



Canadian Airway Focus Group updated consensus-based recommendations for management of the difficult airway: part 2. Planning and implementing safe management of the patient with an anticipated difficult airway

Mise à jour des Lignes directrices consensuelles pour la prise en charge des voies aériennes difficiles du *Canadian Airway Focus Group* : 2^{ème} partie. Planification et mise en œuvre d'une prise en charge sécuritaire du patient présentant des voies respiratoires difficiles anticipées

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Abstract

Purpose Since the last Canadian Airway Focus Group (CAFG) guidelines were published in 2013, the published airway management literature has expanded substantially. The CAFG therefore re-convened to examine this literature and update practice recommendations. This second of two

articles addresses airway evaluation, decision-making, and safe implementation of an airway management strategy when difficulty is anticipated.

Source Canadian Airway Focus Group members, including anesthesia, emergency medicine, and critical care physicians were assigned topics to search. Searches were run in the Medline, EMBASE, Cochrane Central Register of Controlled Trials, and CINAHL

The members of the Canadian Airway Focus Group are listed in Appendix.

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databases. Results were presented to the group and discussed during video conferences every two weeks from April 2018 to July 2020. These CAFG recommendations are based on the best available published evidence. Where high-quality evidence is lacking, statements are based on group consensus.

Findings and key recommendations Prior to airway management, a documented strategy should be formulated for every patient, based on airway evaluation. Bedside examination should seek predictors of difficulty with face-mask ventilation (FMV), tracheal intubation using video- or direct laryngoscopy (VL or DL), supraglottic airway use, as well as emergency front of neck airway access. Patient physiology and contextual issues should also be assessed. Predicted difficulty should prompt careful decision-making on how most safely to proceed with airway management. Awake tracheal intubation may provide an extra margin of safety when impossible VL or DL is predicted, when difficulty is predicted with more than one mode of airway management (e.g., tracheal intubation and FMV), or when predicted difficulty coincides with significant physiologic or contextual issues. If managing the patient after the induction of general anesthesia despite predicted difficulty, team briefing should include triggers for moving from one technique to the next, expert assistance should be sourced, and required equipment should be present. Unanticipated difficulty with airway management can always occur, so the airway manager

should have a strategy for difficulty occurring in every patient, and the institution must make difficult airway equipment readily available. Tracheal extubation of the at-risk patient must also be carefully planned, including assessment of the patient's tolerance for withdrawal of airway support and whether re-intubation might be difficult.

Résumé

Objectif Depuis la dernière publication des lignes directrices du Canadian Airway Focus Group (CAFG) en 2013, la littérature sur la prise en charge des voies aériennes s'est considérablement étoffée. Le CAFG s'est donc réuni à nouveau pour examiner la littérature et mettre à jour ses recommandations de pratique. Ce deuxième article traite de l'évaluation des voies aériennes, de la prise de décision et de la mise en œuvre sécuritaire d'une stratégie de prise en charge des voies aériennes lorsque des difficultés sont anticipées.

Sources Des sujets de recherche ont été assignés aux membres du Canadian Airway Focus Group, qui compte des médecins anesthésistes, urgentologues et intensivistes. Les recherches ont été réalisées dans les bases de données Medline, EMBASE, Cochrane Central Register of Controlled Trials et CINAHL. Les résultats ont été présentés au groupe et discutés lors de vidéoconférences toutes les deux semaines entre avril 2018 et juillet 2020. Les recommandations du CAFG sont fondées sur les

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meilleures données probantes publiées. Si les données probantes de haute qualité manquaient, les énoncés se fondent alors sur le consensus du groupe.

Constatations et recommandations clés Avant d'amorcer la prise en charge des voies aériennes, une stratégie documentée devrait être formulée pour chaque patient, en fonction de l'évaluation de ses voies aériennes. L'examen au chevet devrait rechercher les prédictors de difficultés pour la ventilation au masque, l'intubation trachéale utilisant la vidéolaryngoscopie ou la laryngoscopie directe, l'utilisation d'un dispositif supraglottique, ainsi que pour la cricothyroïdotomie d'urgence. La physiologie du patient et ses problématiques contextuelles devraient également être évaluées. Les difficultés anticipées devraient inciter à prendre des décisions éclairées sur la façon la plus sécuritaire de procéder à la prise en charge des voies aériennes. L'intubation trachéale éveillée peut procurer une marge de sécurité supplémentaire lorsqu'on s'attend à ce que la vidéolaryngoscopie ou la laryngoscopie directe soient impossibles, lorsqu'on prévoit des difficultés pour plus d'un mode de prise en charge des voies aériennes (p. ex., intubation trachéale et ventilation au masque), ou lorsque la difficulté prévue coïncide avec des problèmes physiologiques ou contextuels importants. En cas de choix de prise en charge des voies respiratoires du patient après induction de l'anesthésie générale malgré les difficultés prévues, les directives à l'équipe devraient inclure les déclencheurs pour passer d'une technique à l'autre, l'aide d'experts disponibles et l'équipement requis disponible. Des difficultés imprévues lors de la prise en charge des voies aériennes peuvent toujours survenir, de sorte que la personne responsable de la prise en charge des voies aériennes devrait avoir une stratégie pour chaque patient, et l'établissement doit rendre facilement disponible le matériel pour la prise en charge des voies aériennes difficiles. L'extubation trachéale du patient à risque doit également être soigneusement planifiée, y compris l'évaluation de la tolérance du patient lors du retrait du dispositif de soutien des voies aériennes et d'une ré-intubation potentiellement difficile.

Keywords guidelines · airway management · anticipated · difficult · intubation · tracheal

1 Disclaimer

These recommendations seek to reflect the latest published evidence regarding airway management. Where high-quality evidence was lacking, expert opinion and

consensus is presented. The recommendations do not represent standards of care and instead are suggestions for optimal practice. They should be applied with specific consideration of the individual patient's characteristics, the clinical context, the airway manager's skills, available resources, and local healthcare policies.

2 Introduction

Significant morbidity related to airway management continues to be reported, with the failure to plan for difficulty a recurrent theme.¹⁻³ Most published airway guidelines focus on management of the already-unconscious patient when difficulty with tracheal intubation is encountered. Although less frequently addressed, *avoiding* having to manage an unexpectedly difficult airway almost certainly has greater potential to prevent patient harm. Airway-related morbidity can be prevented by careful patient evaluation and formulation of an airway management strategy (a co-ordinated series of plans) before proceeding with airway management. Lack of an airway evaluation or the failure to change usual practice based on its findings has been associated with morbidity.¹ Airway evaluation includes examination for anatomic predictors of difficulty with tracheal intubation, face-mask ventilation (FMV), supraglottic airway (SGA) use, and emergency front of neck airway access (eFONA). It should also include assessment of physiologic issues (e.g., apnea tolerance, aspiration risk, and altered hemodynamics) and the clinical context (e.g., case urgency, airway manager experience, equipment availability, and access to expert assistance). Airway evaluation should occur before starting airway management as well as before its discontinuation.

Video laryngoscopy (VL) has helped achieve more consistent glottic visualization and has improved first-attempt intubation success rates in the unconscious patient, especially in populations deemed to be at risk for difficult direct laryngoscopy (DL).⁴ Nevertheless, there remain patients who, based on thorough airway evaluation, would likely be more safely managed with awake tracheal intubation. This article addresses airway evaluation and provides recommendations to help formulate and implement a safe airway management strategy when difficulty is anticipated. In part 1 of these updated two-part recommendations,⁵ we address management of airway difficulties encountered in the unconscious patient, whether anticipated or not. Recommendations in both articles are meant to be broadly applicable to all specialties that have airway management in their practice mandate.

3 Methods

The methods presented here are identical to those described in the companion part 1 article⁵ and are reproduced here for the benefit of the reader. The Canadian Airway Focus Group (CAFG) is comprised of 17 members (see [Appendix](#)), with representation from across Canada as well as one member from each of New Zealand and Australia. The CAFG membership includes anesthesiologists, emergency physicians, and critical care physicians. Topics for review were divided among the members, with most assigned to two members. Members reviewed the literature published from 2011 onwards.

A medical librarian helped design and conduct the literature searches. Though not constituting a formal systematic review, databases searched included Medline, EMBASE, Cochrane Central Register of Controlled Trials, and CINAHL. Non-English and non-French, animal, manikin, and cadaver studies were excluded from searches, as were case reports, editorials, and letters. Nevertheless, team members had the discretion to include such material where relevant.

The CAFG met every two weeks by video conference from April 2018 to July 2020 to review findings and arrive at consensus regarding recommendations. Consistent with other recent airway management guidelines,⁶⁻⁹ we did not assign levels of evidence or strength of recommendation. This follows from a lack of what is considered high-level evidence seen in other medical fields. Randomized controlled trials of airway devices typically address efficacy (often in a population of low-risk elective surgical patients) but when critical events are uncommon (as with airway management), they are unable to evaluate the safety of techniques or decision-making.¹⁰ Information gleaned from large database studies is better able to capture uncommon events,¹⁰ but analysis is limited to association rather than causation and the population studied may not represent all practice environments. Thus, although evidence-based to the extent possible, some of the recommendations are based largely on expert consensus.

After review by the CAFG, draft documents were sent to several airway experts internationally (see [Acknowledgments](#)) for informal review and comment.

4 Definitions

The following definitions are used throughout the manuscript.

- **Anticipated difficult airway.** A difficult airway is predicted when the airway manager anticipates

difficulty with any or all of FMV, tracheal intubation, SGA use, or eFONA.

- **Awake tracheal intubation.** Awake tracheal intubation (ATI) refers to tracheal intubation of a patient who is sufficiently conscious to maintain a patent airway unassisted, to maintain adequate gas exchange by spontaneous ventilation, and to protect the airway against the aspiration of gastric contents or other foreign material. Awake tracheal intubation can occur via the nasal, oral, or front of neck routes, and is facilitated by topical, regional, or local infiltrative airway anesthesia.
- **At-risk tracheal extubation.** The at-risk tracheal extubation is defined by the patient anticipated to be intolerant of tracheal extubation or who might be potentially difficult to re-intubate. Difficult re-intubation might be anticipated based on pre-existing or *de novo* conditions (e.g., neck fusion or immobilization; upper airway edema).

5 Prediction of difficulty with airway management

Predicting difficulty underlies the planning for safe airway management. Expert opinion appearing in audits of airway-related morbidity and closed legal claim studies suggest that the “failure to prepare for failure” by *omitting, not documenting, or not acting on positive findings of an airway evaluation* figures prominently in cases with poor outcomes.¹⁻³ Canadian data,³ and that from the USA,² reveal that most anesthesia airway-related closed claims involved patients presenting for elective surgery (78% and 63%, respectively).

Comprehensive airway evaluation includes physical examination of the patient and review of relevant physiologic and contextual issues, pertinent diagnostic imaging studies, and any available records of previous airway management. A history of previous difficulty is more often correctly predictive of difficulty than the bedside examination.¹¹⁻¹⁵

Alone or in combination, the various bedside screening tests of anatomic features have been criticized for their poor performance in correctly predicting when difficulty will indeed occur with airway management.^{11,13,16} Nevertheless, the presence of certain anatomic features (Tables 1, 2, 3, 4, 5, 6, 7) should alert the airway manager to carefully consider the safest approach to airway management and which devices to have available; little downside will accrue if airway management turns out to be non-problematic. Conversely, when bedside screening suggests that no difficulty is expected, while more often correctly predictive of the actual outcome,^{11,16,17}

Table 1 Published predictors of difficult tracheal intubation using direct laryngoscopy**Predictors of difficult laryngoscopy and tracheal intubation using direct laryngoscopy**^{11-13,16,25-31}

- Age > 46 yr
- Male sex
- Modified Mallampati grades 3 or 4
- Thyromental distance < 6 cm
- Prominent, gapped, repaired, or fragile dentition
- Limited cervical spine extension
- Limited inter-incisor gap
- Previous neck radiation
- Increased body mass index (conflicting results)
- History of obstructive sleep apnea
- High upper lip bite test/limited mandibular protrusion
- Increased neck circumference
- History of difficult direct laryngoscopy or tracheal intubation
- Absence of neuromuscular blockade

unanticipated difficulty can still occur, such that the airway manager must be ready with a strategy to address difficulty in *all* patients. Performing and documenting an airway evaluation is standard of care, and furthermore, acts as a cognitive prompt¹⁸ to consider the potential for difficulty with every patient. The CAFG recommends that all patients undergo airway evaluation before the initiation of airway management and before the discontinuation of airway support (e.g., tracheal extubation).

5.1 Published predictors of difficult airway management

Predictors of difficult tracheal intubation by DL and VL and other devices appear in Tables 1–3. Predictors of difficult FMV and difficult SGA use appear in Tables 4 and 5, respectively. Predictors of difficult eFONA have not been prospectively studied but appear on a presumptive basis in Table 6. The likelihood of actually encountering difficulty with any modality increases in proportion to the number of anatomic predictors of difficulty.

There are currently few published studies looking at predictors of difficulty with tracheal intubation using VL; this is a gap in the literature that should be addressed. Physiologic and contextual factors that may also impact planning and implementation of airway management appear in Table 7.

5.2 The enhanced airway evaluation

Patients with obstructing airway pathology may have distortions of upper or lower airway anatomy that cannot be identified by regular bedside screening tests. For the

Table 2 Published predictors of difficult tracheal intubation using video laryngoscopy**Predictors of difficulty with tracheal intubation using video laryngoscopy**³²⁻³⁶

- Abnormal neck anatomy (e.g., due to pathology, scar, remote radiation); thick neck
- Male sex
- Large tongue
- Thyromental distance < 6 cm
- Short sternothyroid distance
- Limited cervical spine motion
- Limited mouth opening
- High upper lip bite test/limited mandibular protrusion
- Upper airway soiled by blood or vomitus
- Previously obtained high Cormack–Lehane grade during direct laryngoscopy
- Surgery type (head and neck or cardiac)
- Airway manager inexperience

Table 3 Published predictors of difficult tracheal intubation using other devices**Predictors of difficulty with tracheal intubation using other devices****Predictors of difficulty with optical stylet use**³⁷

- Increased body mass index
- Decreased mouth opening
- Higher Cormack–Lehane grade

Predictors of difficult flexible bronchoscopic intubation under general anesthesia³⁸

- Visibility impaired by blood or secretions
- Higher neck skinfold thickness
- Larger tracheal tube inner diameter relative to scope outer diameter

patient with known or suspected obstructing glottic or supraglottic airway pathology, awake nasal endoscopy or oral VL performed under local anesthesia immediately before airway management can help clarify the extent and location of the problem.¹⁹ Subglottic pathology can be assessed by review of recent imaging studies.²⁰ Point-of-care ultrasound is playing an increasing role in physiologic diagnosis and evaluation of targeted management of resuscitation before, during, or after airway management.²¹

Another aspect to enhancing the airway exam in patients with significantly altered anatomy is to identify the location of the cricothyroid membrane (CTM).²² If visual inspection or palpation fails to identify the CTM location with certainty, it should be identified using ultrasonography and marked,^{22,23} with the patient's neck in an extended position. The patient can subsequently be positioned

Table 4 Published predictors of difficulty with face-mask ventilation and difficult face-mask ventilation combined with difficult direct laryngoscopy**Predictors of difficult face-mask ventilation**^{25,28,39-48}

- Age \geq 46 yr
- Body mass index \geq 35 kg·m⁻²
- Male sex
- History of snoring
- Obstructive sleep apnea
- Facial hair
- Previous neck radiation
- Thick and/or short neck
- Absence of teeth
- Modified Mallampati class 3 or 4
- Limited mandibular protrusion
- History of difficult tracheal intubation
- Absence of neuromuscular blockade

Predictors of difficult face-mask ventilation combined with difficult direct laryngoscopy (increasing odds ratio of difficulty if four or more risk factors are present)⁴⁴

- Age \geq 46 yr
- Body mass index \geq 30 kg·m⁻²
- Male sex
- Obstructive sleep apnea
- Facial hair
- Modified Mallampati class 3 or 4
- Decreased thyromental distance (e.g., < 6 cm)
- Thick neck; neck mass or previous neck radiation
- Presence of teeth
- Limited cervical spine mobility
- Limited mandibular protrusion.

optimally for the intended airway technique; if eFONA is required, the patient can quickly be returned to the neck-extended position to utilize the previously made marking.²⁴

6 Decision-making when difficult tracheal intubation is predicted

Few published studies or guidelines specifically address which patients with predictors of difficult tracheal intubation can safely be managed after the induction of general anesthesia. Nevertheless, cues can be taken from the UK's NAP4 study¹ and closed claims analyses.^{2,3} In NAP4, ATI was judged to have been underutilized in patients with known difficult airways. Eighteen cooperative patients with predictors of both difficult tracheal intubation and difficult FMV underwent intubation attempts after

Table 5 Published predictors of difficult supraglottic airway use in the adult patient**Predictors of difficult supraglottic airway insertion or ventilation (adult patient)**⁴⁹⁻⁵²

- No teeth or poor dentition
- Reduced inter-incisor distance
- Mallampati 3 or 4
- Limited head/neck mobility
- Non-use of neuromuscular blockade
- Increased body mass index
- Neck circumference > 44 cm
- Non-supine patient position
- Use of desflurane
- Use of smaller size supraglottic airway than recommended
- Multiple insertion attempts

Table 6 Presumptive predictors of difficulty with front of neck airway access**Presumptive predictors of difficulty with front of neck airway access**

- Indistinct anatomic landmarks due to obesity, thick or short neck, subcutaneous emphysema, or surgical scarring
- Overlying hematoma, induration, inflammation, or tumour
- Previous neck radiation
- Female sex
- Laterally deviated larynx
- Limitation to head or neck extension—e.g., fixed flexion deformity

Table 7 Physiologic and contextual issues that may impact airway management**Physiologic issues that may impact airway management**^{53,54}

- Apnea intolerance, based on:
 - Decreased functional residual capacity
 - Increased oxygen consumption
 - Baseline hypoxemia; decreased PaO₂/FiO₂ ratio
 - Acid-base disturbance with respiratory compensation.
- Full stomach or other major risk factor for aspiration.
- Hemodynamic instability.

Contextual issues that may impact airway management

- Adverse location (e.g., remote location, difficult access to patient, adverse lighting conditions)
- Help/backup unavailable (e.g., because of time of day or remote location)
- Airway manager inexperience with chosen or required technique
- Lack of equipment
- Team inexperienced with difficult airway management
- Poor team communication

induction of general anesthesia. All suffered complications and two patients died.¹

When difficulty is predicted, ATI enables patients to maintain their own airway patency, gas exchange, and protection of the lower airway against aspiration during tracheal intubation; thus, ATI potentially provides a safety benefit. Conversely, despite possessing predictors of difficult laryngoscopy or intubation, some patients might still be safely managed after induction of general anesthesia. When difficult laryngoscopy or intubation is predicted, deliberate consideration of the following four questions can help the airway manager decide whether ATI is indicated or if management might safely occur after induction (Fig. 1).

A. Does the patient clearly need awake tracheal intubation?

Significant and obvious anatomic deformities or pathologic alterations of the head and neck are often most safely managed with ATI. Examples include (but are

not limited to) the patient with very limited mouth opening, a fixed flexion deformity of the head and neck, or a pathologically enlarged tongue. In such patients, there is often *no* chance that standard techniques such as DL, Macintosh blade video laryngoscopy (Mac-VL) or hyper-angulated blade VL (HA-VL) are feasible. Alternatives to these standard techniques are likely to be less familiar to the airway manager or take longer to use, especially in the context of distorted anatomy. Thus, if managing the airway in apneic conditions after induction of general anesthesia, this could put the patient at risk of significant hypoxemia. In addition, anatomy altered to this extent will often also predict difficulty with fallback modes of ventilation such as FMV or SGA use (see next section). For these reasons, ATI is a safer option.

B. Is difficulty also predicted with fallback ventilation options?

When difficult tracheal intubation is predicted, no matter how effective the primary device chosen to facilitate

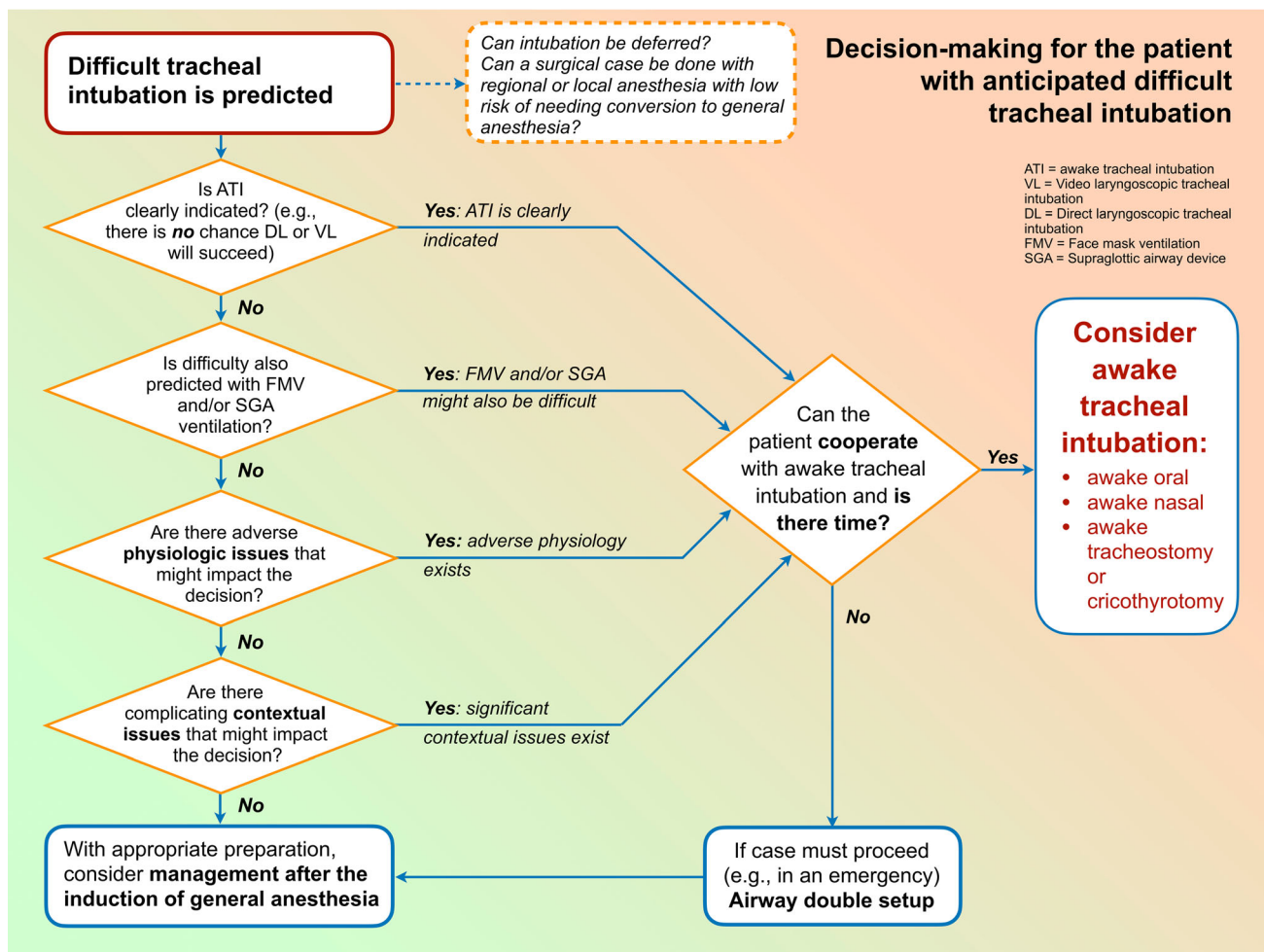


Fig. 1 Flow diagram: Decision-making when difficult tracheal intubation is predicted. ATI = awake tracheal intubation; DL = direct laryngoscopy; FMV = face-mask ventilation; SGA = supraglottic airway; VL = video laryngoscopy.

tracheal intubation may be, all have a failure rate. When this occurs, FMV or SGA ventilation will be needed between attempts. Unfortunately, when difficult or failed tracheal intubation has occurred, difficult FMV is more likely,⁵⁵⁻⁵⁷ and vice versa.^{46,57} Similarly, failed SGA ventilation is associated with a higher incidence of difficult FMV.^{49,52} This phenomenon has been referred to as the “composite failure of airway management”.⁵⁵ Tracheal intubation and FMV are reported to have predictors of difficulty common to both modalities⁴⁴ (Table 4). Thus, when difficulty is predicted with one mode (e.g., tracheal intubation), the airway manager must be especially vigilant in assessing the patient for predicted difficulty with other modes (e.g., FMV, SGA ventilation, or front of neck airway access [FONA]). When significant difficulty is predicted with two or more modes, (e.g., tracheal intubation *and* FMV), ATI should be strongly considered as a potentially safer option.

C. Is there any physiologic compromise?

Physiologic compromise (Table 7) complicates and distracts from difficult airway management.^{53,54} It is also accentuated by induction of anesthesia that additionally risks hypoxemia, aspiration, or hemodynamic instability in those at risk. Separation of difficult airway management from induction of anesthesia is therefore of value; thus, ATI is likely the optimal choice for both safety and controlling the cognitive load of the airway manager.

Rarely, physiologic issues might be the sole indication for ATI, without any anatomic predictors of difficulty with airway management, as with a critically ill patient with significant lung parenchymal disease and a high shunt fraction.⁵⁸

D. Are there any complicating contextual issues?

Contextual issues (Table 7) might also favour ATI when difficult tracheal intubation is predicted. For example, when an airway manager is practicing in a resource-austere setting without access to expert assistance or VL, the use of ATI for the predicted difficult airway patient might improve the margin of safety if patient transfer to a more fully equipped facility is not an option.

As indicated in Fig. 1, if all of the preceding questions are answered in the negative, airway management after induction of general anesthesia may be considered. Nevertheless, it must be emphasized that this decision remains one of clinical judgement and that the algorithm based on these questions has not been validated in a randomized-controlled trial. An airway manager’s individual threshold for performing ATI or other patient or system factors might also impact the decision. Conversely, if the pathway through the Figure 1 flow diagram has suggested that ATI might be a safer option, a fifth question must then be addressed, as follows.

6.1 Can the patient cooperate with ATI and is there time?

Proceeding with ATI generally requires both a cooperative patient and time for its completion. If these are lacking, options become more limited. In some critically ill patients, physiologic disturbances or an alteration in sensorium can make compliance with ATI challenging. This may guide the airway manager towards tracheal intubation after the induction of general anesthesia if airway management must proceed at that time (Fig. 1). Under these circumstances, regardless of how the induction of general anesthesia proceeds (e.g., with or without an attempt to maintain spontaneous ventilation), “double set-up” (Table 8) preparations for eFONA are recommended in case of need. This decision must be balanced against the benefit of delaying tracheal intubation in favour of less invasive approaches for ventilation/oxygenation or further medical management, if this is an option.

When difficulty is predicted, tracheal intubation should only proceed after the induction of general anesthesia when the estimated margin of safety is equivalent to an awake technique. In the elective surgical setting, perceived time pressure or airway manager discomfort with performing ATI must not play a role in decision-making for the patient with a difficult airway. Rather, help might be sought from a colleague with more experience in performing ATI.

7 Implementation of the planned strategy when difficult tracheal intubation is predicted

When difficult tracheal intubation is predicted, the following principles are common to implementing the plan, whether by ATI or after induction of general anesthesia:

- An additional experienced airway manager should be sourced. For more challenging situations, having this individual standing by in the room is advisable;
- The airway manager should brief the assembled team on the intended strategy for securing the airway;
- The briefing should include the planned response to failure of the intended technique;
- An SGA must be available for use as a rescue technique in the event of failed tracheal intubation;
- During the briefing, the airway manager should include triggers for declaring failure of one technique and proceeding to the next. *At this time, all members of the team should be explicitly empowered to state when they believe a trigger has occurred.*

Table 8 Components of the “double set-up” in airway management**The “double set-up” in airway management: components**

- Mark the location of the cricothyroid membrane with the patient’s head and neck extended. Use ultrasound guidance if skilled.
- Decide who will undertake eFONA. This should be someone other than the primary airway manager if possible.
- Ensure equipment for the chosen eFONA technique is present in the room, opened, and ready to use.
- Brief the team before induction, including the potential need for eFONA and triggers for proceeding with it.

Rationale for the double set-up in airway management

- The double set-up will help focus everyone’s attention on the anticipated airway management difficulty and patient risk.
- Equipment and personnel are present in the room while the airway is being secured.
- eFONA will be perceived as part of the plan, rather than the rescue of a failed plan. Timelier onset of eFONA may result.

eFONA = emergency front of neck airway access.

7.1 Awake tracheal intubation in the patient with anticipated difficult tracheal intubation

When performed by experienced airway managers, high success and low complication rates have been reported with ATI.⁵⁹⁻⁶¹ All awake techniques are facilitated by one or more of topical, regional, or local infiltrative anesthesia, often aided by small doses of adjunctive systemic medications. Any discomfort with ATI is typically brief and patients are usually accepting of an airway manager’s recommendation for airway management, especially when its safety aspects are discussed.⁶²

The Difficult Airway Society in the UK has recently published comprehensive guidelines on ATI.⁶³

7.1.1 Topical airway anesthesia for awake tracheal intubation

Topically applied lidocaine provides good conditions for ATI and has a favourable safety profile compared with other agents. Used for ATI, a maximum dosage of 9 mg·kg⁻¹ (lean body weight) of topical lidocaine has been recommended by the DAS ATI guidelines,⁶³ although there have been reports of symptoms and signs of toxicity at this and lower doses in volunteers.⁶⁴ Thus, the lowest lidocaine dose compatible with adequate conditions for the procedure should be used. There is no published evidence to recommend one topicalization regime over another, nor is there evidence that percutaneous nerve blocks are superior to topical airway anesthesia.

7.1.2 Adjunctive systemic medications during awake tracheal intubation

Systemic medications should complement topical airway anesthesia and should *not* be used to compensate for its ineffective application. The goal of therapy should be considered in choosing a systemic agent and its dosage. Anxiolysis and sometimes, amnesia, may be achieved with a benzodiazepine or dexmedetomidine^{65,66}; decreasing airway reflexes may be aided by opioids, such as a low-dose remifentanyl infusion. Sedation is a secondary and arguably less desirable goal during ATI, as it may impair the patient’s ability to cooperate with application of topical anesthesia.⁶⁷ The use of systemic medication in the patient undergoing ATI because of obstructing pathology must be carefully considered, recognizing that total loss of airway patency has been reported.⁶⁸

Reviews on the use of systemic medications during ATI have been published.^{65,69} No single systemic agent has yet been definitively identified as the best to aid ATI, although dexmedetomidine has been established as an effective sedative for the purpose.^{66,69} Airway managers’ preferences and familiarity with the various drugs are important factors to help guide their choice of agent.

7.1.3 Choice of device to facilitate awake tracheal intubation

ATI has traditionally been accomplished using a flexible bronchoscope (FB). More recently, HA-VL has also been reported to successfully facilitate ATI via the oral^{70,71} and nasal⁷² routes. While each class of device has benefits and limitations when used for ATI (Table 9), they appear to have comparable safety profiles.^{73,74} If one technique fails, the other may prove successful. Both options require effective topical airway anesthesia for ATI. Note that awake VL will not be an option for some difficult anatomical presentations (Table 9). Nevertheless, it is important for the airway manager to appreciate that for many difficult airway situations, ATI can proceed with a variety of devices.⁷⁵

Other options to facilitate ATI include optical stylets, the concurrent use of VL and the FB, or awake placement of an SGA under topical anesthesia to provide a conduit for FB-aided intubation.⁷⁷ The latter is particularly effective in the setting of redundant upper airway tissue, as seen with significant obesity, patients with obstructive sleep apnea, and some children with predicted difficult airways.⁷⁸⁻⁸⁰ Blind passage of a tracheal tube through an SGA without being facilitated by a FB is not recommended for ATI.

The CAFG recommends that all airway managers should be competent in ATI. This includes effective application of topical airway anesthesia as well as the use

Table 9 Benefits of and limitations to the use of VL and FB for facilitating awake tracheal intubation**Use of hyper-angulated video laryngoscopy for awake tracheal intubation**^{73,74,76}

- Enables a broad view of anatomy and good spatial awareness; facilitates a shared mental model with other team members.
- The tracheal tube can be directed to and observed to pass between the vocal cords.
- The “pink-out” that can occur if a FB abuts mucosa is avoided.
- Various sized styleted tracheal tubes can be prepared; it is easier to substitute a smaller sized tracheal tube than re-load and re-insert a FB if the initial tube size is too large.
- Space is created in the oropharynx with gentle lifting of the blade during VL.
- As a familiar technique, VL may allow more rapid ATI than the FB.
- VL may not be an option with some anatomic and pathologic abnormalities (e.g., very limited mouth opening, fixed neck flexion deformity, enlarged tongue, or base of tongue masses).

Use of flexible bronchoscopy for awake tracheal intubation

- Passage of the FB and tracheal tube can occur by the nasal route, if necessary.
- Navigation is possible in all planes around obstructing masses (e.g., a base of tongue lesion).
- Advanced to just above the carina, the FB acts as a guide for tracheal tube advancement to, through, and beyond the larynx. The FB can also be used to confirm successful tracheal intubation and can be used to ensure correct tube positioning above the carina.
- The FB can be used for some situations where anatomic constraints preclude use of awake VL. Thus, airway managers must also attain and maintain skills with the FB for ATI.
- Using the FB routinely for ATI maintains skills in a critical technique.
- Permits examination of the trachea to rule out injury, or to ensure a tracheal tube is placed distal to a known or suspected penetrating tracheal injury or fistula.

ATI = awake tracheal intubation; FB = flexible bronchoscope; VL = video laryngoscopy.

of both the FB and VL for that purpose. Maintaining skills in ATI is important to ensure that airway manager discomfort is not a deterrent for performing an awake technique when clinically indicated.

7.1.4 Failed awake intubation

Awake tracheal intubation may fail⁵⁹⁻⁶¹ for a number of reasons, including inadequate topical anesthesia, excess sedation, adverse anatomy, or a lack of patient cooperation. The airway manager must carefully consider the next steps. Simply proceeding with induction of general anesthesia after failed ATI has resulted in major morbidity and death.^{1,81} Options include deferral of an elective surgical case, summoning more experienced help, or application of

additional topical anesthesia. Simply deepening systemic sedation may be hazardous. For an urgent or emergency situation that cannot be deferred, tracheal intubation after the induction of general anesthesia must sometimes be undertaken, with a “double set-up” preparation for eFONA (please see section 6.2 and Table 8).

Reports of complete airway obstruction occurring during attempted ATI have been published,^{59,68,82,83} most often in the setting of advanced obstructing airway pathology. Possible causes include excess sedation, or a direct adverse effect of local anesthetic on upper airway patency.^{84,85} The latter phenomenon does not imply that ATI should be avoided in patients with obstructing airway pathology, but rather, that the airway manager should be ready with an alternate plan, including rapidly proceeding with eFONA if a “cannot ventilate, cannot oxygenate” (CVCO) situation occurs. It should also be noted that if eFONA is anticipated to be difficult and prolonged (e.g., due to a thick neck, previous irradiation or overlying induration or infection), it should not be considered a viable fallback technique. In this situation, awake cricothyrotomy or tracheotomy under local infiltrative anesthesia (next section) may be the more prudent planned approach.

7.1.5 Awake tracheotomy or awake cricothyrotomy

Elective FONA by tracheotomy or cricothyrotomy is a good option as a planned primary technique when great difficulty is predicted with airway management—e.g., with a friable airway cancer and/or severely narrowed airway. Requiring patient cooperation, local infiltrative anesthesia, and most often performed by a surgeon, this option might be chosen in the following situations, among others:

- For the patient presenting with advanced obstructing upper airway pathology that might cause significant technical difficulties during attempted awake oral or nasal intubation (e.g., a very friable, large base of tongue tumour);
- When the glottic opening is very small (e.g., because of obstructing tumour burden) and FB-aided awake oral or nasal intubation would transiently completely occlude the patient’s breathing during intubation, possibly causing panic and loss of patient cooperation;
- When both oral and nasal routes are not available (e.g., because of substantial disruption by trauma or distortion by advanced upper airway pathology);
- When a surgeon elects to do awake tracheotomy as an alternative to awake oral or nasal intubation if the

airway manager is not confident that ATI is a feasible option.

7.1.6 The “impossible airway” and awake institution of extracorporeal membrane oxygenation as a primary technique

An impossible airway might be predicted in clinical situations where all four of FMV, SGA use, tracheal intubation, and FONA are anticipated to fail. Failed FONA might occur with obstructing pathology distal to the thoracic inlet (or planned FONA site), or when anterior neck pathology precludes access to the trachea by cricothyrotomy or tracheotomy. In these circumstances, establishing awake veno-venous or veno-arterial extracorporeal membrane oxygenation (ECMO) prior to or as a replacement for airway intervention might represent a safer option to maintain oxygenation.⁸⁶ This underlying rationale, together with continually improving technology and expertise in ECMO, supports its use in the context of the impossible airway situation, although the currently supportive evidence appears chiefly as single case reports⁸⁷⁻⁸⁹ and case series,⁹⁰ with the attendant potential for positive publication bias. The decision to initiate ECMO prior to airway intervention should ideally occur by multidisciplinary consultation involving surgeons, anesthesiologists, perfusionists, and critical care staff, considering both diagnostic findings and clinical signs and symptoms such as stridor, dyspnea, and orthopnea.

Even in experienced hands, establishing ECMO may be complicated and is time-consuming. Therefore, it has no role as a rescue technique for a failed airway encountered after the induction of general anesthesia. This is distinct from the use of veno-arterial ECMO in the cardiac arrest scenario, when extracorporeal cardiopulmonary resuscitation is possible when specific criteria are met. In this case, patients are often transitioned to mechanical circulatory support some time after cardiac arrest and, although in a low-flow state, they will have received continuous ventilation and oxygenation throughout.

7.2 Management of the patient with anticipated difficult tracheal intubation after the induction of general anesthesia

If difficulty with management is predicted but the airway manager has elected to proceed with tracheal intubation after the induction of general anesthesia, close attention must be paid to details of implementation. Guiding principles are as follows:

- Position the patient optimally for the planned technique;
 - Pre-oxygenate;
 - Use apneic oxygenation throughout;
 - Fully prepare equipment for the planned primary intubation approach;
 - Fully prepare equipment for alternate intubation techniques;
 - Prepare an appropriately sized second-generation SGA for rescue ventilation and oxygenation;
 - Brief the team on the planned progression of techniques, with objective triggers for transitioning to the next technique;
 - Review and communicate the exit strategy⁵ to be used if tracheal intubation fails;
 - Ensure that an additional experienced airway manager has been sourced.
- Further details appear below.
- #### 7.2.1 Patient positioning
- Appropriate patient positioning can help with technical aspects of airway management and by increasing safe apnea time.
- **Positioning for laryngoscopy and intubation.** Published literature suggests optimal patient positioning for direct- and Mac-VL is the “sniffing” position.⁹¹⁻⁹⁴ This is typically obtained by aligning the patient’s tragus with their sternum in the horizontal plane, by flexing the lower neck and extending the head.⁹⁵ In the obese patient, similar alignment can be achieved in several ways, including commercial positioning devices, back-of-bed elevation, or by creating a ramp with folded sheets.⁹⁶⁻¹⁰⁴ There is currently insufficient evidence to recommend a specific patient position for the use of hyper-angulated videolaryngoscopes, which can be used in both the sniffing and neutral positions of the head and neck. The patient positioned in the neutral position with cervical spine immobilization is sub-optimally positioned for DL and Mac-VL, so that an experienced airway manager and alternate devices such as an HA-VL should be available.¹⁰⁵
 - **Positioning for FMV.** Although the evidence is sparse, the sniffing position appears to be beneficial for improving upper airway patency¹⁰⁶ and facilitating FMV.¹⁰⁷
 - **Positioning for SGA insertion.** Product monographs for SGAs typically espouse a sniffing position for insertion, with head extension and lower neck flexion.^{108,109} Furthermore, a prospective study has indicated reduced neck mobility to be a risk factor for difficult SGA insertion.⁵² With respect to ventilation once placed, a systematic review and meta-analysis by

Kim and colleagues compared the performance of a variety of SGAs in the flexed, neutral, and extended positions.¹¹⁰ Compared with the neutral position, the flexed position improved device seal but impaired ventilation as well as the view of the glottis obtainable with flexible endoscopy. Conversely, compared with the neutral position, the extended position worsened the device seal but had no effect on ventilation effectiveness or endoscopic view. These findings suggest that after insertion, SGAs should generally be used with the head and neck in the neutral position.

- **Positioning for eFONA.** Although published evidence is lacking, full extension of the head and neck is likely the optimal position for eFONA.⁴ This will be aided by placing a bolster or pillow under the patient's shoulders. There is some evidence that full neck extension may increase the height of the CTM by as much as 30%.¹¹¹ Pre-induction landmarking of the CTM (e.g., by ultrasound or palpation) should also occur in a position of full neck extension, as the CTM location may change significantly when re-positioning from a neutral to an extended position.¹¹¹

7.2.2 Pre-oxygenation

The American Society of Anesthesiologists and Canadian Medical Protective Association closed claims publications revealed that many patients who sustained airway-related morbidity were healthy and presenting for elective surgery.^{2,3} In some cases, harm might have been prevented or mitigated by closer attention to the use of pre-oxygenation and apneic oxygenation techniques to prolong the safe apnea time. Safe apnea time relates to the volume of the patient's functional residual capacity (FRC), effective de-nitrogenation of the FRC, and oxygen consumption. Of these, FRC and de-nitrogenation are modifiable. As described by Mosier in a recent editorial, three scenarios might be considered, based on the risk of oxygen desaturation with the onset of apnea⁵⁸:

- **Low to moderate risk of oxygen desaturation:** Describing many elective surgical patients with a predicted ample FRC and low shunt fraction, the FRC should be de-nitrogenated by pre-oxygenation with 100% oxygen for three minutes of tidal volume breathing, eight vital capacity breaths over 60 sec,^{112,113} or until the measured fraction of exhaled oxygen (FeO₂) exceeds 0.9.¹¹⁴ More than one strategy has been described for standard pre-oxygenation: 1) use of a tightly applied cuffed face mask attached to an anesthetic circuit or manual resuscitator with O₂ flow \geq 10 L·min⁻¹, or 2) use of a nonbreathing face mask with oxygen flow at "flush rate" (i.e., \geq 40

L·min⁻¹).¹¹⁵ The high flow rate helps match the patient's peak inspiratory flow rate, thus avoiding dilution by room air during peak demand. There is evidence that safe apnea time can be further extended with efforts to increase FRC, e.g., by patient positioning in the semi-seated (Fowler's), reverse Trendelenburg, or seated upright position,¹¹⁶⁻¹²⁰ if hemodynamics allow. This is particularly applicable to morbidly obese patients and term parturients.¹²¹⁻¹²⁴ In addition, gentle FMV between loss of consciousness and beginning laryngoscopy is advocated.

- **Moderate to high risk of oxygen desaturation:** For the patient at higher risk of oxygen desaturation with the onset of apnea, such as those with lower FRC and increased shunt fraction, the optimal pre-oxygenation strategy likely involves use of positive end-expiratory pressure or non-invasive positive pressure ventilation (NIV) during pre-oxygenation,¹²⁵⁻¹²⁸ together with back up or reverse Trendelenburg positioning. The concurrent use of standard nasal cannulae with NIV can augment pre-oxygenation and subsequently provide apneic oxygenation during laryngoscopy and intubation,¹²⁹ although to avoid hazardous gastric insufflation, airway patency must be assured. Use of high-flow nasal oxygenation (HFNO) devices running high flows under a tightly sealed mask should be avoided, e.g., during FMV, for fear of rapid gastric distention or pulmonary hyperinflation and subsequent barotrauma.
- **High risk of oxygen desaturation due to refractory hypoxemia:** The critically ill patient with substantial lung parenchymal disease and high shunt fraction is often refractory to pre-oxygenation and apneic oxygenation techniques, resulting in severely limited safe apnea time. The use of awake intubation and HFNO while maintaining spontaneous ventilation is one option to help address this scenario, if feasible.

The benefit of de-nitrogenation/pre-oxygenation is age dependent. Children have a relatively low FRC and high metabolic demand, which combine to create short apnea times despite pre-oxygenation. They often benefit from apneic oxygenation techniques to help maintain oxygenation during airway management.¹³⁰

The CAGF recommends universal pre-oxygenation before the induction of general anesthesia/rapid-sequence intubation (RSI), if feasible.

7.2.3 Apneic oxygenation

The use of apneic oxygenation can be beneficial in prolonging the safe apnea time during airway management. Apneic oxygenation is most often

accomplished with the use of standard nasal cannulae at flows of 5–15 L·min⁻¹ or devices that provide heated and humidified oxygen at higher flows (40–70 L·min⁻¹ in adults—i.e., HFNO). Apneic oxygenation is thought to work by a number of synergistic mechanisms, including mass flow of oxygen along a pressure gradient from the pharynx to the alveoli, turbulent supraglottic flow vortices and dead space flushing, as well as the effect of cardiac oscillations on intrathoracic pressure.^{131–134} Nevertheless, the airway manager must recognize that while oxygenation might be maintained, carbon dioxide clearance will be diminished during apneic oxygenation. Thus, caution and monitoring are required when allowing prolonged apnea in all patients, but especially those with increased intracranial pressure, metabolic acidosis, or pulmonary hypertension.¹³²

Apneic oxygenation by both standard nasal cannulae and HFNO has been studied in operating room (OR), emergency department (ED), and intensive care unit (ICU) settings. In general, compared with no apneic oxygenation, use of apneic oxygenation is effective in reducing oxygen desaturation during laryngoscopy in both adult and pediatric surgical patients.^{132,135–141} Results are mixed in out-of-OR settings such as the ED or ICU, possibly relating to factors such as patient population (e.g., shunt physiology precluding oxygen uptake) or study design (e.g., a non-patent airway during apnea before laryngoscopy).^{132,142–150}

The CAFG recommends that at a minimum, apneic oxygenation should be used for patients with anticipated difficult or prolonged laryngoscopy/tracheal intubation and/or for the patient with anticipated intolerance of apnea. It is essential to note that apneic oxygenation relies on a patent upper airway and will have no effect if the airway is obstructed.

7.2.4 Maintenance or ablation of spontaneous ventilation?

General anesthesia with maintenance of spontaneous ventilation has been suggested to facilitate tracheal intubation when difficulty is anticipated. Nevertheless, despite the theoretical safety advantage afforded by the maintenance of inspiratory effort,¹⁵¹ functional upper airway obstruction can occur with loss of consciousness, to a greater degree than occurs during natural sleep.¹⁵² This follows from attenuation of upper airway dilator muscle activity, which makes the pharynx vulnerable to collapse.^{153,154} The tendency of an airway to collapse with loss of consciousness is compounded by the negative intraluminal pressures generated during spontaneous inspiration within a narrowed airway.¹⁵³ Although inhalational induction is commonly used in pediatric patients, in adults it can take considerable time to reach a plane of general anesthesia sufficiently deep to allow for

airway instrumentation without provoking reflex glottic closure. The NAP4 report highlighted the hazards of using inhalational induction in the adult patient with obstructing airway pathology.¹ The CAFG does not endorse use of inhalational induction of general anesthesia as a sole strategy for the adult patient with anticipated difficult laryngoscopy or tracheal intubation.

7.2.5 Assessing for FMV efficacy prior to administration of a neuromuscular blocking agent

After the induction of general anesthesia, a trial of FMV prior to administering neuromuscular blocking agents (NMBAs) has been advocated,¹⁵⁵ with a view to potentially allowing the patient to awaken if FMV is unsuccessful. Nevertheless, in this situation, the effect of sedative-hypnotics may not dissipate or be reversible in sufficient time for the patient to resume spontaneous ventilation before significant hypoxemia occurs.¹⁵⁶ Thus, the more appropriate action when impossible FMV occurs would be to proceed with tracheal intubation or SGA insertion, both of which will be facilitated by neuromuscular blockade.^{157–159} Studies of pharmacologic paralysis (albeit almost always having been performed in patients without difficult airways) generally conclude that pharmacologic paralysis facilitates FMV, and virtually never makes it worse.^{160–167} With or without anticipated difficulty, if electing to proceed with tracheal intubation after the induction of general anesthesia, the CAFG did *not* find sufficient evidence to support a recommendation for a trial of FMV prior to NMBA administration.

7.2.6 Use of short or intermediate-acting neuromuscular blockade

When difficulty with tracheal intubation is anticipated, the CAFG could not find evidence of an outcome benefit to justify recommending use of succinylcholine over an intermediate-acting non-depolarizing NMBA. Considerations in choosing a NMBA include the following:

- Pharmacologic modelling studies have indicated that succinylcholine may not necessarily wear off in time to allow resumption of spontaneous ventilation before hypoxemia occurs in the CVCO situation.^{168,169} In addition, the residual effects of the sedative/induction agent may persist, also impairing a return to adequate spontaneous ventilation.
- Similarly, a proportion of patients given sugammadex for reversal of rocuronium or vecuronium would also critically desaturate during the time required to draw up and administer the drug and for it to work, particularly if apnea intolerant.¹⁶⁹ In one simulation study of a

CVCO situation,¹⁷⁰ a substantial time passed from a decision to use the drug, obtaining it, and its administration to the patient. Therefore, the immediate availability of sugammadex is recommended in all airway management locations. It should be noted that sugammadex will not necessarily reverse CVCO situations related to obstructing airway pathology.^{171,172}

- In critically ill patients where airway management is being performed as part of a resuscitation, expectations of a return to effective spontaneous ventilation is unrealistic when the clinical trajectory is rapidly deteriorating. Use of succinylcholine or a plan to reverse rocuronium if difficulty occurs is not a reliable plan if it is the only difficult airway strategy being deployed.
- Use of an intermediate-acting NMBA to facilitate tracheal intubation will optimize conditions for the duration of airway management should more than one attempt be required, including change of device or operator.

7.2.7 Choice of equipment

Resources allowing, the CAGG advocates for the routine use of VL (with appropriately selected blade type) for tracheal intubation, with or without anticipated difficulty.⁵ Regardless of the chosen technique, the airway manager must attain and maintain competence with its use in lower acuity clinical or simulation settings.^{173,174}

7.2.8 Difficulty encountered with a first attempt at tracheal intubation

Difficulty with tracheal intubation after the induction of general anesthesia will inevitably occur from time to time, whether predicted or not. The reader is referred to the accompanying part 1 article⁵ for recommendations on management of this situation.

7.3 Difficult tracheal intubation predicted—other options

When difficult tracheal intubation is predicted, most patients will be intubated either awake or after the induction of general anesthesia with additional preparation and precautions. Nevertheless, in some circumstances, the following options may be considered:

7.3.1 Avoiding predicted difficult tracheal intubation—use of regional or local anesthesia for a surgical case

When difficult tracheal intubation is predicted, some surgical cases may be amenable to regional or local anesthesia, with the following caveats:

- As complications from the surgical procedure itself, administered local anesthetic or sedative medications could all present the need for airway management despite the use of a regional technique, a complete airway evaluation must still occur, and a management strategy determined.
- The surgical procedure must be of a predictable duration, and the block must be shown to be effective before proceeding.
- Ideally, there should be easy access to the patient's airway intraoperatively.
- Before proceeding, the team should be briefed on the patient's difficult airway status, together with the plan for intraoperative airway management if needed.

7.3.2 Deferring management of the patient with predicted difficult tracheal intubation

Occasionally, it might be appropriate to defer airway management when difficult tracheal intubation is predicted. Examples of this include:

- Transferring an elective surgical patient to a more fully equipped hospital;
- Transferring a pediatric surgical patient with known facial dysmorphism to a specialized pediatric hospital for management;
- Rescheduling a semi-urgent surgical procedure from overnight hours until daytime staff have arrived;
- Deferring tracheal intubation of a critically ill patient by temporizing with the use of non-invasive ventilation or HFNO while additional expertise and equipment is sourced, or until the patient is transferred to a different location (e.g., the OR) for the intubation.

7.3.3 Use of an SGA in the patient with known or predicted difficult tracheal intubation

For the patient with predictors or a history of difficult tracheal intubation, the use of an SGA requires careful consideration. Three scenarios that might be considered include:

- For the case normally undertaken with tracheal intubation, electively choosing to proceed with an SGA simply to avoid a difficult tracheal intubation

situation has been shown to be hazardous.¹ The CAFG recommends against this practice. Rather, the difficult intubation situation should be safely dealt with “up front”.

- For a case where an SGA would normally be used, using an SGA in a patient with anticipated difficult tracheal intubation is often successful, although the airway manager must recognize that the fallback option of defaulting to tracheal intubation should the SGA fail may not easily succeed. This might suggest consideration of initial tracheal intubation as the safer plan when general anesthesia is required. If using an SGA regardless, at the very least, there should be a pre-determined plan for airway management should SGA ventilation fail.
- Despite the above, SGA use is often (appropriately) recommended as a fallback option after failed tracheal intubation in the induced patient.^{5,6} The SGA can be used to maintain oxygenation and temporize the situation pending the patient’s awakening, while obtaining more equipment or expertise, or it might be used as a conduit to facilitate FB-aided intubation. In an urgent situation (e.g., failed tracheal intubation during emergency Cesarean delivery under general anesthesia), a risk to benefit analysis might justify continuing with the SGA.

8 Special situations

8.1 The patient with a known or suspected highly infectious respiratory pathogen

Airway management guidelines for patients with known or suspected highly transmissible infections should follow core principles, with some modification. The contemporary experience of the COVID-19 pandemic caused by SARS-CoV-2 infection is but one example that may lead to respiratory failure requiring tracheal intubation.¹⁷⁵

- **Team safety.** The risk of transmission of a highly infectious pathogen such as SARS-CoV-2 to a healthcare worker in the immediate peri-intubation period depends on the pathogen and precautions taken.^{176,177} Spread for most pathogens is assumed to occur by direct contact with droplet containing viral particles, and/or from aerosols generated during a patient cough or an airway procedure (i.e., aerosol-generating medical procedure [AGMP]). Whether it is an elective surgical patient who has tested positive for a highly infectious pathogen, a critically ill patient with unknown status, or a patient requiring tracheal intubation because of primary respiratory disease

caused by a highly infectious pathogen, *airway manager and team safety is paramount*. Hastening to manage one of these patients without considering team safety may result in healthcare worker infections. The number of people in the room should be kept to a minimum, with a pre-assigned primary airway manager, an airway assistant, and ideally a third clinical support practitioner.

- **Personal protective equipment (PPE).** While there has been significant controversy surrounding what defines “safe” PPE for practitioners caring for patients infected by a highly infectious pathogen, it remains possible that airway management poses a significant potential risk for clinicians.¹⁷⁸ During airway management involving AGMPs, an important risk period occurs while removing (doffing) PPE. Incorrectly donning PPE or using inadequate PPE also poses a risk to the airway manager. Airborne, contact, and droplet precaution PPE for practitioners directly performing or assisting in airway management includes an N95 respirator, eye shield, Association for the Advancement of Medical Instrumentation level 3 gown, neck cover, and gloves.^{176,178} Training in donning and doffing PPE should be performed regularly and practitioners should be checked to ensure adequate PPE coverage before entering the patient care room.

The CAFG recommendations for airway management of the patient with a known or suspected respiratory infectious disease spread by droplet or airborne mechanism reflect other published consensus statements on the topic¹⁷⁹⁻¹⁸⁴ and are summarized in Table 10.

8.2 The patient with obstructing airway pathology or a traumatized airway

The patient with known or suspected obstructing airway pathology, or with airway trauma, requires careful and skilled evaluation and planning. Obstructing pathology can occur from tumour, infection, edema, foreign body, or stenosis. Trauma can distort the expected anatomy and might involve a breach of integrity of the airway, sometimes in more than one location. If general anesthesia has been induced and the patient is apneic, patients in both categories may present significant technical difficulties with some or all of DL or VL, FMV and SGA use. When tracheal intubation is indicated and time and resources permit, enhancing the standard airway evaluation is advised. Patient cooperation allowing, nasal endoscopic evaluation of the pharynx and larynx will help clarify the nature and extent of glottic and supraglottic pathology or injury.¹⁹ Any available computed tomography or magnetic

Table 10 Airway management considerations for the patient with known or suspected respiratory infectious disease spread by droplet or aerosol**CAFG recommendations for airway management of the patient with known or suspected highly infectious respiratory infectious disease spread by droplet or airborne mechanism**

Environment and pre-procedure	<ul style="list-style-type: none"> • If out of the operating room/theatre, an airborne infection isolation room is preferred for tracheal intubation. • A negative pressure environment is preferred regardless of location, but ventilation rate/air exchanges are more important than positive or negative pressurization. • Minimize team members in the room. The most experienced available airway manager should perform tracheal intubation. • Supervised personal protective equipment (PPE) donning should occur. • Perform team briefing; use a checklist. • Simulation-based team training is valuable.
Equipment	<ul style="list-style-type: none"> • Place a viral filter between tracheal tube, face mask, or supraglottic airway (SGA) and more proximal ventilation equipment. • Sidestream capnography aspiration to be located proximal to the viral filter. • Use video laryngoscopy as primary technique: <ul style="list-style-type: none"> ○ To increase first-pass success ○ To avoid close proximity to patient's face and respiratory tract ○ To enable a shared mental model and situation awareness of non-intubating team members. • Consider using SGAs for airway rescue scenarios only—not as a planned technique. Second-generation devices are recommended for their higher seal pressures. • Take pre-packaged kits with required equipment into the room. • Position a standby airway cart (+/– additional personnel in PPE as “runners”) outside room.
Pre-oxygenation	<ul style="list-style-type: none"> • Pre-oxygenate with a well-applied face mask. • Add PEEP valve to bag-valve mask set-up, if using. • Limit flow rates to the least required to obtain desired fraction of exhaled oxygen value (e.g., 0.9). This may not always be achievable.
Induction	<ul style="list-style-type: none"> • Intravenous induction with NMB preferred. • FMV discouraged while awaiting onset of NMB unless clinically significant hypoxemia has occurred or is expected. • Avoid apneic oxygenation with HFNO. • If apneic oxygenation is used, consider use of low oxygen flows (e.g., 5 L min⁻¹).
Intubation	<ul style="list-style-type: none"> • Most experienced airway manager available should manage the airway. • Ensure a styleted tracheal tube or bougie is available, as appropriate to the video laryngoscope blade in use. • Institute positive pressure ventilation only after tracheal tube cuff inflation. • If high airway pressures are encountered, ensure tracheal tube cuff pressure is 5 cm H₂O higher than peak inspiratory pressure.
Unanticipated difficult airway	<ul style="list-style-type: none"> • Use FMV between intubation attempts only if needed to re-oxygenate the patient. • If FMV is undertaken, use two-handed mask application with thenar eminence (“V-E”) grip to maximize seal and jaw lift effectiveness. • Use waveform capnography to confirm efficacy of rescue ventilation. • Avoid excessive ventilation. Respiratory rate, volume and inspiratory pressure should ideally be guided by objective feedback (waveform capnography, pressure manometer). • For the elective surgical patient, if SGA rescue is used, consider using a second-generation device that supports FB-aided tracheal intubation. • If SGA rescue has occurred, then patient awakening is preferred: if not feasible, other options include FB-aided intubation through the SGA, or FONA during SGA-supported ventilation. Proceed with surgery only if considered safe. • Above all, the safety of the team must be prioritized.
CVCO and eFONA	<ul style="list-style-type: none"> • Scalpel-bougie emergency FONA is the recommend technique. • Transiently discontinue attempted FMV or SGA ventilation during incision of cricothyroid membrane.

Table 10 continued

Awake tracheal intubation	<ul style="list-style-type: none"> • Avoid awake intubation unless high risk of a CVCO situation with induction of general anesthesia/RSI. • VL or flexible bronchoscopy can be used for awake tracheal intubation, skills allowing. Consider use of an SGA as a conduit for the FB. • Consider alternatives to local anesthetic nebulization or aerosolization for topical airway anesthesia, e.g., local anesthetic gels/ointments or nerve blocks.
Intraoperative phase	<ul style="list-style-type: none"> • Avoid circuit disconnections. • Place ventilator into standby mode if disconnection is needed. • Disconnect circuit proximal to viral filter if feasible; if not, then consider temporarily clamping the tracheal tube, seeking to avoid damaging it or its pilot line.
Extubation	<ul style="list-style-type: none"> • Tracheal extubation is an AGMP with potentially higher risk for aerosol generation than intubation¹⁸⁵. • Use pharmacologic measures to help prevent cough, agitation, or vomiting during or after extubation. • Place a surgical or procedure mask on the patient <i>before</i> awake extubation and extubate while the mouth, nose, and nasal prongs are covered by the mask; leave the mask on the patient during subsequent transfer¹⁸⁶. • Avoid airway exchange procedures if possible.
Post-procedure	<ul style="list-style-type: none"> • Dispose of airway management equipment appropriately. • Doff PPE <i>under supervision</i>.

AGMP = aerosol-generating medical procedure; CAFG = Canadian Airway Focus Group; CVCO = cannot ventilate, cannot oxygenate; eFONA = emergency front of neck airway access; FB = flexible bronchoscope; FMV = face-mask ventilation; FONA = front of neck airway access; NMB = neuromuscular blockade; PEEP = positive end-expiratory pressure; PPE = personal protective equipment; RSI = rapid-sequence intubation; SGA = supraglottic airway.

resonance imaging scans should also be reviewed, especially for patients with pathology below the glottis, recognizing that for dynamic pathology, any imaging occurs at an unknown point in the patient's respiratory cycle.²⁰

Planning a safe approach to tracheal intubation of these patients should occur according to the principles described in Section 6 above, in consultation with all involved team members, including the surgical team. If difficulty is anticipated with two or more of tracheal intubation, FMV, and SGA ventilation, an awake approach (via a nasal, oral, or front of neck route) is advised.

The trauma patient with a blunt or penetrating injury to the airway must be assessed for how best to approach airway management, as well as for the potential for vascular or other injury. Patient cooperation and time allowing, securing the airway awake during spontaneous ventilation (e.g., by awake tracheotomy or awake oral or nasal intubation) enables avoidance of positive pressure ventilation above the level of a known or suspected airway breach, and its attendant risk of causing or exacerbating pneumothorax, pneumomediastinum or subcutaneous emphysema. There is also the potential for entering a tear, creating a false passage, or converting a partial tracheal disruption to a complete disruption during tracheal intubation. Thus, indirect visualization of the anatomy (e.g., using a FB until distal to the suspected or known level of breach) is recommended. Management of the traumatized airway has recently been well reviewed.¹⁸⁷

Successful use of an SGA as a primary technique has been described under combat conditions,¹⁸⁸ as well as in surgical patients with obstructing pathologies.¹⁸⁹ Such reports are limited to observational case series or single case reports; randomized-controlled trials are lacking. Thus, while an SGA might successfully rescue a failed intubation, the CAFG recommends securing the obstructed or traumatized airway by tracheal intubation or FONA, when resources allow. As indicated in section 7.1.6, some severe cases of obstructing pathology below the thoracic inlet might be most safely managed with institution of ECMO before the airway is managed. Multidisciplinary planning and management are required.

8.3 The morbidly obese patient

The obese patient is at elevated risk during airway management. The NAP4 audit reported that patients with a body mass index (BMI) > 30 kg·m⁻² were twice as likely to suffer a severe airway complication, and those with BMI > 40 kg·m⁻² (morbidly obese) were four times as likely.¹ Patients were obese in 68% of difficult intubation claims in a recent analysis of the Anesthesia Closed Claims Project database.²

A higher BMI is associated with difficult FMV.^{25,28,40,45-48} A co-existing thick neck⁴⁰⁻⁴² (e.g., circumference > 40–50 cm), obstructive sleep apnea (OSA),^{25,40,43,46,167} and/or a history of snoring^{39,45,47,48} are also associated with difficult FMV. A thick neck^{15,28,190-192} and OSA¹⁶⁷ are associated with difficult

DL or intubation. Whether obesity alone predicts difficult laryngoscopy/intubation continues to be controversial, with some studies reporting an association,^{15,29,31,39,192-195} and others not.^{11,25,191,196-198} No studies have yet reported obesity to be a risk factor for difficult or failed VL-facilitated tracheal intubation, although one study has reported a thick neck to be associated with failed HA-VL-facilitated tracheal intubation.³³ In another study, a higher neck skinfold thickness was associated with longer times to successful intubation with a FB in anesthetized patients.³⁸ Obesity or a thick neck also predicts difficulty with SGA use in some,⁴⁹⁻⁵¹ but not all¹⁹⁹ studies, and may predict difficulty with palpation of landmarks for eFONA.

Even more significant are physiologic challenges during airway management of the obese patient.⁵³ With reduced FRC, apnea is poorly tolerated, so that if difficulty is encountered in establishing ventilation, rapid oxygen desaturation must be anticipated.

Canadian Airway Focus Group recommendations for airway management of the obese and morbidly obese patient are as follows:

- The potential for technical difficulty with both tracheal intubation and other modes of ventilation, coinciding with likely apnea intolerance, suggests that the airway manager should carefully consider whether ATI might confer a safety benefit (Fig. 1).
- Regardless of the chosen approach, close attention to patient positioning is recommended, with ramping to ensure the patient's tragus is aligned with the sternum.^{96,98} "Back up" or reverse Trendelenburg positioning will help delay oxygen desaturation.¹¹⁶⁻¹²⁴ If general anesthesia is elected, careful pre-oxygenation must occur, with a goal of achieving $\text{FeO}_2 \geq 0.9$.
- Apneic oxygenation is recommended during laryngoscopy and intubation of all morbidly obese patients when managed after the induction of general anesthesia.
- Given the anticipated short apnea time and potential for difficulty with fallback ventilation options, primary use of VL (with appropriately selected blade type) is recommended for tracheal intubation to help maximize first-pass success.
- Careful planning and documentation should occur before embarking on airway management of the obese patient. The team should be briefed on the strategy in the event that difficulty is encountered; this should include the triggers for moving to the next step in the plan. Given the potential for rapid oxygen desaturation, the airway manager should consider having a second experienced airway manager stand by for assistance if required.

8.4 The patient with an increased risk of aspiration

In the NAP4 audit, aspiration was the most common cause of airway management-related death and brain damage.¹ In an incident-reporting study from Australia and New Zealand, aspiration was associated with significant harm, with many of the cases occurring in fasted patients.²⁰⁰ In the difficult airway patient, the risk of aspiration increases in conjunction with the potential for longer or multiple intubation attempts and/or gastric insufflation with FMV between attempts.²⁰¹⁻²⁰³

Tracheal intubation is indicated when general anesthesia is required in the at-risk patient. Although second-generation SGAs with integrated drainage ports may confer some protection against aspiration,²⁰⁴ neither an SGA or FMV would typically be used as an intended primary technique in this scenario. Nevertheless, these modalities can and should be used as needed to maintain oxygenation between intubation attempts.

Although better referred to as "cricoid force", cricoid pressure (CP) applied with a force of 10 N (i.e., 1 kg) before induction and 30 N (i.e., 3 kg) after loss of consciousness may reduce the risk of regurgitation and hence aspiration during RSI by occluding the hypopharynx behind the cricoid cartilage.²⁰⁵ Nevertheless, especially if poorly applied, CP can also make tracheal intubation more challenging,²⁰⁶ and it can also complicate SGA insertion. Evidence on the effectiveness of CP has been conflicting²⁰⁷ and controversial, creating equipoise around its use. Birenbaum *et al.* recently published a large randomized non-inferiority trial ($n = 3,472$ at-risk patients) on the use of CP.²⁰⁸ The primary outcome of aspiration did not differ between the actively applied CP (ten cases; 0.6%) and sham CP (nine cases; 0.5%) groups (relative risk of aspiration for the sham CP group compared with the actual CP group 0.9; 90% confidence interval, 0.39 to 1.99). In addition, glottic visualization and duration of intubation favoured the sham CP group. Despite the clinically equivalent occurrence of aspiration between groups, methodologically, the authors were unable to declare non-inferiority of sham CP because of a lower-than-expected aspiration event rate. Other study limitations included the non-inclusion of obstetric, critical care, and ED patients, and there were few ($< 1\%$ of the total) subjects with an anticipated difficult airway. Nevertheless, given that the original Sellick communication on CP was a small, non-randomized, unblinded, uncontrolled case series of 26 patients,²⁰⁹ having the very large Birenbaum *et al.* study suggest no clinically important difference in the incidence of aspiration in an at-risk population is very helpful in advancing our understanding of CP.

Canadian Airway Focus Group recommendations for airway management of the patient with an anticipated

difficult airway and an increased risk of aspiration are as follows:

- There may still be a role for correctly applied CP in some settings (e.g., obstetrics). Given the limited data available, the ultimate decision to use CP is at the discretion of the airway manager;
- When a significantly elevated risk of aspiration coincides with an anticipated difficult airway, performing ATI with minimal sedation may confer a safety benefit;
- If the airway manager decides to intubate the at-risk patient after the induction of general anesthesia, practical advice includes suctioning a nasogastric tube if already present (consider inserting one if not) before induction, placing the patient in the back up or reverse Trendelenburg position, and having two suction devices immediately available for oropharyngeal suctioning. Before induction, an *in situ* nasogastric tube should be attached to continuous low-pressure suction to prevent intra-gastric pressure accumulation following induction²¹⁰;
- Use of VL allows airway team members to assess the laryngeal view, the impact of CP (if used) on the view of the glottis, and provides heightened situational awareness during a critical time. Nevertheless, should massive regurgitation occur, the camera may be obscured. Thus, unless difficulty in glottic visualization is anticipated, use of Mac-VL is preferable in the patient at high risk of regurgitation, to allow direct, eye-to-glottis visualization if necessary;
- If CP is deemed to be impeding either laryngoscopy or tracheal intubation, it should be removed;
- The use of FMV with low inspiratory pressure during RSI, before or between attempts at tracheal intubation, can extend safe apnea time without oxygen desaturation;
- If the planned tracheal intubation attempts fail, a second-generation SGA should be inserted, and the integrated drainage port used to drain the esophagus. If CP had been applied, it should be removed for insertion of the SGA and not reapplied.

8.5 The patient with a bleeding upper airway

Bleeding in the upper airway and subsequent problems with airway management are important causes of airway-related morbidity and death.²¹¹⁻²¹³ Bleeding in the upper airway is fundamentally different from other challenging airway situations in that flexible bronchoscopic and videolaryngoscopic intubation are often more difficult or impossible because of soiling with blood. In addition, because the stomach may be filled with blood, the use of an

SGA is only suitable as a temporary measure, or as a guide to intubation.^{213,214}

Initial therapeutic measures include compression of the bleeding site, patient positioning (the patient will often only tolerate the sitting position), suctioning, oxygen delivery, and fluid resuscitation. Concomitantly, the airway should be evaluated for predictors of difficult or impossible DL, and the location of the CTM should be established. If laryngoscopy and intubation is predicted to be otherwise technically easy and the CTM is identified with certainty, then RSI can be employed, with two large bore rigid suction catheters ready. Otherwise, preparations should be made for an ATI with alternative techniques that can be used even if visibility of the airway is obscured by blood.²¹³ Such techniques include awake FONA, awake FB-guided intubation via an SGA as well as awake DL or Mac-VL, awake retrograde-, blind nasal-, oral digital-, lighted stylet-, and ultrasound-guided intubation.²¹³ Awake intubation with a FB or VL can still be attempted in this situation, but might fail, so the airway manager should be prepared to use one of the alternatives mentioned above. In addition, a “double set-up” to allow for eFONA should be prepared (Table 8) in case the airway is lost during attempted management.

Management of the bleeding airway has recently been reviewed in detail.^{213,215}

9 Tracheal extubation

Published audits and closed legal claims continue to document the risks associated with tracheal extubation. Re-intubation in the ICU after failed extubation and tracheal tube exchange in the patient with a difficult airway have also caused patient morbidity.^{1-3,216,217} Although such cases consistently account for up to 25% of total airway management-related morbidity, a substantially smaller proportion of all published articles on airway management relate to tracheal extubation, rather than intubation.² Fortunately, excellent guidelines²¹⁸ and narrative reviews^{219,220} on tracheal extubation have been published. Intentional extubation is elective and thus allows for careful planning to occur (Fig. 2), including identification of at-risk patients after tracheal extubation.

9.1 The at-risk tracheal extubation

The patient may be deemed at risk at the time of tracheal extubation in one or both of two ways: 1) failure to tolerate tracheal extubation, where the patient is at risk of failing to maintain gas exchange, airway patency, or airway protection after extubation; and 2) if tracheal re-intubation might be difficult, either because the patient



Fig. 2 Considerations for planning for safe tracheal extubation.

was originally difficult to intubate, or because of an interval event (Table 11).

In some cases, more objective risk stratification can occur before planned tracheal extubation. For example, the patient considered at risk of supraglottic or glottic airway edema might be assessed with a cuff leak test.^{221,226-228} In a recent systematic review, the authors concluded that the absence of a cuff leak in an at-risk patient is associated with post-extubation stridor or need for re-intubation, but the presence of a leak does not necessarily rule out the occurrence of stridor or need for re-intubation.²²⁸ Further assessment of the at-risk patient can occur by indirect visual evaluation of the glottis and supraglottic area using a VL²²⁹ or FB before emergence from anesthesia or sedation begins.

Strategies to manage the at-risk patient upon tracheal extubation are presented in Table 12.

9.2 Lower risk (“routine”) tracheal extubation

Even for the patient not identified as being at risk of morbidity, care must be taken with tracheal extubation. Routine extubation measures such as gas exchange and hemodynamics should be adequate and level of consciousness sufficient to enable airway patency and protection. The patient’s neuromuscular function, temperature, and acid-base status should be near normal. Prior to extubation, the patient should be pre-oxygenated and the pharynx should be suctioned, especially if at risk of pooled pharyngeal blood, to avoid the potential of aspirated blood forming an occluding clot in the trachea.² Extubation at end-inspiration will help avoid immediate aspiration of blood or residual secretions. Additional CAGF recommendations for tracheal extubation are as follows:

Table 11 Potential causes of an at-risk extubation**Potential causes for an at-risk tracheal extubation****Potential causes of failure to tolerate tracheal extubation**

- Functional airway obstruction and/or inadequate management of secretions, due to:
 - Skeletal muscle weakness from residual neuromuscular blockade or intrinsic neuromuscular disease
 - Pre-existing obesity or OSA combined with opioids, residual anesthetics, or other sedative agents
 - Impaired neurologic status or excess drowsiness.
- Anatomic airway obstruction from:
 - Airway edema, due to:
 - Prolonged prone or Trendelenburg intraoperative positioning;
 - Known traumatic or multiple attempts at tracheal intubation;
 - Administration of large volumes of crystalloid fluid;
 - Residual edema after tracheal intubation for neck hematoma or airway infection;²¹⁷
 - In ICU patients, prolonged intubation, large tracheal tube diameter, female sex, unplanned extubation;²²¹
 - Pre-existing edema (e.g., burns or neck radiation).
 - Extrinsic airway compression, e.g., due to neck hematoma, mediastinal mass
 - Airway obstruction from secretions or blood
 - Tracheal collapse, (e.g., tracheomalacia after goitre excision or prolonged intubation)
 - Laryngospasm
 - Unilateral or bilateral vocal cord paresis or paralysis
 - Cervical spine pre-vertebral swelling²²²
 - Surgical occipital-cervical fixation in excess flexion^{217,222-224}
 - Multi-level cervical spine fusion²²⁵
- Cardiopulmonary issues (especially in ICU):
 - Respiratory failure due to non-resolution of an underlying problem
 - Compromised functional residual capacity from obesity, gastric distension with air, incisional pain, or other reason
 - Atelectasis; pneumothorax
 - Advanced chronic obstructive pulmonary disease
 - Left or right ventricular dysfunction
 - Fluid overload.
- Other perioperative issues including hypothermia, altered acid-base status and uncontrolled pain.

Potential causes of difficult tracheal re-intubation

- The original tracheal intubation was difficult.
- Interval development of airway edema.
- Anatomic changes as a result of a surgical intervention:
 - Upper airway surgery
 - Upper cervical spine fusion.
- Applied mechanical constraints, including:
 - Intermaxillary fixation
 - Halo jacket.

ICU = intensive care unit; OSA = obstructive sleep apnea.

- As extubation of the surgical patient is often accompanied by airway manager fatigue and team distraction, a “sterile cockpit” concept of minimizing non-essential conversation during emergence and extubation of the surgical patient is advocated.
- Supplemental oxygen delivery should occur during transportation of all recently extubated patients to high-dependency nursing units including postanesthesia care units. Pulse oximetry monitoring should also be used. Handover should routinely detail the type and ease of airway management.
- In critical care or ED settings, if a consulting service has recommended tracheal extubation of an intubated patient, direct communication should occur between that service and critical care/ED attending staff about the rationale and timing of extubation. Documentation of intubating conditions/difficulty should be clearly available to consulting services to help guide the extubation plan.

9.3 Extubation over an airway exchange catheter (AEC)

If tracheal intubation was or might now be challenging, short-term use of an AEC can be considered at extubation to assist re-intubation should it be required. Appropriately positioned and secured above the carina (e.g., at around 23 cm at the teeth in the adult patient), 11- or 14-French airway exchange catheters are reasonably well tolerated²³⁶ and permit spontaneous ventilation, coughing, and talking. Although AECs can support oxygen insufflation and even jet ventilation, barotrauma and fatalities have been reported in these scenarios.²³⁷⁻²³⁹ Conventional methods of oxygen delivery such as face mask, nasal cannula, or HFNO²³⁷ can still be used when an AEC is present; the CAFG recommends against any routine oxygen administration through an AEC. If unavoidable during an emergency, oxygen insufflation through an AEC should be limited to 2 L·min⁻¹, only as a temporizing measure until oxygenation is re-established by a conventional mode of delivery,²³⁷ and close attention must be paid to ensuring that gas egress can occur.²⁴⁰

An AEC can be left *in situ* after extubation of the difficult airway patient until the need for tracheal re-intubation becomes unlikely. Although case specific, in one published ICU series, most patients requiring tracheal re-intubation over an AEC underwent the procedure within two to ten hours after extubation.²³⁶ The surgical patient will almost always have the AEC removed before leaving the post-anesthetic care unit. Although infrequently required, tracheal re-intubation over an AEC will be facilitated by the use of VL to both retract the tongue and

Table 12 Strategies to address the at-risk patient upon tracheal extubation**Strategies to address the at-risk patient upon tracheal extubation**
Strategies to address the risks of failure to tolerate extubation

- At risk of functional airway obstruction:
 - Plan a multi-modal analgesia strategy for a surgical patient to help minimize need for opioids.
 - Consider continuation of ventilation in the short- or medium-term to allow full recovery from inhaled or intravenous anesthetic or sedative agents.
 - Ensure recovery from neuromuscular blocking agents quantitatively; non-depolarizing agents should have recovery to a train of four ≥ 0.9 before extubation.²³⁰ For the at-risk patient, consider use of sugammadex as a reversal agent for rocuronium or vecuronium.
 - Tracheal extubation awake, rather than deep.
 - Extubation in a head-up or back up position.
 - Early transition to CPAP mask, NIV²³¹⁻²³³ or HFNO^{232,234} if indicated. If used, close monitoring must still occur after extubation, and use of these modalities must not delay re-intubation if indicated.
- At risk of airway edema:
 - Consider more objective assessment of the degree of edema by use of a cuff leak test and/or indirect visualization of pharynx and larynx with VL or flexible endoscopy.
 - Consider deferral of extubation pending a period of short- or medium-term ventilation with head-up positioning and/or administration of steroids.²³⁵
- Optimize cardiac, pulmonary, neurologic, acid-base and body temperature status.
- Consider whether elective tracheotomy might offer a higher margin of safety.

Strategies to address the risks of difficult tracheal re-intubation

- Extubate only with a team briefing regarding the plan for re-intubation if needed.
- Consider deferral of extubation until patient condition is optimized, location is optimal, and equipment and skilled personnel are available for re-intubation if required.
- Consider extubation over a place-holder airway exchange catheter (see narrative).
- Consider whether elective surgical airway might offer a higher margin of safety.

CPAP = continuous positive airway pressure; HFNO = high-flow nasal oxygenation; NIV = non-invasive ventilation; VL = video laryngoscopy.

enable monitoring of tracheal tube passage through the glottis.²⁴¹ In addition, prior passage of an intermediate catheter (e.g., the Aintree catheter; Cook Group Incorporated, Bloomington, IN, USA) over an 11- or 14-French AEC will facilitate passage of a tracheal tube through the adult larynx by reducing the size discrepancy between the outer diameter of the catheter and the inner diameter of the tracheal tube.²⁴²

Of note, the Cook AECs (Cook Group Incorporated, Bloomington, IN, USA) are only licensed for immediate tracheal tube exchange in most countries. Therefore, leaving an AEC *in situ* for retaining airway access following extubation, though widely practiced, is technically an off-label application.

10 Human factors and the anticipated difficult airway

The NAP4 study¹ and published closed legal claims^{2,3} have indicated that airway management misadventure was often associated with inadequate evaluation and lack of a pre-determined airway strategy. That is, airway managers simply did not anticipate difficulty or failed to modify their strategy appropriately despite predicted difficulty. The airway manager must be self-aware of potential human factor pitfalls to avoid. Table 13 presents some issues together with suggested mitigating strategies.

11 Summary and key recommendations

Informed by publications of airway-related morbidity,¹⁻³ guidelines should not only address management techniques for the difficult airway when encountered in the unconscious patient but also emphasize the need for detailed patient evaluation, planning, and communication. In this way, safe airway management decision-making and implementation can occur. Briefly summarized, our guiding principles and recommendations are as follows:

- Airway evaluation of the patient should *always* occur before embarking on airway management;
- Airway evaluation includes bedside examination seeking predictors of technical difficulty with FMV, SGA use, tracheal intubation, and eFONA. Patient physiology and contextual issues should also be assessed. Review of previous airway management records, databases, and imaging studies will contribute to a complete evaluation. Nasopharyngoscopy or VL under local anesthesia can add useful information about the patient with known or suspected glottic or supraglottic pathology;
- Information gleaned from the airway evaluation must be synthesized into the safest decision on how to proceed with airway management. The use of ATI may provide an extra margin of safety when significant difficulty is predicted with VL or DL. It is also useful if difficulty is predicted with more than one mode of airway management (e.g., tracheal intubation *and* FMV), or predicted difficulty coincides with

Table 13 Potential human factor issues during patient evaluation and airway management decision-making, with suggested mitigation strategies

Potential human factor issues during patient evaluation and airway management decision-making, with suggested mitigation strategies

Issue	Possible mitigation strategies:		
	by the airway manager	by the assembled team	by the organization
<i>Failure to match planned strategy with the findings of airway evaluation</i> (anatomy, physiology, and clinical context)	<ul style="list-style-type: none"> Review your planned strategy for a high-risk or difficult case with a colleague. With predicted difficulty, before proceeding, ensure that all equipment for your airway strategy (i.e., planned primary and fallback techniques) is physically present, sized for the patient, and arranged in the order of anticipated use. This will help ensure you have thought through the situation. 	<ul style="list-style-type: none"> For all patients, brief the team on your chosen strategy, including your alternate plans if the intended technique fails, together with triggers for moving to an alternate plan. During the briefing, specifically empower team members to speak up if they think that a trigger has occurred. 	<ul style="list-style-type: none"> The organization should mandate inclusion of the airway strategy in the first surgical safety checklist. Airway management education programs should include material on safe decision-making, rather than only teaching “hands-on” skills.
<i>Maintenance of competence.</i> Use of ATI is decreasing ²⁴³ . When difficulty is predicted, lack of recent experience, confidence, or skills in ATI might tempt the airway manager to avoid its use despite indicators of it being the safest approach. Lack of suitable equipment might also be a factor in some cases.	<ul style="list-style-type: none"> Enlist a colleague to help perform ATI: you will both benefit from the experience. Seek opportunities to perform ATIs, rather than using excuses to avoid them. If the patient’s anatomy is amenable, consider using a more familiar device for ATI (e.g., VL). 	<ul style="list-style-type: none"> For the patient requiring ATI with obstructing pathology, a surgeon should be physically present to perform fallback eFONA. 	<ul style="list-style-type: none"> The organization should provide training and maintenance of competence workshops in ATI techniques, including use of the FB. Provide airway simulators or standard airway training manikins for individual practice at any time. Ensure equipment for all aspects of ATI is easily accessible at airway management locations. Package all equipment and local anesthetics needed for topical airway anesthesia together in easily-accessed “grab kits”.
<i>“Production pressure”</i> to get a case done might lead to an unsafe decision to manage a difficult airway patient after the induction of general anesthesia, when ATI might be the safer approach.	<ul style="list-style-type: none"> When sensing production pressure, (whether self-induced or from another source) push back by deliberately slowing to reflect on whether the pressure is adversely impacting your patient’s safety. Pre-empt any pushback on planned ATI by using “safest for the patient” language. 	<ul style="list-style-type: none"> Increase team buy-in by early communication with the surgeon and team when ATI is needed for an operative case. 	<ul style="list-style-type: none"> Multidisciplinary team training or rounds on adverse airway events might help improve communication and cooperation for future difficult airway situations that involve multiple specialties.
<i>“Normalization of deviance”</i> ³ : the airway manager might have managed a series of patients after the induction of general anesthesia where despite predictors of difficulty, none occurred. On the basis of thus “getting away with it” over time, inducing such patients might become a clinician’s normal practice, rather than even considering ATI.	<ul style="list-style-type: none"> With significant predicted difficulty, if considering tracheal intubation after the induction of general anesthesia, as a thought exercise, satisfy yourself that it can occur with a margin of safety equal to or greater than ATI. If not, proceed with the ATI. Beware of “gambler’s fallacy”: the false belief that the outcome of the current case is less (or more) likely given results of previous events. Judge every case on its own, based on findings from the airway evaluation. 	<ul style="list-style-type: none"> Team members should be encouraged to speak up if uncomfortable with the airway manager’s chosen approach. The “PACE” (probe-alert-challenge-emergency) or similar mnemonic can be used as a prompt by team members to question the planned approach. 	<ul style="list-style-type: none"> Appoint a hospital “airway lead”²⁴⁴ in your department or hospital, tasked with ensuring a full array of difficult airway equipment is readily available across the institution, arranging airway education, including skills in ATI, and to help constructively debrief airway-related critical incidents and near-events.

ATI = awake tracheal intubation; eFONA = emergency front of neck airway access; FB = flexible bronchoscope; VL = video laryngoscopy.

- significant physiologic (e.g., apnea intolerance or aspiration risk) or contextual issues;
- Awake tracheal intubation can proceed via oral, nasal, or front of neck routes. In some cases, oral or nasal ATI can be facilitated by a variety of devices (e.g., flexible bronchoscopy or VL);
- If a lack of patient cooperation or time precludes ATI, and airway management after the induction of general anesthesia must proceed, it should proceed with “double set-up” preparation allowing for immediate eFONA;

- Management of the anticipated difficult airway after the induction of general anesthesia should only occur with an appropriate pre-determined strategy for difficulty if/when encountered. A second airway manager should be sourced, the team briefed, and the required equipment brought to the room. Attention should be paid to patient positioning, pre-oxygenation, and apneic oxygenation;
- Regardless of the chosen approach when difficulty is predicted, the airway manager must clearly communicate the planned management strategy to the team, including the triggers for moving from one technique to the next;
- Extra care should be used in the planning and implementation of care for the patient with head and neck pathology, obesity, or increased aspiration risk;
- Tracheal extubation of the at-risk patient must be carefully planned in terms of assessing whether the patient can tolerate extubation and whether re-intubation might be difficult;
- As unanticipated difficulty with airway management can occur despite none being predicted, the airway manager must be ready with a strategy for difficulty occurring in *every* patient, and the institution must make difficult airway equipment readily available and easily accessible;
- As pandemic conditions add complexity to both routine and difficult airway decision-making and management, individual and institutional preparedness should be mandated.

Management of difficulty with airway management occurring in the already-unconscious patient is addressed in the part 1 companion article.⁵

Author contributions See [Appendix](#).

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Appendix: Author contributions and disclosures

Author	Contributions	Disclosure(s)
J. Adam Law, MD	Focus Group chair; data acquisition, analysis and interpretation; writing and critically revising article; final approval of version to be published.	Work supported by the Department of Anesthesia, Dalhousie University. Course co-director of <i>Airway Interventions and Management in Emergencies</i> (AIME) course and partner in parent company AIME Training Inc. Course director of the Anesthesia edition of the Difficult Airway Course and partner in parent company Airway Management Education Center, LLC. Recipient of equipment as loan or donation from Verathon, Ambu, Karl Storz and Covidien.
Laura Duggan, MD	Data acquisition, analysis and interpretation; critically revising article; final approval of version to be published.	Editor of the journal <i>Anaesthesia</i> and co-creator of <i>The Airway App</i>
Mathieu Asselin, MD	Data acquisition, analysis and interpretation; writing and critically revising article; final approval of version to be published.	None

Appendix continued

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Paul Baker, MBChB, MD	Data acquisition, analysis and interpretation; critically revising article; final approval of version to be published.	Co-owner and inventor, the ORSIM bronchoscopy simulator. Owner of the AirwaySkills course and recipient of equipment as loan or donation from Fisher and Paykel Healthcare, Karl Storz, Verathon, Ambu, Covidien, Truphatec, AAM Healthcare, Welch Allyn
Edward Crosby, MD	Data acquisition, analysis and interpretation; writing and critically revising article; final approval of version to be published.	None
Andrew Downey, MBBS	Data acquisition, analysis and interpretation; critically revising article; final approval of version to be published.	None
Orlando R. Hung, MD	Data acquisition, analysis and interpretation; critically revising article; final approval of version to be published.	Holds a US patent of a Light-guided Tracheal Intubation Device. Co-authored a textbook: <i>Management of the Difficult and Failed Airway</i> .
Philip M. Jones, MD, MSc	Data acquisition, analysis and interpretation; critically revising article; final approval of version to be published.	No industry conflicts to declare. Dr Jones is Deputy Editor-in-Chief of the <i>Canadian Journal of Anesthesia</i> .
George Kovacs, MD, MHPE	Data acquisition, analysis and interpretation; critically revising article; final approval of version to be published.	Work supported by the Department of Emergency Medicine, Dalhousie University. Course co-director of <i>Airway Interventions and Management in Emergencies (AIME)</i> course and partner in parent company AIME Training Inc. Recipient of equipment as loan or donation from Verathon, Ambu, Karl Storz and Covidien.

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Roanne Preston, MD	Data acquisition, analysis and interpretation; critically revising article; final approval of version to be published.	None
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Timothy P. Turkstra, MD, MEng	Data acquisition, analysis and interpretation; writing and critically revising article; final approval of version to be published.	None
David T. Wong, MD	Data acquisition, analysis and interpretation; critically revising article; final approval of version to be published.	Board of Directors, Society for Airway Management

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