Airway Management in Ambulatory Anesthesia

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Abstract Ambulatory surgery numbers are rising in the United States at a rapid pace. Between 1996 and 2006, procedures carried out in free-standing surgical centers rose by 300 %. Airway management is a key factor in time management, patient safety, and cost-effectiveness. For the anesthesiologist practicing in a free-standing or office-based unit, patient selection and preparation for all eventualities are essential. A combination of traditional skills and advances in technology and anesthetic research are discussed to outline what we believe is a guide to safe anesthetic practice and airway management in the ambulatory setting. Pre-assessment of the patient, the management of the uncomplicated airway, and management of the anticipated and unanticipated difficult airway are discussed in this article.

Keywords Airway · Difficult Airway · Ambulatory · Management · Videolaryngoscopy · Fiberscope · Algorithm · Pre-assessment · LMA · ETT

Introduction

Ambulatory anesthesia is becoming increasingly more common worldwide as the result of advancing surgical technology, improved peri-operative care, and rising financial pressure. It is associated with improved patient

quality of life [1]. In the United States of America (USA), ambulatory surgery can involve a patient's admission for 23 h or less. All these factors combined have resulted in procedures with previously protracted hospital stays (e.g., thyroidectomy and total knee arthroplasty) being carried out in an ambulatory setting [2]. Ambulatory surgery may occur in one of three settings: (1) a day surgery unit as part of a large hospital, (2) a stand-alone ambulatory unit, or (3) an office-based practice. In the two latter environments, the anesthesiologist is working independently and may not have access to help or the necessary facilities should the unanticipated occur. In the USA in 2006, there were 34.7 million visits for ambulatory surgery, 19.9 million were to hospitals, and 14.9 million occurred in freestanding ambulatory surgery centers. In the decade between 1996 and 2006, there was a 300 % rise in visits to free-standing ambulatory centers [3]. There are many anesthetic factors necessary for safe and successful ambulatory surgery. Airway management is a key element.

In the ambulatory surgery setting, patient “turn-over” is paramount. Rapid awakening and “extubation” allow for earlier operating room (OR) exit and shorter post-anesthesia care unit (PACU) stay. As we will see later, the choice of airway contributes to these parameters. The correct choice of anesthetic technique including airway, therefore, plays a pivotal role in maintaining the momentum required of ambulatory surgical lists.

Airway management is also vital for patients both with anticipated and unanticipated difficult airways. Pre-assessment prior to anesthesia and surgery allows assessment of the patient's airway and previous airway history thus guiding the anesthesiologist's management throughout the peri-operative period.

Finally, airway management of the unanticipated difficult airway in the ambulatory setting is a significant

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concern to the anesthesiologist, especially those practicing in stand-alone facilities.

This article will explore and discuss these elements—pre-assessment, day-to-day management, management of the anticipated and unanticipated difficult airway—and provide some recommendations on airway management in the ambulatory setting.

Airway Pre-Assessment

The choice of patient for the ambulatory surgery setting is important. Patients with multiple co-morbidities may be found to be unsuitable for the ambulatory setting and must be excluded accordingly [4•], [5]. Patients with elevated body mass index (BMI), a history of obstructive sleep apnea (OSA), and patients with a history of chronic obstructive pulmonary disease (COPD) are particularly pertinent co-morbidities with regard to predicting difficulties in airway management and difficulties in intubation and ventilation as well as extubation [4•], [6, 7]. Patients with a history of head and neck cancer and in particular previous treatment with surgery or radiotherapy carry a high risk of failed intubation [8]. Pre-assessment allows the anesthesiologist to form an anesthetic plan and involves the patient in these decisions.

There are multiple scoring systems, both new and more traditional (Table 1) for grading the airway. These can be useful tools, but none are without limitation.

The Modified Mallampati Score is one of the commonest used classifications but should be used in combination with other methods of pre-operative airway assessment [9]. When used as a single predictor, it fails in detection of the difficult airway in up to 35.4 % of patients [10, 11]. Other methods of airway assessment such as thyromental distance, mouth opening, cervical spine movement, body habitus, BMI, and the Wilson Score (a score of 0–2 for each: weight; head and neck movement; lower jaw protrusion; receding mandible; prominent

overbite, with a maximum score of 10) provide us with an overall picture, but all carry significant weaknesses in terms of sensitivity and specificity [7, 12]. Some studies do show that the best predictor, when using the classical assessments of difficult intubation, is a combination of Modified Mallampati Score and thyromental distance assessment [7]. However, this still only has a specificity of 87 % with a very low sensitivity of 36 %. Newer computer-assisted models for prediction of difficult airway are promising [12] as well as more novel approaches such as sublingual ultrasound [13] are being piloted but are still in their infancy and cannot yet be recommended for everyday clinical ambulatory practice.

These scoring systems are for predicting difficult laryngoscopy and therefore possible difficult intubation. For anesthesiologists, the “fall back” safe position for oxygenation is mask ventilation. Anesthesiologists need to be aware that this “fall back” position may fail even if intubation is not being considered for their patient. Kheterpal and colleagues reviewed 53,041 attempts at mask ventilation [14•]. They found a 0.15 % incidence of failed mask ventilation with predictive factors being male sex, OSA, Mallampati 3 or 4, presence of a beard, or neck radiation changes. A further study of 176,679 cases of mask ventilation and attempted laryngoscopy demonstrated difficult mask ventilation and difficult laryngoscopy in 698 patients (0.4 %) [15•]. One patient required emergency cricothyrotomy. Importantly, over 89 % were successfully intubated by another operator using direct laryngoscopy (DL), DL plus a bougie introducer, or using a videolaryngoscopy (23.4 %). Other predictive factors of both difficult mask ventilation and DL were age: 46 yr or more, BMI: 30 or more, neck mass, limited thyromental distance, presence of teeth, thick neck, limited cervical spine mobility, and limited jaw protrusion [15•]. As can be seen, difficult mask ventilation combined with difficult laryngoscopy is a rare but possible event. The management of these situations required one of the following: presence of another airway operator, specialized airway equipment (bougie, fiberoptic scope), use of videolaryngoscopy, or an emergency cricothyrotomy. These factors need to be considered when practicing ambulatory airway management in any setting.

Unfortunately, as we have seen, although pre-assessment can alert us to a suspected difficult airway, current tools are neither sensitive nor specific enough to reliably predict or out-rule the difficult airway. More importantly, mask ventilation may be unsuccessful as often as 1 in every 250 patients. Therefore, the unanticipated difficult airway must always be considered a possibility in any ambulatory setting. The management of this will be discussed later in this article.

Table 1 Airway Pre-assessment

- Modified Mallampati Score
- Thyromental distance
- Mouth opening
- Wilson Score
- Lower jaw protrusion maneuver
- Body habitus
- Dentition
- Neck movement
- Oropharyngeal pathology
- Previous head and neck surgery or radiotherapy

Day-To-Day Airway Management

The airway management of a patient undergoing ambulatory anesthesia necessitates a balance between the requirements of the surgery, safety of the patient throughout anesthesia, an efficient awakening process as well as being cost-effective. The choice of airway plays a part in these factors.

The Natural Airway

This method, though not advisable during general anesthesia, is commonly used during sedation for day case procedures such as endoscopic investigation. It involves correct positioning (e.g., semi-prone), spontaneous breathing, and the possible use of an adjuvant (e.g., nasal trumpet) [16], as well as the use of maneuvers to increase the patency of the airway such as jaw-thrust and chin lift [17]. Natural airways, while a cost-effective and time efficient method of airway management, are not without their problems; patient body habitus has a large role to play, and a history of respiratory problems such as OSA and COPD means that patients are at a higher risk of desaturation during the procedure [18].

The use of the natural airway is a practice that is becoming more common as much of the ambulatory anesthesia work load is moving out of the traditional OR setting and into stand-alone centers and office-based environments. While adverse events in this setting are rare, there still remains a significant risk. The American Society of Anesthesiologists (ASA) Closed Claims database shows that for the decade from 2000 to 2010, 17 % of all surgery-related claims were as a result of respiratory mis-management [19].

The routine use of capnography would further increase the safety of this practice and help to identify the early development of possible complications, particularly airway obstruction [20, 21], and the ASA has now included monitoring of expired carbon dioxide as mandatory for moderate-to-deep sedation (asahq.org).

The Supraglottic Airway

Supraglottic airway devices (SADs) are designed to be placed in the pharynx, above the glottis. As SADs do not pass through the patient's vocal cords, they have both strengths and weaknesses compared to traditional tracheal intubation [22].

The commonest and first SAD was the Laryngeal Mask Airway (LMA) (Teleflex Inc, North Carolina), invented by Dr. Archie Brain in 1981 [23, 24]. There are now a large number of these devices on the market [25] with newer ones such as the Baska® (Proact Medical Ltd, Northants,

UK) being introduced [26]. The majority of data on SADs are from studies of LMAs, and therefore care should be taken when considering one SAD over another.

Originally, the LMA was used in place of a facemask in a spontaneously breathing patient; however, all types of SADs are used with positive pressure ventilation, which has raised concerns about failure to adequately ventilate the lungs and the increased likelihood of pulmonary aspiration of gastric contents [27•]. These controversial issues will be discussed below.

Nevertheless there are many advantages of the various SADs (mainly LMAs) over endotracheal tubes (ETTs), particularly in the ambulatory setting. They are tolerated under lighter anesthesia [28] and are less stimulating to the sympathetic nervous system resulting in decreased risk of cardiovascular events, have a lower incidence of sore throat post-operatively [29] and allow spontaneous ventilation during the procedure. SADs can be used with or without the addition of neuromuscular blocking agents. The data comparing ETTs and SADs with regards to insertion and extubation time vary in particular when comparing different types of surgery [29, 30], and it has been shown that there is a significantly shorter time to home-readiness when LMAs are used [29]. In addition, success rates of “intubation” with LMAs have been shown to be over 90 % and can be done in the supine, left-lateral, and right-lateral positions with similar results [31].

Despite these benefits, as SADs do not provide a cuffed seal of the trachea, contraindications for their use focus mainly on the increased risk of pulmonary aspiration [32] or difficulties with adequate ventilation because of leak pressures, which generally lie between 20 and 25 cmH₂O [33, 34]. Common relative contraindications suggested are laparoscopic surgery, patient position (e.g., prone or Trendelenburg), obesity, and pregnancy [32], [35••]. Active gastroesophageal reflux, hiatus hernia, and intestinal obstruction would all be considered absolute contraindications except in cases where the use of a SAD may rescue a difficult airway situation [22].

Concerns regarding inadequate ventilation with SADs are largely unfounded—one study of 180 patients comparing 5 SADs with an ETT found no differences in leak pressures between devices in non-paralyzed patients [25]. A Cochrane review of 2 studies with 232 obese patients (BMI > 30 kg/m²) found a small failure rate of 4.2 % because of unsatisfactory placement or excessive leak (primarily during abdominal insufflation for laparoscopic surgery) [36].

There have been a number of large studies [35••], [37•], meta-analyses [36, 38], and a recent review examining the risks of pulmonary aspiration with SADs, primarily LMAs. The NAP 4 National Airway Audit looked at the incidence of serious airway complications in the UK, and their data

provide information on airway complications with SADs [39••].

Baker and colleagues gave 56 patients (one group LMA, the other group facemask, and Guedel airway) with no risk of gastric regurgitation, a gelatin capsule with methylene blue dye 10 min before induction of anesthesia. 7 of 28 patients who had a LMA had evidence of dye in the mask compared to none of the facemask group. There was no evidence of aspiration in either group [32]. A study of 5 different SADs found no differences in regurgitation episodes (hypopharyngeal pH < 4) compared to ETT or each other [25]. A recent review of 29 RCTs of LMA versus ETT found that LMAs reduce hoarse voice, laryngospasm, coughing, and sore throat compared to ETTs with no difference in the risk of regurgitation, vomiting, or nausea [40]. They reported that only one study described a case of aspiration, this occurred in a patient with an ETT.

A 1993 meta-analysis looking at the incidence of aspiration associated with LMA, found three cases of pulmonary aspiration in 12,901 patients giving an incidence of 1 in 4,300 [38]. The Cochrane meta-analysis already discussed only looked at obese patients and found no cases of pulmonary aspiration in their limited sample of 232 patients [36].

A recent study of unique LMATM (LMA North America, San Diego, California) use in 15,795 patients, with 83.4 % anesthetized in the ambulatory setting, demonstrated a failure rate of 1.1 % (170 patients). Failure was higher in older patients, male gender, increased BMI, thick neck, poor dentition, smoking, reduced thyromental distance, and surgical table rotation but less common in ambulatory patients (0.99 vs. 1.48 % P value = 0.03) [37•]. Inadequate ventilation occurred in 72 patients only (0.5 %), with significant airway adverse events seen in 106 patients. Gastric contents were seen in 3 patients with no report of pulmonary aspiration (1 per 5,265). Of note unplanned hospital admission occurred in 13.7 % of ambulatory patients with LMA failure with 5.6 % requiring critical care admission [37•].

A large retrospective Italian study of 65,712 procedures compared 35,630 LMA uses with positive pressure ventilation with 30,082 cases of tracheal intubation [35••]. Three cases of pulmonary aspiration occurred with LMA use and seven cases with tracheal intubation. There were no deaths from aspiration in either group. The incidence of aspiration was 1 per 11,877 LMA uses. There were no cases of aspiration in 861 elective laparoscopic surgeries preformed with a LMA [35••].

Finally, the NAP 4 National Airway Audit in the UK found 21.7 (CL 14.5–28.8) serious airway complications per 1 million anesthesia cases associated with SAD use compared to 82.5 (CL 65.6–99.5) per 1 million with tracheal tubes [39••]. Of the 23 cases of pulmonary aspiration

of gastric contents, 14 occurred with a SAD in an estimated 2.9 million general anesthetics [41••]. It was estimated that airway management was with a SAD in 56 % of cases. There were no cases of aspiration with the LMA ProsealTM (Teleflex Inc, North Carolina) and 1 of the 14 with the i-gelTM (Intersurgical Ltd, Wokingham, Berkshire, UK).

The incidence of pulmonary aspiration of gastric contents with SAD is very low especially in the ambulatory setting, which may be related to patient selection. There are suggestions that second generation devices such as the LMA ProsealTM, i-gelTM, and LMA SupremeTM (Teleflex Inc, North Carolina) may have a lower risk profile than the first generation LMAs [41••].

These second generation SADs have modifications in an attempt to overcome aspiration risk, such as double cuffs to allow a better seal and an inlet to allow gastric drainage and placement of oro-gastric tubes. These modified LMAs show positive results, particularly for laparoscopic surgery [42] even showing a link in reduced analgesia requirement [43]. The i-gelTM has also been found to be effective for positive pressure ventilation in non-obese adults and children [44–46]. With laparoscopic surgery increasingly done in the ambulatory setting consideration should be given to the use of these modified SADs.

In summary, a SAD is a very useful resource for ambulatory anesthesia. In the ambulatory setting, use of SADs permits lighter anesthesia, faster recovery, the avoidance of neuromuscular blocking drugs, a lower incidence of sore throat, and more rapid extubation. Recognition of their limitations is important—while traditional concerns of inadequate ventilation and pulmonary aspiration may be exaggerated, there are certain patient groups or surgeries that may be higher risk. There is still limited data on SAD use for laparoscopic surgery, and we would therefore advice careful consideration of SAD use for this type of surgery and would recommend the use of a second generation SAD, if used in these cases. SADs and their use in the difficult airway are described later in the article.

Tracheal Intubation

In the ambulatory surgery setting, ETTs are used when SADs are contraindicated. There have been many alterations to the ETT to allow it to better fit the purpose it is used for, resulting in a multitude of different forms.

While most standard ETTs allow for nasal insertion, newer, more pliable pre-formed tubes, with a double curve, or a “north facing” bend are designed specifically for this purpose. Ring, Adair, Elwyn ETT (RAE tubes) (MallinckrodtTM Dublin, Ireland) are pre-formed “south-facing” oral ETTs which allow more efficient clearance of the operating area for oral surgery. Stainless steel, double-cuffed, saline cuff inflated ETTs that reduce the risk of

thermal injury or airway fire injury to the patient during laser surgery of the larynx appeared in their current form in the early 1990 s [47]. Microlaryngoscopy endotracheal tubes (MLT) allow a better view to the surgeon while still allowing adequate ventilation of the patient.

Traditionally, it was common practice to use un-cuffed ETTs in children under the age of eight, yet recent studies have demonstrated that with correct care and knowledge of cuff inflation pressures, cuffed tubes have a lower rate of leak and require fewer changes with no significant increased risk to the child [48], [49••].

The main disadvantages of using an ETT instead of a SAD are that visualization and manipulation of the laryngeal glottis are required, which can be challenging. DL requires a direct line of sight from the operator's eye to the laryngeal aperture. Anatomical, pathological, surgical, and/or radiotherapy factors may limit or prevent this view.

The use of videolaryngoscopes (VL), familiar in otolaryngology since the early 1980's [50], was first described for pediatric intubation [51] and may be changing the way that tracheal intubation is managed [52•]. Unlike DL blades, VL devices have a built in camera at the tip of the laryngoscope blade. There are a number of these devices now in clinical use—Pentax AWS[®], Ambu USA, Airtraq[®], Prodol Meditec S.A., Spain, C-MAC[®], Karl Storz Endoscopy, California, GlideScope[®], Verathon Inc, Washington, McGrath MAC[®] & series 5, Aircraft Medical Ltd., Edinburgh, UK.

Some of the devices (MacGrath MAC[®] Aircraft Medical Ltd., Edinburgh, UK, GlideScope[®], Verathon Inc, Washington) have an angulated tip allowing in effect the operator to “look around the corner”. Others have an integrated channel for the ETT (Pentax AWS[®], Ambu USA, Airtraq[®], Prodol Meditec S.A., Spain). Others such as the Bonfils[®], Karl Storz Endoscopy, California are in the form of a videostylet. The use of VL has been shown to improve glottic views compared to DL [53, 54].

Unlike a fiberscope, VL for intubation requires fewer new skills, and has a greater field of vision and is less expensive [55]. A Danish study found that anesthesia residents had greater success rates (89–93 vs. 40 % and faster intubating times with the McGRATH[®] Series 5) (Aircraft Medical Ltd., Edinburgh, UK), in 2 of 3 simulated difficult airway scenarios compared with fiberoptic intubation [56].

VLs improve the success rate at first attempt at intubation [57] and have become integrated into the ASA guidelines for difficult airway management as an alternative method of airway management if DL has failed or is difficult [58]. VLs with disposable blades are also available (MacGrath MAC[®] Aircraft Medical Ltd., Edinburgh, UK).

Despite their increasing popularity, VL is currently not a replacement for DL which has a 95 % success rate of intubation and is the “gold standard” at present [59, 60].

The data on which to base this are summarized in a number of recent and comprehensive reviews on VL, and the reader is directed to them for more information [52•], [59, 61]. Nevertheless, anesthesiologists are increasingly turning to VL to rescue difficult airway situations—in the Multicenter Perioperative Outcomes Group (MPOG) study, VL was used successfully in 163 of 698 cases of difficult mask ventilation and difficult intubation [15•].

However, although VL results in improved views, faster intubation times, and an alternative in cases of a difficult airway, they have a number of limitations. Mouth opening needs to be sufficient to allow blade entry and will depend on the device used—15 mm for GlideScope[®], Verathon Inc, Washington, and 12 mm for MacGrath MAC[®] Aircraft Medical Ltd., Edinburgh, UK [personal communication S. Mannion]. The commonest difficulty is advancing the ETT into the glottis despite a good view [52•], [59]. The ETT often abuts that the superior part of the glottis and various techniques (bougie, stylet, ETT manipulations, or VLs with an integrated channel) are suggested [52•], [59]. In our own institution which is a regional center for Head and Neck Cancer Surgery and ENT, we combine a VL with the fiberscope, allowing the fiberscope to act as a dynamic bougie or tracheal introducer [55]. This technique offers the benefits of both techniques, the main limitation being the requirement of a second operator (which can be a nurse holding the VL once the correct laryngeal view is obtained).

In summary, ETTs should be used in the ambulatory setting where the use of a SAD would be contraindicated or undesirable, even though SAD use results in quicker patient turnover [62]. The increasing popularity and use of VLs may offer anesthesiologists a safer, faster, and more successful means of tracheal intubation but should not be considered currently as an alternative to avoiding DL where traditional concerns surrounding a patient whose trachea is difficult to intubate are present.

The Anticipated Difficult Airway

Airway management is often similar for both ambulatory and non-ambulatory patients as long as difficulties do not occur. However, airway concerns are greatly amplified in the ambulatory setting—practice is often single-handed, isolated, and separate from the main hospital. Equipment may be unavailable because of cost or lack of preparedness. Finally, the rapid turn-around and discharge of patients may discourage admitting patients with known airway problems to the ambulatory center.

The overall incidence of difficult airway is dependent on the definition used. A review of 35 studies involving 50,760 patients found an overall incidence of difficult intubation of 5.8 % [7]. More recently data from larger

single projects such as the NAP 4 National Airway Audit in the UK [39••] and the Multicenter Perioperative Outcomes Group (MPOG) [15•] have been reported. The NAP 4 project found an estimated incidence of major airway complications of 1 in 22,000 with 52 cases of difficult or delayed intubation, failed intubation, and “can’t ventilate, can’t intubation” in an estimated 2.9 million general anesthetics [39••]. The MPOG found an incidence of difficult mask ventilation and difficult laryngoscopy of 0.4 % [15•]. If all 492,239 cases are included the incidence falls to 0.14 % or 1.4 per 1000 general anesthetics.

The ASA Updated Practice Guidelines For Management of the Difficult Airway defines a difficult airway as “a clinical situation in which the conventionally trained anesthesiologist experiences difficulty with face mask ventilation of the upper airway, intubation, or both” [58]. Both the ASA Guidelines [58] and the Canadian Airway Focus Group (CFAG) [63••] have excellent algorithms for the assessment and management of the difficult airway. Neither guideline is specifically for ambulatory patients, but the basic approach is the same. Issues that may and do arise in ambulatory anesthesia practice are related to the isolated and single-handed setting. The impact of these factors is discussed later.

The CAFG published an in-depth guide to managing the expected difficult airway in 2013 [63••]. Similar to the ASA practice parameters, they emphasize the importance of airway pre-assessment of all patients before undergoing a procedure where their airway may require management. They explore the management of the predicted difficult airway in five categories: avoiding general anesthesia (e.g., through regional or infiltration anesthesia); avoiding intubation in general anesthesia (e.g., use of natural airways or supra-glottic devices); deferral of surgery (if elective); awake intubation (using fiberoptic intubating laryngoscope/bronchoscope); and asleep intubation (generally for those who have fewer difficult airway predictive factors). It should be noted that even in cases where there is a wish to avoid general anesthesia or tracheal intubation, adequate equipment should still be immediately to hand, and a plan for rescue should be present should there be a failure to ventilate or difficulty with the patient’s airway arises [63••].

Ultimately, the decisions with regards to which clinical path to proceed with are dependent on the anesthesiologist’s experience, an assessment of how difficult the anesthesiologist predicts the patient’s airway to be and the staff and equipment available at the time of anesthesia. In the case of a predicted difficult airway, the CAFG recommends the use of regional anesthesia, if the patient and the procedure are suitable. If not, they suggest that evaluation of whether the patient is likely to have a high or low risk of failed oxygenation after induction of anesthesia

(predicted multiple attempts at intubation; predicted failure to ventilate with a supra-glottic airway; patient factors; equipment factors; etc.). If there is a low risk of failed oxygenation they suggest proceeding with general anesthesia followed by intubation; if the risk of failed oxygenation is high they suggest establishing an awake airway (either awake tracheal intubation or awake tracheostomy) [63••].

In addition to careful patient airway evaluation and developing good decision making processes, both the CFAG and the ASA make other suggestions, such as correct positioning of the patient for maximized oxygenation and access to their airway, pre-oxygenation of the patient before any action is taken, a “plan B” and an exit strategy and the presence of skilled staff to aid the anesthesiologist. There is particular emphasis on pre-oxygenation of patients either with 100 % oxygen for 3 min with tidal breaths, eight vital capacity breaths, or until the expired oxygen is greater than 90 % [58], [63••].

The ASA guidelines outline the non-invasive methods of managing a difficult intubation: awake fiberoptic intubation; video-assisted laryngoscopy; intubating supra-glottic airways; changing rigid laryngoscope blades for varying size and design; and fiber optic-guided intubation.

The introduction of the fiberoptic bronchoscope in 1967 [64] has resulted in its use in both expected difficult airway plans and as rescue technique. While re-usable fiberoptic laryngoscopes/bronchoscopes are very expensive, the introduction of single-use devices (Fig. 1) (aScope®, Ambu, Ballerup, Denmark) costing \$300–\$400 should allow greater access to fiberoptic intubating equipment. Studies vary regarding the ease of use in single-use fiberscopes; however, they show equal success rates when compared with re-usable scopes [65], [66•]. A French study showed that the costs between the single use and re-usable flexible fiberoptic scopes are similar [67•].

VL as we have discussed earlier is being used with increasing frequency in the management of the difficult airway and can be used alone or in combination with the fiberscope as part of a fiberoptic-assisted videolaryngoscopy (FAV) technique [55].

Supra-glottic airways and intubating LMAs are part of many difficult airway management guidelines [58], [63••], [68]. We would recommend becoming familiar and experienced with one or two devices.

Extubation of the patient with whom you have experienced a difficult airway situation is a process that requires consideration. The recent NAP 4 National Airway Audit study in the UK showed that 16 % of all airway events occurred at emergence from anesthesia [39••]. Awake extubation is recommended by the ASA Guidelines [58], over deep extubation. The use of tracheal exchange catheters during extubation is also a suggestion. A plan should

Fig. 1 Single-use fiberoptic videoscope (aScope™, Ambu®, Ballerup)

always be in place should the patient require re-intubation. The situation may be difficult to manage in a stand-alone facility without on-site critical care facilities. Airway management will require ventilation, and monitoring of the patient in the OR or PACU until recovery occurs, help arrives, or a suitable transfer is arranged.

The patient should be later advised and counselled about the processes carried out as it is important that the patient is aware that they have been found to have a difficult airway.

Ultimately, the decision to anesthetize a patient with a known or suspected difficult airway will depend on qualified personnel, appropriate equipment, and access to rescue services such as critical care, ENT surgeons, and proximity to other anesthesiologists.

In our opinion, these patients can be anesthetized in the ambulatory setting if the following criteria are met: presence of a trained, experienced anesthesiologist, appropriate equipment in place, immediate access to surgical invasive airway expertise (trained surgeon, anesthesiologist), and protocol-based transfer available to a hospital with a critical care facility. Stand-alone or office-based practices should not care for these patients.

The Unanticipated Difficult Airway

The unanticipated difficult airway is always a possibility, and as such full and correct preparation of the anesthesiologist and associated staff is required. In the ideal setting,

recommendations and guidelines would identify and exclude any patient with a difficult airway from the stand-alone ambulatory setting. Unfortunately, as has been discussed, we are currently unable to predict accurately who will and will not present as a difficult airway. The presence of a “difficult airway trolley” is paramount in any environment where general anesthesia is being carried out. There are many varying protocols when managing the difficult airway in an emergency situation, but the ASA practice parameters along with the Difficult Airway Society (DAS) guidelines from the UK are most commonly utilized [58], [39••].

Expert groups advise that in an emergency situation, the operator should not be attempting the use of equipment that they are not comfortable using. Anesthesiologists working in an environment where they cannot call for help (e.g., working in a small stand-alone unit), should ensure that they are practiced in the use of all available rescue equipment. This will involve continuing professional training through a combination of clinical exposure to suitable cases and teaching/training courses including invasive airway management.

All guidance algorithms advocate a staged approach to an emergency airway situation. They work off the principle of having multiple back-up plans in the event of “Plan A” failing. They should be studied in advance and practice of techniques such as simulator training can be very useful in improving success rates [69]. The early identification of the emergency situation, calling for help early, and changing technique or equipment in a timely fashion are crucial in the management of the unexpected difficult airway.

Adjuvants to airway management such as those previously discussed (VLs, fiberoptic scopes, intubating LMAs) are all options in the management of the unanticipated difficult airway to the operator who is experienced in their use.

The presence of a portable unit for storage of equipment for the management of a difficult airway is recommended [58], [63••], [68] to be present in all locations where general anesthesia is carried out. Similar to a “crash/emergency trolley”, it should be readily available and should be stocked and checked on a regular basis. The DAS has a suggested list of contents for the difficult airway trolley (Table 2) [70]. The recent availability of disposable, single-use fiberscopes, and VL blades and devices should ensure that these can be stocked on all airway trolleys in a cost-effective manner.

Finally, it is critical to note that all anesthesiologists who carry out general anesthesia should be prepared for the possibility that they may have to establish an advanced or surgical airway [68]. Plans should be in place in the eventuality of this occurring to further manage patients either by ENT or Head and Neck surgeons or by critical

Table 2 Difficult airway trolley contents⁵⁴

- Algorithm or flowchart for management of difficult airway
- Equipment list for re-stocking
- At least one alternative laryngoscope blade (e.g., straight, McCoy)
- Intubating LMA (ILMATM) set (size 3,4,5 with dedicated tubes and pusher)
- Tracheal tubes—reinforced and microlaryngoscopy size 5 and 6
- Flexible fibroscope laryngoscope (with portable battery light source)
- Proseal LMA (ProSeal LMATM)
- Cricothyroid cannula (e.g., Ravussin) with high pressure jet ventilation system (e.g., Manujet) OR
- Large bore cricothyroid cannula (e.g., QuicktrachTM)
- Surgical cricothyroidotomy kit

care physicians skilled in this technique. This is a very infrequent event, and thus advance training and frequent updating of experience are required [15, 69]. There are multiple cricothyroid kits on the market (e.g., the Rusch[®] QuickTrach[®] Kit, Teleflex Inc, North Carolina). Constant improvements are being made in this area to improve ease of use and success [71].

Conclusion and Suggestions

Airway management is an important factor to consider when providing anesthesia in the ambulatory setting. We must balance patient safety and surgical requirements, while at the same time, maintaining quick patient turn-over and a high level of efficiency. Thorough patient evaluation is crucial in this process, and the acknowledgement that certain patients are not suitable for ambulatory surgery or surgery in stand-alone units is crucial. Patients with known or suspected difficult airways can be managed as ambulatory cases if the criteria already described are met. Recent advances in technology (such as the development of VL and single-use fiberoptic scopes) mean that difficult airway trolleys can be stocked with gold-standard equipment at relatively little expense.

The airway experience of the anesthesiologist is often the limiting factor in any situation involving a difficult airway. As a result, it is important to re-emphasize the importance of self-education and self-preparation for the management of the anticipated or unanticipated difficult airway. The patient with the difficult airway is a fact of life for all anesthetic staff, and as a result preparation is key.

Compliance with Ethics Guidelines

Conflict of Interest Greta Gormley and Stephen Mannion declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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