

Management of the Obstructed Airway

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QUESTIONS

Before continuing, try to answer the following questions. The answers can be found at the end of the article, together with an explanation. **Please answer True or False:**

1. **A 69-year old woman presents to the emergency department with a 3-day history of worsening stridor. A mobile lesion obstructing 70% of the glottis is seen on fiberoptic nasal endoscopy**
 - a. Immediate medical management in the form of humidified oxygen, nebulised adrenaline and intravenous steroids should be considered
 - b. Transfer of the patient to theatre does not require specialist staff or equipment
 - c. Induction in the anaesthetic room is ideal
 - d. Face mask ventilation is likely to be easy
 - e. Examination of the neck and identification of the cricothyroid membrane using ultrasound is advisable

2. **The following statements are correct with regard to endotracheal intubation**
 - a. Direct laryngoscopy is likely to be easy with a base of tongue tumour
 - b. Videolaryngoscopy may produce a good view of the glottis however intubation may still be difficult
 - c. Awake fiberoptic intubation may result in complete obstruction in a critical airway
 - d. Transnasal humidified rapid inspiratory ventilatory exchange (THRIVE) can be used in conjunction with direct and indirect laryngoscopy
 - e. The United Kingdom National Audit project on Major Airway Complications recommended multiple attempts at laryngoscopy in patients with head and neck pathology

3. **Regarding induction of anaesthesia**
 - a. Inhalational induction of anaesthesia using a spontaneously breathing technique is always the best option in an obstructed airway
 - b. Elective narrow-bore needle cricothyroidotomy may be considered as an option prior to induction
 - c. Awake tracheostomy can be a difficult procedure in an obstructed airway
 - d. The introduction of Sugammadex means that all patient should have an intravenous induction
 - e. Knowledge of human factors in complex airway management is less important than technical expertise

Key Points

- It is important to identify the nature, level and speed of onset of airway obstruction when planning a management strategy
- Fiberoptic nasendoscopy, CT, and MRI should be considered where time allows to investigate the extent of the obstructing lesion
- Management of airway obstruction requires a multidisciplinary approach, with senior anaesthetic and surgical input from an early stage
- A key consideration in the management strategy is whether the airway should be secured awake
- Anaesthetists should be familiar with and regularly practice can't intubate can't oxygenate (CICO) drills
- Appreciation of human factors are instrumental to the successful management of a difficult airway

INTRODUCTION

Obstruction of the airway at its most extreme is an anaesthetic emergency requiring immediate intervention. In advanced life support algorithms, it usually refers to loss of airway patency in the unconscious patient or blockage by a foreign body in the event of choking. In these cases, airway opening manoeuvres or back blows and abdominal thrusts to relieve an obstruction may be life-saving before hypoxia and cardiac arrest ensue. In the context of this article, we will be discussing management of airway obstruction relating to pathology of the head and neck.

Airway obstruction may present acutely or chronically depending on the site, degree of narrowing and cause. The anatomical level can broadly be categorised as supraglottic, glottic (laryngeal) or subglottic (Figure 1). The obstruction may be due to luminal pathology such as inflammation, tumour or haematoma or it may result from external

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compression and distortion. Central airway compromise due to anterior mediastinal masses can pose difficulties by nature of the obstruction being sited distal to surgical airway rescue¹. Management of the obstructed airway is particularly challenging and accounted for 40% of all cases (72 out of 184 patients) reported to the 4th UK National audit project of major airway complications (NAP 4)². Important recommendations arising from the review of these cases have been instrumental in guiding the assessment, planning and management strategies of patients with an obstructed airway to optimise their outcome.

LEVEL OF OBSTRUCTION	PATHOLOGY
Supraglottic	Oropharyngeal lesions, base of tongue tumours, epiglottitis, retropharyngeal abscess, invasive high oesophageal tumours
Glottic	Vocal cord paralysis, glottic tumours, polyps
Subglottic	Tracheal stenosis, laryngomalacia, subglottic tumours
Distal tracheal	Lymphoma, thyroid mass, mediastinal masses

Figure 1. Potential pathological causes of airway obstruction

PATIENT ASSESSMENT

Symptoms and signs

A thorough history should be taken if the urgency of the situation allows. There may be a history of previous airway problems and / or previous radiotherapy to the head and neck. Anaesthetic records and any difficult airway alert forms should be reviewed.

Symptoms and signs generally reflect the site, extent of narrowing and its speed of onset (Figure 2). In an acute obstruction, for example due to trauma, epiglottitis or Ludwig's angina (cellulitis of the floor of the mouth and submandibular tissues), stridor and dyspnoea are commonly encountered. **Stridor** is a harsh, high-pitched noise created by turbulent airflow through a partially obstructed airway. It implies a reduction in airway diameter of at least 50%³. In the inspiratory phase, stridor points to obstruction at a supraglottic or glottic level, whereas biphasic inspiratory-expiratory stridor implies subglottic compromise⁴. Expiratory stridor or wheeze classically suggests tracheal or tracheobronchial obstruction. **Stertor** is a term to describe heavy snoring respiration and is usually generated from obstruction at a nasopharyngeal level whereas gurgling may suggest an oropharyngeal origin¹. Other pertinent symptoms of airway obstruction include hoarseness, voice change, a preference for sitting up, nocturnal dyspnoea, orthopnoea, worsening fatigue, dysphagia and drooling.

Signs of impending airway obstruction
<ul style="list-style-type: none"> • Dyspnoea • Stridor • Stertor • Voice change/ Hoarseness/ • Dysphagia • Drooling/ Unable to swallow secretions • Unable to lie flat, sitting forward to maintain airway patency

Figure 2. Table showing signs of airway obstruction

Chronic obstruction may present insidiously as patients become gradually conditioned to progressive narrowing of the airway. Adequate alveolar minute ventilation can be achieved at rest through an orifice as little as 3 millimetres when respiratory muscles have become trained¹. A patient who appears uncompromised and asymptomatic in this situation is falsely reassuring. Stridor and sudden deterioration may only occur as critical obstruction is reached. Slow-growing tumours of the pharynx, base of tongue, vocal cords, those causing external compression such as from the thyroid and mediastinum, and some neuromuscular diseases may evolve in this way.

In addition to the above symptoms, patients with a mediastinal obstruction may report chest pain or fullness, sweats, symptoms of superior vena cava obstruction, postural cough and syncope⁵. Alternatively they may be asymptomatic with incidental finding of a mass reported on imaging.

Examination

The posture adopted by the patient should be noted. They may be dyspnoeic, using accessory muscles of respiration and require supplementary oxygen. Assessment of the airway should include mouth opening, dentition, tongue protrusion, Mallampati classification, jaw subluxation and neck movement. The neck should also be examined for masses, mobility of the trachea, airway distortion and any potential difficulties for front of neck access (e.g. previous radiotherapy)⁶.

Investigations

Fibreoptic nasendoscopy (Figure 3) should be performed where possible; either in clinic, at the bedside or in theatre, depending on the urgency of the situation. This is usually well tolerated by the patient. Inspection of the larynx in this way can provide important information about the nature, level and degree of obstruction, attachment to surrounding structures and any movement of the lesion during respiration. It may also enable anticipation of the effects of traumatising the lesion if it appears vascular or friable. These findings should be discussed with the surgical team to help formulate a management strategy. It is important to anticipate that induction of anaesthesia and postural change may worsen the degree of obstruction seen.

Ultrasound examination of the neck may provide additional information about the lesion and degree of airway distortion, especially if no landmarks are palpable. It is also valuable for identifying and marking the cricothyroid membrane and noting any overlying vascular structures if front-of-neck access is contemplated⁶.

MR and CT imaging is recommended where time and the patient conditions allow (lying flat may result in worsening of symptoms) to further investigate the extent of any lesion² (Figure 4). Imaging is particularly helpful in delineating a mediastinal mass. A CT will demonstrate the position and extent of the airway obstruction. Awake CT-guided needle biopsy may be an option to avoid manipulation of the airway under anaesthesia. Patients with cardiovascular symptoms or signs should be investigated using echocardiography as this may be a feature of mediastinal masses⁵.



Figure 3. The authors undertaking fibreoptic nasendoscopy

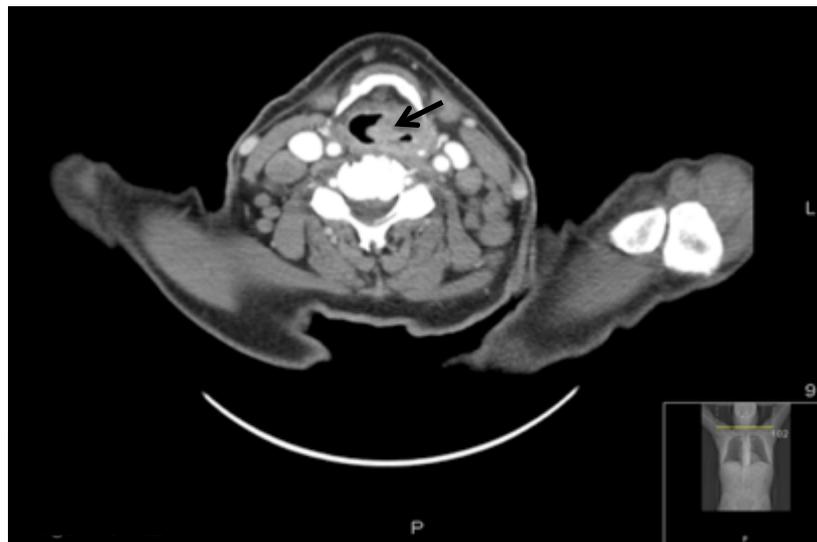


Figure 4. CT image of a supraglottic lesion (black arrow) in an 82-year old man, demonstrating the level and extent of airway obstruction

MULTIDISCIPLINARY TEAM, PLANNING AND HUMAN FACTORS

Management of patients with an obstructed airway requires senior anaesthetic and surgical input from an early stage². The case should be jointly assessed where possible to clarify the level, extent and likely cause of the obstruction. In chronic cases, imaging should ideally be reviewed in a multidisciplinary team setting and chaired by radiologists with head and neck expertise.

For patients requiring urgent intervention, theatre staff should be alerted to prepare specialist teams and equipment. Plans should be made to secure the airway in theatre alongside the rest of the team rather than in the anaesthetic room². Inter or intra hospital transfer of an unstable patient should be done by medical personnel with airway expertise. Equipment must be immediately available for airway maintenance or attempt to secure the airway if necessary. In extreme cases such as central airway obstruction, a patient may require transfer to a specialist centre capable of

instituting cardiopulmonary bypass (CPB) before induction of anaesthesia. This decision should be made early by the multidisciplinary team, as using CPB as a back-up plan in the event of complications is unlikely to yield successful outcome⁵.

Careful consideration of the relative risks and benefits of the proposed airway strategy, preparation of equipment, and contingency planning are key to the successful management of an anticipated difficult airway. Clear role assignment and briefing of the multidisciplinary team, and an appreciation of human factors are vital⁷. The leader should be clearly identified (usually the most senior anaesthetist present) and should ensure clear communication and good teamwork as the clinical situation may rapidly change.

MANAGEMENT STRATEGIES

In an emergency situation the nature of the obstruction may be unknown and the location, expertise and equipment may be lacking. Optimising the ability to oxygenate is fundamental to all airway strategies¹. Immediate medical management should include high-flow humidified oxygen and consideration of intravenous corticosteroids. Nebulised adrenaline and Heliox (79% helium / 21% oxygen mixture) may also be indicated although the latter does restrict the amount of oxygen that can be given. Where it becomes necessary to secure the airway, assistance from an anaesthetist skilled in advanced airway techniques should be urgently sought. The Difficult Airway Society (DAS) guidelines for the management of an unanticipated difficult intubation should be followed⁸. Anaesthetists should be familiar with and regularly practice ‘cant-intubate, can’t oxygenate’ drills, including front of neck access.

The Aintree Difficult Airway Management (ADAM) website⁹ is a useful aid to decision making. It identifies 10 devices which can potentially facilitate management of the difficult airway, ranging from conventional direct laryngoscopy to videolaryngoscopy, rigid and flexible fibreoptic laryngoscopy and needle or surgical cricothyroidotomy. A difficult airway scenario can be selected from a drop down menu and a problem list is completed. The ADAM website then generates a management matrix which rates the utility of each device as recommended by a panel of experts from 1 - 5 (1 - minimally hazardous, 5 - extremely hazardous). The summary rating is the worst hazard rating for each device. It then allows for a printable contingency plan to be generated with observed problems and steps to intubation with the device. This website can be accessed free of charge by registered medical professionals who can request a login at <http://adam.liv.ac.uk/adam8/login.aspx> (Figure 5 and 6).

Summary Table			
Choose your device in the Select column			
Device(s)	Abbreviation	Rating	Select
Awake Nasal Fibreoptic Laryngoscopy	AFNL	5	<input type="radio"/>
Awake Oral Fibreoptic Laryngoscopy	AFOL	5	<input type="radio"/>
LMA / AIC Exchange	AIC	5	<input type="radio"/>
Airtraq Laryngoscopy	ARTQ	5	<input type="radio"/>
Bonfils laryngoscopy	BFS	5	<input type="radio"/>
Glidescope	GLS	5	<input type="radio"/>
Macintosh Laryngoscopy	MAC	5	<input type="radio"/>
Straight blade retromolar laryngoscopy	MILL	5	<input type="radio"/>
Cricothyroid Needle / Jet Ventilation	NCJV	5	<input type="radio"/>
Scalpel Cricothyroid Intubation	STAB	5	<input type="radio"/>
Surgical Tracheostomy	STRAC	4	<input type="radio"/>

Figure 5. This is an example of the ADAM difficult airway device summary table that is generated for the scenario of a **supraglottic laryngeal tumour**. The summary matrix gives the “worst score” for the device (1 - minimal hazard, 2 - 4 increasing hazardous, 5 - extremely hazardous). In this scenario all devices have some aspect of their use that is hazardous, by clicking ‘select’ a contingency plan is generated for that device, with problems that may be encountered and steps on how to use the device (see figure 7).

Start Admin New Choose TestCase

Awake Nasal Fibreoptic Laryngoscopy

Sort messages by rating Sort Messages

Hide Device Considerations

0 universal problems

- 3 : Hypoxia risk - Desaturation at rest**
- 3 : Neurological problem - Vocal cord paralysis**
- 3 : Airway obstruction - Stridor**

1 check equipment / position patient

- Adverse patient positioning
- Inadequate nasal patency
- Illumination not satisfactory
- Tube incorrectly loaded on 'scope
- Stack image not optimised
- Tube size inappropriate
- Tube type inappropriate

2 prepare nasal passage, oxygen, start sedation

- Worsening airway (LA anaesthetising pharynx)
- Apnoea (excess sedation)
- Respiratory depression (excess sedation)
- (Anaphylaxis after LA)
- 5 : IPPV problem - Pedunculated ball valve tumour**
- 5 : IPPV problem - Supraglottic tumour bulk obstructs breathing**
- 3 : IPPV problem - IPPV against closed glottis**
- 3 : Neurological problem - Pharyngo-laryngeal incompetence**
- 2 : IPPV problem - Food debris contaminating airway**

3 mount tracheal tube on FOL

- Tube sticks when loading
- Tube not loaded / loaded incorrectly (Murphy eye)

Figure 6. Awake Nasal Fibreoptic laryngoscopy has been selected which gives a contingency plan. Blue text = sequence of steps required for a successful intubation, green text = everyday problems in using the device, red = observed problems for this case and the ADAM rating for them (NB only the start of the plan is illustrated here).

AIRWAY STRATEGIES

There are four main options to consider when planning an airway strategy (Figure 7):

- 1) **Inhalational induction**
- 2) **Intravenous induction**
- 3) **Awake fiberoptic intubation**
- 4) **Awake tracheostomy**

NAP-4 identified that the site of obstruction in particular has a great influence on the efficacy and suitability of a technique². We will consider these four techniques in turn.

Inhalational induction of anaesthesia

Inhalational induction of anaesthesia has classically been described as the preferred route in a patient with upper airway obstruction¹⁰ and specifically in patients with central airway obstruction⁵. Theoretically, this technique preserves spontaneous ventilation and should the patient completely obstruct due to airway collapse, the uptake of vapour would cease and awakening would ensue. In practice with severe obstruction, the onset of induction is slow and may precipitate laryngospasm or apnoea with subsequent hypoxia^{1,3}. NAP 4 emphasised the risks of inhalational induction with reports of 23 out of 27 cases becoming significantly compromised. In some cases, this necessitated rescue front-of-neck access². Reports demonstrated that in the event of compromise, patients did not rapidly waken as suggested. It is therefore vital to have a contingency plan in place when this technique is considered. This may involve administration of neuromuscular blockade and mask ventilation if possible pending intubation¹. The use of halothane to facilitate instrumenting of the airway under deep inhalational anaesthesia has all but disappeared in the UK but is a technique employed in many low to middle income countries due to its ready availability and the lack of advanced airway equipment. Inhalational induction is still commonly used in difficult paediatric airways where there is less likely to be airway collapse and it is possible to maintain airflow.

Intravenous induction of anaesthesia

The choice between inhalational and intravenous induction can be difficult and both scenarios may fail¹. Carefully planned back-up techniques are therefore paramount. There is physiological evidence to suggest that in the case of extra-thoracic intraluminal laryngotracheal stenosis, positive-pressure ventilation after intravenous induction is preferable to spontaneous ventilation¹¹. The advent of Sugammadex to potentially reverse deep neuromuscular blockade in the event of failed intubation may enhance contingency planning. That said, awakening and effective spontaneous ventilation cannot be guaranteed. The use of a muscle relaxant gives the best intubating conditions and also optimum access to the neck if a “can’t intubate, can’t oxygenate” (CICO) situation develops. Careful consideration of the intubation technique should be made prior to induction of anaesthesia and may involve direct intubation, the use of videolaryngoscopy, flexible or rigid fiberoptic laryngoscopy (see section on devices). Alternatively, the recently published technique of Transnasal Humidified Rapid-Insufflation Ventilator Exchange (THRIVE)¹² or NO-DESAT!¹³ where high flow oxygen is delivered via nasal cannula may be considered in isolation or to complement oxygenation prior to intubation. This technique has many benefits however its role in the acutely obstructed airway remains unclear and it may give the clinician a false sense of security.

Awake fiberoptic intubation (AFOI)

Depending on operator expertise, equipment availability and the site and extent of airway obstruction, AFOI can be used successfully¹⁴. Its use should be considered carefully after discussion with the surgical team and following nasendoscopy. It may not be the best option if there is a potential to cause complete airway obstruction; the so-called “cork-in-bottle” situation³, for example in glottic tumours where the aperture of the airway may be greatly reduced. It may also be ill-advised if the anatomy is grossly distorted, there is a risk of bleeding, the patient would struggle to co-operate or if there is a risk of airway compromise due to either over-sedation or local anaesthetic topicalisation. AFOI in patients with an obstructed airway therefore remains controversial¹. Indeed, NAP 4 reported failure of this technique in 14 of 23 head and neck cases².

Awake tracheal access

The decision to perform an awake surgical tracheostomy under local anaesthetic depends on urgency, experience, location, and the ability to perform contingency plans¹. Indications may include severe stridor, a fixed hemi-larynx, advanced tumours, gross anatomical distortion, a larynx not seen on fiberoptic nasendoscopy, or where surgical intervention will render the post-operative calibre of the airway poor^{1,3,15}. Several cases reported to NAP 4 were criticised for failing to perform tracheostomy prior to induction of anaesthesia². This technique may be technically very challenging depending on the underlying pathology and the ability of the patient to tolerate lying supine. A recent study described the outcome of 68 patients requiring emergent awake tracheostomy due to upper airway obstruction (85% of

cases due to malignancy)¹⁶. Although 19 cases were lost to follow-up, the procedure was considered to be safe and effective in securing the airway in these patients, with long-term complications reported in only three cases (tracheitis and granuloma).

Where awake tracheostomy is not deemed necessary, elective narrow-bore needle cricothyroidotomy may be considered as an option prior to induction allowing a cannula to be left in situ. This may be used for jet ventilation in the event of failure to secure an endotracheal tube and conversion via a Seldinger technique (for example, using the Melker cricothyroidotomy set) to a wide-bore cricothyroidotomy if necessary. It is important to note the diameter of the cannula if non-standardised equipment is being used to ensure compatibility with the Seldinger set. In the CICO situation, NAP-4 warned of a significant failure rate with cannula cricothyroidotomy, and the new DAS guidelines⁸ recommend a surgical approach when emergency front-of-neck access is required.

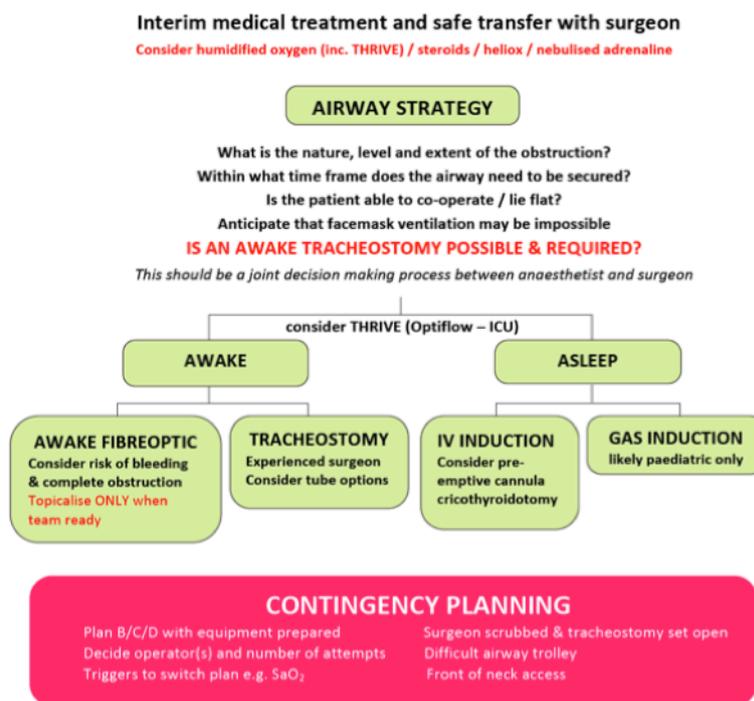


Figure 7. A cognitive aid to planning an airway strategy in an obstructed airway¹⁷

ENDOTRACHEAL INTUBATION DEVICES

Broadly speaking, endotracheal intubation devices can be divided into four main categories. Each device has advantages and disadvantages and no single device is ideal for every difficult airway scenario⁹. The choice ultimately relies on the site and nature of the obstruction, device availability and operator preference and expertise.

Direct Laryngoscopy

Macintosh blade direct laryngoscopy is a well-established technique which affords the operator a wide view of the larynx and surrounding structures. A gently inserted bougie may be useful to aid intubation. Straight blade retromolar laryngoscopes may be preferred to directly elevate the epiglottis. NAP-4 recommends that multiple attempts at direct laryngoscopy in patients with head and neck pathology should be avoided as this may lead to complete airway obstruction.² Supraglottic pathology may make access to the vallecula and therefore laryngoscopy, difficult.

Indirect Videolaryngoscopy

There are a range of videolaryngoscopes currently available and comparison of devices is ongoing. They can be divided into channeled (e.g Airtraq) and non-channelled (e.g Storz C-MAC, GlideScope). The image is transmitted from the tip of the instrument providing an indirect view of the larynx. The advantages are that the view is magnified and depending on the angulation of the blade allows an improved view. There is also the benefit that members of the operating team can see the difficulties being encountered which improves communication and team work. The role of videolaryngoscopy in the obstructing lesion is unclear as despite a good view of the larynx the operator may encounter difficulty advancing the

endotracheal tube through the cords¹⁸. Indirect videolaryngoscopy has more recently been used in awake patients as the force of laryngoscopy is reduced and this technique may become more popular as experience increases.^{19, 20}

Flexible Fiberoptic Laryngoscopy (nasal or via LMA)

Asleep fiberoptic laryngoscopy is an alternative strategy depending on the nature of the obstruction. Its use via an LMA and passage of a pre-mounted Aintree Exchange catheter has been advocated in preference to the intubating LMA⁹. A case report described successful airway rescue using this technique via a ProSeal LMA in a patient with severe supraglottic swelling following carotid endarterectomy²¹. This technique should be rehearsed in simulation if it is the chosen plan A or back-up strategy to optimise chances of success.

Rigid Fiberoptic Laryngoscopy

Rigid optical stylets such as the Bonfils fibrescope can be advantageous when negotiating laryngeal pathology. Its utility lies in the ability to gently push obstructing lesions to one side to enter the trachea and deploy the pre-mounted tube⁹. This technique requires training and should be considered carefully if there is a risk of causing bleeding and worsening obstruction.

EXTUBATION CONSIDERATIONS

NAP-4 identifies extubation and early recovery as a period of risk for patients with head and neck pathology. In these cases it is important to appreciate that the obstruction may not be effectively relieved by surgery due to residual disease, haematoma or swelling. Risk of bleeding remains a possibility and demands a high index of suspicion in the postoperative period. The report recommends that the surgical team remain immediately available at extubation until the patient is effectively managing their own airway². Staged extubation kits are available for consideration in some patients. These contain a wire which can be placed via the endotracheal tube prior to extubation and an airway catheter which can be passed over the wire in the event of airway compromise. Its use should be discussed with the surgical team since it involves instrumentation of the airway and may risk disrupting surgical site haemostasis.

SUMMARY

Management of the obstructed airway requires careful assessment, planning and execution to optimise success. Involvement of the multidisciplinary team at an early stage is recommended. The NAP-4 report has significantly impacted our approach to safely managing these cases (Figure 8). In particular it identifies potential pitfalls to be wary of and the need for detailed contingency planning with a multidisciplinary approach.

Key recommendations from NAP 4 for the management of the obstructed airway
<ul style="list-style-type: none">• Senior anaesthetic and surgical staff should be involved• Anaesthetists should gain useful information from CT, MR imaging and nasendoscopy whenever possible• Airway investigations should be jointly reviewed by the surgeon and anaesthetist• The level of the obstruction in the airway should be determined whenever possible• If no additional investigations are available, consideration should be given to awake nasendoscopy in theatre to reassess the situation prior to starting• An agreed airway management strategy should be formulated by the anaesthetist, surgeon and theatre team prior to starting• The anaesthetic management of any case in which surgical tracheostomy is a rescue option should start in the operating room with the entire team assembled and ready• Multiple attempts at direct laryngoscopy should be avoided• If fiberoptic intubation is the primary plan, there are good reasons for undertaking this in the awake patient• Inhalational induction may fail with loss of airway and failure to wake and a clear rescue plan should be ready• Emergency needle or large bore cricothyrotomy cannot be assumed to be possible or successful• The team managing the patient should not disperse after extubation until the airway is safe• Patients in ICU (intubated or with tracheostomy) require a continuously-ready strategy for reintubation if the tube dislodges or blocks

Figure 8. Summary table of recommendations from NAP 4²

ANSWERS TO QUESTIONS

1. **A 69-year old woman presents to the emergency department with a 3-day history of worsening stridor. A mobile lesion obstructing 70% of the glottis is seen on fiberoptic nasal endoscopy**
 - a. **True.** Immediate medical management involves maximizing oxygenation of the spontaneously breathing patients. Nebulised adrenaline may improve airflow by causing bronchodilation and IV steroids may reduce oedema.
 - b. **False.** Transfer to theatre will need to be done with experienced staff who have advanced airway skills along with appropriate equipment in case the patients deteriorates during the transfer.
 - c. **False.** Induction in patients with a compromised airway should ideally be done in theatre with all members of the anaesthetic and surgical team present in case the patient deteriorates and needs front of neck access. This was highlighted in NAP4.
 - d. **False.** In a patient with worsening stridor and a glottic lesion, face mask ventilation may be difficult as following general anaesthesia loss of airway tone may result in the glottic lesion completely obstructing the airway
 - e. **True.** This may be useful in case emergency front of neck access is necessary.

2. **The following statements are correct with regard to endotracheal intubation**
 - a. **False.** Access to the vallecula may be impossible with a base of tongue tumour making direct laryngoscopy difficult.
 - b. **True.** Videolaryngoscopy may give an improved view of the glottis however tube advancement may still be difficult as a good indirect view does not necessarily correspond with ease of intubation.
 - c. **True.** Awake fiberoptic intubation may result in the “cork in bottle” effect where a partially obstructed airway becomes completely obstructed.
 - d. **True.** THRIVE can be used to optimise apnoeic oxygenation when the airway is being instrumented.
 - e. **False.** NAP 4 found that repeated attempts at laryngoscopy and intubation often resulted in airway oedema and deterioration from a difficult airway to a compromised airway

3. **Regarding induction of anaesthesia**
 - a. **False.** Inhalational induction, although still used in children, can result in complete obstruction of the airway in adults as gas flow across the obstruction is limited. This results in less anaesthetic being delivered and potentially suboptimal intubating conditions
 - b. **True.** Elective narrow-bore needle cricothyroidotomy may be considered prior to induction as a rescue technique if intubation is difficult.
 - c. **True.** In a hypoxic patient who is struggling to maintain adequate gas exchange an awake tracheostomy may be difficult due to compliance and difficulty in positioning
 - d. **False.** Although Sugammadex may mean that muscle relaxants can be reversed quickly an awake technique may be the preferred option in the compromised airway.
 - e. **False.** Human factors are as important as technical expertise. NAP 4 found that there were numerous examples where human factors contributed to a poor outcome.

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