or critical illness, reduces muscle tone in the upper airway which can contribute to airway obstruction. Airway manoeuvres improve patency by applying chin tilt and jaw thrust. A hollow oropharyngeal or nasopharyngeal tube can also be inserted for airway patency and to aid facemask ventilation. Two- or even four-handed mask technique can aid ventilation if it becomes difficult. If airway compromise is severe to start with there may be little reserve for further compromise during anaesthetic induction.

Besides the usual types of anaesthetic breathing circuits used with facemask ventilation, a self-inflating bag, e.g. Ambu bag, has the advantage that no gas flow is required to re-inflate the reservoir bag between breaths. This is especially useful for providing ventilation in an emergency outside theatre.

The risk of gastric reflux should be considered with facemask ventilation because the glottis is exposed. The unconscious patient risks pulmonary aspiration as airway reflexes are obtunded. If there is significant risk of reflux either a rapid sequence induction is performed with application of cricoid pressure, or intubation is performed awake.

Supraglottic airway device

This is a mask airway device inserted through the oropharynx that sits above the vocal cords in the larynx. Second generation devices are now routinely used that are defined by:

- Integral bite block
- Increased gastric aspiration safety
- Higher oropharyngeal leak pressures.

Some devices contain a gastric port to insert a suction catheter for secretions or refluxed gastric contents (*Figure 1a* shows a first generation device, *Figures 1b–d* are second generation).

A supraglottic airway device is not usually used for first-line management of the difficult airway, but can be an appropriate rescue plan for difficult facemask ventilation or intubation. When a supraglottic airway device is inserted, the adequacy of ventilation must be assessed to ensure it is seated well. A change of size or type may improve conditions.

Difficult ventilation may remain if the problem is distal to the larynx, although the application of positive pressure can alleviate a distal narrowing. If the rescue supraglottic airway device is performing effectively it could remain in situ. Considerations for this include the level of confidence in its ongoing performance, the urgency and nature of the surgery, risk of aspiration and the complexity of further airway management in the event of supraglottic airway device failure. Any preceding vigorous facemask ventilation may have insufflated the stomach resulting in raised intragastric pressures and further risk of reflux. Continuing with an inadequate supraglottic airway device predisposes the patient to serious airway complications (Cook et al, 2011b). If the patient can be woken up this should be considered. It is also possible to intubate via supraglottic airway device under the guidance of a flexible bronchoscope, e.g. a size 6 tracheal tube will pass through a size 4 i-gel, to provide a more definitive airway.

Tracheal intubation

Direct laryngoscopy

Direct laryngoscopy is the traditional method of intubation. The glottis is visualized by lining up the three planes of the mouth, pharynx and glottis. The ideal position is flexion at the base of the neck with head extension. The laryngoscopy blade is used to sweep the tongue aside and elevate the mandible to gain a view of the glottis.

If there is difficulty passing the tracheal tube, a malleable gum-elastic bougie may be used. It is initially introduced into the glottis before passing the tracheal tube over the bougie, using it as a conduit. Airway exchange catheters are similar devices but the hollow tubing and a connector allows simultaneous oxygenation, if required. Alternatively, a tracheal tube can be preloaded onto a stylet which can be rigid and curved, or straight and malleable to modify the shape.

If direct laryngoscopy is difficult one variable should be changed to improve conditions for each additional attempt, including (but not limited to):

1. Optimizing patient position
2. Change blade size, type or handle
3. External laryngeal manipulation
4. Use of a bougie or stylet
5. Release of cricoid pressure, if being applied
6. Change intubator to colleague with more experience.

Suctioning any secretions or blood to improve the view is also crucial.

Videolaryngoscopy

Videolaryngoscopy is a method of intubation achieved via indirect visualization of the glottis. Either an image is projected from the tip of the blade or the operator looks down a channel which projects the view via a prism. There

is a range of videolaryngoscopy designs available (*Figure 2*). They are generally characterized by:

1. Blade style – standard Macintosh-type or hyperangulated
2. Presence of a channel for preloading and guiding a tracheal tube.

Videolaryngoscopy can be used when it is thought to be difficult to traverse the angle of the upper airway anteriorly during direct laryngoscopy. Examples include fixed flexion deformity of the neck and manual in-line neck stabilization during trauma. Despite good visualization of the glottis, a common problem with videolaryngoscopy is difficulty directing the tracheal tube into the glottis. A stylet or bougie is helpful in this instance, although this should be considered from the outset when using a hyperangulated videolaryngoscope. Another problem may be hold up at the glottic inlet on structures such as the epiglottis or arytenoid cartilage. Rotating the tracheal tube may overcome the obstacle, change the angle of approach or direction of the bevel. Videolaryngoscopy for awake intubation with topical local anaesthetic is emerging as an alternative method for awake tracheal intubation (Rosenstock et al, 2012; Fitzgerald et al, 2015).

A systematic review (Lewis et al, 2016) reported that in all settings videolaryngoscopy results in:

- Improved view of the larynx
- Improved ease of use
- Decreased airway trauma
- Reduced failures.

This is recognized in Difficult Airway Society guidelines which recommend that all anaesthetists should be skilled in use of videolaryngoscopy and that the devices should be universally available (Frerk et al, 2015). In the intensive care unit setting, it is also recommended that if a poor view is gained at the outset during intubation subsequent attempts should use videolaryngoscopy (Higgs et al, 2018). Furthermore, routine practice is advocated in order to develop expertise and understand how videolaryngoscopy may fail. It should be appreciated that gaining a view of the larynx is only one part of the process of facilitating intubation. Blind intubation techniques should be avoided in favour of real-time visualization of the effects of cricoid pressure, external laryngeal manipulation and advancing a tracheal tube or bougie. A screen enables this to be a coordinated team effort. Presently, these recommendations are based on consensus by experts. The focus of ongoing research is to determine whether one type of videolaryngoscopy performs better than another for a given patient group or setting.

Flexible bronchoscopic intubation

A tracheal tube is loaded onto a flexible bronchoscope (*Figure 3*) through which the operator looks or an image is projected from the distal tip onto a screen. The scope is manoeuvred by rotation and by directing the tip up or down with a thumb lever. Narrow passages can be traversed via the oral or nasal routes. This confers an advantage if laryngoscopy and intubation is anticipated to be difficult.

Figure 2. C-MAC (Karl Storz, Tuttlingen, Germany) videolaryngoscope with range of blades and Magill forceps to aid tube placement.

Figure 3. Flexible bronchoscope.

A side port exists for suctioning but some choose to use it for administering oxygen or injecting local anaesthetic.

If facemask ventilation is likely to be possible and the patient is unlikely to aspirate then the procedure can be done asleep. However, awake tracheal intubation using a flexible bronchoscope can be performed if anaesthetic induction presents a significant risk to securing the airway. The procedure is well tolerated with effective topical local anaesthetic and handling of the scope, in conjunction with ongoing oxygenation. Sedation is often used for patient comfort but this should be carefully titrated as conditions could deteriorate. Having a separate seditionist is recommended (Johnston and Rai, 2013). Awake tracheal intubation can be safely abandoned without having compromised the airway through anaesthesia or neuromuscular blockade (El-Boghdadly et al, 2017b). Various techniques are described for performing awake tracheal intubation.

The patient should be assessed for cooperation. Awake tracheal intubation may not be possible with cognitive impairment or anxiety. There are points during the procedure that result in some degree of discomfort, notably railroading the tracheal tube through the nostril and glottis.

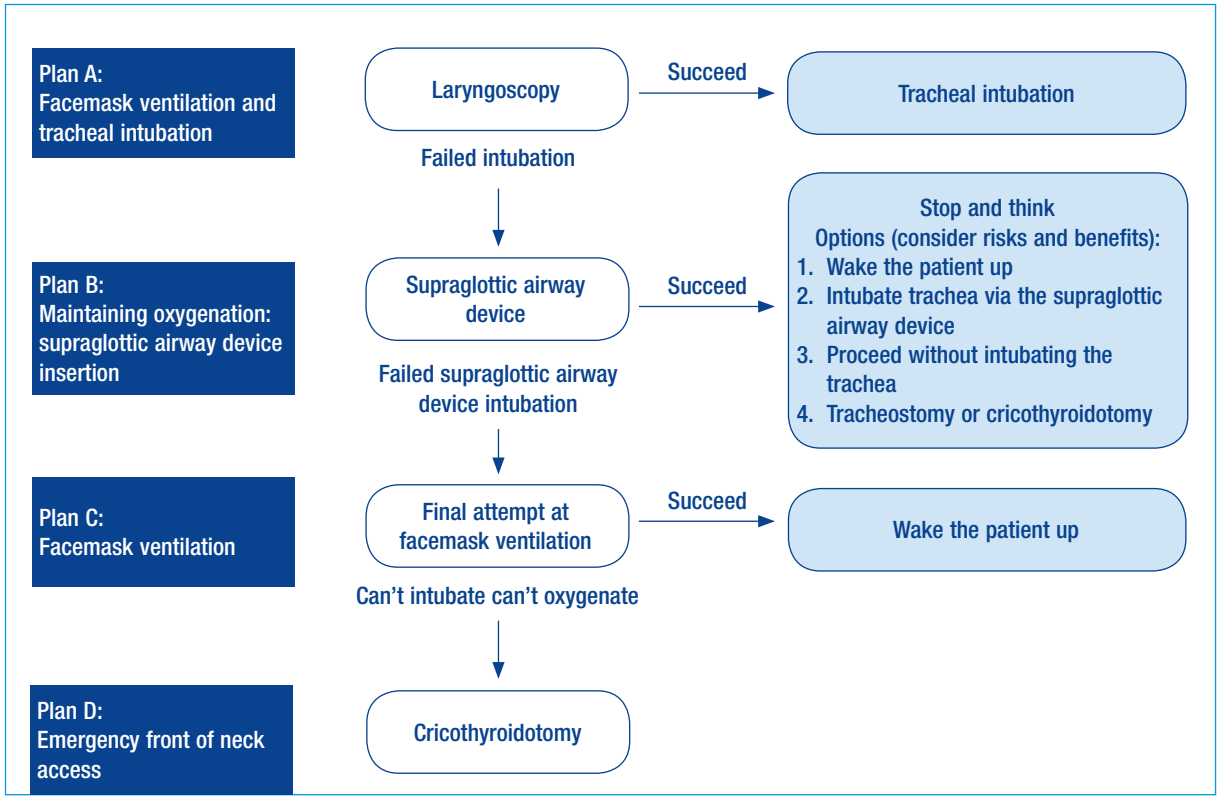

Figure 4. Overview of the Difficult Airway Society guidelines for unanticipated difficult intubation. From Frerk et al (2015).

Flexible bronchoscopic intubation is not without its limitations. Tumours may be friable and prone to bleed resulting in loss of visualization through the scope. Distorted anatomy may sometimes be too difficult to navigate. On rare occasions, narrowing at or below the level of the glottis may be severe enough to prevent the passage of a tracheal tube. In these clinical scenarios, supraglottic ventilation can be performed via an inserted rigid bronchoscope, jet ventilation delivered through narrow catheters, or front of neck access may be required.

Front of neck access

This route directly accesses the trachea via the cricothyroid membrane in the anterior neck or between the tracheal cartilage rings below. The cricothyroid membrane can be felt between the thyroid and cricoid cartilages. Difficult Airway Society guidelines advocate surgical cricothyroidotomy rather than needle cricothyroidotomy in an emergency, using a scalpel, bougie and tracheal tube (Frerk et al, 2015). Needle techniques have a higher failure rate (Cook et al, 2011b). The optimum position for performing front of neck access is with the head and neck extended.

This invasive technique may be a last resort in a 'can't intubate, can't oxygenate' scenario, or in some circumstances of anticipated difficult airway it may be the initial plan of choice. Front of neck access must be considered in an anaesthetized patient if all airway management strategies fail and hypoxia ensues. If the risk of losing the airway is significant, the cricothyroid membrane should be identified before embarking on airway management, either using a landmark technique or with ultrasound. Furthermore, if time allows the procedure is best performed in an operating theatre environment. For all plans where front of neck access is considered a rescue option, appropriately trained surgeons must be scrubbed with equipment prepared and available so that a transition to front of neck access can be made in minimal time. Front of neck access may be performed awake under local anaesthesia if there is concern of losing the airway once asleep, ideally inserted between the first and second tracheal rings as this site is more comfortable for the patient long term. If performed asleep conditions should be optimized with the patient paralysed. Front of neck access may be difficult with short large necks, neck masses, e.g. goitre, limited neck extension, previous head and neck surgery or radiotherapy.

Transnasal humidified rapid-insufflation ventilatory exchange

Transnasal humidified rapid-insufflation ventilatory exchange (THRIVE) is a novel method for delivering high flow rates of humidified oxygen via nasal cannulae at up to 70 litres/min. Supplementary oxygenation is achieved through mass flow and low grade positive airway pressure thereby splinting the airways. It also reduces work of breathing. This form of oxygenation has transformed the field of airway management. During intubation attempts THRIVE can maintain oxygenation until intubation has been achieved. This results in a change from the stop–start approach with re-oxygenation between intubation attempts (Mir et al, 2017). THRIVE may be considered

as a bridging technique and is very seldom a substitute for a definitive airway. The applications of THRIVE are being realized in a variety of hospital settings.

Guidelines

Difficult intubation

The Difficult Airway Society has produced guidelines for a standardized approach to the unanticipated difficult airway (Frerk et al, 2015) (*Figure 4*). It recommends plans A–D with a specified number of attempts at each stage. This prevents task fixation on a technique that has failed and enables the anaesthetist to move on. There are also algorithms for the unanticipated difficult airway in obstetric and paediatric patients, as well as critically ill adults (Higgs et al, 2018).

Extubation

One third of airway events take place during emergence or recovery. The commonest cause is obstruction. Difficult intubation and blood in the airway predispose to complications around extubation (Cook et al, 2011b).

The 'at risk' algorithm (*Figure 5*) suggests some advanced extubation techniques as well as the consideration of keeping the patient asleep and extubating when conditions are more suitable (Popat et al, 2012).

Tracheostomy

Tracheostomy tube displacement is the greatest cause of major morbidity and mortality in the intensive care unit (Cook et al, 2011b). Guidelines are available for tracheostomy emergencies for patients with a patent upper airway or who have had a laryngectomy (McGrath et al, 2012). The latter account for 1 in 10 stomas. These are so-called 'neck breathers' and the stoma is their only route of airway access. The steps to follow for emergency tracheostomy management are:

1. Assess ventilation by attaching Mapleson C system ('Waters circuit') with high-flow oxygen
2. Remove speaking valve or cap (if present)
3. Remove inner tube
4. Pass suction catheter to assess patency
5. If obstructed, deflate cuff (if present)

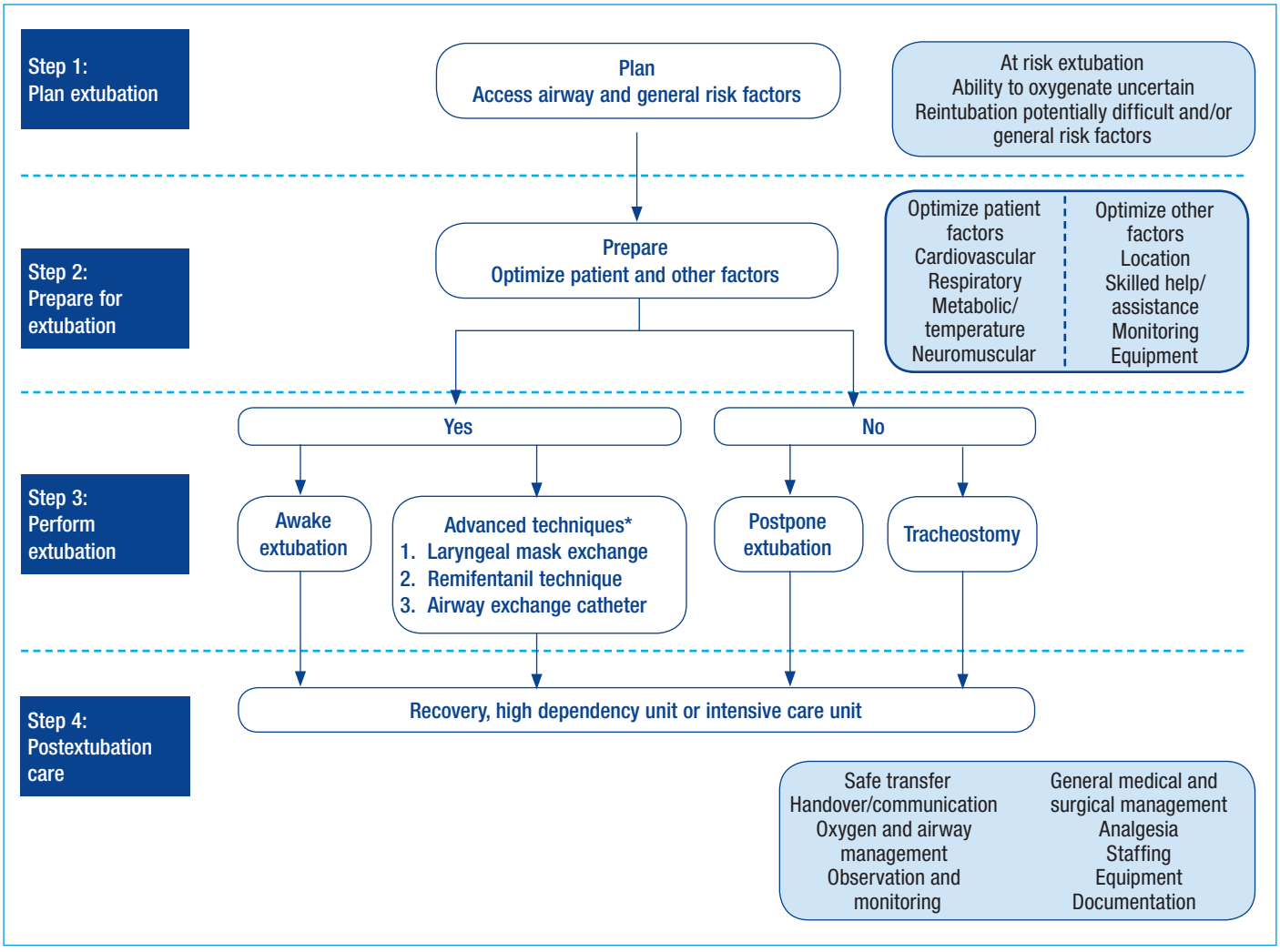

Figure 5. Difficult Airway Society extubation guidelines: 'at risk' algorithm. *Advanced techniques: require training and experience. From Popat et al (2012).

KEY POINTS

- The difficult airway can be anticipated or unanticipated with implications for timing and preparation.
- Algorithms for the unanticipated difficult airway provide a prescribed strategy for airway management that can result in life-saving interventions.
- The final step in the management plan of the unanticipated difficult airway is invasive front-of-neck access via cricothyroidotomy. Although situations are rarely encountered where this is required, every anaesthetist must be trained and prepared to perform this procedure if indicated.
- Awake flexible bronchoscopic intubation is the gold standard technique for managing the difficult airway as spontaneous ventilation is preserved along with the patient's protective airway reflexes. This allows procedural time to secure the airway and the procedure to be abandoned relatively safely if it fails.
- Videolaryngoscopes and THRIVE are both developments in recent years that are becoming well-established airway tools. Their potential is yet to be fully realized in clinical practice.

6. If patient not improving, remove tracheostomy tube
7. Attempt oxygenation via either the oral route or the stoma via bag-valve-mask, supraglottic airway device or tracheal tube.

Conclusions

The vast majority of airway management is uneventful. The operator must be dispassionate about the failure of an airway technique and prepared to move on. If necessary he/she should hand over control to a more experienced colleague or ear, nose and throat surgeon. Sometimes this is recognized before executing an airway plan. At each point during difficult airway management the adequacy of the airway must be assessed and continually monitored. It cannot be overemphasized that maintaining oxygenation is the key priority throughout. When further intervention is needed, smooth transitions are possible with prompt action and team coordination. This article has outlined a range of airway devices and techniques for the difficult airway. This is a continually developing field where technology and innovation play an important role in improving patient safety. **BJHM**

Figure 4 *is reproduced from Frerk et al (2015).* Figure 5 *is reproduced from Popat et al (2012) by permission of the Association of Anaesthetists of Great Britain & Ireland/Blackwell Publishing Ltd.*
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Aintree Difficult Airway Management Course. 2018. The Aintree Difficult Airway Management Website. (accessed 1 August 2018) https://adam.liv.ac.uk/adam9/Default

Apfelbaum JL, Hagberg CA, Caplan RA et al; American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Anesthesiology. 2013 Feb;118(2):251–270. https://doi.org/10.1097/ALN.0b013e31827773b2

Cook TM, Morgan PJ, Hersch PE. Equal and opposite expert opinion. Airway obstruction caused by a retrosternal thyroid mass: management and prospective international expert opinion. Anaesthesia. 2011a Sep;66(9):828–836. https://doi.org/10.1111/j.1365-2044.2011.06650.x

Cook TM, Woodall N, Frerk C; Fourth National Audit Project. Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 1: Anaesthesia. Br J Anaesth. 2011b May;106(5):617–631. https://doi.org/10.1093/bja/aer058

Crawley SM, Dalton AJ. Predicting the difficult airway. BJA Educ. 2015 Oct;15(5):253–258. https://doi.org/10.1093/bjaceaccp/mku047

El-Boghdadly K, Onwochei DN, Millhoff B, Ahmad I. The effect of virtual endoscopy on diagnostic accuracy and airway management strategies in patients with head and neck pathology: a prospective cohort study. Can J Anesth. 2017a Nov;64(11):1101–1110. https://doi.org/10.1007/s12630-017-0929-6

El-Boghdadly K, Onwochei DN, Cuddihy J, Ahmad I. A prospective cohort study of awake fibreoptic intubation practice at a tertiary centre. Anaesthesia. 2017b Jun;72(6):694–703. https://doi.org/10.1111/anae.13844

Fitzgerald E, Hodzovic I, Smith AF. From darkness into light': time to make awake intubation with videolaryngoscopy the primary technique for an anticipated difficult airway? Anaesthesia. 2015 Apr;70(4):387–392. https://doi.org/10.1111/anae.13042

Frerk C, Mitchell VS, McNarry AF et al; Difficult Airway Society intubation guidelines working group. Difficult Airway Society 2015 guidelines for management of unanticipated difficult intubation in adults. Br J Anaesth. 2015 Dec;115(6):827–848. https://doi.org/10.1093/bja/aev371

Higgs A, McGrath BA, Goddard C, Rangasami J, Suntharalingam G, Gale R, Cook TM; Difficult Airway Society; Intensive Care Society; Faculty of Intensive Care Medicine; Royal College of Anaesthetists. Guidelines for the management of tracheal intubation in critically ill adults. Br J Anaesth. 2018 Feb;120(2):323–352. https://doi.org/10.1016/j.bja.2017.10.021

Johnston KD, Rai MR. Conscious sedation for awake fibreoptic intubation: a review of the literature. Can J Anesth. 2013 Jun;60(6):584–599. https://doi.org/10.1007/s12630-013-9915-9

Kristensen MS, Teoh WH, Rudolph SS. Ultrasonographic identification of the cricothyroid membrane: best evidence, techniques, and clinical impact. Br J Anaesth. 2016 Sep;117 Suppl 1:i39–i48. https://doi.org/10.1093/bja/aew176

Kwanten LE, Madhivathanan P. Supraglottic airway devices: current and future uses. Br J Hosp Med. 2018 Jan 02;79(1):31–35. https://doi.org/10.12968/hmed.2018.79.1.31

Lewis SR, Butler AR, Parker J, Cook TM, Smith AF. Videolaryngoscopy versus direct laryngoscopy for adult patients requiring tracheal intubation. Cochrane Database Syst Rev. 2016 Nov 15;11:CD011136. https://doi.org/10.1002/14651858.CD011136.pub2

Lynch J, Crawley SM. Management of airway obstruction. BJA Educ. 2018 Feb;18(2):46–51. https://doi.org/10.1016/j.bjae.2017.11.006

McGrath BA, Bates L, Atkinson D, Moore JA; National Tracheostomy Safety Project. Multidisciplinary guidelines for the management of tracheostomy and laryngectomy airway emergencies. Anaesthesia. 2012 Sep;67(9):1025–1041. https://doi.org/10.1111/j.1365-2044.2012.07217.x

Mir F, Patel A, Iqbal R, Cecconi M, Nouraei SAR. A randomised controlled trial comparing transnasal humidified rapid insufflation ventilatory exchange (THRIVE) pre-oxygenation with facemask pre-oxygenation in patients undergoing rapid sequence induction of anaesthesia. Anaesthesia. 2017 Apr;72(4):439–443. https://doi.org/10.1111/anae.13799

Ponnusamy K, Sajayan A, Mir F. 2018. DAS Airway Alert Card and Difficult Airway Database - General information. (accessed 1 August 2018) https://www.das.uk.com/aac/project_information

Popat M, Mitchell V, Dravid R, Patel A, Swampillai C, Higgs A. Difficult Airway Society Guidelines for the management of tracheal extubation. Anaesthesia. 2012 Mar;67(3):318–340. https://doi.org/10.1111/j.1365-2044.2012.07075.x

Rosenstock CV, Thøgersen B, Afshari A, Christensen AL, Eriksen C, Gätke MR. Awake fiberoptic or awake video laryngoscopic tracheal intubation in patients with anticipated difficult airway management: a randomized clinical trial. Anesthesiology. 2012 Jun;116(6):1210–1216. https://doi.org/10.1097/ALN.0b013e318254d085