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SPECIAL ARTICLE

Canadian Airway Focus Group updated consensus-based recommendations for management of the difficult airway: part 1. Difficult airway management encountered in an unconscious patient

Mise à jour des lignes directrices consensuelles pour la prise en charge des voies aériennes difficiles du *Canadian Airway Focus Group*: 1ère partie. Prise en charge de voies aériennes difficiles chez un patient inconscient

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Abstract

Purpose *Since the last Canadian Airway Focus Group (CAFG) guidelines were published in 2013, the literature on airway management has expanded substantially. The CAFG therefore re-convened to examine this literature and update practice recommendations. This first of two articles addresses difficulty encountered with airway management in an unconscious patient.*

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*

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

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Register of Controlled Trials, and CINAHL 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 was lacking, statements are based on group consensus.

Findings and key recommendations *Most studies comparing video laryngoscopy (VL) with direct laryngoscopy indicate a higher first attempt and overall success rate with VL, and lower complication rates. Thus, resources allowing, the CAFG now recommends use of VL with appropriately selected blade type to facilitate all tracheal intubations. If a first attempt at tracheal intubation or supraglottic airway (SGA) placement is unsuccessful, further attempts can be made as long as patient ventilation and oxygenation is maintained. Nevertheless, total attempts should be limited (to three or fewer) before declaring failure and pausing to consider "exit strategy" options. For failed intubation, exit strategy options in the still-oxygenated patient include awakening (if feasible), temporizing with an SGA, a single further attempt at tracheal intubation using a different technique, or front-of-neck airway access (FONA). Failure of tracheal intubation, face-mask ventilation, and SGA ventilation together with current or imminent hypoxemia defines a "cannot ventilate, cannot oxygenate" emergency. Neuromuscular blockade should be confirmed or established, and a single final attempt at face-mask ventilation, SGA placement, or tracheal intubation with hyper-angulated blade VL can be made, if it had not already been attempted. If ventilation remains impossible, emergency FONA should occur without delay using a scalpel-bougie-tube technique (in the adult patient). The CAFG recommends all institutions designate an individual as "airway lead" to help institute difficult airway protocols, ensure adequate training and equipment, and help with airway-related quality reviews.*

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 premier article de deux traite de la prise en charge des voies aériennes difficiles chez un patient inconscient.*

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

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Constatations et recommandations clés *La plupart des études comparant la vidéolaryngoscopie à la laryngoscopie directe indiquent un taux de réussite plus élevé à la première tentative et globalement avec la vidéolaryngoscopie, ainsi que des taux de complication inférieurs. Ainsi, les ressources le permettant, le CAFG recommande dorénavant l'utilisation de vidéolaryngoscopes avec le type de lame convenablement sélectionné pour faciliter toutes les intubations trachéales. En cas d'échec de la première tentative d'intubation trachéale ou d'échec de positionnement du dispositif supraglottique (DSG), d'autres tentatives peuvent être entreprises tant que la ventilation et l'oxygénation du patient le permettent. Néanmoins, le nombre total de tentatives devrait être limité, à trois ou moins, avant de déclarer un échec et de considérer les options de « stratégie de retrait ». En cas d'échec de l'intubation, les options de stratégie de retrait chez un patient toujours oxygéné comprennent l'éveil (si possible), la temporisation avec un DSG, une dernière tentative d'intubation trachéale à l'aide d'une technique différente, ou une cricothyroïdotomie. L'échec de l'intubation trachéale, de la ventilation au masque facial et de la ventilation via un DSG accompagné d'une hypoxémie présente ou imminente, définit une urgence « impossible de ventiler, impossible d'oxygéner ». Le bloc neuromusculaire doit alors être confirmé ou mis en place, et une tentative finale de ventilation au masque, de positionnement du DSG ou d'intubation trachéale avec une lame de vidéolaryngoscopie hyper-angulée peut être réalisée, si cette approche n'a pas encore été essayée. Si la ventilation demeure impossible, une cricothyroïdotomie d'urgence devrait être réalisée sans délai utilisant une technique de scalpel-bougie-tube (chez le patient adulte). Le CAFG recommande à toutes les institutions de désigner une personne comme « leader des voies aériennes » afin d'assister à la mise en place de protocoles pour les voies aériennes difficiles, d'assurer une formation et un équipement adéquats et d'aider aux examens de la qualité en rapport avec les voies aériennes.*

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

1 Disclaimer

These recommendations aim to reflect the latest published evidence regarding airway management. Where high-quality evidence is 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 institutional policies.

2 Introduction

Morbidity related to airway management continues to be reported in closed legal claims[1,2] and practice audits.[3,4] When such adverse airway outcomes are subject to peer review and analysis, patterns of care are often found to be suboptimal.[1–3] Common themes include persistence with one technique when tracheal intubation proves difficult; failure to recognize an evolving "cannot ventilate, cannot oxygenate" (CVCO) scenario and failure to perform timely emergency front-of-neck airway access (eFONA) when indicated. Failure of non-technical skills such as effective communication and good team dynamics have often also contributed to airway-related morbidity.[1–3] With previous guidelines published in 1998[5] and 2013,[6,7] this update to Canadian airway management recommendations reflects new evidence and opinion appearing in the literature. It applies to difficulty encountered with airway management in an unconscious and often apneic patient.

Significant difficulty with airway management in the unconscious patient can often be avoided by careful airway evaluation before the induction of general anesthesia. In part 2 of these updated recommendations,[8] we have addressed decision-making and implementation of the planned airway strategy for the patient with an anticipated difficult airway. Recommendations in both articles are meant to be broadly applicable to all specialties involved in airway management.

3 Methods

The Canadian Airway Focus Group (CAFG) comprises 17 members (see Appendix), with representation from across Canada as well as one member each from 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, as were case reports, editorials, and letters. Nevertheless, team members had discretion to include such material where relevant.

The CAFG met every two weeks via videoconference from April 2018 to July 2020 to review findings and arrive at consensus regarding recommendations. Similar to other airway management guidelines,[9–12] 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.[13] Information gleaned from large database studies is better able to capture uncommon events,[13] 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 that follow are based largely on expert consensus.

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

4 Definitions

The following definitions are used throughout the manuscript:

- **Difficult airway.** A difficult airway exists when an experienced airway manager anticipates or encounters difficulty with any or all of laryngoscopy or tracheal intubation, face-mask ventilation (FMV), supraglottic airway (SGA) use, or eFONA. The airway extends from the nostrils and lips to the alveoli, and anatomical variation or pathological distortion anywhere along its length may cause difficulty. Physiologic or contextual issues may compound difficulty with airway management.
- **Difficult and failed face-mask ventilation.** Difficulty with or the failure of FMV can be described according to the four-grade scale presented in Table 1.[14,15] Grades 3 and 4 correspond to difficult and failed ventilation, respectively. The CAFG does not include the number of hands used for a mask seal (i.e., 1 *vs* 2) in its definition of difficulty, recognizing that the use of two hands may simply reflect clinician preference or the need to optimize a seal to minimize patient exhalation/air leak to the environment.
- **Difficult and failed supraglottic airway use.** Supraglottic airway use is *difficult* when more than one attempt at insertion is required, or the resulting ventilation is inadequate. *Failed* use of an SGA is defined by inadequate ventilation and oxygenation after a maximum of three attempts. As with FMV, this will be reflected by an absent or severely attenuated capnography trace.
- **Difficult and failed direct or video laryngoscopy.** The view obtained during direct laryngoscopy (DL) or video laryngoscopy (VL) is typically quantified using the Cormack-Lehane[16] grade or one of its modifications[17,18] (Table 2). Secretions, blood, emesis, and fogging or illumination issues can also cause difficulty with laryngoscopy. *Difficult* laryngoscopy is generally described as a Cormack–Lehane grade 2b or 3a view and does not necessarily imply that difficult or failed tracheal intubation will follow. Grade 3b and 4 views define *failed* DL or VL.
- **Difficult and failed tracheal intubation**. Tracheal intubation is considered *difficult* if more than one attempt at optimized laryngoscopy and tracheal tube passage is made, a more experienced operator is required, or a change is made in technique/device. Tracheal intubation has *failed* if the patient is not intubated after a maximum of three attempts by an experienced airway manager. The definition of failed intubation exists not to be pejorative, but to serve notice to the airway manager that help should be sought and an alternate course of action pursued.
- **"Cannot ventilate, cannot oxygenate".** The CVCO situation has occurred if attempts to ventilate the patient with *all three* of tracheal intubation, FMV, and an SGA have failed (i.e., cannot ventilate), resulting in imminent or current hypoxemia (i.e., cannot oxygenate). After much discussion, the CAFG has chosen to introduce the term CVCO rather than referring to "cannot intubate, cannot oxygenate" (CICO) for two reasons. First, it helps de-emphasize what may have been an inappropriate focus on tracheal intubation given that the physiologic endpoints of ventilation and oxygenation are the more important goals. Historically, this might have led to persistence with multiple futile attempts at tracheal intubation in the imminently or already hypoxemic patient and may have failed to prompt an attempt at ventilation using an SGA. Secondly, it acknowledges that the absent or severely attenuated waveform capnography that accompanies each of failed tracheal intubation, FMV, and SGA use (i.e., cannot ventilate) will sometimes precede significant oxygen desaturation, especially in the well pre-oxygenated patient (or possibly, when apneic oxygenation is in use). This window of imminent hypoxemia, between the recognition of the "cannot ventilate" situation and the onset of severe

Table 1 Grading scale and clinical indicators for ease of face-mask ventilation (after Han *et al.*[14] and Lim *et al.*[15])

Grade	Description	Ease	Example clinical/monitoring indicators
Grade 0	*Face-mask ventilation not attempted*		
Grade 1	Successfully ventilated by face mask	Easy	Plateau phase is present on capnograph; chest rise occurs with positive pressure ventilation (PPV).
Grade 2	Successfully ventilated by face mask with use of an oral airway or another adjunct; minimal evidence of leak		
Grade 3	Ventilation by face mask is inadequate or unstable, despite optimizing maneuvers	Difficult	Attenuated capnographic trace (no plateau phase occurs); decreased chest rise with attempted PPV.
Grade 4	Unable to face-mask ventilate, despite optimizing maneuvers	Failed	There is a flat or severely attenuated capnograph and absent chest rise with attempted PPV; there is also inadequate restoration or maintenance of SpO_2.

PPV = positive pressure ventilation; SpO_2 = peripheral oxygen saturation by pulse oximetry

Table 2 Grading scale for direct or video laryngoscopy (after Cormack-Lehane,[16] Yentis[17] and Cook[18])

Grade	Description	Ease of laryngoscopy	Ease of tracheal intubation
Grade 1	All or most of vocal cords are visible	Easy	Intubation is generally non-problematic
Grade 2a	Partial view of vocal cords can be obtained		
Grade 2b	Only the posterior cartilages are visible	Moderately difficult	Intubation is often manageable with adjuncts, e.g., a tracheal tube introducer ("bougie") or rigid or semi-malleable stylet
Grade 3a	Only the epiglottis is visible, but it can be lifted off the posterior pharyngeal wall		
Grade 3b	Only the epiglottis is visible, and it cannot be readily elevated	Failed	Intubation is often difficult or impossible; an alternate device is generally required
Grade 4	Neither the epiglottis nor glottis is visible		

hypoxemia offers the best opportunity for a good patient outcome by promptly performing eFONA.

- **Emergency front-of-neck airway access.** This refers to emergency access to the trachea via the front of the neck by either cricothyrotomy or tracheotomy. In the hands of non-surgeons, eFONA most often occurs in the adult patient by cricothyrotomy and is considered difficult if it requires more than one attempt.

5 Incidence of difficult and failed airway management

Table 3 outlines data from studies in various contexts reporting the frequency of difficult and/or failed FMV, SGA use, tracheal intubation, and eFONA. The studies from which these data are taken are heterogeneous, with inconsistent variables such as patient population, airway manager experience, definitions of difficulty or failure, and the use of neuromuscular blockade. This is likely to explain some of the table's wide-ranging numbers.

6 Response to difficulty with airway management in the unconscious patient

Airway managers should be ready with a pre-planned, stepwise approach to managing difficulty with FMV, SGA use, or tracheal intubation.

6.1 Response to difficult FMV

Difficult FMV is challenging to reliably predict,[19] and is often indicated by an attenuated waveform capnography trace.[15,71] Options for responding to difficult FMV are presented in Table 4.

6.2 Response to difficult SGA insertion or ventilation

Although SGAs are used as the intended primary airway technique in many elective surgical procedures, they also play a vital rescue role when a difficult or failed tracheal intubation is encountered in any context. An SGA can also serve as a conduit to facilitate flexible bronchoscope (FB)-

Table 3 Incidence of difficult and failed airway management by practice location. Note that some definitions of "difficult" and "failed" may differ between the referenced studies and those used in this article

	Operating room	Obstetric anesthesia	Pediatric anesthesia	Emergency department or pre-hospital, MD-performed	Critical care
Difficult FMV	0.7–3%[19–22]	7.1%[23] 30%[24]	6.6%–9.5%[25,26]	Approx. 15%[27]	17%[28]
Failed or impossible FMV	0.03–0.2%[19,21,29]	14%[23] 9%[24]	No data	7–18%[30,31]	No data
Difficult FMV combined with difficult laryngoscopy/ intubation	0.3–0.4%[19,22]	No data	12.5%[26]	No data	27%[28]
Difficult tracheal intubation	3–8%[19,22,32,33]	1.6–5.7%[23,34–37]	0.2–5.5%[25,26,38,39]	1–11%[27,40–44]	5–23%[28,33,45–47]
Failed tracheal intubation	0.006–0.4[19,48,49]	0–0.7%[23,34–37,50,51]	0.08%[38]	0–6%[44,52–56]	7%[45]
Difficult SGA use	0.5%[57]	0–1.7%[37,58–60]	0.4–7.1%[38,61]	7%[62]	No data
Failed SGA use	0.2–1%[57,63]	0–25%[24,35,37,58–60]	0.08–2%[38,61,64]	2–34%[30,65–67]	No data
CVCO or eFONA	0.006% (ENT patients 0.2%)[68]	0–0.2%[23,24,34,35,37,50]	No data	0.1–0.9%[27,44,53,54,69,70]	No data

CVCO = cannot ventilate, cannot oxygenate; eFONA = emergency front of neck airway access; ENT = ear, nose, and throat; FMV = face-mask ventilation; SGA = supraglottic airway

Table 4 Recommended options for responding to difficult face-mask ventilation

Options for responding to difficult face-mask ventilation

- Ensure adequate depth of anesthesia.
- Use an oropharyngeal airway (routine use is recommended for all emergency airway management). A nasopharyngeal airway is an alternative if the mouth cannot be accessed.
- Use a two-handed mask hold with exaggerated jaw lift;[72,73] positive pressure ventilation can be performed by an assistant or a ventilator set to pressure control ventilation at ≥ 15-cm H_2O.[74,75]
- Use a thenar eminence ("V-E") grip for two-handed mask seal/jaw lift.[72,76]
- Ensure neuromuscular blockade.[63,77]
- Consider an alternate size or type of face mask to improve the airway seal.
- Perform additional head extension[72] or lateral head rotation[78] (if not contraindicated).
- Release any applied cricoid pressure.[79]
- Consider head-up patient positioning (hemodynamics permitting).
- Consider gastric decompression via an orogastric tube if significant gastric distention is suspected.
- Exclude presence of a physical obstruction or compression (e.g., foreign body, tumour, or stenosis) in the upper airway or trachea.
- Progress to an alternate mode of ventilation, e.g., SGA or tracheal intubation.[22,80]

SGA = supraglottic airway

guided tracheal intubation, either in a rescue capacity or as the intended primary technique.

Second-generation SGAs are defined by the presence of an esophageal drainage port and cuff design to help maximize seal. They may or may not also be designed to support FB-guided tracheal intubation. Second-generation devices have some benefit over first-generation devices with respect to addressing aspiration risk, but clinically significant aspiration events are rare so this potential advantage has yet to be proven. Nevertheless, given the potential benefits of second-generation SGAs[81] and with no reported disadvantages, the CAFG recommends the routine use of second-generation devices whenever an SGA is needed. Recommended options for SGA insertion troubleshooting appear in Table 5.

6.3 Response to difficult tracheal intubation facilitated by direct or video laryngoscopy

Tracheal intubation facilitated by DL or VL comprises two separate actions: visualizing the glottis, followed by intubating the trachea. Difficulty may occur with either or both component(s).

Table 5 Recommended options for responding to difficult supraglottic airway insertion

Options for responding to difficult supraglottic airway (SGA) insertion
• Ensure an adequate depth of general anesthesia for SGA insertion.
• Unless contraindicated, use a "sniff" position for SGA insertion, with lower neck flexion and head extension.[82,83]
• Consider rotating the SGA 90° during advancement around the tongue.[84–87]
• Use an alternate size[88,89] or design of SGA, including one with a different cuff material.[90]
• In the context of failed tracheal intubation, release any applied cricoid pressure for SGA insertion.[91–93]
• Consider neuromuscular blockade (evidence regarding benefit during SGA use is conflicting; however, no harm is reported).[94–97]
• Consider SGA insertion facilitated by direct or video laryngoscopy.[89,90,98–102] With a second-generation SGA, a tracheal tube introducer ("bougie") placed through the SGA's esophageal drainage port can first be advanced into the esophagus to subsequently help guide the SGA into position.[103,104]
• Progress to an alternate mode of ventilation, e.g., tracheal intubation or FMV.

FMV = face-mask ventilation; SGA = supraglottic airway

The terms "direct" and "video" laryngoscopy encompass a variety of devices. For the purposes of the following discussion, we categorize laryngoscopy as follows:

- **Direct laryngoscopy** refers to use of non-video enabled laryngoscopes, typically with Macintosh or Miller blades. Glottic visualization occurs by direct eye-to-glottis sighting.
- **Video laryngoscopy** refers chiefly to use of laryngoscopes with a camera in the blade that delivers an image to an external video screen. Originally designed with a hyper-angulated blade (HA-VL), video laryngoscopes are now available with varying blade geometries, including Macintosh-shaped video laryngoscopy (Mac-VL). Further details appear in Table 6.

Responses to difficulty with glottic exposure or difficulty with tracheal intubation using DL and Mac-VL appear in Table 7. Unless the glottis is obscured by pathology,[122] fogging, blood or secretions/emesis in the pharynx, difficult laryngoscopy is unusual when using HA-VL, provided the blade can be inserted and placed within the oropharynx. Instead, difficulty with HA-VL facilitated tracheal intubation often relates to difficulty with "around the corner" delivery of the tracheal tube to and through the glottis. Recommended measures to help address difficulty with tracheal tube delivery when using HA-VL are presented in Table 8.

6.4 Primary use of video laryngoscopy

The CAFG studied whether a recommendation could be made for the routine primary use of VL (as opposed to DL) to facilitate tracheal intubation. Unfortunately, the currently available literature comparing Macintosh DL with VL is difficult to interpret. While plentiful, most systematic reviews and meta-analyses comparing DL with VL combine various VL blade types (HA-VL and Mac-VL), patient populations, clinical contexts, airway manager experience, and measured outcomes.[141] Nevertheless, compared with DL, the first-attempt and overall success rates of tracheal intubation using VL (Mac-VL or HA-VL) are rarely worse, and are often better.[105,113,114,142–153]

The use of a Mac-VL,[106,154] HA-VL,[48,155] or VL of unspecified blade type[37] have all been shown to facilitate successful tracheal intubation after failed DL. In addition, there may be lower complication rates with VL, including fewer occurrences of esophageal intubation.[52,113,144–147,156–159] The use of VL also enables a "shared mental model", helping to increase engagement of all airway team members. On balance, and resources allowing, the CAFG recommends the routine primary use of VL with an appropriate blade type for all tracheal intubations. If difficulty is predicted with glottic exposure using DL or Mac-VL, first-attempt use of HA-VL to facilitate tracheal intubation should be strongly considered. For the patient at risk of upper airway soiling (e.g., blood, emesis), consider using Mac-VL so that direct, eye-to-glottis visualization can occur should the video camera become obscured. Intermediate geometry blade VL (e.g., McGrath Mac) or DL are alternatives in this situation.

7 Response to an unsuccessful first (or subsequent) attempt at the intended airway technique

The following sections address difficulty and failure encountered with attempted tracheal intubation. The response to difficulty and failure with an SGA is discussed in section 8.

Table 6 Video laryngoscope blade types with commonly used examples ([A]Karl Storz Endoscopy America Inc., El Segundo, CA, USA; [B]Verathon Inc., Bothell, WA, USA; [C]Medtronic Canada, Brampton, ON; [D]Ambu, Inc., Columbia, MD, USA; [E]Teleflex, Morrisville, NC, USA)

Video laryngoscopy (VL) blade types

Blade type	Comment	Commonly used example(s)
Macintosh geometry video laryngoscopy (Mac-VL)	Using similar technique and optimizing maneuvers as DL, Macintosh geometry VL (Mac-VL) enables laryngeal visualization to occur by direct eye-to-glottis sighting *or* indirect, on-screen videoscopic sighting. The videoscopic view may be better than that afforded by standard direct laryngoscopy[105–107] and may[108–111] or may not[112] be significantly better than that afforded by direct eye-to-glottis viewing with the same video laryngoscope. Higher first-pass[105,113] and overall[105,114] success rates have been reported with Mac-VL than with DL. As with DL, once a view of the glottis is obtained, tracheal tube delivery tends to be straightforward.	• C-MAC® with Macintosh blade[A] • GlideScope® DVM[B]
Hyper-angulated or hyper-curved blade video laryngoscopy (HA-VL)	Hyper-angulated blade VL (HA-VL) allows "around the corner" viewing of the glottis by indirect, videoscopic viewing only. The view with HA-VL is often superior to that obtained by DL[115–117] or Mac-VL.[117] First pass tracheal intubation success with HA-VL is frequently higher than with DL.[113] Tracheal intubation with HA-VL requires use of a stylet[118] or other adjunct and for the inexperienced airway manager, may be more challenging or take longer than with DL.[119,120] This can occur despite good glottic visualization.[121,122] It is important to maintain direct (i.e., non-videoscopic) intraoral visual contact with the advancing styleted tube until its tip is past the soft palate, to avoid inadvertent soft-tissue injuries.[123,124] In this regard, a malleable stylet is preferred and equally effective[118] to a rigid stylet. Some HA-VLs feature an integrated channel in the blade to help safely guide the tracheal tube to the glottis.	Non-channelled • C-MAC® D-blade • GlideScope® LoPro • McGrath™ Mac[C] with X blade Channelled • King Vision™ [D] • Airtraq™ [E]
Intermediate geometry video laryngoscope blades	Video laryngoscope blades exist with angulation or curvature intermediate between that of typical Mac-VL (30°) and HA-VL (60–90°) blades. The view afforded[125] and ease of tube delivery is correspondingly intermediate between that of Mac-VL and HA-VL. Use of a stylet or a tracheal tube introducer ("bougie") is recommended.	• McGrath™ Mac[C] with Mac blade

DL = direct laryngoscopy; HA-VL = hyper-angulated blade video laryngoscopy; Mac-VL = Macintosh geometry blade video laryngoscopy

Table 7 Recommended options for difficulty encountered with glottic exposure and/or tracheal intubation using DL or Mac-VL

Options for response to *difficulty with glottic exposure* using direct laryngoscopy (DL), Macintosh geometry blade video laryngoscopy (Mac-VL) or intermediate geometry blade video laryngoscopy

- Ensure neuromuscular blockade.
- Apply external laryngeal manipulation (not cricoid pressure).
- Ensure the Macintosh blade is inserted sufficiently deep into the vallecula to engage the hyoepiglottic ligament.
- Consider directly lifting the epiglottis (applies to both Macintosh and straight blades).
- Exaggerate head lift and "sniff" positions,[126–129] if not contraindicated.
- Release any applied cricoid pressure.[130]
- If using Mac-VL, switch to indirect, videoscopic viewing[108–110] if direct eye-to-glottis viewing is suboptimal.
- For continued difficulty with glottic exposure, if the patient remains well-oxygenated, strongly consider progressing to HA-VL.[48]

Options for response to *difficulty with tracheal tube passage* during DL or Mac-VL

- Use a tracheal tube introducer ("bougie"). The bougie is an effective adjunct when Mac-VL or DL results in a limited (e.g., Cormack–Lehane 2b or 3a) view.[40,131] The CAFG endorses the immediate availability of a bougie in all airway management locations.
- If not using a bougie, use a stylet to optimally shape the tracheal tube.
- If difficulty with tube passage has occurred in the context of a suboptimal glottic view, consider progressing to HA-VL[48] if the patient remains well-oxygenated.

DL = direct laryngoscopy; HA-VL = hyper-angulated blade video laryngoscopy; Mac-VL = Macintosh geometry blade video laryngoscopy

Table 8 Recommended options for response to difficulty with tube delivery facilitated by HA-VL

Options for response to ***difficulty with tracheal tube delivery*** when using hyper-angulated blade video laryngoscopy (HA-VL)	
HA-VL (non-channelled blades)	• Partially withdraw the HA-VL blade during laryngoscopy, seeking to achieve no more than a limited view of the larynx (e.g., Grade 2).[132] This allows for both a wider field of view and also a straighter pathway for tube delivery. • Modify the curvature of the styleted tracheal tube to accommodate specific patient anatomy. When a semi-rigid or malleable stylet is used to facilitate HA-VL, it should generally be shaped to match the angulation or curvatureof the blade (i.e., not including the handle)—typically at angles between 60 and 90°.[118,133,134] • Centre the view of the glottis on the screen, then slide the styleted tube's tip along the undersurface of the blade to help direct it to the glottis.[135] • Withdraw the stylet by 4 cm once the tip of the tracheal tube has been passed through the glottis. By allowing the tracheal tube to reflect off the anterior tracheal wall, this facilitates its further advancement down the trachea. • For tube "hang-up" persisting after partial stylet withdrawal, rotation of the tube 45–90° to the right (clockwise) may help address tube impingement on the cricoid cartilage or a tracheal ring.[135] • Insertion of a styleted tube before[136] or concomitantly with[137] the videolaryngoscope blade may help with tube passage in the patient with a small mouth. Note that blind insertion of a styleted tracheal tube is contraindicated in some clinical circumstances (e.g., retropharyngeal abscess). • Changing to DL or Mac-VL may succeed if tube delivery continues to be problematic with HA-VL,[122,138,139] unless already proven unsuccessful.
HA-VL (channelled blades)	• Slight withdrawal, caudad angulation of the blade and lifting of the scope may help better align the advancing tube with the glottic opening and trachea[140]. It is important to not use too small a tracheal tube, as it can exit the channel in an excessively caudad direction.

DL = direct laryngoscopy; HA-VL = hyper-angulated blade video laryngoscopy; Mac-VL = Macintosh geometry blade video laryngoscopy

7.1 The hazards of multiple attempts at tracheal intubation

Airway managers are susceptible to a variety of cognitive biases[160] that may negatively affect patient care[161]. One of the most concerning is *perseveration*, defined in the 2019 American Society of Anesthesiologists (ASA) closed claims publication as the "consistent application of any airway management technique or tool more than twice without deviation or change of technique, or the return to a technique or tool that had previously been unsuccessful".[1] Perseveration with multiple tracheal intubation attempts appears to be particularly prevalent in otherwise healthy adults[1] and in children where no difficulty was anticipated.[39] Most airway managers recognize that failure of an optimized attempt using one device should mean that another device, technique or operator should be employed during subsequent attempts. Yet even with the substitution of a different device, multiple attempts are correlated with adverse events. Thus, first-attempt success at the intended technique should always be a goal.

Adverse outcomes associated with multiple attempts at tracheal intubation include hypoxemia, esophageal intubation, airway trauma, and cardiac arrest. This association exists in pre-hospital care (if tracheal intubation is used),[162,163] pediatric settings,[164–166] critical care,[167–169] emergency medicine,[43,44,170–172] and in the operating room (OR)[38,39] (Table 9). Similar evidence exists regarding multiple attempts at SGA insertion.[38,166] As a result, virtually all national airway management guidelines in adults,[6,9,10,12,71,173–180] obstetrics,[181,182] and pediatrics[183–185] agree that a *maximum* of two to four optimized attempts (collectively, by all airway managers involved) at tracheal intubation occur before pausing to consider an alternate ("exit") strategy, with the goal of returning the patient to a point of safety.

7.2 Unsuccessful first or subsequent attempt at tracheal intubation with oxygen saturation in a safe range

The following narrative should be read in conjunction with the flow diagram depicted in the Figure. If a first attempt at tracheal intubation is unsuccessful, further attempts at tracheal intubation can be made according to the following guiding principles:

- Further intubation attempts should only be made if the peripheral oxygen saturation (SpO_2) remains in, or has been returned to, a safe range for the patient (e.g., ≥ 90%). This may occur by FMV or SGA ventilation, the effectiveness of which can be seen by waveform capnography. It also includes the situation where the patient is not ventilated after an unsuccessful first intubation attempt, but the SpO_2 is maintained in a safe range because of pre-oxygenation and/or the use of apneic oxygenation.
- For a further attempt at tracheal intubation, if not already applied, apneic oxygenation should be considered. This can be administered by via conventional nasal prongs at 5–15 $L \cdot min^{-1}$ or a high-

Table 9 The adverse outcomes associated with multiple attempts at tracheal intubation

Summary of findings of adverse outcomes related to multiple attempts at tracheal intubation

Reference	Number of patients	Clinical context	Findings
Mort 2004[167]	2,833	In-hospital, outside of operating room	> 2 attempts associated with increased complications (cardiac arrest RR, 7; 95% CI, 2.4 to 9.9). Recommend maximum of three attempts.
Griesdale *et al.* 2008[168]	136	Critical care unit	$\geq$ 2 attempts independently associated with increased risk of severe complications (OR, 3.3; 95% CI, 1.3 to 8.4).
Martin *et al.* 2011[169]	3,423	In-hospital, outside of operating room	$\geq$ 3 attempts associated with complications (OR, 6.7; 95% CI, 3.2 to 14.2).
Hasegawa *et al.* 2012[43]	2,616	Emergency department	$\geq$ 3 attempts associated with adverse events (OR, 4.5; 95% CI, 3.4 to 6.1)
Rognås *et al.* 2013[162]	683	Pre-hospital (intubation by experienced anesthesiologists)	Complication rates: 7% (1 attempt), 23% (2 attempts) and 32% (>2 attempts).
Sakles *et al.* 2013[170]	1,828	Emergency department	Adverse event rates: 14% (1 attempt), 47% (2 attempts), 64% (3 attempts), 71% (4 or more attempts). >1 attempt associated with adverse events (OR, 7.5; 95% CI, 5.9 to 9.6)
Kim *et al.* 2014[163]	512	Pre-hospital cardiac arrests	Failed initial attempt associated with reduced odds of return of spontaneous circulation (OR, 0.4; 95% CI, 0.23 to 0.71).
Goto *et al.* 2015[171]	4,094	Emergency department	Second attempt by same operator associated with lower success rate (OR, 0.50; 95% CI, 0.36 to 0.71).
Kerslake *et al.* 2015[44]	3,738	Emergency department	Complication rate: 7% (1 attempt), 15% (2 attempts), 32% (3 attempts).
Bodily *et al.* 2016[172]	166	Emergency department	>1 attempt associated with oxygen desaturation (OR, 3.4; 95% CI, 1.4 to 6.1).
Sauer *et al.* 2016[164]	308	Neonatal intensive care unit: neonates < 750 gm.	Multiple attempts associated with severe intraventricular hemorrhage (OR, 1.5; 95% CI, 1.1 to 2.1).
Lee *et al.* 2016[165]	2,080	Pediatric intensive care unit (NEAR4KIDS database)	Severe oxygen desaturation (defined as < 70%) 1 attempt: 12%; 2 attempts: 30% (OR, 3.1; 95% CI, 2.4 to 4.0); > 2 attempts: 44% (OR, 5.7; 95% CI, 4.3 to 7.5)
Fiadjoe *et al.* 2016[39]	1,018	Pediatric operating room (PeDI registry reported difficult intubation encounters)	Cumulative risk of complications: 1 attempt 13%; 2 attempts 31%; 3 attempts 53%. OR of a complication 1.5 per attempt (95% CI, 1.4 to 1.6).
Engelhardt *et al.* 2018[38]	31,024	Pediatric operating room	$\geq$ 3 attempts at tracheal intubation (RR,, 2.1; 95% CI 1.3 to 3.4) or SGA insertion (RR, 4.3; 95% CI, 1.9 to 9.9) associated with an increase in critical respiratory events.
Stinson *et al.* 2018[166]	1,448	Hospitalized pediatric patients	Failure of intubation or SGA insertion on 1st attempt associated with progression of acute respiratory compromise to cardiac arrest (OR, 1.8; 95% CI, 1.2 to 2.6).
Gálvez *et al.* 2019[186]	1,341	Infants: Operating room and diagnostic imaging	2 or more attempts associated with increased odds ratio of SpO_2 < 90% for at least one minute (OR, 1.78; 95% CI, 1.3 to 2.4).
Amalric *et al.* 2020[187]	202	Critical care	Complications occurred in 11% of those intubated on the first attempt; 32% with $\geq$ 2 attempts ($P < 0.001$).

CI = confidence interval; OR = odds ratio; RR = relative risk; SpO_2 = peripheral oxygen saturation by pulse oximetry

flow humidified device at 50–70 L·min^{-1} in adults; pediatric flows are weight-based.[188]

- A second attempt at tracheal intubation should address the likely cause of the previous unsuccessful attempt and not simply repeat a technique already shown to have failed. Examples include: 1) an unsuccessful intubation attempt due to poor view (e.g., Cormack-Lehane grade 2b or 3a [Table 2]) obtained with DL or Mac-VL might be managed on a second attempt by adjunctive use of a tracheal tube introducer ("bougie"); 2) a Cormack–Lehane grade 3b or 4 glottic view on a first attempt might be addressed on a second attempt by use of HA-VL to improve glottic exposure;[139,189] 3) unsuccessful tracheal intubation due to difficulty with tracheal tube passage through the glottis despite good laryngeal exposure on a first attempt with HA-VL might be addressed on a second attempt by using Mac-VL or DL to help straighten the pathway for tracheal tube delivery;[139,189] and 4) an inexperienced airway manager might have a more experienced airway manager perform a subsequent intubation attempt with the same or a different device.

- A third attempt should only be made with a substantive change of technique, device, or airway manager, and again, only if the patient remains well-oxygenated. If not already attempted, use of HA-VL and/or a FB should be considered, assuming that the device and a clinician skilled in its use is available.
- If the patient is still not tracheally intubated after a maximum of three attempts but ventilation and oxygenation continue to be non-problematic, the airway manager should verbally declare a "failed intubation" situation, call for help, and pause to consider exit strategy options. The verbal declaration (e.g., "This is a failed intubation situation—oxygenation is being maintained, but we will need help and must move on to doing something different") will help alert all team members to the evolving risk to the patient.
- Based on a first or second attempt, it may be evident that *any* further attempts at tracheal intubation are futile with standard or available methods, or in that airway manager's hands. Immediately pausing to think about exit strategy options would be appropriate.

7.3 Exit strategy options after failed tracheal intubation, with SpO_2 in a safe range

Once a failed tracheal intubation situation has been declared and help summoned, the airway manager should maintain patient ventilation and oxygenation (e.g., often with FMV, but optionally with an SGA), retain composure, and consider an appropriate exit strategy. If not already done, anterior neck landmarks should be assessed for the location of the cricothyroid membrane, in case eFONA becomes necessary. Exit strategy options include the following:

A. Awaken the patient

If feasible, when both ventilation and oxygenation are non-problematic, allowing the patient to emerge from general anesthesia after failed tracheal intubation may prevent deterioration to a CVCO scenario. Airway patency and gas exchange can be supported using FMV or an SGA until spontaneous ventilation resumes and the patient can maintain airway patency without assistance. The status of any neuromuscular blockade and sedative agents must be assessed and managed (e.g., with medications such as sugammadex,[190] naloxone, or flumazenil, as appropriate). Once a patient has emerged from general anesthesia, options include regional anesthesia, deferring elective surgery, or if the surgery is urgent, immediate awake oral/nasal tracheal intubation, or awake tracheotomy.

Awakening the patient after failed tracheal intubation in the context of a surgical emergency or critical illness (as with most emergency department or critical care intubations) might not be possible or appropriate, as the patient's clinical trajectory with deteriorating course over time may preclude a return to a functional respiratory or cognitive state. In this case, other exit strategy options should be considered.

B. Temporize with an SGA

An SGA can be placed after failed tracheal intubation to temporize (e.g., pending the arrival of additional equipment or expertise) or to support the airway while the patient emerges from general anesthesia. In general, when tracheal intubation was the intended technique for an elective surgical case but has failed, proceeding with the case using only the SGA is inadvisable.[3] This follows from the trauma and swelling to the larynx that may have occurred with the preceding attempts at tracheal intubation. Also, if subsequent intraoperative SGA malfunction occurs, the fallback option of tracheal intubation has already proven to have failed. Nevertheless, in certain contexts (e.g., emergency Cesarean delivery [CD]), the potential benefit of proceeding with a surgical procedure with an SGA after failed tracheal intubation may exceed the risk, although the risk of aspiration must be considered. A second-generation SGA should be used (ideally one that also supports FB-guided intubation) and a plan for intraoperative SGA failure should be considered.

The critically ill non-surgical patient successfully temporized by SGA or FMV after failed tracheal intubation will likely still require timely tracheal intubation (see next section) or FONA.

C. Proceed with a further attempt at tracheal intubation

Pausing to consider exit strategy options after a maximum of three attempts at tracheal intubation helps to both avoid perseveration with failed techniques and maintain situational awareness. It does *not* absolutely preclude another attempt at tracheal intubation. Nevertheless, a further intubation attempt should only be considered as an exit strategy option with the following provisos: 1) ventilation and oxygenation by FMV or an SGA remain non-problematic; 2) the patient has already undergone prior attempts at tracheal intubation and the larynx may have been subjected to trauma, so an exit strategy intubation should be limited to a single attempt by an airway manager experienced with the planned technique; 3) the planned technique should have a high likelihood of addressing the anatomic constraints that contributed to the earlier failure(s); and 4) a second airway manager should be present. The intubation technique is chosen according to clinical judgement. Nevertheless, if not already attempted, an FB can often prove effective, used on its own or in conjunction with another device:

- **Flexible bronchoscope use on its own**: When used on its own, an intubating oropharyngeal airway[48] (e.g., Williams, Berman, or Ovassapian) can aid with FB intubation in the unconscious patient. Manual tongue extraction or a jaw thrust by a second individual can enhance the pharyngeal space for FB navigation and optimize apneic oxygenation.
- **Flexible bronchoscope-guided intubation through an SGA**: This technique has a high success rate in experienced hands and should ideally proceed through an SGA designed to support tracheal intubation.[191] It can also occur through non-intubating SGAs using an Aintree intubation catheter (Cook Inc., Bloomington, IN, USA) as an airway adjunct.[192]
- **Flexible bronchoscope used in combination with VL**: This is an effective combination,[48,193–195] with each device working synergistically to address the limitations of the other. Once well advanced into the trachea, the FB acts as an extended flexible stylet to facilitate tracheal intubation, addressing the issue of difficult tracheal tube delivery with HA-VL used on its own. Similarly, the VL controls collapsing soft tissues in the anesthetized patient to create a patent pharyngeal conduit through which to advance the FB, and also enables visualization of tracheal tube passage through the larynx over the FB. Using both devices together may increase success more than using either device alone, but it does require practice in co-ordinating the tasks of two airway managers—i.e., one to maintain a stable VL view while another manages the FB. Apneic oxygenation should be used throughout.

A successful exit strategy tracheal *intubation* should prompt the airway manager to carefully consider a safe tracheal *extubation* strategy (see companion article).[8] Conversely, failure of an exit strategy tracheal intubation attempt should prompt re-consideration of other exit strategy options, including awakening the patient, temporizing with an SGA, or proceeding to FONA.

D. Front-of-neck (surgical) airway access

Although very rarely indicated in the still-oxygenated elective surgical patient, this option may be appropriate after failed tracheal intubation of a critically ill patient, or for the patient requiring emergency surgery. Patient ventilation and oxygenation may be maintained by FMV or an SGA while FONA is performed by cricothyrotomy or tracheotomy.

7.4 The "cannot ventilate, cannot oxygenate" situation

The CVCO situation is defined as the failure of tracheal intubation, face-mask-, and SGA ventilation (cannot ventilate), resulting in current or imminent hypoxemia (cannot oxygenate). Thus, in the context of tracheal intubation, this means that one or more intubation attempts has failed *and,* despite fallback attempts at ventilating and oxygenating the patient by optimized FMV and SGA ventilation, the patient is:

- *Currently hypoxemic* (e.g., SpO_2 is $< 90\%$)
- *Imminently hypoxemic* (SpO_2 is currently $\geq 90\%$—e.g., because of pre-oxygenation or the use of apneic oxygenation—but an absent or severely attenuated waveform capnograph for all of tracheal intubation, FMV, and SGA use has indicated a "can't ventilate" situation, so that hypoxemia will likely rapidly follow).

Depicted on the right-hand side of the Figure, the CVCO situation should be managed according to the following guiding principles:

- Once recognized, the CVCO situation should be verbally declared (e.g., "This is a can't ventilate, can't oxygenate situation and we need to perform a cricothyrotomy immediately") and eFONA should proceed without delay. It is worth emphasizing that it is not desirable to allow hypoxemia to occur before transitioning to eFONA when hypoxemia is a predictable consequence of the "cannot ventilate" situation. Successfully performing eFONA before severe or prolonged hypoxemia has occurred in a CVCO situation will maximize the possibility of a good outcome.
- Help should be summoned.
- Equipment for eFONA should be obtained, the anterior neck quickly landmarked and the most qualified person *already present* should be delegated to perform eFONA.

Concurrent with the foregoing preparations for beginning eFONA, neuromuscular blockade should be confirmed or established, especially if tracheal intubation had proceeded with succinylcholine or without neuromuscular blockade. FMV generally gets easier with the onset of neuromuscular blockade or, at worst, remains unchanged.[77,196–199] It may also facilitate SGA placement and performing eFONA. In addition to neuromuscular blockade, a single attempt at any or all of the following should be made, *if not yet attempted:*

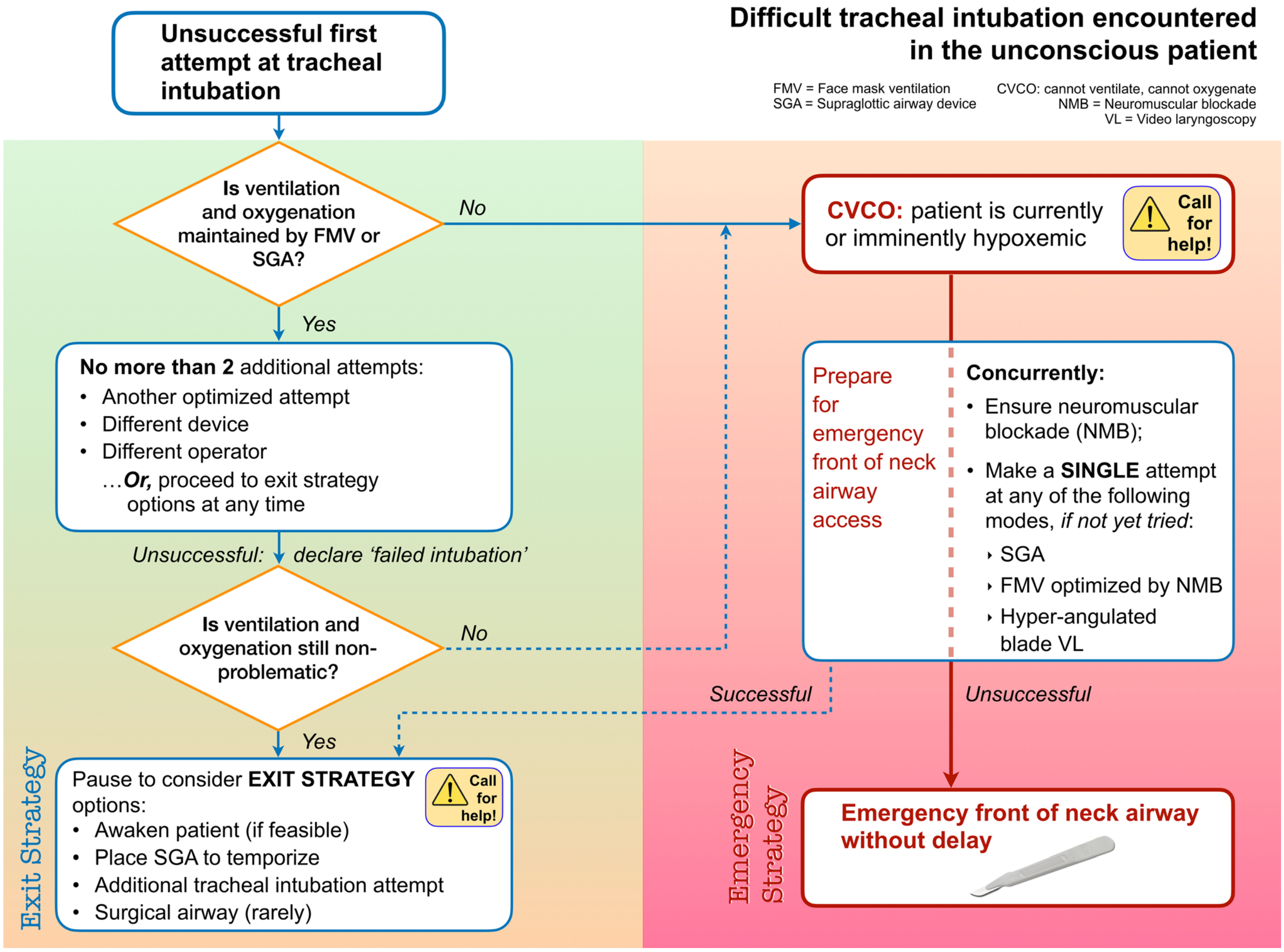

FIGURE Flow diagram: difficult tracheal intubation encountered in the unconscious patient

- Placement of an SGA. A number of reports have indicated that an attempt at SGA placement was often overlooked prior to performing eFONA.[3,68]
- Two-handed FMV with an oropharyngeal airway, facilitated by neuromuscular blockade.
- Video laryngoscopic tracheal intubation, if not already attempted. The CAFG is of the opinion that an attempt at tracheal intubation facilitated by HA-VL should ideally have occurred prior to eFONA. Notwithstanding, in an already hypoxemic patient, this option implies that the video laryngoscope is already present, so that the attempt will not substantively delay the onset of eFONA, if unsuccessful.

If adequate oxygenation is restored with any of the foregoing, eFONA is not immediately required and the airway manager can now consider exit strategy options (FIGURE). Conversely, if the foregoing options have failed, then eFONA should proceed without delay (see next section).

The ASA Closed Claims[1] and NAP4[3] studies describe airway manager delay in the recognition of an evolving CVCO emergency as a major contributor to brain damage and death. While some CVCO situations may be immediately evident (e.g., cannot ventilate, currently hypoxemic), others may occur over time, making their recognition more challenging for those managing the patient ("change blindness").[200,201] Thus, all team members should be explicitly empowered to say when they believe a trigger for declaring a CVCO situation has occurred. Multidisciplinary simulation exercises can help identify and break down barriers to having any team member speak up in such situations.[202,203] Although infrequent, CVCO emergencies are often unanticipated and can occur in otherwise healthy patients (e.g., those presenting for elective surgery). Therefore, all airway managers should regularly practice their skills in eFONA to maintain competence in the procedure.

7.5 Emergency FONA

While surgeons familiar with the technique may prefer to perform rapid tracheotomy in the CVCO situation,[204] in the hands of non-surgeon clinicians, and because of anatomic advantages in adult patients, eFONA should generally proceed via the cricothyroid space. For its simplicity, ease of equipment stocking, generalizability to different airway manager types, and emerging evidence of first-pass success in various settings,[205,206] the CAFG recommends a scalpel-bougie-tube approach for cricothyrotomy. If feasible, the neck should be fully extended. The location of the cricothyroid membrane (CTM) itself may be difficult to identify by external palpation in some patients,[207] so the CAFG recommends beginning cricothyrotomy with an initial 4–6 cm longitudinal incision over the estimated location of the midline of the larynx in all adult patients. Identifying the laryngeal cartilage and its midline may be aided by a "laryngeal handshake" (i.e., moving the laryngeal cartilage from side to side while attempting to palpate the cricothyroid space).[208] Following the longitudinal incision, re-palpation within the wound will allow more accurate identification of the CTM. A transverse incision is made through the CTM, then access to the opened trachea is maintained with the airway manager's finger or the scalpel blade turned into a cephalad-caudad orientation. The bougie is passed into the trachea behind the placeholder finger or alongside the blade, then with finger or blade removed, a 6.0-mm internal diameter cuffed tube (adult patient) is advanced over the bougie. The cuff is inflated and correct tube location confirmed. The CAFG recommends stocking the following equipment at every airway management location: disposable scalpel (#10, 20, or 21 blade), a bougie, and a 6.0 tracheal tube (for adult hospitals), all packaged together. Size-based pediatric equipment should be readily available in pediatric facilities. Pediatric eFONA options are discussed in section 11.6.

False passage of a bougie or tracheal tube can occur during cricothyrotomy or tracheotomy, so correct tube placement must be confirmed by waveform capnography. A flat trace should be considered to represent a mal-positioned tracheal tube until proven otherwise and must *not* be attributed to hypoxemic cardiac arrest.[3,209]

8 Supraglottic airway use as the intended technique

Similar considerations to those appearing in section 7 on tracheal intubation apply to the use of an SGA as the intended airway management technique.

8.1 Unsuccessful first attempt at SGA use with SpO_2 in a safe range

If SGA placement and ventilation is unsuccessful on the first attempt, provided patient oxygenation remains non-problematic, the following recommendations apply:

- Further attempts at SGA insertion can be made but should involve doing something different than what has already failed. Troubleshooting options for further attempts appear in Table 5. Ventilation through a successfully placed SGA is likely optimized with the head and neck in a neutral position.[210]
- Multiple SGA insertion attempts also involve the potential for trauma;[38,166] although less data underscores the recommendation, attempts at SGA insertion should be limited.
- After a maximum of three unsuccessful SGA attempts, SGA failure should be declared, and the airway manager should move to SGA exit strategy options. Exit strategy options might be considered after fewer attempts when SGA failure has occurred after failed tracheal intubation.

8.2 Exit strategy options after failed SGA use, with SpO_2 in a safe range

Once a failed SGA situation has been determined and declared, provided patient ventilation and oxygenation remain non-problematic with FMV, the following exit strategy options can be considered:

- **Proceed with tracheal intubation:** Proceeding with tracheal intubation is often prudent after the failure of SGA placement or use. If not already administered during SGA troubleshooting, laryngoscopy and intubation should be facilitated by NMB.
- **Temporize, or proceed with FMV**: As long as it remains effective, FMV can be maintained pending the preparation of additional equipment (e.g., for tracheal intubation), arrival of additional expertise, or until the patient's emergence from general anesthesia. Alternatively, a short surgical case could be completed with FMV, if appropriate. Attention should be directed towards maximizing upper airway patency during FMV and minimizing delivery airway pressure, to help limit gastric insufflation.
- **Awakening the patient:** As with failed tracheal intubation, awakening the patient is an option after failed SGA use in the adequately oxygenated patient. This option is especially recommended if tracheal intubation is anticipated to be difficult or suspected trauma had already occurred with SGA insertion

attempts. Conversely, when intended SGA use fails in the arrested or critically ill patient, awakening the patient will not be an option - temporizing with FMV, tracheal intubation or, rarely, FONA will be the only available exit strategies.

8.3 Failed SGA use with current or imminent hypoxemia

When SGA ventilation has failed, if both tracheal intubation and FMV are also unsuccessful, then a CVCO situation exists. Neuromuscular blockade should be ensured. Management of the CVCO situation should proceed according to the foregoing description in sections 7.4 and 7.5.

9 Confirmation of tracheal intubation and continuous waveform capnography

The CAFG advocates continuous waveform capnography as the gold standard for confirming correct tracheal tube placement. Waveform capnography has excellent sensitivity and specificity (Table 10) and is widely available. Pattern recognition of capnographic waveforms can easily be learned.[211] For tracheal intubation by nasal, oral or front-of-neck routes, assessment of multiple sustained amplitude waveforms[212] are required to conclude the tracheal tube is correctly positioned and to avoid false positive results (e.g., CO_2 detection with esophageal intubation).

Waveform capnography should also be routinely used to confirm effective ventilation by face-mask[15,71] or SGA.[213] Capnography will generally provide earlier feedback on their effectiveness than changes in SpO_2.

Effectiveness of chest compressions as well as return of spontaneous circulation during cardiopulmonary resuscitation can also be assessed using waveform capnography. The 2015 American Heart Association guidelines for cardiopulmonary resuscitation in adults recommends waveform capnography as "the most reliable method of confirming and monitoring correct placement of an ETT" during cardiac arrest.[214] After cardiac arrest, CO_2 detectable by waveform capnography is likely to persist for at least 30 min,[215] although the waveform will be attenuated. In this context, a flat capnograph must not be ascribed to the absence of pulmonary perfusion—rather, esophageal intubation or false passage must be excluded ("no trace = wrong place").[209]

Colorimetric capnometry is less specific than waveform capnography, with additional causes of a false positive result (Table 10). It may have a role if waveform capnography is not available. Other modes of tracheal tube confirmation together with their potential pitfalls, sensitivities, and specificities are presented in Table 10.

The CAFG recommends the routine use of waveform capnography with at least one other method to confirm successful tracheal intubation. To help direct the airway manager's attention to the need for objective confirmation, we recommend routinely making a verbal declaration such as "sustained CO_2 confirmed" or "good trace, right place" once success has been determined.[209,216] Finally, the CAFG recommends ongoing waveform capnography monitoring in all intubated patients, in all hospital locations, including within-hospital transportation.

10 The obstetric patient—special considerations

Many studies continue to indicate a higher risk of failed tracheal intubation in the parturient than in the general surgical population,[35,37,51,249,250] although this has been challenged by other studies.[36,251] Regardless, other patient and contextual factors amplify difficulty. The parturient can be physiologically unforgiving, the need for out-of-hours emergency work common, and the obstetrical suite can be isolated from access to difficult airway equipment or additional expertise.

Obstetrical suites should be well-equipped with difficult airway equipment including, but not limited to, second-generation SGAs, video laryngoscopes, a FB, and equipment for cricothyrotomy.[181] As rates of regional anesthesia for CD continue to be high,[36,252] trainees and attending staff with significant exposure to obstetrical practice must make the effort to attain and maintain competence in difficult airway techniques.

Antenatal airway screening of all obstetrical patients should ideally occur with multidisciplinary consultation when indicated.[253,254] Should a parturient possess a non-reassuring airway, early epidural catheter placement and testing should occur during labour. If CD under general anesthesia is required, the airway should be re-assessed, recognizing the dynamic nature of the airway during labour.[253,255] Landmarking neck anatomy including the cricothyroid space by external palpation is particularly challenging in this population; ultrasound has proven useful.[256,257]

For CD under general anesthesia, the patient should be positioned optimally and pre-oxygenation undertaken with a tightly fitting face mask with a standard flow of 15 L min^{-1}. Evidence for the benefit of high-flow nasal oxygen (HFNO) therapy for the obstetric patient is mixed. It is less effective than a tightly applied face mask for pre-oxygenation[258–260] but may provide benefit during

Table 10 Modes of confirmation of tracheal intubation, with test sensitivities, specificities and select causes of false negative and false positive results

Confirmation of tracheal intubation				
Method	Published sensitivity range, if available (percentage of tracheal intubations correctly identified by a positive test result)	Published specificity range, if available (percentage of esophageal intubations correctly identified by a negative test result)	Select causes of a false negative result (tube is in trachea, but a negative test result suggests it is in the esophagus)	Select causes of a false positive result (tube is in esophagus or pharynx, but a positive test result suggests it is in the trachea)
Waveform capnography	98–100% (non-arrest)[212,217–223] 68% (arrest)[217]	100% (non-arrest)[212,217–221] 100% (arrest)[217]	• Equipment malfunction or disconnect • Severe bronchospasm • Kinked or occluded tube • Tracheal obstruction • Tracheal tube cuff not inflated • Obstruction of pulmonary circulation	• Failure to assess for sustained waveforms • Tube lying in pharynx outside larynx (e.g., cuff above the cords) • Recent extensive use of FMV or bi-level positive airway pressure non-invasive ventilation[222] • Ingestion of antacid or carbonated beverages
Colorimetric capnometry	97–100% (non- arrest)[220,223–225] 69–85% (arrest)[223,225,226]	91–100% (non-arrest)[220,223,224] 100% (arrest)[223,226]	As above, plus: • Low cardiac output/severe hypotension • $ETCO_2 < 2–5\%$ • Neonates and infants[227]	As above, plus: • Contamination of detector with acidic gastric contents;[228] • Recent instillation of medications through the tracheal tube including epinephrine, atropine, surfactant,[229] naloxone.
Visualization of tracheal tube between cords	No data	No data	• Adverse patient anatomy precludes a view of any aspect of the larynx during DL or Mac-VL	• "Glottic impersonation": entrance to hypopharynx is misinterpreted as the larynx during excess lifting pressure on laryngoscope[230] • Inadvertent intubation of a tracheoesophageal fisutla[231,232]
Endoscopic visualization of trachea through tracheal tube	No data	No data	• Visualization obscured by blood, secretions or aspirated gastric contents • Scope fogging	No data
Ultrasound	92–99%[233–236]	93–100%[233–236]	• Image misinterpretation by inexperienced clinician	• Image misinterpretation by inexperienced clinician
Auscultation	70–100%[217–219,221,237,238]	50–95%[217–219,221,237,238]	• Poor quality stethoscope • Noisy environment • Thick chest & abdominal walls • Severe bronchospasm	• Thin chest/abdominal wall • Transmitted sounds • Expectation bias
Esophageal detector device	83–100%[217,239–246]	92–100%[217,239–246]	• Obesity (BMI > 35) • Parturients at induction of general anesthesia • < 10 kg • Bronchospasm; mainstem intubation • Tube occluded by pulmonary edema, mucus plug or blood	• Significant recent FMV or SGA ventilation • Bulb filling with emesis rather than gas.
Tube misting	100%[237,247,248]	15–71%[237,247,248]	No data	• The esophagus is also a moist environment.

BMI = body mass index; DL = direct laryngoscopy; $ETCO_2$ = end-tidal carbon dioxide; FMV = face-mask ventilation; Mac-VL = Macintosh geometry blade video laryngoscopy; SGA = supraglottic airway

apnea[261] and laryngoscopy (provided airway patency is maintained). With potential benefit and minimal downside, apneic oxygenation with HFNO or standard nasal cannulae at flows of 5–15 L min^{-1} is recommended during apnea for the parturient undergoing general anesthesia. Cricoid pressure should be applied by a trained individual. After general anesthesia induction, gentle FMV (e.g., keeping positive inspiratory pressure < 20 cm H_2O) is recommended while awaiting the onset of neuromuscular blockade to help extend the safe apnea time during subsequent laryngoscopy.[181] The CAFG recommends the primary use of VL to facilitate tracheal intubation of the parturient.

10.1 Unsuccessful first attempt at tracheal intubation in the parturient

An unsuccessful optimized attempt at tracheal intubation in the parturient should be transitioned rapidly to FMV or SGA insertion. Help should be enlisted. Cricoid pressure should be released if thought to be contributing to difficulty. If face-mask- or SGA ventilation is successful and adequate patient oxygenation is maintained, a second attempt at tracheal intubation can be made with a different device or by a more experienced airway manager. The use of VL has been reported to be effective after failed DL in the parturient.[37,262] If the second attempt is unsuccessful, a failed tracheal intubation situation should be declared and exit strategy options considered. This is one fewer attempt than might be considered for the non-parturient, reflecting the parturient's adverse physiology.

10.2 Failed tracheal intubation in the parturient with SpO_2 in a safe range—exit strategy options

Having verbally declared the failed intubation situation, the airway manager should maintain oxygenation by face-mask- or SGA ventilation while considering exit strategy options. Help should be sought, if available. Further actions are predicated on the status of the mother and the fetus.

- **No fetal or maternal distress:** If the situation is stable without maternal or fetal emergency, the mother can be allowed to emerge from general anesthesia. Once awake, use of regional anesthesia can be revisited if not contraindicated, or awake tracheal intubation can be performed.
- **Fetal or maternal distress exists:** If the situation is unstable with either fetal or maternal emergency, an SGA should be placed (if not already done) to enable CD or maternal resuscitation to proceed. Cricoid pressure should be released. For CD while using an SGA, a generous surgical incision should be made, minimal fundal pressure applied, and vacuum extraction considered, as necessary.[263] Early use of an SGA in a rescue scenario is accepted practice in the parturient, with success rates reported to be between 86 and 100%.[37,51,250] In a review of 45 years of obstetric airway management in the United Kingdom, there was a steady, decade-over-decade increase in continuing with CD using SGAs after failed tracheal intubation, coinciding with their increasing use as rescue devices.[51] A second-generation SGA with an esophageal drainage port should be used, optimally incorporating a wide-diameter conduit to support FB-aided tracheal intubation, if chosen. When feasible, a suction catheter can be advanced down the drainage port to help drain the esophagus of any gastric contents. The catheter should be removed after suctioning is completed.

Once the fetus has been delivered or the maternal emergency stabilized, whether to complete the case using the SGA or to secure the airway by tracheal intubation before proceeding should be based on the context of the patient's body mass index, fasting status, and predicted surgical complexity and duration. Currently, there is no evidence to support or refute continuing with the case with a well-functioning SGA. Use of an SGA to complete CD after failed tracheal intubation is supported by studies of the elective use of SGAs for CD under general anesthesia rather than tracheal intubation. Most such studies originate from outside North America, in countries where general anesthesia is more commonly used for CD and the population may be of lower average body mass index.[58–60,264] With most using second-generation SGAs, the studies indicate a high success rate and minimal occurrence of gastric content aspiration.[265] Notwithstanding, the CAFG does not currently espouse SGA use for elective CD. This position might change as the role of ultrasound in assessing gastric contents and aspiration risk becomes more understood.[265]

10.3 "Cannot ventilate, cannot oxygenate" in the parturient

The CVCO scenario in the parturient is also defined as failed tracheal intubation not rescued by attempts at both face-mask- or SGA ventilation, with current or imminent hypoxemia. Maternal oxygen desaturation is likely to occur rapidly, leading to fetal compromise and precluding maternal emergence from general anesthesia. Thus, cricothyrotomy must occur without delay. Once correct placement of a cuffed tracheal tube placed via cricothyrotomy is confirmed, CD can proceed.

10.4 Tracheal extubation and the postpartum period

Maternal mortality data from both the USA and UK indicate that many of the reported obstetric-related airway catastrophes occurred during the postpartum period—i.e., at emergence after CD, in the postanesthesia care unit, or during postpartum surgical procedures (e.g., postpartum hemorrhage).[266,267] Vigilance during these phases is thus paramount.

11 The pediatric patient—special considerations

Respiratory events are the most common cause of adverse events during pediatric anesthesia.[268] These complications are age dependent, with neonates and infants being at highest risk. Elective management of patients < 12 months of age with a known or suspected difficult airway should occur in a specialized centre, when feasible.[269]

Young children are predisposed to adverse respiratory events during airway management because of their high metabolic demand and relatively small respiratory reserve. Resulting short apnea times can lead to hypoxemia, bradycardia, and cardiac arrest.[39] Supplementary oxygen before and during tracheal intubation is recommended to reduce the risk of hypoxemia. Options include HFNO[270] or oxygen applied buccally, via a laryngoscope, or through an advancing tracheal tube.

Airway assessment tools have not been validated in small children, but micrognathia, microstomia, macroglossia, and evidence of temporomandibular joint dysfunction are suggestive of airway management difficulty. Asthma, wheezing, upper respiratory tract infections, snoring, and smoking exposure are associated with critical respiratory events regardless of the airway device used.

11.1 Pediatric airway obstruction

Help should be summoned and poor head/neck position, nasal/oral obstruction, secretions, foreign material, atelectasis, and gastric distension should be considered and treated promptly. Pharmacologic treatment should be employed for laryngospasm, bronchospasm, opioid-mediated rigidity, and light anesthesia.

11.2 Pediatric FMV

The incidence of difficult FMV (albeit with varying definitions) in children has been reported to be between 6.6 and 9.5%.[25,26] Impossible FMV is less common, with only six occurrences reported in 1,018 pediatric difficult intubation registry cases.[39]

11.3 Pediatric SGAs

Pediatric SGAs have significantly improved in recent years.[271] Fewer adverse respiratory events have been described with SGA use for infant airway management compared with tracheal intubation. Neonatal resuscitation with SGAs can result in fewer neonatal intensive care unit admissions and superior resuscitation rates compared with FMV and tracheal intubation.

11.4 Pediatric flexible bronchoscopy through a conduit

Performing FB intubation through an SGA is particularly useful for difficult infant airways, compared with VL.[272] Supraglottic airways for this purpose should have a wide inlet, a short ventilation tube and should facilitate a good bronchoscopic view of the glottis. They should also allow for easy withdrawal of the SGA. The air-Q ILA™, (Cookgas® LLC, Mercury Medical, Clearwater, FL, USA) has shown comparatively higher airway leak pressures and superior flexible bronchoscopic views of the glottis than the LMA Unique (Teleflex, Inc., Wayne, PA, USA) in pediatric patients.[273]

11.5 Pediatric tracheal intubation

In a multicentre pediatric difficult intubation registry, easy tracheal intubation by an anesthesiologist occurred in up to 99.8% of pediatric cases.[39] Of the remaining cases that proved difficult, 20% had an airway-related complication. Risk factors for complications included $\geq$ two intubation attempts, weight < 2 kg, a short thyromental distance, and multiple DL attempts.[39] The CAFG recommends limiting DL attempts to two and rapidly transitioning to a FB or VL. When used after failed DL, a FB was successful in 54% of cases and VL succeeded in 55%. Cuffed tracheal tubes are recommended for all children > 3 kg, with appropriate care to avoid cuff overinflation.[274]

11.6 Pediatric eFONA

Employing eFONA through the CTM in a neonate or infant is not feasible or recommended. At this age, the CTM is underdeveloped and difficult to landmark; the cartilages are also fragile and susceptible to injury. An open tracheotomy is preferred if an individual with the skills is present. Needle tracheotomy is an alternative, although one animal study suggests a low success rate and significant risk of tracheal compression by the advancing needle.[275] If needle cricothyrotomy is used, ventilation should ideally proceed using a Ventrain device (Ventinova Medical, Eindhoven, Netherlands).[276,277] For older children (i.e., > 8–12 yr), the scalpel-bougie technique can be used via the CTM. There is no evidence that cricothyrotomy kits are superior to a scalpel cricothyrotomy technique.

12 Tracheal extubation of the at-risk airway

Tracheal extubation is an elective procedure and is addressed further in the companion article[8].

13 Human factors in airway management

The term "difficult airway" typically relates to patient anatomy or physiology that adversely affects ease of airway management. Difficulty can also arise from how an airway manager and the assembled team performs during challenging airway management. This can sometimes be impacted by suboptimal organizational culture. Human factor issues have been reported to be contributory in 40–100% of airway management-related adverse outcomes.[1,278]

Many human factor issues occurring during airway management relate to dysfunctional team dynamics. These are characterized by poor communication, inadequate leadership, and the lack of a shared mental model.[279] *In situ* multidisciplinary training improves team dynamics but is still not commonly done.[280] Checklists can improve communication, help ensure equipment availability, and aid in team briefing.[281–283] While the published evidence for tracheal intubation checklists has not shown decreased mortality, outcomes such as hypoxemia may be reduced.[284]

Human factor issues that may impact airway management and their potential mitigation strategies are presented in Table 11. The published evidence base regarding these factors continues to evolve.

14 Airway leads and quality assurance

The CAFG recommends designating an individual as departmental or hospital "airway lead" to help adopt or develop difficult airway protocols, recommend difficult airway equipment, and ensure equipment standardization across hospital locations.[3,288] The airway lead or a multidisciplinary airway committee can also help organize training events and assist in airway-related quality assurance by debriefing critical incidents or near-events. Debriefing can provide opportunities to share concerns but also to help reinforce what went well. It is important that such quality assurance occurs using an objective "just culture" model, focusing more on organizational learning and less on the role of any one individual in the event.

15 Documentation

All airway management events should be documented in the patient's paper or electronic medical record (EMR). Previously documented difficult or failed tracheal intubation is a robust predictor of subsequent difficulty.[289] In general, the airway technique used should be recorded, together with optimizing maneuvers or adjuncts used, view obtained, number of attempts, details of any challenges encountered as well as how they were resolved. Major (e.g., significant hypoxemia, hypotension, cardiac arrest) and minor (e.g., mucosal bleeding, dental injury) complications should be recorded. Suggestions for future airway management should also be recorded.

If performed, ease of FMV must always be recorded (e.g., with a mandatory field in an EMR). This is crucial information to help guide future planning for airway management.

The airway manager should personally inform the patient after a significantly difficult airway encounter and provide a written letter describing the difficulty and how it was resolved. Copies of the letter should be added to the patient's medical record and forwarded to the patient's primary care physician. The patient should be flagged as having a potentially difficult airway during subsequent hospital admissions, including use of in-hospital alert bracelets. Difficult airway information should also be submitted to local or national difficult airway databases, if available (e.g., www.medicalert.org/everybody/difficult-airwayintubation-registry). In addition, using a robust incident reporting system will help address system-wide patient safety and quality of care issues.[290]

In the future, it may be possible to routinely add photos or recordings of VL to the EMR, or for the patient to use secure, app-based technology to store or access their own airway-related information.[291]

16 Airway management education

Routine clinical practice may not be sufficient to maintain airway management skills. Performing a scalpel-bougie aided cricothyrotomy in a CVCO situation is a rare, yet high acuity event. Successfully performing such infrequently used skills requires deliberate practice, characterized by regular learning opportunities in a simulation environment that incorporates clear goals, focuses on technique, and provides timely expert feedback.[292–295] This option is safe for the learner, teacher, and patient. Mistakes can be corrected through coaching, and procedures can be simulated repetitively and interrupted for immediate feedback. As competence and comfort with a skill such as cricothyrotomy increases, the airway manager is more likely to consider its use as part of a plan rather than symbolic of a failure of the plan.

Valuable lessons in airway management can also occur through experiential learning in the OR. Nevertheless, the experience that develops over years is not necessarily equivalent to expertise. Expertise is gained by exposure to difficult airways, with learners pushing themselves to manage increasingly difficult experiences.[294] Learning is

Table 11 Human factor-related issues in airway management, with potential mitigating strategies

Potential human factor-related issues that may occur during management of the difficult airway in the unconscious patient, with mitigation strategies			
Issue	Possible mitigation strategies:		
	by the airway manager	by the assembled team	by the organization
Calling for help: The airway manager might overlook calling for help when difficulty occurs.	• Have personal triggers for calling for help, e.g., (1) whenever you *first* contemplate it; (2) failed intubation or failed SGA insertion after a maximum of 3 attempts or (3) a CVCO situation. • Recognize that a helper can provide hands for tasks, so that the airway manager can concentrate on the "big picture" and reduce their stress level. • Consider making a habit of asking a colleague to physically stand by when inducing a patient with *anticipated* airway risk.	• Strongly consider physically attending any request for backup, even if phrased as a "heads-up". • A helper should announce their arrival by asking "How can I help?" • Any team member should be empowered to call for help, bring in equipment, or call a code blue independently.	• All departments should foster a culture of calling for help. • During team training, e.g., during *in situ* simulation sessions, requesting help should always be debriefed as a critical action.
Loss of "situation awareness." During an airway crisis, it can be difficult to correctly receive and process incoming information. This will impair diagnosis and decision-making and may promote inappropriate fixation on a single familiar but ineffective technique (perseveration).[285]	• Maintaining situation awareness involves long-term memory content, which may be difficult to access during a critical event. Help from other staff provides the airway manager with additional processing capacity for integration of basic information.[285,286] • Call for help after 3 failed attempts at the intended technique: a fresh pair of eyes will help interrupt perseveration. Be alert for the "change blindness"[200,201] that can occur when a critical airway event evolves over time. A newly arrived helper may better be able to see the obvious. • Use difficult airway techniques in day-to-day routine practice (e.g., the combination of VL and FB) so that their use is practiced, and so that you think of them when in difficulty.	• Perform a team briefing before embarking on all airway management. Include specific mention of triggers for moving from one plan to the next and empower all team members to speak up once they feel a trigger has occurred. • Team members should be trained in the interpretation of waveform capnography and pulse oximetry and should be empowered to declare when waveform capnography is non-reassuring or the SpO_2 is decreasing. • Ensure all team members have been empowered to suggest using an SGA for rescue or CVCO at any time and that they know the equipment's location.	• Mandate adherence to a standard operating procedure for the difficult airway by using an algorithm or cognitive aid based on the algorithm. • Facilitate multidisciplinary *in situ* team simulation to practice using the algorithm or cognitive aid for difficult airway scenarios. A major objective during such sessions is to encourage and empower all team members to speak up. • Airway workshops should include education on non-technical as well as technical skills. Common cognitive errors should be addressed.
Fear. Faced with a hypoxemic patient, the airway manager might experience a maladaptive sympathetic response. This might include fight (e.g., arguing with team members); flight (e.g., disbelief of patient vital signs) or freeze (e.g., not performing eFONA when indicated).	• Call for help early in any evolving airway event. Not being emotionally invested, a newly arrived colleague might possess better situation awareness. • Have a strategy (a coordinated series of plans) for encountering difficulty in *all* patients, whether predicted or not. Moving smoothly and deliberately through the steps of a pre-planned strategy will help keep you in control of yourself as well as the situation. Mentally rehearse the strategy on a regular basis.	• During an airway crisis, team members must recognize that the airway manager who induced the patient is deeply emotionally invested. They might be experiencing a profound sympathetic response, compromising thinking or motor skills. Any team member should call for help if they feel it is in the best interest of the patient. • Once qualified help arrives, the initial airway manager should consider moving to a supportive role on the team, providing information and suggestions.	• High acuity but rare events such as CVCO should be "overlearned" during simulation sessions.[286] This will help demystify them and make their management more routine in clinicians' minds.
Barriers to use of eFONA can include not knowing which procedure to employ ("device confusion"), lack of confidence in one's ability to perform the procedure, or a "freeze" response to fear. The reluctance to act may manifest by insisting a surgeon or better qualified person be called to perform eFONA.	• By training in eFONA, all airway managers must be prepared to proceed with eFONA themselves. • Deliberately practice eFONA on a part-task trainer at least twice a year. • When encountering difficulty, follow the department's recommended algorithm or cognitive aid.	• Team performance in rare emergencies such as CVCO benefits from *in situ* simulation. • Swapping team roles during simulation sessions may reveal latent errors in communication and equipment.	• The organization should ensure that all airway managers are trained in and prepared to perform eFONA. • Minimize choices to a single technique for high-stress procedures such as eFONA (e.g., scalpel-bougie-tube for the adult patient). • Make task trainers easily accessible for individual clinician eFONA practice. This can include 3D-printed models of the larynx.

Table 11 continued

Potential human factor-related issues that may occur during management of the difficult airway in the unconscious patient, with mitigation strategies

Issue	Possible mitigation strategies: by the airway manager	by the assembled team	by the organization
CRM during an airway event	• Avoid use of vague language, such as "we should…", "somebody…" • Delegate specific tasks by name. • Use 3-step "closed loop" communication:[287] (a) Transmit message to receiver, by name. (b) Receiver to verbally acknowledge message. (c) Transmitter verifies with the receiver that the message has been received and correctly understood. • Listen to suggestions or observations from anyone present, regardless of (perceived) hierarchy. • Help avoid detrimental task fixation (e.g., on tracheal intubation) by delegating an individual to monitor the overall clinical situation or to look after other aspects of a resuscitation.	• All team members should practice graded assertiveness, when indicated, e.g., by use of the "PACE" mnemonic: *Probe* to see if others are aware of an issue the team member has identified. *Alert* others of the problem. *Challenge* the current action if necessary, or to seek clarification. *Emergency*; give explicit instruction, e.g., "you must do a surgical airway now". • Passage of time during an airway crisis can appear distorted. A team member should be tasked with keeping the rest of the team appraised. • A flat hierarchy between colleagues or a (perceived) hierarchy between members of different professions can both be problematic. Roles should be respectfully clarified by either party. • Avoid assumptions: the loudest voice is not necessarily the most knowledgeable.	• Train airway managers in the relevant principles of CRM. • Train all team members to use "PACE" (or similar) graded assertiveness prompts during multidisciplinary simulation sessions. • Wear name tags in locations where team members are likely to not know each other (e.g., a trauma code).

CRM = crisis resource management; CVCO = "cannot ventilate, cannot oxygenate"; eFONA = emergency front of neck airway access; FB = flexible bronchoscope; SGA = supraglottic airway; SpO_2 = peripheral oxygen saturation by pulse oximetry; VL = video laryngoscopy

optimally achieved by assessing the trainee's background knowledge and skill before starting in the OR, establishing educational goals, and supervising performance with immediate feedback.[296] Thus, a knowledgeable teacher can optimize learning for trainees in the OR.[297,298] Making educational programs multidisciplinary can further augment benefit by creating positive relationships between disciplines.

17 Summary and key recommendations

As the literature on airway management evolves, guidelines and recommendations must be updated regularly.[299] Published national airway management guidelines espouse largely consistent management principles. This invites an opportunity to develop a universal lexicon of terms to describe common airway management situations[300] and accepted principles on how to manage them.[301] When such universal guidance is published, it must still be applied to the national or local context in which the airway manager practices. In this third iteration of airway management recommendations from the CAFG, there are few guiding principles and recommendations:

- Resources allowing, VL, with appropriately selected blade type, should be used for the first attempt at tracheal intubation.
- Multiple attempts at tracheal intubation and even SGA insertion are associated with adverse events; first-attempt success should be a goal.
- If unsuccessful on the first attempt, further attempts can be made at the intended technique provided patient ventilation and oxygenation are maintained. A stepwise progression through different optimizing maneuvers, devices, or airway managers should occur.
- Total attempts at the intended technique should be limited to three or fewer before pausing to consider exit strategy options. Patient ventilation and oxygenation should be maintained while considering and then executing the exit strategy.
- Exit strategy options to consider after declaring failed tracheal intubation include awakening the patient, temporizing with an SGA, proceeding with one further controlled attempt at tracheal intubation with a different technique, or FONA.

- A CVCO situation is defined by the failure of tracheal intubation, FMV, and SGA use, with imminent or current hypoxemia. Neuromuscular blockade should be ensured, and eFONA undertaken in a timely fashion.
- The CAFG recommends that a scalpel-bougie-tube technique be used for adult eFONA, and that the necessary equipment for eFONA, packaged together, be stocked at every hospital airway management location.
- Similar principles are broadly applicable to the parturient and to the pediatric patient.
- Human factors often contribute to airway-related adverse events; efforts should be made to educate airway managers about common pitfalls.
- An airway lead is recommended for all hospitals to help many aspects of airway management at an organizational level.

Without doubt, no matter how well addressed, it will always be preferable to avoid having to manage a difficult airway presenting in the unconscious patient. To this end, thorough patient airway evaluation should be made, followed by appropriate decision-making and safe implementation of the plan. These aspects of safe management of a patient with a difficult airway are addressed further in the companion article[8], as is advice on tracheal extubation of the difficult airway patient.

Author contributions See Appendix.

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