2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway*

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ABSTRACT

The American Society of Anesthesiologists; All India Difficult Airway Association; European Airway Management Society; European Society of Anaesthesiology and Intensive Care; Italian Society of Anesthesiology, Analgesia, Resuscitation and Intensive Care; Learning, Teaching and Investigation Difficult Airway Group; Society for Airway Management; Society for Ambulatory Anesthesia; Society for Head and Neck Anesthesia; Society for Pediatric Anesthesia; Society of Critical Care Anesthesiologists; and the Trauma Anesthesiology Society present an updated report of the Practice Guidelines for Management of the Difficult Airway.

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HIGHLIGHTS BOX

These updated guidelines:

- Replace the "Practice Guidelines for Management of the Difficult Airway: A Report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway," adopted by the American Society of Anesthesiologists in 2012 and published in 2013.[1]
- Specifically address difficult airway management. The guidelines do not address education, training, or certification requirements for practitioners who provide anesthesia and airway management.
- Differ from previous guidelines in that they were developed by an international task force of anesthesiologists representing several anesthesiology, airway, and other medical organizations.
- Provide new evidence obtained from recent scientific literature along with findings from new surveys of expert consultants, American Society of Anesthesiologists members, and 10 participating organizations.
- Provide consideration for the development of a difficult airway management strategy including considerations for awake airway management.
- Update equipment for standard and advanced difficult airway management.
- Recommend supplemental oxygen administration before initiating and throughout difficult airway management, including the extubation process.
- Offer noninvasive and invasive alternatives for difficult airway management.
- Emphasize awareness of the passage of time and limiting the number of attempts of different devices and techniques during difficult airway management.
- Provide more robust recommendations for extubation of the difficult airway.
- Provide new algorithms and infographics for adult and pediatric difficult airway management.

Practice guidelines are systematically developed recommendations that assist the practitioner and patient in making decisions about health care. These recommendations may be adopted, modified, or rejected according to clinical needs and constraints and are not intended to replace local institutional policies. In addition, practice guidelines developed by the American Society of Anesthesiologists (ASA) are not intended as standards or absolute requirements, and their use cannot guarantee any specific outcome. Practice guidelines are subject to revision as warranted by the evolution of medical knowledge, technology, and practice. They provide basic recommendations that are supported by a synthesis and analysis of the current literature, expert and practitioner opinion, open forum commentary, and clinical feasibility data.

This document is a revision of the "Practice guidelines for management of the difficult airway: A report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway," adopted by the ASA in 2012 and published in 2013.[1]

Supplemental Digital Content is available for this article. Direct URL citations appear in the printed text and are available in both the HTML and PDF versions of this article. Links to the digital files are provided in the HTML text of this article on the Journal's Web site (www.anesthesiology.org).

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*Updated by the American Society of Anesthesiologists; All India Difficult Airway Association; European Airway Management Society; European Society of Anaesthesiology and Intensive Care; Italian Society of Anesthesiology, Analgesia, Resuscitation and Intensive Care, Learning, Teaching and Investigation Difficult Airway Group; Society for Airway Management; Society for Ambulatory Anesthesia; Society for Head and Neck Anesthesia; Society for Pediatric Anesthesia; Society of Critical Care Anesthesiologists; and the Trauma Anesthesiology Society: Jeffrey L. Apfelbaum, M.D., Chicago, Illinois (Co-Chair); Carin A. Hagberg, M.D., Houston, Texas (Co-Chair); Richard T. Connis, Ph.D., Woodinville, Washington (Chief Methodologist); Basem B. Abdelmalak, M.D., Cleveland, Ohio; Madhulika Agarkar, M.P.H., Schaumburg, Illinois (Methodologist); Richard P. Dutton, M.D., Dallas, Texas; John E. Fiadjoe, M.D., Philadelphia, Pennsylvania; Robert Greif, M.D., Bern, Switzerland; P. Allan Klock, Jr., M.D., Chicago, Illinois; David Mercier, M.D., Dallas, Texas; Sheila N. Myatra, M.D., Mumbai, India; Ellen P. O'Sullivan, M.D., Dublin, Ireland; William H. Rosenblatt, M.D., New Haven, Connecticut; Massimiliano Sorbello, M.D., Catania, Italy; Avery Tung, M.D., Chicago, Illinois; in collaboration with the Society for Pediatric Anesthesia, Pediatric Difficult Intubation Collaborative (pediatric algorithm and infographic).
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Methodology

Definition of Difficult Airway

For these practice guidelines, a difficult airway includes the clinical situation in which anticipated or unanticipated difficulty or failure is experienced by a physician trained in anesthesia care, including but not limited to one or more of the following: facemask ventilation, laryngoscopy, ventilation using a supraglottic airway, tracheal intubation, extubation, or invasive airway. These clinical situations are further defined as follows.

Difficult Facemask Ventilation. It is not possible to provide adequate ventilation (*e.g.*, confirmed by end-tidal carbon dioxide detection), because of one or more of the following problems: inadequate mask seal, excessive gas leak, or excessive resistance to the ingress or egress of gas.

Difficult Laryngoscopy. It is not possible to visualize any portion of the vocal cords after multiple attempts at laryngoscopy.

Difficult Supraglottic Airway Ventilation. It is not possible to provide adequate ventilation because of one or more of the following problems: difficult supraglottic airway placement, supraglottic airway placement requiring multiple attempts, inadequate supraglottic airway seal, excessive gas leak, or excessive resistance to the ingress or egress of gas.

Difficult or Failed Tracheal Intubation. Tracheal intubation requires multiple attempts or tracheal intubation fails after multiple attempts.

Difficult or Failed Tracheal Extubation. The loss of airway patency and adequate ventilation after removal of a tracheal tube or supraglottic airway from a patient with a known or suspected difficult airway (*i.e.*, an "at risk" extubation).

Difficult or Failed Invasive Airway. Anatomic features or abnormalities reducing or preventing the likelihood of successfully placing an airway into the trachea through the front of the neck.

Inadequate Ventilation. Indicators of inadequate ventilation include absent or inadequate exhaled carbon dioxide, absent or inadequate chest movement, absent or inadequate breath sounds, auscultatory signs of severe obstruction, cyanosis, gastric air entry or dilatation, decreasing or inadequate oxygen saturation, absent or inadequate exhaled gas flow as measured by spirometry, anatomic lung abnormalities as detected by lung ultrasound, and hemodynamic changes associated with hypoxemia or hypercarbia (*e.g.*, hypertension, tachycardia, bradycardia, arrhythmia). Additional clinical symptoms may include changed mental status or somnolence.

Purposes of the Guidelines

The purposes of these guidelines are to guide the management of patients with difficult airways, optimize first attempt success of airway management, improve patient safety during airway management, and minimize/avoid adverse events. The principal adverse outcomes associated with the difficult airway include (but are not limited to) death, brain injury, cardiopulmonary arrest, airway trauma, and damage to the teeth. The appropriate choice of medications and techniques for anesthesia care and airway management is dependent upon the experience, training, and preference of the individual practitioner, requirements or constraints imposed by associated medical issues of the patient, type of procedure, and environment in which airway management takes place. The choice of agents, techniques, and devices may be limited by federal, state, or municipal regulations or statutes.

Focus

These guidelines focus specifically on the management of the difficult airway encountered with mask ventilation, tracheal intubation, or supraglottic airway placement during procedures requiring general anesthesia, deep sedation, moderate sedation, or regional anesthesia or elective airway management without a procedure. Procedures include diagnostic, elective, and emergency procedures and invasive airway access. Airway management during cardiopulmonary resuscitation is not addressed by these guidelines. The guidelines are intended for adult and pediatric patients with either anticipated or unanticipated difficult airways, obstetric patients, intensive care (ICU) patients, and critically ill patients. The guidelines do not address patients at risk of aspiration without anatomically difficult airways, patients where difficult airways are not encountered, or physiologically difficult airways that are not anatomically difficult.‡

These guidelines do not address education, training, or certification requirements for practitioners who provide anesthesia and airway management. Some aspects of the guidelines may be relevant in other clinical contexts. The guidelines do not represent an exhaustive consideration of all manifestations of the difficult airway or all possible approaches to airway management.

Application

These guidelines are intended for use by anesthesiologists and all other individuals who perform anesthesia care or airway management. The guidelines are intended to apply to all airway management and anesthetic care delivered in inpatient (*e.g.*, perioperative, nonoperating room, emergency department, and critical care settings) and ambulatory settings (*e.g.*, ambulatory surgery centers and office-based surgery and procedure centers performing invasive airway procedures). Excluded are prehospital settings and individuals who do not deliver anesthetic care or perform airway management. These guidelines are also intended to serve as a resource for other physicians and patient care personnel who are involved in the care of difficult airway patients, including those involved in local policy development.

‡These include, but are not limited to, patients at increased risk for cardiorespiratory deterioration with airway management due to underlying conditions such as hypoxemia, hypotension, severe metabolic acidosis, or right ventricular failure.

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Task Force Members

In 2019, the ASA Committee on Standards and Practice Parameters requested that these guidelines be updated. This update is a revision developed by an ASA-appointed task force of 15 members, including physician anesthesiologists in both private and academic practices from the United States, India, Ireland, Italy, and Switzerland; an independent consulting methodologist; and an ASA staff methodologist. Conflict-of-interest documentation regarding current or potential financial and other interests pertinent to the practice guideline were disclosed by all task force members and managed.§

Process and Evaluation of Evidence

These updated guidelines were developed by means of a six-step process. First, consensus was reached on the criteria for evidence. Second, a comprehensive literature search was conducted by an independent librarian to identify citations relevant to the evidence criteria. Third, original published articles from peer-reviewed journals relevant to difficult airway management were evaluated and added to literature included in the previous update. Fourth, consultants who had expertise or interest in difficult airway management and who practiced or worked in various settings (*e.g.*, private and academic practice) were asked to participate in opinion surveys addressing the appropriateness, completeness, and feasibility of implementation of the draft recommendations and to review and comment on a draft of the guidelines. Fifth, additional opinions were solicited from random samples of active members of the ASA and participating organizations. Sixth, all available information was used to build consensus to finalize the Guidelines. A summary of recommendations is provided in appendix 1. Preparation of these updated guidelines followed a rigorous methodologic process, described in more detail in appendix 2 and other related publications.[2–5]

Criteria for literature acceptance included randomized controlled trials, prospective nonrandomized comparative studies (*e.g.*, quasiexperimental, cohort), retrospective comparative studies (*e.g.*, case control), observational studies (*e.g.*, correlational or descriptive statistics), and case reports or case series from peer-reviewed journals. Literature exclusion criteria included: (1) patients or practitioners described in the study who were specifically excluded or not identified by evidence criteria in the evidence model; (2) interventions not identified or specifically excluded in the evidence model; (3) studies with insufficient or no outcome data or reported outcomes not relevant to the evidence model; (4) articles with no original data, including review articles, descriptive letters, or editorials; (5) systematic reviews, secondary data, meta-analysis,‖ or other articles with no original data; (6) abstracts, letters, or articles not published in a peer-reviewed journal; (7) studies outside of designated search dates; (8) duplicate data presented in a different reviewed article; or (9) retracted publications.

Within the text of these guidelines, literature classifications are reported for each intervention as follows: Category A, level 1, meta-analysis of randomized controlled trials; Category A, level 2, multiple randomized controlled trials; Category A, level 3, a single randomized controlled trial; Category B, level 1, nonrandomized studies with group comparisons; Category B, level 2, nonrandomized studies with associative findings; Category B, level 3, nonrandomized studies with descriptive findings; and Category B, level 4, case series or case reports. Statistically significant outcomes ($P < 0.01$) are designated as either beneficial (B) or harmful (H) to the patient; statistically nonsignificant findings are designated as equivocal (E).# When available, Category A evidence is given precedence over Category B evidence for any particular outcome. The lack of sufficient scientific evidence in the literature is reported in the text of the guidelines as "insufficient evidence."** Opinions regarding the scientific quality of the studies or opinion ratings of the strength of recommendations are not reported in this document.

Survey findings from task force–appointed expert consultants and samples of the memberships of ASA and participating organizations†† are reported in appendix 2. Survey responses for each recommendation are reported using a five-point scale based on median values from strongly agree to strongly disagree.

Guidelines

Evaluation of the Airway

Airway evaluation topics include (1) risk assessment to predict a difficult airway or risk of aspiration, and (2) airway examination (bedside and advanced). Risk assessment includes evaluation of information obtained from a patient's history or medical records, including demographic information, clinical conditions, diagnostic tests, and patient/family interviews or questionnaires. An airway examination is intended to identify the presence of upper airway pathologies or anatomical anomalies. Issues addressed in these guidelines include: (1) measurement of facial and jaw features, (2) anatomical measurements and landmarks, (3) imaging with ultrasound or virtual laryngoscopy/bronchoscopy, (4) three-dimensional printing, and (5) bedside endoscopy.

Literature Findings. Patient demographic and personal characteristics evaluated for difficult airway risk prediction included age, sex, body mass index, weight, and height. Clinical characteristics assessed included a history of difficult

§Additional conflict of interest information is located after appendix 2 in this document.

‖All meta-analyses are conducted by the ASA methodology group. Meta-analyses from other sources are reviewed but not included as evidence in this document. A minimum of five independent randomized controlled trials (*i.e.*, sufficient for fitting a random-effects model) is required for meta-analysis.

#The complete bibliography used to develop this updated advisory, arranged alphabetically by author, is available as Supplemental Digital Content 1, http://links.lww.com/ALN/C694.

**A more detailed description of the definition of insufficient evidence is described in appendix 2.

††See appendix 2 for tables reporting survey findings.

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intubation, distorted airway anatomy, snoring, obstructive sleep apnea, diabetes mellitus, or findings from diagnostic tests (*e.g.*, radiography, computed tomography), patient interviews, and questionnaires. Measurement of facial and jaw features included mouth opening, the ability to prognath, head and neck mobility, prominent upper incisors, presence of a beard, and an upper lip bite test. Anatomical measures included Mallampati and modified Mallampati scores, thyromental distance, sternomental distance, interincisor distance, neck circumference, ratio of neck circumference to thyromental distance, ratio of height to thyromental distance, hyomental distance, and hyomental distance ratio. Measurements obtained from ultrasound included skin-to-hyoid distance, tongue volume, and distance from skin to epiglottis.

Observational studies reported comparative demographic findings for difficult *versus* nondifficult airway patients, as well as sensitivity, specificity, positive predictive, negative predictive, and accuracy values for difficult laryngoscopy, supraglottic airway use, and tracheal intubation. Findings for the above patient characteristics were shown to have very high predictive and comparative variability, with sensitivity, specificity, and significance values ranging from low to very high across all patient demographic measures *(Category B2-E evidence)*.[6–70] No single characteristic was identified as consistently being more predictive than another, and multivariate measures intended to predict difficult airways were too few and diverse among the studies to determine a common set of predictors.

Case reports identified difficult laryngoscopy or difficult intubation occurring among patients with a variety of acquired or congenital disease states (*e.g.*, ankylosing spondylitis, degenerative osteoarthritis, Treacher–Collins, Klippel–Feil, Down syndrome, mucopolysaccharidosis, and airway masses) *(Category B4-H evidence)*.[71–122]

Observational studies reported comparative findings for facial and jaw features and anatomical measurement for difficult *versus* nondifficult airway patients as well as sensitivity, specificity, positive predictive, negative predictive, and accuracy values for difficult laryngoscopy and intubation. Findings for facial and jaw features,[7–11,13,14,18,27,33,38–40,42,43,45–47,49,51–54,57,58,64,68,123–159] anatomical measurements,[7–11,13–15,18,22,23,27–30,33,35,37–40,45–47,49,51–54,57,58,60,64,65,68,70,123–132,134–154,156,158–203] and ultrasound anatomical measurements[69,139,162,170,194,196,203–213] were shown to have very high predictive and comparative variability, with sensitivity, specificity, and significance values ranging from low to very high across all patient measures *(Category B2-E evidence)*. No single characteristic was identified as consistently being more predictive than another, and multivariate measures intended to predict difficult airways were too few and diverse among the studies to determine a common set of predictors.

A prospective cohort study reported improved laryngeal views (during tongue protrusion) when transnasal endoscopy was added to the preoperative bedside evaluation *(Category B2-B evidence)*,[214] and an observational study utilizing preoperative endoscopic examination as an added airway assessment tool reported that airway management plans were revised in 26% of patients based on the results of this examination *(Category B3-B evidence)*.[215] Observational studies and case reports indicated that radiography and computed tomography scans identified anatomical characteristics such as laryngeal deviations, cervical abnormalities, fractures, and abscesses that may suggest a potential difficult airway *(Category B3-B and B4-B evidence)*.[90,216–219] Observational studies indicated that patient questionnaires may identify patients at risk of difficult ventilation and intubation *(Category B3-B evidence)*.[163,220,221] The literature was insufficient to evaluate the predictive value of virtual laryngoscopy/bronchoscopy or three-dimensional printing.

Survey Findings. The consultants and members of participating organizations strongly agree with recommendations to ensure that an airway risk assessment is performed by the person(s) responsible for airway management whenever feasible before the initiation of anesthetic care or airway management and with the recommendation to conduct an airway physical examination before the initiation of anesthetic care or airway management.

Recommendations for Evaluation of the Airway

- Before the initiation of anesthetic care or airway management, ensure that an airway risk assessment is performed by the person(s) responsible for airway management whenever feasible to identify patient, medical, surgical, environmental, and anesthetic factors (*e.g.*, risk of aspiration) that may indicate the potential for a difficult airway.
  - When available in the patient's medical records, evaluate demographic information, clinical conditions, diagnostic test findings, patient/family interviews, and questionnaire responses.
  - Assess multiple demographic and clinical characteristics to determine a patient's potential for a difficult airway or aspiration.
- Before the initiation of anesthetic care or airway management, conduct an airway physical examination to further identify physical characteristics that may indicate the potential for a difficult airway.
  - The physical examination may include assessment of facial features‡‡ and assessment of anatomical measurements and landmarks.§§
  - Additional evaluation to characterize the likelihood or nature of the anticipated airway difficulty may include

‡‡Examples of facial features include mouth opening, the ability to prognath, head and neck mobility, prominent upper incisors, presence of a beard, and the upper lip bite test.

§§Examples of anatomical measures include Mallampati and modified Mallampati scores, thyromental distance, sternomental distance, interincisor distance, neck circumference, ratio of neck circumference to thyromental distance, ratio of height to thyromental distance, hyomental distance, and hyomental distance ratio. Measurements obtained from ultrasound included skin-to-hyoid distance, tongue volume, and distance from skin to epiglottis.

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bedside endoscopy, virtual laryngoscopy/bronchoscopy, or three-dimensional printing.‖‖

- Assess multiple airway features to determine a patient's potential for a difficult airway or aspiration.

Preparation for Difficult Airway Management

Topics related to interventions intended to prepare for difficult airway management include (1) the availability of equipment for airway management (*e.g.*, items for anesthetizing locations, portable storage unit, cart, or trolley for difficult airway management); (2) informing the patient with a known or suspected difficult airway; (3) preoxygenation; (4) patient positioning; (5) sedative administration; (6) local anesthesia; (7) supplemental oxygen during difficult airway management; (8) patient monitoring; and (9) human factors.##

Literature Findings. Although the need for immediate access to difficult airway management equipment is a well accepted practice, the literature is insufficient to directly evaluate outcomes associated with the availability of such equipment. In addition, the literature is insufficient to evaluate the outcomes associated with informing the patient of a known or suspected difficult airway, preoxygenation, administration of sedatives or local anesthesia, or patient monitoring. One randomized controlled trial comparing the ramped with sniffing positions reported equivocal findings ($P > 0.01$) for laryngoscopic view and intubation success *(Category A3-E evidence)*.[222] A nonrandomized study comparing the sniffing position with head and neck raised beyond the sniffing position reported improved laryngeal views with the raised position *(Category B-2 B evidence)*.[223]

Survey Findings. The consultants and members of participating organizations strongly agree with recommendations to ensure that a skilled individual is present or immediately available to assist with airway management if a difficult airway is known or suspected; inform the patient or responsible person of the special risks and procedures pertaining to management of the difficult airway; and administer oxygen before initiating management of the difficult airway and to deliver supplemental oxygen throughout the process of difficult airway management, including extubation.

Recommendations for Preparation for Difficult Airway Management

- Ensure that airway management equipment is available in the room.***
- Ensure that a portable storage unit that contains specialized equipment for difficult airway management is immediately available.†††
- If a difficult airway is known or suspected:
  - Ensure that a skilled individual is present or immediately available to assist with airway management when feasible.
  - Inform the patient or responsible person of the special risks and procedures pertaining to management of the difficult airway.
  - Properly position the patient, administer supplemental oxygen before initiating management of the difficult airway,‡‡‡ and continue to deliver supplemental oxygen whenever feasible throughout the process of difficult airway management, including extubation.§§§
- Ensure that, at a minimum, monitoring according to the ASA Standards for Basic Anesthesia Monitoring are followed immediately before, during, and after airway management of all patients.‖‖‖

Anticipated Difficult Airway Management

Airway management of an anticipated difficult airway consists of interventions addressing awake tracheal intubation, anesthetized tracheal intubation, or both awake and anesthetized intubation.

Literature Findings for Awake Tracheal Intubation. Studies with observational findings reported successful awake intubation in 88 to 100% of anticipated difficult airway patients *(Category B3-B evidence)*.[224–227] Case reports for awake intubation (*e.g.*, blind tracheal intubation, intubation through supraglottic devices, optically guided intubation) also observed success with anticipated difficult airway patients *(Category B4-B evidence)*.[228–230]

Literature Findings for Anesthetized Tracheal Intubation. The literature is insufficient to evaluate the benefit or harm of the following interventions: use of cricoid pressure (*i.e.*, Sellick maneuver), pressure-limited mask ventilation *versus* ablation of spontaneous ventilation, maintenance of spontaneous ventilation *versus* ablation of spontaneous ventilation, administration of neuromuscular blockade to improve mask ventilation, or rocuronium with sugammadex *versus* suxamethonium or succinylcholine for airway management of anticipated difficult airway patients.

Literature Findings for Both Awake and Anesthetized Intubation. Interventions addressed for anticipated difficult airway patients receiving either awake or anesthetized

‖‖In addition to airway evaluation, three-dimensional printing may be a useful means of testing methods for device insertion or for practitioner training.

##Human factors are generally considered part of airway preparation as well as management and postevent airway care (see table 3 for additional human factor information).

***See table 1 for examples of appropriate airway equipment.

†††See table 2 for examples of specialized equipment for a portable storage unit.

‡‡‡The uncooperative or pediatric patient may impede opportunities for oxygen administration.

§§§Opportunities for supplemental oxygen administration include (but are not limited to) oxygen delivery by nasal cannulae, facemask, or supraglottic insufflation.

‖‖‖This recommendation does not preclude local or institutional policies that require more stringent monitoring.

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airway management include (1) airway maneuvers, (2) noninvasive airway management devices, (3) combination techniques, (4) invasive airway management interventions, and (5) extracorporeal membrane oxygenation (ECMO).

Airway Maneuvers. Two case reports indicated that use of a backward-upward-rightward pressure of the larynx maneuver resulted in successful intubation of difficult airway patients *(Category B4-B evidence)*.[231,232] One case report observed successful intubation using external cricoid manipulation after failed direct intubation *(Category B4-B evidence)*.[233]

Noninvasive Devices. Noninvasive devices for airway management of patients with anticipated difficult airways include rigid laryngoscopic blades of alternative design and size; adjuncts (*e.g.*, introducers, bougies, stylets, and alternative tracheal tubes); videolaryngoscopes; flexible intubation scopes; supraglottic airway devices; lighted or optical stylets; and rigid bronchoscopes. The literature is insufficient to evaluate which devices are most effective when attempted first after failed intubation, nor is the literature sufficient to evaluate the most effective order of devices to be used for attempted intubation of an anticipated difficult airway.

Rigid laryngoscopic blades of alternative design and size. A randomized controlled trial comparing levering laryngoscopes to standard laryngoscopes reported no differences in laryngoscopic view, but shorter times to intubation and fewer intubation maneuvers were needed for successful intubation with the levering laryngoscope *(Category A3-B evidence)*.[234] Case reports observed intubation success with levering laryngoscopic blades *(Category B4-B evidence)*.[235,236] Case reports of mechanical failure and arytenoid dislocation have been noted with levering blades *(Category B4-H evidence)*.[237–239]

Adjuncts (*e.g.*, introducers, bougies, stylets, alternative tracheal tubes, intubating stylets, or tube changers). Observational studies reported intubation success ranging from 87 to 100% of patients *(Category B3-B evidence)*,[240–242] and case reports observed intubation success with bougies and stylets *(Category B4-B evidence)*.[243–248]

Videolaryngoscopes. Meta-analyses of randomized controlled trials comparing video-assisted laryngoscopy with direct laryngoscopy in patients with predicted difficult airways reported improved laryngeal views, a higher frequency of successful intubations, a higher frequency of first attempt intubations, and fewer intubation maneuvers with video-assisted laryngoscopy *(Category A1-B evidence)*;[249–259] findings for time to intubation were equivocal *(Category A1-E evidence)*.[250,253–255,258–261###] Randomized controlled trials comparing video-assisted laryngoscopy with awake laryngoscopy with a flexible intubation scope reported equivocal findings for laryngeal view, visualization time, first attempt intubation success, and time to intubation *(Category A2-E evidence)*.[262–265] Randomized controlled trials comparing channel-guided videolaryngoscopes with non–channel-guided videolaryngoscopes reported equivocal findings for laryngeal view, intubation success, first attempt intubation, time to intubation, and needed intubation maneuvers *(Category A3-E evidence)*.[256,266] Randomized controlled trials reported equivocal findings for laryngoscopic view, intubation success, first attempt intubation success, and time to intubation when hyperangulated videolaryngoscopes were compared with nonangulated videolaryngoscopes for anticipated difficult airways *(Category A2-E evidence)*.[257,259]

Observational studies indicated intubation success rates for videolaryngoscopes ranging from 85 to 100% of patients[267–275] and first attempt successful intubation rates ranging from 51 to 100%[267,269,271–275] *(Category B3-B evidence)*. Case reports observed videolaryngoscope intubation successes with a wide range of difficult airway conditions *(Category B4-B evidence)*.[160,276–297] Adverse outcomes that may occur include sore throat, laryngospasm, lip, dental, or mucosal injuries (*Category B4-H evidence)*.[278,298]

Flexible intubation scopes. A nonrandomized comparative study comparing intubation with a flexible bronchoscope *versus* direct laryngoscopy reported equivocal findings for complicated intubations *(Category B2-E evidence)*.[299] Studies with observational findings for flexible intubation scopes indicated success rates ranging from 78 to 100% *(Category B3-B evidence)*.[224–227,300–303] Case reports also observed successful intubation with flexible intubation scopes *(Category B4-B evidence)*.[304–356]

Supraglottic airway devices. Observational studies indicated successful supraglottic airway insertion and intubation ranging from 65 to 100% of anticipated difficult airway patients *(Category B3-B evidence)*.[357–367] Three observational studies reported oxygen desaturation occurring in 1.8 to 3.3% of patients after supraglottic airway placement *(Category B3-H evidence)*.[362,363,368] Case reports observed successful ventilation and intubation with various supraglottic airways *(Category B4-B evidence)*.[369–413]

Randomized controlled trials comparing flexible intubation through supraglottic airways *versus* flexible intubation scopes alone reported a higher frequency of first attempt intubation success with the supraglottic airway *(Category A2-B evidence)*[414–417]; findings were equivocal for overall successful intubation and time to intubation *(Category A2-E evidence)*.[415–417] A randomized controlled trial comparing second generation supraglottic airways with first generation supraglottic airways reported faster times to intubation with second generation supraglottic airways *(Category A2-B evidence)*.[418] Randomized controlled trials reported equivocal findings for overall successful intubation *(Category A2-E evidence)*.[418,419]

Lighted or optical stylets. A randomized controlled trial comparing intubation with a lightwand *versus* blind intubation for patients with anticipated difficult airways reported a significantly higher frequency of successful intubations and shorter

###See appendix 2 for meta-analysis details.

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intubation times for the lightwand *(Category A3-B evidence)*.[420] Two randomized controlled trials reported shorter intubation times when lighted stylets were compared with direct laryngoscopy *(Category A2-B* evidence); findings were equivocal for successful intubation and first attempt success *(Category A2-E evidence)*.[255,421] Randomized controlled trials comparing lighted stylets with flexible bronchoscopes reported shorter intubation times with lighted stylets *(Category A3-B* evidence).[422,423]

Observational studies reported successful intubation ranging from 84.9 to 100% of anticipated difficult airway patients when lighted stylets were used *(Category B3-B evidence)*.[424–428] Case reports observed successful intubations with lighted and optical stylets *(Category B4-B evidence)*.[429–437]

Rigid bronchoscopes. The literature is insufficient to evaluate the benefit or harm of the rigid bronchoscope for patients with anticipated difficult airways.

Combination techniques. Examples of combination techniques include: (1) direct or video laryngoscopy combined with either optical/video stylet, flexible intubation scope, airway exchange catheter, retrograde-placed guide wire, or supraglottic airway placement and (2) supraglottic airway combined with either optical/video stylet or flexible intubation scope (with or without hollow guide catheter). A randomized controlled trial comparing a lightwand combined with direct laryngoscopy *versus* a lightwand alone for intubation reported equivocal findings for successful intubation, first attempt success, time to intubation, and number of intubation attempts *(Category A3-E evidence)*.[438] A randomized controlled trial comparing a videolaryngoscope combined with a flexible bronchoscope reported a greater first attempt success rate with the combination technique than with a videolaryngoscope alone *(Category A3-B evidence)*.[439]

Observational studies indicated successful intubation with combination techniques ranging from 80 to 90%[440–445] and first attempt success rates ranging from 50 to 100% of anticipated difficult airway patients[440–442,446] *(Category B3-B evidence)*. Case reports also observed successful intubation occurring with various combinations of techniques *(Category B4-B evidence)*.[447–468]

Invasive Interventions. Invasive airway management interventions for anticipated difficult airway management include retrograde wire–guided intubation, front-of-neck percutaneous or surgical cricothyrotomy/tracheostomy, awake cricothyrotomy/tracheostomy, and ECMO. Case reports observed successful intubations when retrograde wire–graded intubation was performed for patients with anticipated difficult airways *(Category B4-B evidence)*.[469–473] A case report observes successful percutaneous tracheostomy for an anticipated difficult airway patient as an alternative after unsuccessful surgical tracheostomy *(Category B3-B evidence)*.[474] The literature is insufficient to evaluate awake cricothyrotomy/tracheostomy and ECMO for anticipated difficult airway patients.

Survey Findings for Anticipated Difficult Airway Management. The consultants and members of participating organizations strongly agree with the recommendation to identify a strategy for (1) awake intubation, (2) the patient who can be adequately ventilated but is difficult to intubate, (3) the patient who cannot be ventilated or intubated, and (4) alternative approaches to airway management failure. The consultants strongly agree and members of participating organizations agree or strongly agree with recommendations to perform awake intubation, when appropriate, if the patient is suspected to be a difficult intubation and difficult ventilation (face mask/supraglottic airway) is anticipated; perform awake intubation, when appropriate, if the patient is suspected to be a difficult intubation and increased risk of aspiration is anticipated; and perform awake intubation, when appropriate, if the patient is suspected to be a difficult intubation and the patient is likely incapable of tolerating a brief apneic episode. The consultants and members of participating organizations strongly agree with the recommendation to perform awake intubation, when appropriate, if the patient is suspected to be a difficult intubation and difficulty with emergency invasive airway rescue is anticipated.

The consultants and members of participating organizations strongly agree with the recommendation to identify a preferred sequence of noninvasive devices to use for airway management if a noninvasive approach is selected. The consultants strongly agree and members of participating organizations agree or strongly agree that if difficulty is encountered with individual techniques, combination techniques may be performed. The consultants and members of participating organizations strongly agree with the recommendation to be aware of the passage of time the number of attempts and oxygen saturation. The consultants strongly agree and members of participating organizations agree or strongly agree with the recommendation to provide and test mask ventilation between attempts. The consultants and members of participating organizations strongly agree with recommendations to limit the number of attempts at tracheal intubation or supraglottic airway placement to avoid potential injury and complications; identify a preferred intervention if an elective invasive approach to the airway is selected; ensure that an invasive airway is performed by an individual trained in invasive airway techniques whenever possible; and identify an alternative invasive intervention if the selected invasive approach fails or is not feasible.

Recommendations for Anticipated Difficult Airway Management

- Have a preformulated strategy for management of the anticipated difficult airway.
  - This strategy will depend, in part, on the anticipated surgery, the condition of the patient, patient cooperation/consent, the age of the patient, and the skills and preferences of the anesthesiologist.
  - Identify a strategy for: (1) awake intubation, (2) the patient who can be adequately ventilated but is difficult to intubate, (3) the patient who cannot be ventilated or intubated, and (4) difficulty with emergency invasive airway rescue.

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- When appropriate, perform awake intubation if the patient is suspected to be a difficult intubation and one or more of the following apply: (1) difficult ventilation (face mask/supraglottic airway), (2) increased risk of aspiration, (3) the patient is likely incapable of tolerating a brief apneic episode, or (4) there is expected difficulty with emergency invasive airway rescue.****
- The uncooperative or pediatric patient may restrict the options for difficult airway management, particularly options that involve awake intubation. Airway management in the uncooperative or pediatric patient may require an approach (*e.g.*, intubation attempts after induction of general anesthesia) that might not be regarded as a primary approach in a cooperative patient.
- Proceed with airway management after induction of general anesthesia when the benefits are judged to outweigh the risks.
- For either awake or anesthetized intubation, airway maneuver(s) may be attempted to facilitate intubation.
- Before attempting intubation of the anticipated difficult airway, determine the benefit of a noninvasive *versus* invasive approach to airway management.
  - If a noninvasive approach is selected, identify a preferred sequence of noninvasive devices to use for airway management.††††
    - If difficulty is encountered with individual techniques, combination techniques may be performed.‡‡‡‡
    - Be aware of the passage of time, the number of attempts, and oxygen saturation.
    - Provide and test mask ventilation after each attempt, when feasible.
    - Limit the number of attempts at tracheal intubation or supraglottic airway placement to avoid potential injury and complications.
  - If an elective invasive approach to the airway is selected, identify a preferred intervention.§§§§
    - Ensure that an invasive airway is performed by an individual trained in invasive airway techniques, whenever possible.
    - If the selected approach fails or is not feasible, identify an alternative invasive intervention.
      - Initiate ECMO when/if appropriate and available.

****Any one factor alone (*i.e.*, assessed difficulty with intubation or ventilation, increased risk of aspiration or desaturation) may be of sufficient clinical importance to warrant an awake intubation.

††††Noninvasive devices include rigid laryngoscopic blades of alternative designs and sizes (with adequate face mask ventilation after induction), adjuncts (*e.g.*, introducers, bougies, stylets, alternative tracheal tubes, and supraglottic airways), video/video-assisted laryngoscopy, flexible intubation scopes, supraglottic airway devices, lighted or optical stylets, alternative optical laryngoscopes, and rigid bronchoscopes.

‡‡‡‡Combination techniques may include but are not limited to (1) direct or video laryngoscopy combined with either optical/video stylet, flexible scope intubation, airway exchange catheter, retrograde-placed guide wire or supraglottic airway placement and (2) supraglottic airway combined with either optical/video stylet, flexible scope intubation (with or without hollow guide catheter), or retrograde-placed guide wire.

Unanticipated and Emergency Difficult Airway Management

Airway management of an unanticipated or emergency difficult airway consists of interventions addressing (1) calling for help, (2) optimization of oxygenation, (3) use of a cognitive aid, (4) noninvasive airway management devices, (5) combination techniques, (6) invasive airway management interventions, and (7) ECMO.

Literature Findings. The literature is insufficient to evaluate patient outcomes associated with the immediate access to airway management support equipment or calling for help, although the necessity of these interventions is obvious. The literature is also insufficient to evaluate difficult airway patient outcomes associated with the use of a visual aid, cognitive aid, or algorithm for unanticipated or emergency difficult airways.

Case reports have observed successful emergency ventilation *via* tube exchangers using expiratory ventilation assistance after multiple failed intubation attempts *(Category B4-B evidence)*.[475,476] Devices for noninvasive airway management of patients with unanticipated or emergency difficult airways include rigid laryngoscopic blades of alternative designs and sizes; adjuncts (*e.g.*, introducers, bougies, stylets, and alternative tracheal tubes), videolaryngoscopes; flexible intubation scopes; supraglottic airway devices (supraglottic airways); lighted or optical stylets; and rigid bronchoscopes.

The literature is insufficient to evaluate patient outcomes associated with rigid laryngoscopic blades of alternative designs and sizes for patients with unanticipated or emergency difficult airways. Observational findings from a randomized trial reported a first attempt intubation success rate for difficult airways of 96% with bougies and 82% with stylets and tracheal tubes in an emergency department *(Category B3-B evidence)*.[477] Case reports observed intubation successes with bougies, introducers, and stylets for patients with unanticipated or emergency difficult airways *(Category B4-B evidence)*.[114,478–485]

Nonrandomized studies comparing videolaryngoscopes with direct laryngoscopy reported equivocal findings for intubation success with difficult airways in emergency departments *(Category B1-E evidence)*.[6,486,487] Observational studies indicated successful videolaryngoscope-guided intubation rates after failed intubation ranging from 92 to 100% for unanticipated and emergency difficult airways *(Category B4-B evidence)*.[488–491] Case reports also observed successful intubation with videolaryngoscopes in unanticipated and emergency difficult airways *(Category B4-B evidence)*.[160,492–496] A retrospective observational study reported a flexible bronchoscopy success rate of 78% for intubation rescue after failed direct laryngoscopy *(Category B3-B evidence)*.[488] Case reports of flexible bronchoscopy or fiberoptic

§§§§Invasive interventions may include, but are not limited to, one of the following techniques: surgical cricothyrotomy (*e.g.*, scalpel-bougie-tube), needle cricothyrotomy with a pressure-regulated device, large-bore cannula cricothyrotomy or surgical tracheostomy, retrograde wire–guided intubation, and percutaneous tracheostomy.

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nasotracheal intubation observed successful rescue intubations for unanticipated and emergency difficult airways *(Category B4-B evidence)*.[497–503]

A retrospective observational study reported a 78% successful rescue intubation rate, and another observational study reported 94.1% successful rescue ventilation with supraglottic airway placement *(Category B3-B evidence)*.[488,504] Case reports also observed successful rescue ventilation and intubation using supraglottic airways for unanticipated and emergency difficult airways *(Category B4-B evidence)*.[505–521]

A retrospective observational study reported a success rate with a lighted stylet of 77% for intubation rescue after failed direct laryngoscopy *(Category B3-B evidence)*.[488] Case reports observed successful intubations with lighted stylets after failed direct laryngoscopies for emergency airways *(Category B4-B evidence)*.[522,523] A case report observed successful intubation with a rigid bronchoscope in an emergency airway obstruction case *(Category B4-B evidence)*.[524]

An observational study reported successful intubation in 97.7%, first attempt success in 86.4%, and successful ventilation in 100% of unanticipated difficult airway patients using a combination of a supraglottic airway and lighted stylet *(Category B3-B evidence)*.[525] Case reports also observed intubation success for unanticipated and emergency airway patients when combination techniques were used *(Category B4-B evidence)*.[526–536] The literature is insufficient to evaluate which of the above devices are most effective when attempted first after failed intubation, nor is the literature sufficient to evaluate the most effective order of devices to be used for attempted intubation of an unanticipated or emergency difficult airway.

Invasive airway management interventions for unanticipated and emergency difficult airway management include retrograde wire–guided intubation, front-of-neck percutaneous or surgical cricothyrotomy/tracheostomy, awake cricothyrotomy/tracheostomy, jet ventilation, and ECMO. A case series of two patients reported successful intubation using retrograde wire–guided intubation after failed intubation through a supraglottic airway *(Category B4-B evidence)*.[537] Observational findings from a randomized controlled trial comparing percutaneous dilatational tracheotomy with percutaneous cricothyrotomy reported successful procedure rates of 97.6 and 95.3% *(Category B3-B evidence)*,[538] and case reports also observed success with percutaneous procedures *(Category B4-B evidence)*.[539–544]

A retrospective observational study reported restoration of oxygen saturation levels to above 90% when rescue transtracheal jet ventilation was used *(Category B3-B evidence)*,[545] and case reports observed improvements in oxygen saturation levels with supraglottic jet oxygenation in "cannot intubate, cannot ventilate" situations *(Category B4-B evidence)*.[546,547] Case reports observed oxygen saturations of 72 to 100% with the use of ECMO for difficult airways before intubation attempts for emergency procedures *(Category B4-B evidence)*.[548–550]

Survey Findings for Unanticipated and Emergency Difficult Airway Management. The consultants and members of participating organizations strongly agree with recommendations to determine the benefit of waking and/or restoring spontaneous breathing upon encountering an unanticipated difficult airway; determine the benefit of a noninvasive *versus* invasive approach to airway management; and identify a preferred sequence of noninvasive devices to use for airway management if a noninvasive approach is selected.

The consultants strongly agree and members of participating organizations agree or strongly agree that if difficulty is encountered with individual techniques, combination techniques may be performed. The consultants and members of participating organizations strongly agree with recommendations to be aware of the passage of time, the number of attempts, and oxygen saturation; provide and test mask ventilation between attempts; limit the number of attempts at tracheal intubation or supraglottic airway placement to avoid potential injury and complications; identify a preferred intervention if an invasive approach to the airway is necessary (*i.e.*, cannot intubate, cannot ventilate); ensure that an invasive airway is performed by an individual trained in invasive airway techniques, whenever possible; ensure that an invasive airway is performed as rapidly as possible; and identify an alternative invasive intervention if the selected invasive approach fails or is not feasible.

Recommendations for Unanticipated and Emergency Difficult Airway Management

- Call for help.
- Optimize oxygenation.||||||
- When appropriate, refer to an algorithm#### and/or cognitive aid.
- Upon encountering an unanticipated difficult airway:
  - Determine the benefit of waking and/or restoring spontaneous breathing.
  - Determine the benefit of a noninvasive *versus* invasive approach to airway management.
  - If a noninvasive approach is selected, identify a preferred sequence of noninvasive devices to use for airway management.*****
    - If difficulty is encountered with individual techniques, combination techniques may be performed.
    - Be aware of the passage of time, the number of attempts, and oxygen saturation.
    - Provide and test mask ventilation after each attempt, when feasible.

||||||Examples include low- or high-flow nasal oxygen during efforts securing a tube.

####See figs. 1 to 4 for examples of algorithms or cognitive aids.

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- Limit the number of attempts at tracheal intubation or supraglottic airway placement to avoid potential injury and complications.
- If an invasive approach to the airway is necessary (*i.e.*, cannot intubate, cannot ventilate), identify a preferred intervention.†††††
  - Ensure that an invasive airway is performed by an individual trained in invasive airway techniques, whenever possible.
  - Ensure that an invasive airway is performed as rapidly as possible.
  - If the selected invasive approach fails or is not feasible, identify an alternative invasive intervention.
    - Initiate ECMO when/if appropriate and available.

Confirmation of Tracheal Intubation

Literature Findings. Studies with observational findings indicate that capnography or end-tidal carbon dioxide monitoring confirms tracheal intubation in 88.5 to 100% of difficult airway patients (*Category B3-B evidence*).[551,552] Case reports also observed intubation confirmation with capnography *Category B4-B evidence*).[354,553] The literature is insufficient to evaluate whether visualization (any technique), flexible bronchoscopy, ultrasonography, or radiography can be effective in confirming appropriate tracheal intubation.

Survey Findings. The consultants and members of participating organizations strongly agree with the recommendation to confirm tracheal intubation using capnography or end-tidal carbon dioxide monitoring. The consultants strongly agree and members of participating organizations agree or strongly agree with the recommendation that when uncertain about the location of the tracheal tube, determine whether to either remove it and attempt ventilation or use additional techniques to confirm positioning of the tube.

Recommendations for Confirmation of Tracheal Intubation

- Confirm tracheal intubation using capnography or end-tidal carbon dioxide monitoring.
- When uncertain about the location of the tracheal tube, determine whether to either remove it and attempt ventilation or use additional techniques to confirm positioning of the tracheal tube.‡‡‡‡

*****Noninvasive devices include rigid laryngoscopic blades of alternative design and size (with adequate face mask ventilation after induction), adjuncts (*e.g.*, introducers, bougies, stylets, alternative tracheal tubes, and supraglottic airways), video/video-assisted laryngoscopy, flexible intubation scopes, supraglottic airway devices, lighted optical stylets, alternative optical laryngoscopes, and rigid bronchoscopes.

†††††Invasive interventions may include surgical cricothyrotomy (*e.g.*, scalpel-bougie technique), surgical tracheostomy, needle cricothyrotomy with pressure-regulated ventilation (*e.g.*, transtracheal jet ventilation or other pressure-regulated techniques), and large-bore cannula cricothyrotomy (including Seldinger guided techniques).

Extubation of the Difficult Airway

An extubation strategy includes interventions that may be used to facilitate airway management associated with extubation of a difficult airway. Extubation intervention topics addressed by these guidelines include: (1) assessment of patient readiness for extubation, (2) the presence of a skilled individual to assist with extubation, (3) selection of an appropriate time and location for extubation, (4) planning for possible reintubation, (5) elective tracheostomy, (6) awake extubation or supraglottic airway removal, (7) supplemental oxygen throughout the extubation process, and (8) extubation with an airway exchange catheter or supraglottic airway. The task force regards the concept of an extubation strategy as a logical extension of the intubation strategy.

Literature Findings. A retrospective observational study comparing successfully extubated patients with patients who failed extubation observed differences in duration of intubation; conditions associated with failed extubation included airway granulations and subglottic stenosis *(Category B1-H evidence)*.[554] An observational study reported that staged extubation and reintubation with a Cook airway exchange catheter was successful in 92% of known or presumed difficult extubation patients *(Category B3-B evidence)*.[555] Another observational study reported single occurrences of a wire in the esophagus, a nontolerable cough, and gagging or salivation with a Cook airway exchange catheter *(Category B3-H evidence)*.[556] A case report observed successful extubation with an airway exchange catheter *(Category B3-B evidence)*.[557] Another case report observed an esophageal misplacement of an airway exchange catheter during extubation of a difficult airway patient *(Category B3-H evidence)*.[558] The literature is insufficient to evaluate the benefits of the presence of a skilled individual to assist with extubation, selection of an appropriate time and location for extubation, awake extubation or supraglottic airway removal, supplemental oxygen, planning for possible reintubation, and elective tracheostomy for difficult airway patients.

Survey Findings. The consultants and members of participating organizations strongly agree with recommendations to have a preformulated strategy for extubation and subsequent airway management, ensure that a skilled individual is present to assist with extubation, and select an appropriate time and location for extubation when possible. The consultants strongly agree and members of participating organizations agree or strongly agree with recommendations to assess the relative clinical merits and feasibility of the short-term use of an airway exchange catheter and/or supraglottic airway that can serve as a guide for expedited reintubation and evaluate the risks and benefits of elective surgical tracheostomy before attempting extubation. The

‡‡‡‡‡Additional techniques include, but are not limited to, visualization (any technique), flexible bronchoscopy, ultrasonography, or radiography.

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consultants and members of participating organizations strongly agree with recommendations to evaluate the risks and benefits of awake extubation *versus* extubation before the return to consciousness and assess the clinical factors that may produce an adverse impact on ventilation after the patient has been extubated.

Recommendations for Extubation of the Difficult Airway

- Have a preformulated strategy for extubation and subsequent airway management.
  - This strategy will depend, in part, on the surgery/procedure, other perioperative circumstances, the condition of the patient, and the skills and preferences of the clinician.
- Assess patient readiness for extubation.
- Ensure that a skilled individual is present to assist with extubation when feasible.
- Select an appropriate time and location for extubation when possible.
- Assess the relative clinical merits and feasibility of the short-term use of an airway exchange catheter and/or supraglottic airway that can serve as a guide for expedited reintubation.§§§§§
  - Minimize the use of an airway exchange catheter with pediatric patients.
- Before attempting extubation, evaluate the risks and benefits of elective surgical tracheostomy.
- Evaluate the risks and benefits of awake extubation *versus* extubation before the return to consciousness.
- When feasible, use supplemental oxygen throughout the extubation process.
- Assess the clinical factors that may produce an adverse impact on ventilation after the patient has been extubated.

Follow-up Care

Follow-up care includes the topics of: (1) postextubation care (*i.e.*, steroids, racemic epinephrine), (2) postextubation counseling (*i.e.*, informing and advising the patient or responsible individual of the occurrence and potential complications associated with a difficult airway), (3) documentation of difficult airway and management in the medical record and to the patient, and (4) registration with a difficult airway notification service.

Literature Findings. The literature is insufficient to evaluate the benefits of postextubation steroids or epinephrine, counseling, documentation in the medical record, or registration with a difficult airway notification service. A case report of a difficult airway patient who was awakened after failed intubation indicated that records of previous difficult intubations were unavailable *(Category B4-H evidence)*.[559]

Survey Findings. The consultants and members of participating organizations strongly agree with the recommendation to inform the patient (or responsible person) of the airway difficulty that was encountered to provide the patient (or responsible person) with information to guide and facilitate the delivery of future care and to document the presence and nature of the airway difficulty in the medical record to guide and facilitate the delivery of future care.

Recommendations for Follow-up Care. • Use postextubation steroids and/or racemic epinephrine when appropriate.

- Inform the patient or a responsible person of the airway difficulty that was encountered to provide the patient (or responsible person) with a role in guiding and facilitating the delivery of future care.
  - The information conveyed may include (but is not limited to) the presence of a difficult airway, the apparent reasons for difficulty, how the intubation was accomplished, and the implications for future care.
- Document the presence and nature of the airway difficulty in the medical record to guide and facilitate the delivery of future care.‖‖‖‖‖‖‖
- Instruct the patient to register with an emergency notification service when appropriate and feasible.

§§§§§These interventions are considered advanced techniques.

‖‖‖‖‖‖‖Aspects of documentation include, but are not limited to, (1) a description of the airway difficulties that were encountered, distinguishing between difficulties encountered in facemask or supraglottic airway ventilation and difficulties encountered in tracheal intubation and (2) a description of the various airway management techniques that were used, indicating the extent to which each of the techniques served either a beneficial or detrimental role in management of the difficult airway.

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Appendix 1: Summary of Recommendations

Recommendations for Evaluation of the Airway

- Before the initiation of anesthetic care or airway management, ensure that an airway risk assessment is performed by the person(s) responsible for airway management whenever feasible to identify patient, medical, surgical, environmental, and anesthetic factors (*e.g.*, risk of aspiration) that may indicate the potential for a difficult airway.
  - When available in the patient's medical records, evaluate demographic information, clinical conditions, diagnostic test findings, patient/family interviews, and questionnaire responses.
  - Assess multiple demographic and clinical characteristics to determine a patient's potential for a difficult airway or aspiration.
- Before the initiation of anesthetic care or airway management, conduct an airway physical examination to further identify physical characteristics that may indicate the potential for a difficult airway.
  - The physical examination may include assessment of facial features##### and assessment of anatomical measurements and landmarks.******
  - Additional evaluation to characterize the likelihood or nature of the anticipated airway difficulty may include bedside endoscopy, virtual laryngoscopy/bronchoscopy, or three-dimensional printing.††††††
- Assess multiple airway features to determine a patient's potential for a difficult airway or aspiration.

Recommendations for Preparation for Difficult Airway Management

- Ensure that airway management equipment is available in the room.‡‡‡‡‡‡
- Ensure that a portable storage unit that contains specialized equipment for difficult airway management is immediately available.§§§§§§
- If a difficult airway is known or suspected:
  - Ensure that a skilled individual is present or immediately available to assist with airway management when feasible.
  - Inform the patient or responsible person of the special risks and procedures pertaining to management of the difficult airway.
  - Properly position the patient, administer supplemental oxygen before initiating management of the difficult airway,‖‖‖‖‖‖‖‖‖ and continue to deliver supplemental oxygen whenever feasible throughout the process of difficult airway management, including extubation.######
- Ensure that, at a minimum, monitoring according to the ASA Standards for Basic Anesthesia Monitoring is performed immediately before, during, and after airway management of all patients.*******

Recommendations for Anticipated Difficult Airway Management

- Have a preformulated strategy for management of the anticipated difficult airway.
  - This strategy will depend, in part, on the anticipated surgery, the condition of the patient, patient cooperation/consent, the age of the patient, and the skills and preferences of the anesthesiologist.
  - Identify a strategy for: (1) awake intubation, (2) the patient who can be adequately ventilated but is difficult to intubate, (3) the patient who cannot be ventilated or intubated, and (4) difficulty with emergency invasive airway rescue.
  - When appropriate, perform awake intubation if the patient is suspected to be a difficult intubation and one or more of the following apply: (1) difficult ventilation (face mask/supraglottic airway), (2) increased risk of aspiration, (3) the patient is likely incapable of tolerating a brief apneic episode, or (4) there is expected difficulty with emergency invasive airway rescue.†††††††
  - The uncooperative or pediatric patient may restrict the options for difficult airway management, particularly options that involve awake intubation. Airway management in the uncooperative or pediatric patient may require an approach (*e.g.*, intubation attempts after induction of general anesthesia) that might not be regarded as a primary approach in a cooperative patient.

#####Examples of facial features include mouth opening, the ability to prognath, head and neck mobility, prominent upper incisors, presence of a beard, and the upper lip bite test.

******Examples of anatomical measures include Mallampati and modified Mallampati scores, thyromental distance, sternomental distance, interincisor distance, neck circumference, ratio of neck circumference to thyromental distance, ratio of height to thyromental distance, hyomental distance, and hyomental distance ratio. Measurements obtained from ultrasound included skin-to-hyoid distance, tongue volume, and distance from skin to epiglottis.

††††††In addition to airway evaluation, three-dimensional printing may be a useful means of testing methods for device insertion or for practitioner training.

‡‡‡‡‡‡See table 1 for examples of appropriate airway equipment.

§§§§§§See table 2 for examples of specialized equipment for a portable storage unit.

‖‖‖‖‖‖‖‖‖The uncooperative or pediatric patient may impede opportunities for oxygen administration.

######Opportunities for supplemental oxygen administration include (but are not limited to) oxygen delivery by nasal cannulae, facemask, or supraglottic insufflation.

*******This recommendation does not preclude local or institutional policies that require more stringent monitoring.

†††††††Any one factor alone (*i.e.*, assessed difficulty with intubation or ventilation, increased risk of aspiration or desaturation) may be of sufficient clinical importance to warrant an awake intubation.

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- Proceed with airway management after induction of general anesthesia when the benefits are judged to outweigh the risks.
- For either awake or anesthetized intubation, airway maneuver(s) may be attempted to facilitate intubation.
- Before attempting intubation of the anticipated difficult airway, determine the benefit of a noninvasive *versus* invasive approach to airway management.
  - If a noninvasive approach is selected, identify a preferred sequence of noninvasive devices to use for airway management.‡‡‡‡‡‡‡
    - If difficulty is encountered with individual techniques, combination techniques may be performed.§§§§§§§
    - Be aware of the passage of time, the number of attempts, and oxygen saturation.
    - Provide and test mask ventilation after each attempt, when feasible.
    - Limit the number of attempts at tracheal intubation or supraglottic airway placement to avoid potential injury and complications.
  - If an elective invasive approach to the airway is selected, identify a preferred intervention.‖‖‖‖‖‖‖‖‖‖
    - Ensure that an invasive airway is performed by an individual trained in invasive airway techniques, whenever possible.
    - If the selected approach fails or is not feasible, identify an alternative invasive intervention.
      - Initiate ECMO when/if appropriate and available.

Recommendations for Unanticipated and Emergency Difficult Airway Management

- Call for help.
- Optimize oxygenation.#######
- When appropriate, refer to an algorithm******** and/or cognitive aid.
- Upon encountering an unanticipated difficult airway:
  - Determine the benefit of waking and/or restoring spontaneous breathing.
  - Determine the benefit of a noninvasive *versus* invasive approach to airway management.
  - If a noninvasive approach is selected, identify a preferred sequence of noninvasive devices to use for airway management.††††††††
    - If difficulty is encountered with individual techniques, combination techniques may be performed.
    - Be aware of the passage of time, the number of attempts, and oxygen saturation.
    - Provide and test mask ventilation after each attempt, when feasible.
    - Limit the number of attempts at tracheal intubation or supraglottic airway placement to avoid potential injury and complications.
- If an invasive approach to the airway is necessary (*i.e.*, cannot intubate, cannot ventilate), identify a preferred intervention.‡‡‡‡‡‡‡‡
  - Ensure that an invasive airway is performed by an individual trained in invasive airway techniques, whenever possible.
  - Ensure that an invasive airway is performed as rapidly as possible.
  - If the selected invasive approach fails or is not feasible, identify an alternative invasive intervention.
    - Initiate ECMO when/if appropriate and available.

Recommendations for Confirmation of Tracheal Intubation

- Confirm tracheal intubation using capnography or end-tidal carbon dioxide monitoring.
- When uncertain about the location of the tracheal tube, determine whether to either remove it and attempt ventilation or use additional techniques to confirm positioning of the tracheal tube.§§§§§§§§

‡‡‡‡‡‡‡Noninvasive devices include rigid laryngoscopic blades of alternative designs and sizes (with adequate face mask ventilation after induction), adjuncts (*e.g.*, introducers, bougies, stylets, alternative tracheal tubes, and supraglottic airways), video/video-assisted laryngoscopy, flexible intubation scopes, supraglottic airway devices, lighted or optical stylets, alternative optical laryngoscopes, and rigid bronchoscopes.

§§§§§§§Combination techniques may include, but are not limited to, (1) direct or video laryngoscopy combined with either optical/video stylet, flexible scope intubation, airway exchange catheter, retrograde-placed guide wire, or supraglottic airway placement and (2) supraglottic airway combined with either optical/video stylet, flexible scope intubation (with or without hollow guide catheter), or retrograde-placed guide wire.

‖‖‖‖‖‖‖‖‖‖Invasive interventions may include, but are not limited to, one of the following techniques: surgical cricothyrotomy (*e.g.*, scalpel-bougie-tube), needle cricothyrotomy with a pressure-regulated device, large-bore cannula cricothyrotomy or surgical tracheostomy, retrograde wire–guided intubation, and percutaneous tracheostomy.

#######Examples include low- or high-flow nasal oxygen during efforts securing a tube.

********See figs. 1 to 4 for examples of algorithms or cognitive aids.

††††††††Noninvasive devices include rigid laryngoscopic blades of alternative design and size (with adequate face mask ventilation after induction), adjuncts (*e.g.*, introducers, bougies, stylets, alternative tracheal tubes, and supraglottic airways), video/video-assisted laryngoscopy, flexible intubation scopes, supraglottic airway devices, lighted optical stylets, alternative optical laryngoscopes, and rigid bronchoscopes.

‡‡‡‡‡‡‡‡Invasive interventions may include surgical cricothyrotomy (*e.g.*, scalpel-bougie technique), surgical tracheostomy, needle cricothyrotomy with pressure-regulated ventilation (*e.g.*, transtracheal jet ventilation or other pressure-regulated techniques), and large-bore cannula cricothyrotomy (including Seldinger guided techniques).

§§§§§§§§Additional techniques include but are not limited to visualization (any technique), flexible bronchoscopy, ultrasonography, or radiography.

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Recommendations for Extubation of the Difficult Airway

- Have a preformulated strategy for extubation and subsequent airway management.
  - This strategy will depend, in part, on the surgery/procedure, other perioperative circumstances, the condition of the patient, and the skills and preferences of the clinician.
- Assess patient readiness for extubation.
- Ensure that a skilled individual is present to assist with extubation when feasible.
- Select an appropriate time and location for extubation when possible.
- Assess the relative clinical merits and feasibility of the short-term use of an airway exchange catheter and/or supraglottic airway that can serve as a guide for expedited reintubation.||||||||||||
  - Minimize the use of an airway exchange catheter with pediatric patients.
- Before attempting extubation, evaluate the risks and benefits of elective surgical tracheostomy.
- Evaluate the risks and benefits of awake extubation *versus* extubation before the return to consciousness.
- When feasible, use supplemental oxygen throughout the extubation process.
- Assess the clinical factors that may produce an adverse impact on ventilation after the patient has been extubated.

Recommendations for Follow up Care

- Use postextubation steroids and/or racemic epinephrine when appropriate.
- Inform the patient or a responsible person of the airway difficulty that was encountered to provide the patient (or responsible person) with a role in guiding and facilitating the delivery of future care.
  - The information conveyed may include (but is not limited to) the presence of a difficult airway, the apparent reasons for difficulty, how the intubation was accomplished, and the implications for future care.
- Document the presence and nature of the airway difficulty in the medical record to guide and facilitate the delivery of future care.########
- Instruct the patient to register with an emergency notification service when appropriate and feasible.

||||||||||||These interventions are considered advanced techniques.

########Aspects of documentation include, but are not limited to, (1) a description of the airway difficulties that were encountered, distinguishing between difficulties encountered in facemask or supraglottic airway ventilation, and difficulties encountered in tracheal intubation and (2) a description of the various airway management techniques that were used, indicating the extent to which each of the techniques served either a beneficial or detrimental role in management of the difficult airway.

Appendix 2: Methods and Analyses

For these updated guidelines, a systematic search and review of peer-reviewed published literature was conducted, with scientific findings summarized and reported below and in the document. Assessment of conceptual issues, practicality, and feasibility of the guideline recommendations were also evaluated, with opinion data collected from surveys and other sources. The systematic literature review is based on evidence linkages or statements regarding potential relationships between interventions and outcomes associated with difficult airway management. The evidence model below guided the search, providing inclusion and exclusion information regarding patients, procedures, practice settings, providers, clinical interventions, and outcomes. The opinion data were obtained from surveys based on proposed recommendations derived from the literature findings (see "Consensus-based evidence" below).

After review of all evidentiary information, the task force placed each recommendation into one of three categories: (1) provide the intervention or treatment, (2) provide the patient with the intervention or treatment based on circumstances of the case and the practitioner's clinical judgment, or (3) do not provide the intervention or treatment. The policy of the ASA Committee on Standards and Practice Parameters is to update practice guidelines every 5 yr. The ASA Committee on Standards and Practice Parameters reviews all practice guidelines at the ASA annual meeting and determines update and revision timelines.

Evidence Model

Patients

- Inclusion criteria:
  - Patients with or at risk of difficult mask ventilation
  - Patients with or at risk of difficult laryngoscopy (direct or indirect)*********
  - Patients with or at risk of difficult ventilation using a supraglottic airway
  - Patients with or at risk of difficult/failed tracheal intubation
  - Patients with or at risk of difficult/failed extubation
  - Anticipated difficult airway patients
  - Unanticipated difficult airway patients
  - Adult patients
  - Pediatric patients including infants and neonates
  - Obstetric patients
  - ICU/critically ill patients
- Exclusion criteria
  - Patients where difficult airways are not encountered

*********Patients "at risk" refers to difficult laryngoscopy where it is not possible to visualize any portion of the vocal cords after multiple attempts.

†††††††††These include, but are not limited to hypoxemia, hypotension, severe metabolic acidosis, and right ventricular failure.

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- Physiologically difficult airways that are not anatomically difficult††††††††

Procedures

- Inclusion criteria:
  - Procedures requiring general anesthesia
  - Procedures requiring sedation or regional anesthesia
  - Elective/emergency airway management without a procedure
  - Diagnostic procedures
  - Elective procedures
  - Emergency procedures
  - Invasive airway access
- Exclusion criteria:
  - Airway management during cardiopulmonary resuscitation

Practice Settings

- Inclusion criteria:
  - In-hospital
    - Perioperative care settings
    - Nonoperating room anesthetic setting
    - Emergency department setting
    - ICU/critical care setting
  - Ambulatory surgery centers
  - Office-based procedure/anesthesia locations
  - Out-of-hospital or prehospital (*i.e.*, field) settings, included only if emergency invasive airway is performed
- Exclusion criteria:
  - Out-of-hospital or prehospital (*i.e.*, field) settings, excluded except for emergency invasive airway

Providers

- Inclusion criteria:
  - Anesthesia care providers
- Exclusion criteria:
  - Individuals who do not deliver anesthetic care and airway management

Interventions

- Evaluation of the airway
  - Risk prediction (for difficult airway or aspiration) obtained from history/medical records
    - Demographic conditions (*e.g.*, age, sex)
    - Clinical conditions (*e.g.*, body mass index, previous difficult airway, diabetes, obesity)
    - Diagnostic test findings (*e.g.*, radiography, computed tomography, magnetic resonance imaging, bedside endoscopy, bedside ultrasound)
    - Patient interview/questionnaires (*e.g.*, MACOCHA, STOP-Bang)
  - Airway assessment/exam (bedside and advanced) when a difficult airway is known or suspected
    - Assessment of facial features (*e.g.*, mouth opening, nose slope, neck slope, ratio of brow to nose to chin, full beard)
    - Upper lip bite test
    - Anatomical measurements and landmarks (*e.g.*, Mallampati/modified Mallampati, neck circumference, neck mobility (neck radiation changes), prognathism, ruler or finger measurements of thyromental, sternomental, or temporomandibular distance)
- Individual measures contained in airway scoring systems (*e.g.*, Wilson risk sum scores, simplified airway risk index scores, El-Ganzouri scores)
- Imaging
  - Ultrasound
  - Virtual laryngoscopy/bronchoscopy (magnetic resonance imaging/computed tomography reconstruction)
  - 3D printing
  - Bedside endoscopy
  - Direct laryngoscopy (*e.g.*, Cormac–Lehane grades)
  - Bronchoscopy
  - Nasopharyngoscopy
- Preparation for difficult airway management
  - Availability of equipment for airway management (*i.e.*, items for anesthetizing locations, portable storage unit, cart, or trolley for difficult airway management)
  - Availability of an assigned individual to provide assistance when a difficult airway is encountered (from previous evidence model)
  - Informing the patient with a known or suspected difficult airway
  - Preoxygenation‡‡‡‡‡‡‡‡‡
    - Preoxygenation *versus* room air
    - 3 to 5 min of O_2 (3 to 5 min at tidal volume, $F_{IO_2} = 1$) *versus* 1 min (1 min at tidal volume, $F_{IO_2} = 1$)
    - 3 to 5 min of O_2 (3 to 5 min at tidal volume, $F_{IO_2} = 1$) *versus* 4 to 12 deep breaths at forced vital capacity in 1 min or the shortest time lag ($F_{IO_2} = 1$)
    - 3 min of preoxygenation to reach an end-tidal oxygen concentration of 0.90 of higher ($Et_{O_2} \geq 0.9$)
    - Preoxygenation using noninvasive ventilation (pressure support with positive end expiratory pressure)
  - Patient positioning (*e.g.*, sniffing, sitting, head/neck extension, head-elevated laryngoscopy, ramped)
  - Sedative *versus* hypnotic administration
  - Local anesthesia *versus* no local anesthesia

‡‡‡‡‡‡‡‡‡Methods to deliver preoxygenation include oxygen delivery with nasal cannulae, facemask (including humidified nasal cannula and continuous positive airway pressure), or supraglottic airway insufflation.
§§§§§§§§§Methods to deliver supplemental oxygen include oxygen delivery with nasal cannulae, facemask (including humidified nasal cannula and continuous positive airway pressure), or supraglottic airway insufflation.

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- Supplemental oxygen during airway management §§§§§§§§§
- Patient monitoring (according to ASA standards)

- Anticipated difficult airway management.
  - Awake tracheal intubation (any device)
    - Awake/sedated intubation *versus* intubation after induction
    - Awake/sedated *versus* anesthetized intubation in patients with full stomach
  - Anesthetized tracheal intubation
    - Rapid sequence induction/intubation
- With *versus* without cricoid pressure (Sellick maneuver)
- Pressure-limited mask ventilation *versus* ablation of spontaneous ventilation
  - Maintenance of spontaneous ventilation *versus* ablation of spontaneous ventilation
  - Administration of neuromuscular blockade to improve mask ventilation
  - Rocuronium with sugammadex *versus* suxamethonium or succinylcholine
- Both awake and anesthetized intubation
  - Airway maneuvers (*e.g.*, jaw thrust chin lift, external laryngeal manipulation, backwards/upwards/rightwards pressure)
- Airway management devices
  - Rigid laryngoscopic blades of alternative design and size: with adequate face mask ventilation after induction (alternatives to standard blades such as Macintosh, Miller)
  - Adjuncts – introducers, bougies, stylets, alternative tracheal tubes
  - Video/video-assisted laryngoscopy
- Video/video-assisted laryngoscopy *versus* direct laryngoscopy
- Video/video-assisted laryngoscopy *versus* fiberoptic laryngoscopy
- Channel-guided *versus* non–channel-guided videolaryngoscopes||||||||||||||
- Hyperangulated *versus* nonangulated devices
  - Flexible intubation scopes
- Flexible intubation scopes *versus* blind tracheal or nasotracheal intubation
- Flexible intubation scopes *versus* rigid laryngoscopic intubation
  - Supraglottic airway
- Supraglottic airway *versus* face mask for ventilation
- Intubation with *versus* without a supraglottic airway
- Intubating techniques with a supraglottic airway
  - Laryngoscopic intubation with a supraglottic airway *versus* blind intubation with a supraglottic airway
  - Flexible scope intubation with a supraglottic airway *versus* standard laryngoscopic intubation with a supraglottic airway
  - Optically/image-guided intubation with a supraglottic airway *versus* standard laryngoscopic intubation with a supraglottic airway
- Second *versus* first generation supraglottic airway
  - Lighted stylet, light wand, optical stylet
- Lighted stylet, light wand, or optical stylet *versus* blind intubation
- Lighted stylet, light wand, or optical stylet *versus* laryngoscopic intubation
  - Rigid bronchoscope
- Intubation with *versus* without a supraglottic airway
- Intubating techniques with a supraglottic airway
- Laryngoscopic intubation with a supraglottic airway *versus* blind intubation with a supraglottic airway
- Flexible scope intubation with a supraglottic airway *versus* standard laryngoscopic intubation with a supraglottic airway
- Optically/image-guided intubation with a supraglottic airway *versus* standard laryngoscopic intubation with a supraglottic airway
  - Additional airway management interventions (with anticipated failure of airway management devices)
    - Retrograde wire–guided intubation
    - Invasive airway
- Cricothyrotomy (percutaneous)
- Cricothyrotomy (surgical)
- Tracheostomy/tracheotomy
- Scalpel bougie technique or scalpel bougie tube technique *versus* needle cannula technique
- Awake/sedated cricothyrotomy/tracheostomy for invasive airway
  - Combination techniques#########
- Unanticipated and emergency (*i.e.*, cannot oxygenate or ventilate) difficult airway management.
  - Call for help
  - Maximize oxygenation
    - Nasal oxygen during efforts securing a tube
    - Expiratory ventilation assistance
    - High-flow nasal cannula oxygen/transnasal humidified rapid insufflation ventilatory exchange
  - Use of a cognitive aid
  - Airway management devices
    - Rigid bronchoscope

||||||||||||||Channel-guided devices include Airtraq, Kingvision, and Pentax videolaryngoscopes. Non–channel-guided devices include Glidescope, C-MAC, and McGrath videolaryngoscopes.

#########Combination techniques include (1) direct laryngoscopy with supraglottic airway, bougie, optical stylet, flexible intubation scope, airway exchange catheter, or retrograde intubation; (2) videolaryngoscopes with supraglottic airway, bougie, optical stylet, flexible scope/fiberoptic scope, airway exchange catheter, or retrograde intubation; (3) flexible intubation scope with supraglottic airway, airway exchange catheter, retrograde intubation, or cricothyrotomy; (4) optical stylet with supraglottic airway, bougie, flexible scope intubation scope, or retrograde intubation; and (5) airway exchange catheter with supraglottic airway, retrograde intubation, or cricothyrotomy.

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    - Rigid laryngoscopic blades of alternative design and size: with adequate face mask ventilation after induction (alternatives to standard blades such as Macintosh, Miller)
    - Lighted stylet, light wand, optical stylet
- Lighted stylet, light wand, or optical stylet *versus* blind intubation
- Lighted stylet, light wand, or optical stylet *versus* laryngoscopic intubation
    - Flexible intubation scopes)
- Flexible scope intubation *versus* blind tracheal or nasotracheal intubation
- Flexible scope intubation *versus* rigid laryngoscopic intubation
    - Video/video-assisted laryngoscopy
- Video/video-assisted laryngoscopy *versus* direct laryngoscopy
- Video/video-assisted laryngoscopy *versus* flexible scope intubation
- Hyperangulated *versus* nonangulated devices
- Channel-guided *versus* non–channel-guided videolaryngoscopes
- Alternative optical laryngoscopes
    - Adjuncts – introducers, bougies, stylets, alternative tracheal tubes
    - Supraglottic airway
- Supraglottic airway *versus* face mask for ventilation
- Intubation with *versus* without a supraglottic airway
- Intubating techniques with a supraglottic airway
    - Laryngoscopic intubation with a supraglottic airway *versus* blind intubation with a supraglottic airway
    - Flexible scope intubation with a supraglottic airway *versus* standard laryngoscopic intubation with a supraglottic airway
    - Optically/image-guided intubation with a supraglottic airway *versus* standard laryngoscopic intubation with a supraglottic airway
- Second- *versus* first-generation supraglottic airway
    - Additional airway management interventions (with anticipated failure of airway management devices)
        - Retrograde wire–guided intubation
        - Emergency invasive airway
- Cricothyrotomy (percutaneous)
- Cricothyrotomy (surgical)
- Tracheostomy/tracheotomy
- Scalpel bougie technique or scalpel bougie tube technique *versus* needle cannula technique
- Awake/sedated cricothyrotomy/tracheostomy for emergency invasive airway
    - ECMO
    - Jet ventilation
    - Combination techniques
- Confirmation of successful intubation
    - Pulse oximetry (for oxygen saturation levels/desaturation/hypoxemia/hypoxia)
    - Capnography for carbon dioxide levels/hypercarbia/hypercapnia
        - Capnography *versus* capnometry
        - Capnography *versus* colorimetry
    - Visualization (any technique)
    - Flexible bronchoscopy
    - Ultrasound
    - Radiography
- Extubation
    - Assess readiness for extubation
    - Presence of a skilled individual to assist
    - Selection of ideal time and location
    - Plan for possible reintubation
    - Elective tracheostomy
    - Awake extubation or supraglottic airway removal
        - Awake tracheal tube extubation *versus* asleep (anesthetized) extubation
        - Awake supraglottic airway removal *versus* anesthetized supraglottic airway removal
        - Apnea *versus* spontaneous ventilation during extubation
    - Supplemental oxygen throughout extubation (*e.g.*, by mask, blow-by, nasal cannula, continuous positive airway pressure, bilevel positive airway pressure, or high-flow nasal cannula)
    - Supplemental oxygen after extubation
    - Staged extubation
- Airway exchange catheter
- Supraglottic airway exchange catheter (Bailey maneuver)
- Follow-up care
    - Postextubation steroids
    - Postextubation epinephrine
    - Postextubation counseling (*i.e.*, informing and advising the patient or responsible patient of the occurrence and potential complications associated with a difficult airway)
    - Documentation of difficult airway and management in the medical record and to the patient
    - Registration with an emergency notification service
- Human factors

Excluded Interventions

- Interventions not addressing any aspect of airway and anesthetic management
- Lung separation
    - Double lumen tube

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- Bronchial blocker
- Physiologically difficult airway
- Details of awake intubation techniques
- Submental intubation
- Cardiopulmonary bypass
- Effects of anesthetics/sedatives on ease of intubation/supraglottic airway insertion (*e.g.*, propofol)
- Details of ECMO

Outcomes

- Inclusion criteria:
  - Identification of patient characteristics at risk of difficult intubation
  - Identification of patient characteristics leading to awake intubation
  - Intubation/ventilation success/failure:
    - Face/bag mask ventilation (success/failure, easy/difficult)
    - supraglottic airway placement (success/failure, number of attempts)
    - Laryngoscopy (success/failure, number of attempts)
    - Tracheal intubation (success/failure, number of attempts)
    - Invasive airway
- Percutaneous cricothyrotomy (success/failure)
- Surgical cricothyrotomy (success/failure)
- Tracheostomy (success/failure)
- Scalpel bougie technique or scalpel bougie tube technique *versus* needle catheter technique (success/failure)
    - Restoration of failed oxygenation (success/failure)
    - Esophageal intubation
    - Barotrauma (pneumothorax, pneumomediastinum)
    - Subcutaneous emphysema
    - Gastric rupture
    - Tracheal rupture
    - Delayed tracheal stenosis
  - Physiologic outcomes (measurement of physiologic functioning)
    - Oxygenation/desaturation
    - Carbon dioxide levels
    - Hemodynamic levels (*e.g.*, mean arterial pressure, central venous pressure)
  - Clinical outcomes
    - Hypoxemia/hypoxia
    - Hypercapnia/hypercarbia
    - Hemodynamic instability
    - Aspiration
    - Airway injury/trauma
    - Soft tissue injuries/blind spot injuries
    - Sore throat
    - Palatal injury
    - Oral/dental damage
    - Cardiac events (*e.g.*, cardiac arrest)
    - Neurologic injury
    - Unplanned tracheotomy/surgical airway
    - Neurologic deficit of less than 72 h
  - Permanent (long-term) outcomes
    - Death
    - Respiratory system damage
- Airway trauma
- Pneumothorax
- Aspiration
  - Nerve/brain damage
- Nerve damage
- Neurologic/memory deficit
- Permanent brain damage
- Brain injury (anoxic encephalopathy)
  - Cardiovascular damage
- Cardiopulmonary arrest
  - Fetal/newborn damage
  - Functional deficit
- Awareness/fright
- Loss of employment
  - Nonclinical outcomes
    - Unplanned ICU admission
    - Unplanned hospital admission
    - Surgery postponed/cancelled
    - Length of hospital stay
    - Patient satisfaction
- Exclusion criteria:
  - No exclusion criteria

Evidence Collection

- Literature inclusion criteria:
  - Randomized controlled trials
  - Prospective nonrandomized comparative studies (*e.g.*, quasiexperimental, cohort)
  - Retrospective comparative studies (*e.g.*, case control)
  - Observational studies (*e.g.*, correlational or descriptive statistics)
  - Case reports, case series
- Literature exclusion criteria (except to obtain new citations):
  - Editorials
  - Literature reviews
  - Meta-analyses conducted by others
  - Unpublished studies
  - Studies in non–peer-reviewed journals
  - Newspaper articles
- Survey evidence:
  - Expert consultant survey
  - ASA membership survey
  - Membership surveys of other participating organizations
  - Reliability survey
  - Feasibility survey

State of the Literature

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For the systematic review, potentially relevant clinical studies were identified *via* electronic and manual searches. Bibliographic database searches included PubMed and EMBASE. The searches covered a 9.25-yr period from January 1, 2012, through March 31, 2021. Citation searching (backward and forward) of relevant meta-analyses and other systematic reviews was also performed. No search for gray literature was conducted. Publications identified by task force members were also considered. Accepted studies from the previous guidelines were re-reviewed, covering the period of January 1, 2002, through June 31, 2012. Only studies containing original findings from peer-reviewed journals were acceptable. Editorials, letters, and other articles without data were excluded. A literature search strategy and PRISMA★ flow diagram are available as Supplemental Digital Content 2, http://links.lww.com/ALN/C695. In total, 12,544 unique new citations were identified, with 1,026 full articles assessed for eligibility. After review, 619 were excluded, with 407 new studies meeting inclusion criteria. These studies were combined with 190 pre-2012 articles from the previous guidelines, resulting in a total of 597 articles accepted as evidence for these guidelines. In this document, 559 are referenced, with a complete bibliography of articles used to develop these guidelines, organized by section, available as Supplemental Digital Content 3, http://links.lww.com/ALN/C696.

Each pertinent outcome reported in a study was classified by evidence category and level and designated as beneficial, harmful, or equivocal. Findings were then summarized for each evidence linkage and reported in the text of the updated guidelines.

Evidence categories refer specifically to the strength and quality of the research design of the studies. Category A evidence represents results obtained from randomized controlled trials, and category B evidence represents observational results obtained from nonrandomized study designs or randomized trials without pertinent comparison groups. When available, category A evidence is given precedence over category B evidence for any particular outcome. These evidence categories are further divided into evidence levels. Evidence levels refer specifically to the strength and quality of the summarized study findings (*i.e.*, statistical findings, type of data, and the number of studies reporting/replicating the findings). In this document, the highest level of evidence is included in the summary report for each intervention–outcome pair, including a designation of benefit, harm, or equivocality.

Category A

Randomized controlled trials report comparative findings between clinical interventions for specified outcomes. Statistically significant ($P < 0.01$) outcomes are designated as either beneficial (B) or harmful (H) for the patient; statistically nonsignificant findings are designated as equivocal (E).

Level 1

The literature contains a sufficient number of randomized controlled trials to conduct meta-analysis,********** and meta-analytic findings from these aggregated studies are reported as evidence.

Level 2

The literature contains multiple randomized controlled trials, but the number of randomized controlled trials is not sufficient to conduct a viable meta-analysis for the purpose of these guidelines. Findings from these randomized controlled trials are reported separately as evidence.

Level 3

The literature contains a single randomized controlled trial, and findings from this study are reported as evidence.

Category B

Observational studies or randomized controlled trials without pertinent comparison groups may permit inference of beneficial or harmful relationships among clinical interventions and clinical outcomes. Inferred findings are given a directional designation of beneficial (B), harmful (H), or equivocal (E). For studies that report statistical findings, the threshold for significance is $P < 0.01$.

Level 1

The literature contains nonrandomized comparisons (*e.g.*, quasiexperimental, cohort [prospective or retrospective], or case-control research designs) with comparative statistics between clinical interventions for a specified clinical outcome.

Level 2

The literature contains noncomparative observational studies with associative statistics (*e.g.*, correlation, sensitivity, and specificity).

Level 3

The literature contains noncomparative observational studies with descriptive statistics (*e.g.*, frequencies, percentages).

Level 4

The literature contains case reports.

**********A minimum of five independent randomized controlled trials (*i.e.*, sufficient for fitting a random-effects model) is required for meta-analysis.[560]

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Insufficient Literature

The lack of sufficient scientific evidence in the literature may occur when the evidence is either unavailable (*i.e.*, no pertinent studies found) or inadequate. Inadequate literature cannot be used to assess relationships among clinical interventions and outcomes, either, because a clear interpretation of findings is not obtained due to methodologic concerns (*e.g.*, confounding of study design or implementation) or the study does not meet the criteria for content as defined in the "focus" of the guidelines.

Literature addressing risk prediction reported sensitivity, specificity, positive and negative predictive, and other common values for age, sex, body mass index, weight, height, and history of snoring. Values for airway assessment were reported for facial and jaw features, anatomical landmarks, and measurements.

Literature relating to videolaryngoscopes contained enough studies with well defined experimental designs and statistical information to conduct formal meta-analyses (table 4). Outcomes assessed were (1) laryngoscopic view, (2) intubation success, (3) first attempt intubation success, (4) assist maneuvers used for intubation, and (5) time to intubation. For meta-analyses of studies reporting frequency of events, event rates and odds ratios were pooled. Time to intubation was pooled using mean differences (continuous outcomes) for clinical relevance. Fixed-effects models were fitted using Mantel–Haenszel or inverse variance weighting as appropriate. Random-effects models were fitted with inverse variance weighting using the DerSimonian and Laird estimate of between-study variance. Sensitivity to effect measure was also examined. Heterogeneity was quantified with I^2 and a significance level of $P < 0.01$ was applied for analyses. Statistics for individual studies and forest plots are available as Supplemental Digital Content 4, http://links.lww.com/ALN/C697.

Interobserver agreement among task force members and two methodologists was assessed for this update, with agreement levels using a κ statistic for two-rater agreement pairs as follows: (1) research design, $\kappa = 0.55$ to 0.61; (2) type of analysis, $\kappa = 0.55$ to 0.83; (3) evidence linkage assignment, $\kappa = 0.67$ to 0.79; and (4) literature inclusion for database, $\kappa = 0.08$ to 0.79. Three-rater κ values between two methodologists and task force reviewers were (1) research design, $\kappa = 0.61$; (2) type of analysis, $\kappa = 0.65$; (3) linkage assignment, $\kappa = 0.67$; and (4) literature database inclusion, $\kappa = 0.15$. These values represented low to moderate levels of agreement.

Consensus-based Evidence

Validation of the concepts addressed by these guidelines and subsequent recommendations proposed was obtained by consensus from multiple sources, including (1) survey opinion from expert consultants who were selected based on their knowledge or expertise in difficult airway management; (2) survey opinions from randomly selected samples of active members of the ASA and participating organizations; and (3) internet commentary. All opinion-based evidence relevant to each topic was considered in the development of these guidelines. However, only findings obtained from formal surveys are reported in the document. Opinion surveys were developed by the task force to address each clinical intervention identified in the document. Identical surveys were distributed to expert consultants, a random sample of ASA members, and members of the participating organizations.

Survey responses were recorded using a five-point scale and summarized based on median values††††††††††:

Strongly agree: Median score of 5 (at least 50% of the responses are 5)

Agree: Median score of 4 (at least 50% of the responses are 4 or 4 and 5)

Equivocal: Median score of 3 (at least 50% of the responses are 3, or no other response category or combination of similar categories contains at least 50% of the responses)

Disagree: Median score of 2 (at least 50% of responses are 2 or 1 and 2)

Strongly disagree: Median score of 1 (at least 50% of responses are 1)

For consultant respondents, the rate of return for the survey addressing guideline recommendations was 82% (n = 174 of 212), and the results are presented in table 5. For membership respondents, the survey totals were as follows: American Society of Anesthesiologists (ASA) = 220; All India Difficult Airway Association (AIDAA) = 74; European Airway Management Society (EAMS) = 79; Italian Society of Anesthesiology, Analgesia, Resuscitation and Intensive Care (SIAARTI) = 177; Learning, Teaching and Investigation Difficult Airway Group (FIDIVA) = 24; Society for Ambulatory Anesthesia (SAMBA) = 47; Society for Airway Management (SAM) = 70; Society for Head and Neck Anesthesia (SHANA) = 27; Society for Pediatric Anesthesia (SPA) = 268; Society of Critical Care Anesthesiologists (SOCCA) = 85; and Trauma Anesthesiology Society (TAS) = 21. Survey results for each organization are presented as Supplemental Digital Content 5, http://links.lww.com/ALN/C698.

An additional survey was sent to the consultants accompanied by a draft of the guidelines asking them

††††††††††When an equal number of categorically distinct responses are obtained, the median value is determined by calculating the arithmetic mean of the two middle values. Ties are calculated by a predetermined formula.

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to indicate which, if any, of the recommendations would change their clinical practices if the guidelines were instituted. The rate of return was 31% (n = 68 of 218). The percentage of responding consultants expecting *no change* associated with each linkage were as follows: (1) evaluation of the airway = 82%, (2) availability of airway management equipment = 79%, (3) the presence of a skilled individual to assist = 82%, (4) supplemental oxygen delivery = 76%, strategy for management of an anticipated difficult airway = 88%, awake intubation strategy = 81%, selection of an elective invasive airway = 84%, preferred sequence of devices for attempting intubation = 93%, strategy for management of an unanticipated difficult airway = 88%, strategy for management of an emergency difficult airway = 87%, use of an algorithm, cognitive aid, or infographic = 65%, use of capnography for confirmation of intubation = 90%, strategy for invasive management of a difficult airway = 82%, supplemental oxygen delivery for extubation = 87%, and documentation of the encountered difficult airway = 81%. Of all the respondents, 91% indicated that the guidelines would have *no effect* on the amount of time spent on a typical case, 7% indicated that there would be an increase of the amount of time spent on a typical case, and 1% indicated a decrease in time with the implementation of these guidelines; 72% indicated that new equipment, supplies, or training would *not* be needed to implement the guidelines; and 86% indicated that implementation of the guidelines would *not* require changes in practice that would affect costs.

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Competing Interests

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Address correspondence to the American Society of Anesthesiologists: 1061 American Lane, Schaumburg, Illinois 60173. jeffa@dacc.uchicago.edu. This Practice Guideline, as well as all published ASA Practice Parameters, may be obtained at no cost through the Journal Web site, https://pubs.asahq.org/anesthesiology.

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Table 1. Airway Management Items for Anesthetizing Locations

Self-inflating resuscitation bag
Suction tubing, Yankauers, suction catheters, and appropriate connectors
Various sizes of face masks
Various sizes of oral and nasal airways
Various sizes and types of laryngoscope blades and handles
Various sizes and types of tracheal tubes
Tracheal tube introducer (bougie) for adult patients
Tracheal tube stylets (malleable and rigid)
Equipment for emergency invasive airway management
Various sizes of supraglottic airways
Water-soluble medical lubricant
Nasal cannula and oxygen face masks
Video laryngoscope with appropriate stylets
Standard ASA monitors
Anesthetic induction, maintenance, and rescue medications

The examples listed in this table represent basic minimum contents for an anesthetizing location cart or trolley. The cart may be customized to meet the specific needs, preferences, and skills of the practitioner and healthcare facility.
ASA, American Society of Anesthesiologists.

Table 2. Portable Storage Unit Items for Difficult Airway Management

Category*	Item†‡
Alternative/rescue ventilation equipment	Oral and nasal airways of assorted sizes
	Supraglottic airways of assorted sizes/cuffed pharyngeal sealer
	Nasal cannula
Alternative intubation equipment	Tracheal tubes of assorted sizes (including microlaryngeal tubes)
	Rigid blades of alternate design and size for intubation
	Tracheal tube guides. Examples include (but are not limited to) semirigid stylets, lighted stylets, forceps designed to manipulate the distal portion of the tracheal tube
	Intubating supraglottic airway
	Videolaryngoscope with appropriate stylet
	Optical laryngoscope
	Intubating video stylet
	Flexible intubating bronchoscope along with topical anesthetic and equipment, and airway/bite block
	Aintree catheter
Emergency airway equipment	Equipment for emergency invasive airway management
	Jet ventilation equipment
Miscellaneous	Airway exchange catheters of assorted sizes
	Multiple exhaled carbon dioxide detectors
	A laminated version of a local accepted difficult airway algorithm/cognitive aid/checklist
	Defogger

The examples listed in this table represent airway management equipment beyond what may be available in the anesthetizing location (see Table 1). In areas where these items are not available at the anesthetizing location, add them to this portable storage unit.

*Equipment and supplies sizes should match the intended population to be served (*e.g.*, neonates, pediatrics, adults). †The items listed in this table represent suggestions. The contents of the portable storage unit should be customized to meet the specific needs, preferences, and skills of the practitioner and healthcare facility. ‡Choice of some items (*e.g.*, videolaryngoscope, jet ventilation equipment) may depend on practitioner familiarity and experience with the device.

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Table 3. Human Factors Relevant to Difficult Airway Management

- Practitioner factors
  - Before
    - Practitioner knowledge and training
    - Possible alternate outcomes (plan B)
    - Preoperative assessment
    - Complacency
  - During
    - Internal and external stressors (fatigue, illness, production pressure)
    - Decision-making (perseveration, judgment, situational awareness, interpretation of data)
    - Team dynamics (leadership, role assignment, empowerment, sterile cockpit)
    - Calling for assistance
  - After
    - Strategic debriefing
- External factors
  - Patient factors
    - Anatomical/physiological airway difficulty risk, aspiration risk, infection risk, exposure risk, urgency, comorbidities
  - Environment factors
    - Airway equipment
    - Monitoring
    - Personal protective equipment
  - Institutional factors
    - Culture, staffing, shift duration
    - Protocols, reporting
    - Supervision/support, training

This table lists aspects of airway management that address how the practitioner may interact with patients, other clinicians, assistants, equipment, or the environment during the process of airway management. Practitioners may consider these factors before, during, and/or after the course of airway management. Factors are classified as related directly to or external to the practitioner.

Table 4. Meta-analysis Summary: Videolaryngoscopy *versus* Direct Laryngoscopy*

			Effect				Heterogeneity	
	Studies†	Patients	Fixed	*P*	Random	*P*	I^2	*P*
			Odds Ratio‡ (99% CI)					
Laryngoscopic view	8	1,100	0.123 (0.078, 0.194)	< 0.001	0.124 (0.056, 0.275)	< 0.001	53%	0.036
Successful intubation	10	1,213	0.181 (0.097, 0.339)	< 0.001	0.225 (0.063, 0.803)	0.003	52%	0.026
First attempt success	9	624	0.327 (0.161, 0.666)	< 0.001	0.357 (0.170, 0.749)	< 0.001	0%	0.719
Additional maneuvers	6	738	0.379 (0.250, 0.574)	< 0.001	0.311 (0.149, 0.650)	< 0.001	57%	0.041
			Mean Difference (99% CI)					
Intubation time	10	793	–0.158 (–0.347, 0.030)	0.031	–0.036 (–0.652, 0.580)	0.880	90.12%	< 0.001

*Statistics for individual studies and forest plots are available as Supplemental Digital Content 4, http://links.lww.com/ALN/C697. †Number of studies included in the meta-analysis. ‡Continuity correction of 0.5 for zero cell frequencies.

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Table 5. Expert Consultant Survey Results (Response Rate = 82%)

Recommendations	N	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
Evaluation of the airway						
1a. Before the initiation of anesthetic care or airway management, ensure that an airway risk assessment is performed by the person(s) responsible for airway management whenever feasible to identify patient, medical, surgical, environmental, and anesthetic factors (*e.g.*, risk of aspiration) that may indicate the potential for a difficult airway.	174	92*	6	1	0	1
1b. Before the initiation of anesthetic care or airway management, conduct an airway physical examination.	174	84*	13	1	0	1
Preparation for Difficult Airway Management						
2a. If a difficult airway is known or suspected, ensure that a skilled individual is present or immediately available to assist with airway management.	174	94*	5	0	0	1
2b. If a difficult airway is known or suspected, inform the patient or responsible person of the special risks and procedures pertaining to management of the difficult airway.	174	74*	21	3	1	1
2c. If a difficult airway is known or suspected, administer oxygen before initiating management of the difficult airway and deliver supplemental oxygen throughout the process of difficult airway management, including extubation.	173	83*	10	6	1	1
Anticipated Difficult Airway Management						
3. Identify a strategy for (1) awake intubation, (2) the patient who can be adequately ventilated but is difficult to intubate, (3) the patient who cannot be ventilated or intubated, and (4) alternative approaches to airway management failure.	164	84*	12	3	1	1
4a. When appropriate, perform awake intubation if the patient is suspected to be a difficult intubation and difficult ventilation (face mask/supraglottic airway) is anticipated.	165	68*	22	7	2	1
4b. When appropriate, perform awake intubation if the patient is suspected to be a difficult intubation and increased risk of aspiration is anticipated.	165	42	30*	15	11	2
4c. When appropriate, perform awake intubation if the patient is suspected to be a difficult intubation and anticipated to be incapable of tolerating a brief apneic episode.	166	44	34*	14	6	2
4d. When appropriate, perform awake intubation if the patient is suspected to be a difficult intubation and difficulty with emergency invasive airway rescue is anticipated.	166	58*	25	11	4	1
5. If a noninvasive approach is selected, identify a preferred sequence of noninvasive devices to use for airway management.	166	63*	29	7	0	1
5a. If difficulty is encountered with individual techniques, combination techniques may be performed.	167	66*	28	5	1	1
5b. Be aware of the passage of time, the number of attempts, and oxygen saturation.	166	91*	6	2	0	1
5c. Provide and test mask ventilation between attempts.	167	58*	23	13	6	1
5d. Limit the number of attempts at tracheal intubation or supraglottic airway placement to avoid potential injury and complications.	167	77*	19	2	1	1
6. If an elective invasive approach to the airway (*e.g.*, surgical cricothyrotomy, tracheostomy, or large-bore cannula cricothyrotomy) is selected, identify a preferred intervention.	165	72*	21	6	1	1
6a. Ensure that an invasive airway is performed by an individual trained in invasive airway techniques, whenever possible.	166	83*	15	2	0	1
6b. If the selected invasive approach fails or is not feasible, identify an alternative invasive intervention.	166	72*	22	5	1	1
Unanticipated and Emergency Difficult Airway Management						
7a. Upon encountering an unanticipated difficult airway, determine the benefit of waking and/or restoring spontaneous breathing.	164	64*	23	10	2	1
7b. Upon encountering an unanticipated difficult airway, determine the benefit of a noninvasive *versus* invasive approach to airway management.	161	62*	30	5	2	1
8. If a noninvasive approach is selected, identify a preferred sequence of noninvasive devices to use for airway management.	164	73*	24	1	1	1
8a. If difficulty is encountered with individual techniques, combination techniques may be performed.	163	66*	26	6	1	1
8b. Be aware of the passage of time, the number of attempts, and oxygen saturation.	162	88*	9	2	0	1
8c. Provide and test mask ventilation between attempts.	159	59*	25	9	7	1
8d. Limit the number of attempts at tracheal intubation or supraglottic airway placement to avoid potential injury and complications.	163	83*	12	4	1	1
9. If an invasive approach to the airway (*e.g.*, surgical cricothyrotomy, tracheostomy, or large-bore cannula cricothyrotomy) is necessary (*i.e.*, cannot intubate, cannot ventilate), identify a preferred intervention.	161	76*	20	2	1	1
9a. Ensure that an invasive airway is performed by an individual trained in invasive airway techniques, whenever possible.	163	83*	14	2	1	1
9b. Ensure that an invasive airway is performed as rapidly as possible.	163	67*	23	7	2	1
9c. If the selected invasive approach fails or is not feasible, identify an alternative invasive intervention.	163	74*	20	4	1	1

(*Continued*)

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Table 5. (Continued)

Recommendations	N	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
Confirmation of tracheal intubation						
10. Confirm tracheal intubation using capnography or end-tidal carbon dioxide monitoring.	164	91*	7	0	1	1
11. When uncertain about the location of the tracheal tube, determine whether to either remove it and attempt ventilation or use additional techniques to confirm positioning of tracheal tube.	163	60*	28	7	4	1
Extubation of the difficult airway						
12. Have a preformulated strategy for extubation and subsequent airway management.	163	91*	8	1	0	1
13. Ensure that a skilled individual is present to assist with extubation.	162	72*	23	3	1	1
14. Select an appropriate time and location for extubation when possible.	163	77*	20	2	1	1
15. Assess the relative clinical merits and feasibility of the short-term use of an airway exchange catheter and/or supraglottic airway that can serve as a guide for expedited reintubation.	163	64*	29	5	1	1
16. Before attempting extubation, evaluate the risks and benefits of elective surgical tracheostomy.	163	47	33*	18	2	1
17. Evaluate the risks and benefits of awake extubation *versus* extubation before the return to consciousness.	163	57*	23	9	6	6
18. Assess the clinical factors that may produce an adverse impact on ventilation after the patient has been extubated.	162	75*	23	1	0	1
Follow-up care						
19. Inform the patient (or responsible person) of the airway difficulty that was encountered to provide the patient (or responsible person) with a role in guiding and facilitating the delivery of future care.	162	88*	11	1	0	1
20. Document the presence and nature of the airway difficulty in the medical record to guide and facilitate the delivery of future care.	163	94*	5	1	0	1

*An asterisk beside a percentage score indicates the median.

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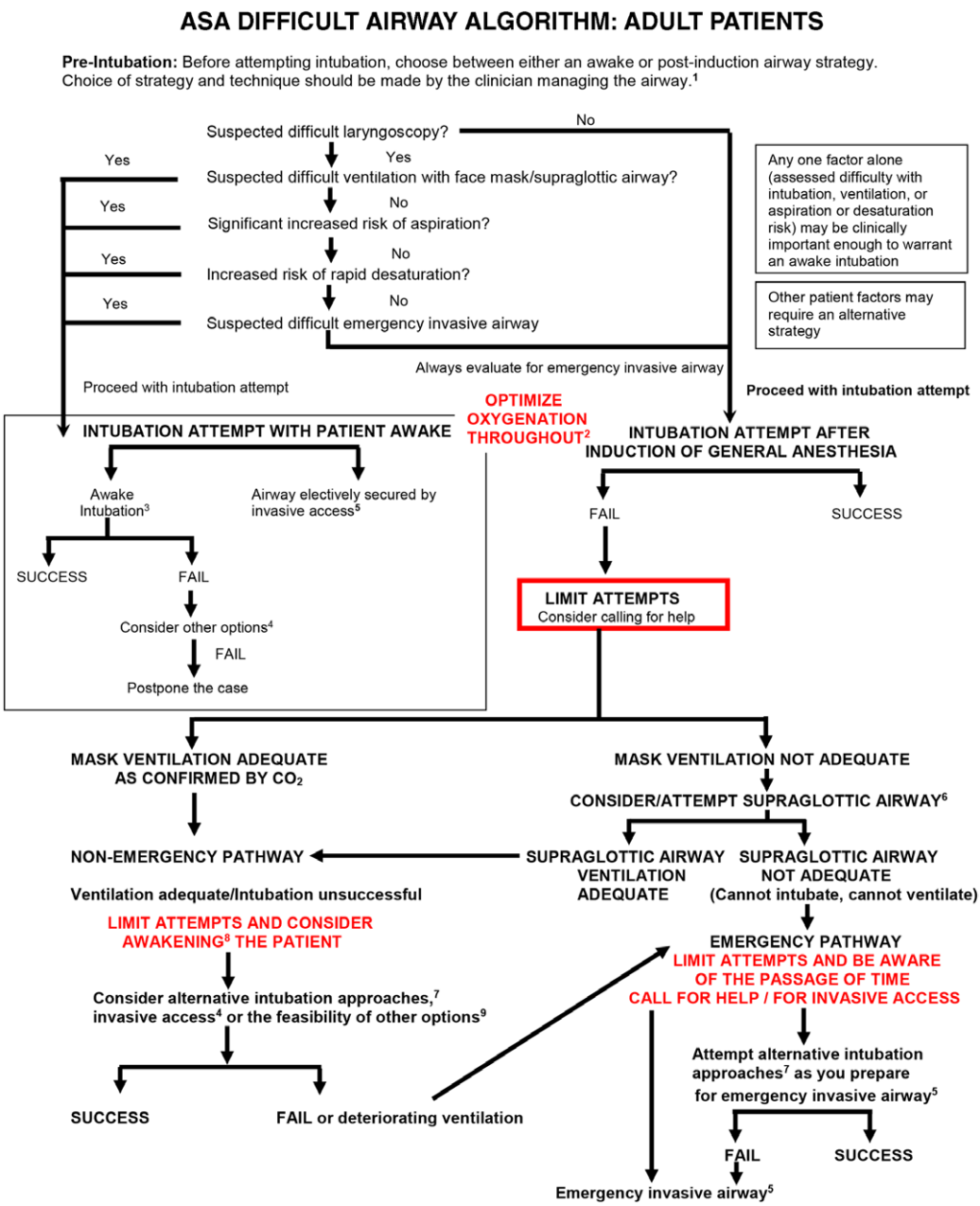

Fig. 1. Difficult airway algorithm: Adult patients. [1]The airway manager's choice of airway strategy and techniques should be based on their previous experience; available resources, including equipment, availability and competency of help; and the context in which airway management will occur. [2]Low- or high-flow nasal cannula, head elevated position throughout procedure. Noninvasive ventilation during preoxygenation. [3]Awake intubation techniques include flexible bronchoscope, videolaryngoscopy, direct laryngoscopy, combined techniques, and retrograde wire-aided intubation. [4]Other options include, but are not limited to, alternative awake technique, awake elective invasive airway, alternative anesthetic techniques, induction of anesthesia (if unstable or cannot be postponed) with preparations for emergency invasive airway, and postponing the case without attempting the above options. [5]Invasive airway techniques include surgical cricothyrotomy, needle cricothyrotomy with a pressure-regulated device, large-bore cannula cricothyrotomy, or surgical tracheostomy. Elective invasive airway techniques include the above and retrograde wire–guided intubation and percutaneous tracheostomy. Also consider rigid bronchoscopy and ECMO. [6]Consideration of size, design, positioning, and first *versus* second generation supraglottic airways may improve the ability to ventilate. [7]Alternative difficult intubation approaches include but are not limited to video-assisted laryngoscopy, alternative laryngoscope blades, combined techniques, intubating supraglottic airway (with or without flexible bronchoscopic guidance), flexible bronchoscopy, introducer, and lighted stylet or lightwand. Adjuncts that may be employed during intubation attempts include tracheal tube introducers, rigid stylets, intubating stylets, or tube changers and external laryngeal manipulation. [8]Includes postponing the case or postponing the intubation and returning with appropriate resources (*e.g.*, personnel, equipment, patient preparation, awake intubation). [9]Other options include, but are not limited to, proceeding with procedure utilizing face mask or supraglottic airway ventilation. Pursuit of these options usually implies that ventilation will not be problematic.

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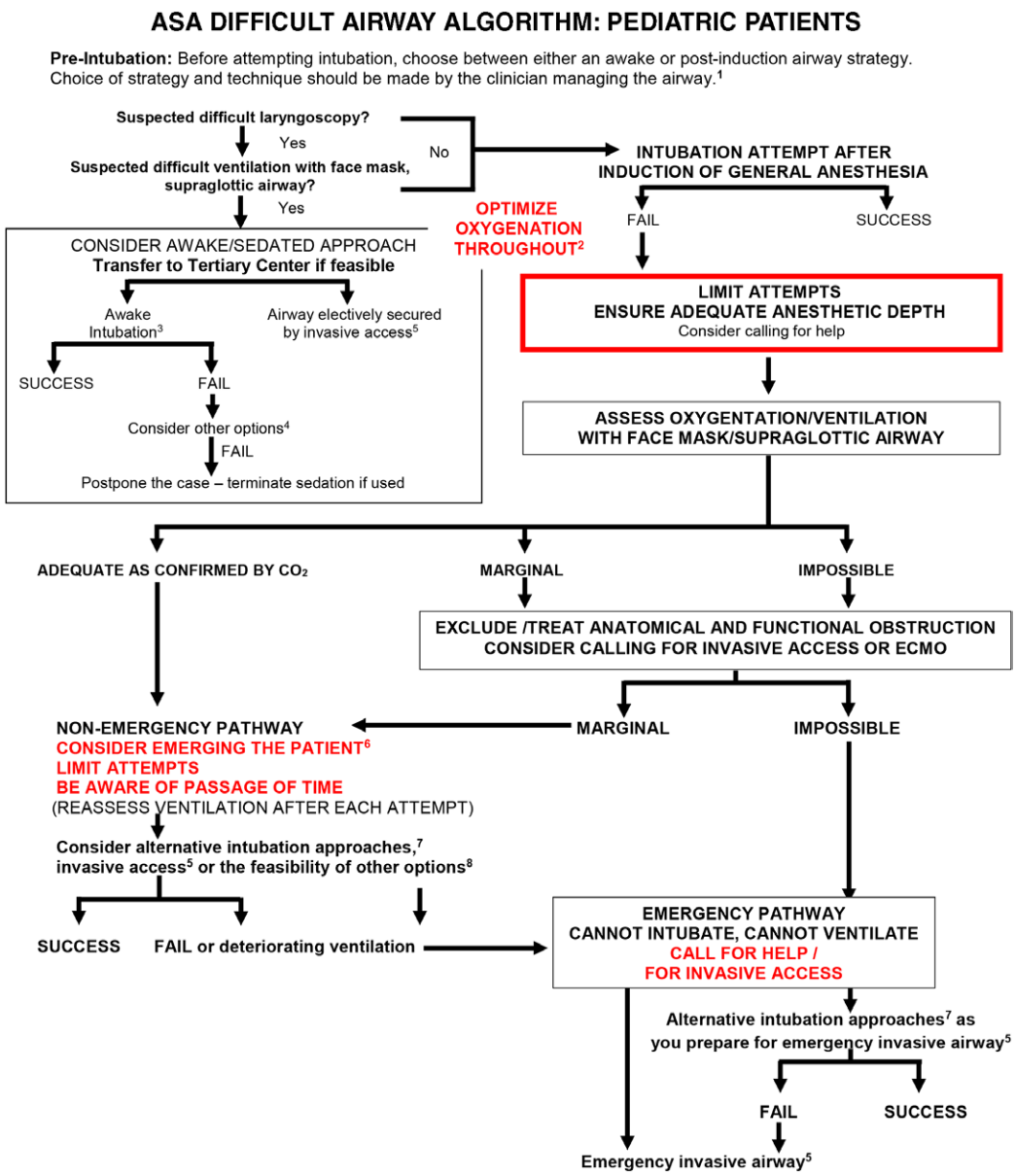

Fig. 2. Difficult airway algorithm: Pediatric patients. [1]The airway manager's assessment and choice of techniques should be based on their previous experience; available resources, including equipment, availability, and competency of help; and the context in which airway management will occur. [2]Low- or high-flow nasal cannula, head elevated position throughout procedure. Noninvasive ventilation during preoxygenation. [3]Awake intubation techniques include flexible bronchoscope, videolaryngoscopy, direct laryngoscopy, combined techniques, and retrograde wire-aided intubation. [4]Other options include, but are not limited to, alternative awake technique, awake elective invasive airway, alternative anesthetic techniques, induction of anesthesia (if unstable or cannot be postponed) with preparations for emergency invasive airway, or postponing the case without attempting the above options. [5]Invasive airway techniques include surgical cricothyroidotomy, needle cricothyroidotomy if age-appropriate with a pressure-regulated device, large-bore cannula cricothyroidotomy, or surgical tracheostomy. Elective invasive airway techniques include the above and retrograde wire–guided intubation and percutaneous tracheostomy. Also consider rigid bronchoscopy and ECMO. [6]Includes postponing the case or postponing the intubation and returning with appropriate resources (*e.g.*, personnel, equipment, patient preparation, awake intubation). [7]Alternative difficult intubation approaches include, but are not limited to, video-assisted laryngoscopy, alternative laryngoscope blades, combined techniques, intubating supraglottic airway (with or without flexible bronchoscopic guidance), flexible bronchoscopy, introducer, and lighted stylet. Adjuncts that may be employed during intubation attempts include tracheal tube introducers, rigid stylets, intubating stylets, or tube changers and external laryngeal manipulation. [8]Other options include, but are not limited to, proceeding with procedure utilizing face mask or supraglottic airway ventilation. Pursuit of these options usually implies that ventilation will not be problematic.

Developed in collaboration with the Society for Pediatric Anesthesia and the Pediatric Difficult Intubation Collaborative: John E. Fiadjoe, M.D., Thomas Engelhardt, M.D., Ph.D., F.R.C.A., Nicola Disma, M.D., Narasimhan Jagannathan, M.D., M.B.A., Britta S. von Ungern-Sternberg, M.D., Ph.D., D.E.A.A., F.A.N.Z.C.A., and Pete G. Kovatsis, M.D., F.A.A.P.

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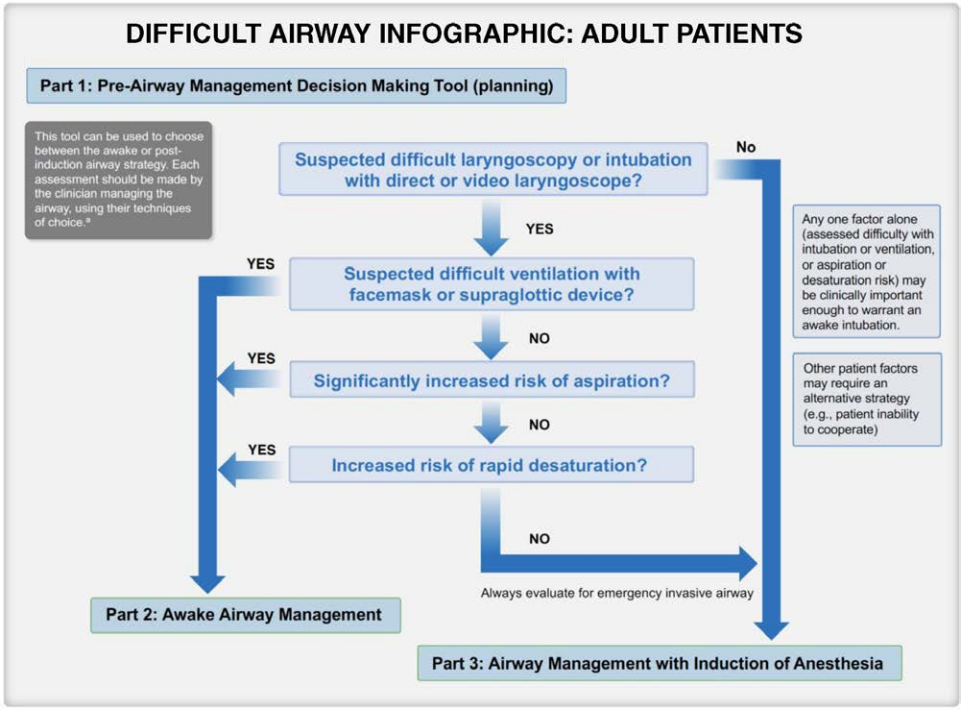

Fig. 3. Difficult airway infographic: Adult patient example. This figure provides three tools to aid in airway management for the patient with a planned, anticipated difficult, or unanticipated difficult airway. *Part 1* is a decision tool that incorporates relevant elements of evaluation and is intended to assist in the decision to enter the awake airway management pathway or the airway management with the induction of anesthesia pathway of the ASA difficult airway algorithm. *Part 2* is an awake intubation algorithm. *Part 3* is a strategy for managing patients with induction of anesthesia when an unanticipated difficulty with ventilation (as determined by capnography) with a planned airway technique is encountered. [a]The airway manager's assessment and choice of techniques should be based on their previous experience; available resources, including equipment, availability, and competency of help; and the context in which airway management will occur. [b]**Review airway strategy**: Consider anatomical/physiologic airway difficulty risk, aspiration risk, infection risk, other exposure risk, equipment and monitoring check, role assignment, and backup and rescue plans. Awake techniques include flexible intubation scope, videolaryngoscopy, direct laryngoscopy, supraglottic airway, combined devices, and retrograde wire-aided. [c]**Adequate ventilation** by any means (*e.g.,* face mask, supraglottic airway, tracheal intubation) should be confirmed by capnography, when possible. [d]**Follow-up care** includes postextubation care (*i.e.,* steroids, racemic epinephrine), counseling, documentation, team debriefing, and encouraging patient difficult airway registry. [e]**Postpone the case/intubation** and return with appropriate resources (*e.g.,* personnel, equipment, patient preparation, awake intubation). [f]**Invasive airways** include surgical cricothyroidotomy, needle cricothyroidotomy with a pressure-regulated device, large-bore cannula cricothyroidotomy, or surgical tracheostomy. Elective invasive airways include the above, retrograde wire–guided intubation, and percutaneous tracheostomy. Other options include rigid bronchoscopy and ECMO. [g]Invasive airway is performed by an individual trained in invasive airway techniques, whenever possible. [h]In an unstable situation or when airway management is mandatory after a failed awake intubation, a switch to the airway management with the induction of anesthesia pathway may be entered with preparations for an emergency invasive airway. [i]Low- or high-flow nasal cannula, head elevated position throughout procedure. Noninvasive ventilation during preoxygenation. [j]The intent of limiting attempts at tracheal intubation and supraglottic airway insertion is to reduce the risk of bleeding, edema, and other types of trauma that may increase the difficulty of mask ventilation and/or subsequent attempts to secure a definitive airway. Persistent attempts at any airway intervention, including ineffective mask ventilation, may delay obtaining an emergency invasive airway. A reasonable approach may be to limit attempts with any technique class (*i.e.,* face mask, supraglottic airway, tracheal tube) to three, with one additional attempt by a clinician with higher skills. [k]**Optimize**: suction, relaxants, repositioning. **Face mask**: oral/nasal airway, two-hand mask grip. **Supraglottic airway**: size, design, repositioning, first versus second generation. **Tracheal tube**: introducer, rigid stylet, hyperangulated videolaryngoscopy, blade size, external laryngeal manipulation. Consider other causes of inadequate ventilation (including but not limited to laryngospasm and bronchospasm). [l]First *versus* second generation supraglottic airway with intubation capability for initial or rescue supraglottic airway. [m]Videolaryngoscopy as an option for initial or rescue tracheal intubation. (*Continued*)

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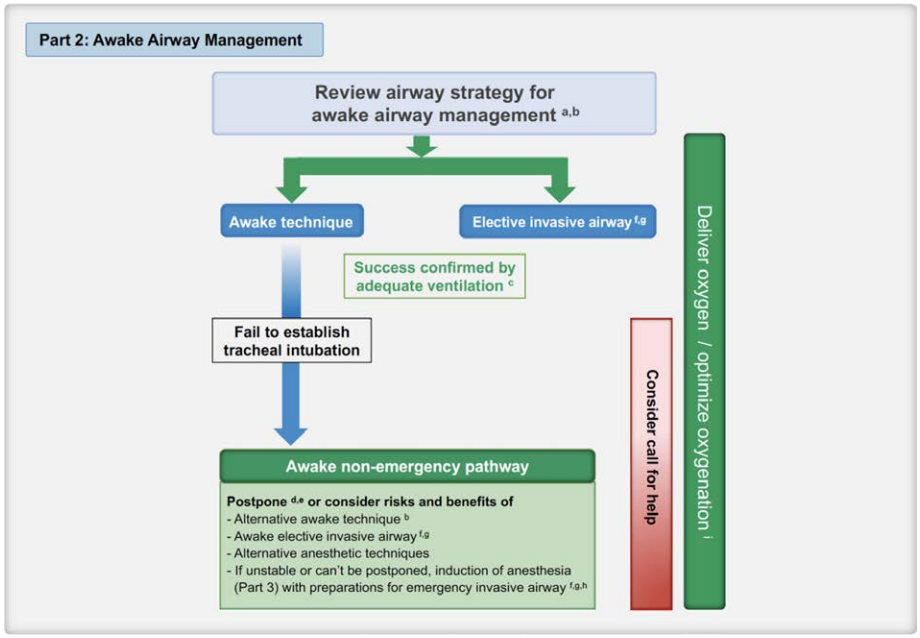

Fig. 3 (*Continued*)

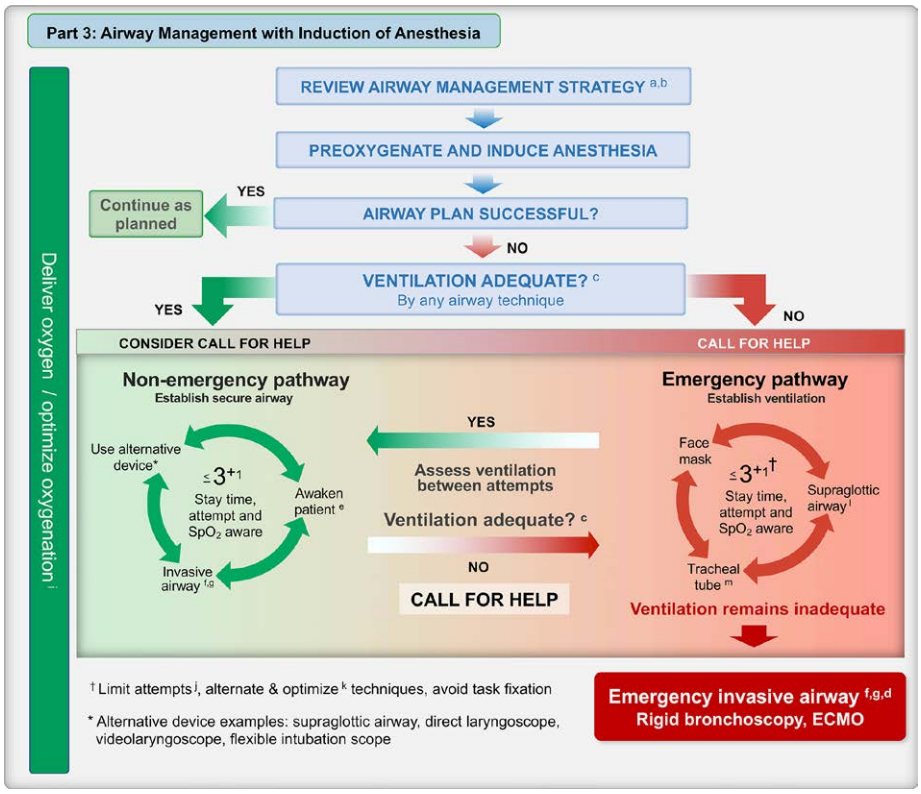

Fig. 3 (*Continued*)

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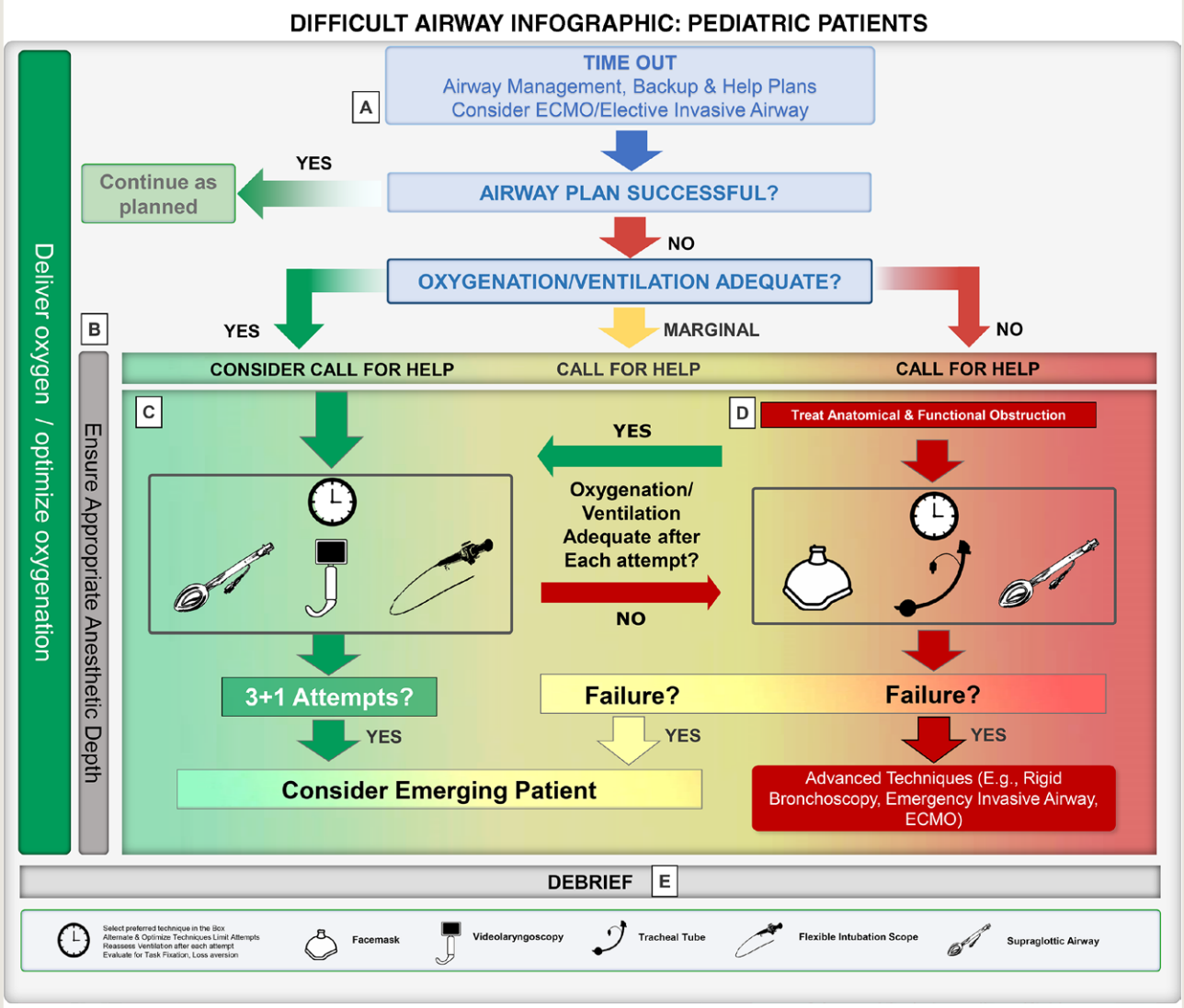

Fig. 4. Difficult airway infographic: Pediatric patient example. [A]**Time Out** for identification of the airway management plan. A team-based approach with identification of the following is preferred: the primary airway manager and backup manager and role assignment, the primary equipment and the backup equipment, and the person(s) available to help. Contact an ECMO team/otolaryngologic surgeon if noninvasive airway management is likely to fail (*e.g.*, congenital high airway obstruction, airway tumor, etc.). [B]Color scheme. The colors represent the ability to oxygenate/ventilate: green, easy oxygenation/ventilation; yellow, difficult or marginal oxygenation/ventilation; and red, impossible oxygenation/ventilation. Reassess oxygenation/ventilation after each attempt and move to the appropriate box based on the results of the oxygenation/ventilation check. [C]Nonemergency pathway (oxygenation/ventilation adequate for an intubation known or anticipated to be challenging): deliver oxygen throughout airway management; attempt airway management with the technique/device most familiar to the primary airway manager; select from the following devices: supraglottic airway, videolaryngoscopy, flexible bronchoscopy, or a combination of these devices (*e.g.*, flexible bronchoscopic intubation through the supraglottic airway); other techniques (*e.g.*, lighted stylets or rigid stylets may be used at the discretion of the clinician); optimize and alternate devices as needed; reassess ventilation after each attempt; limit direct laryngoscopy attempts (*e.g.*, one attempt) with consideration of standard blade videolaryngoscopy in lieu of direct laryngoscopy; limit total attempts (insertion of the intubating device until its removal) by the primary airway manager (*e.g.*, three attempts) and one additional attempt by the secondary airway manager; after four attempts, consider emerging the patient and reversing anesthetic drugs if feasible. Clinicians may make further attempts if the risks and benefits to the patient favor continued attempts. [D]Marginal/emergency pathway (poor or no oxygenation/ventilation for an intubation known or anticipated to be challenging): treat functional (*e.g.*, airway reflexes with drugs) and anatomical (mechanical) obstruction; attempt to improve ventilation with facemask, tracheal intubation, and supraglottic airway as appropriate; and if all options fail, consider emerging the patient or using advanced invasive techniques. [E]Consider a team debrief after all difficult airway encounters: identify processes that worked well and opportunities for system improvement and provide emotional support to members of the team, particularly when there is patient morbidly or mortality.

Developed in collaboration with the Society for Pediatric Anesthesia and the Pediatric Difficult Intubation Collaborative: John E. Fiadjoe, M.D., Thomas Engelhardt, M.D., Ph.D., F.R.C.A., Nicola Disma, M.D., Narasimhan Jagannathan, M.D., M.B.A., Britta S. von Ungern-Sternberg, M.D., Ph.D., D.E.A.A., F.A.N.Z.C.A., and Pete G. Kovatsis, M.D., F.A.A.P.

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