



Why a Focus On Diversity, Equity, and Inclusion is a Perioperative Patient Quality and Safety Imperative

by Paloma Toledo, MD, MPH, and Jerome Adams, MD, MPH

In *Crossing the Quality Chasm*, the Institute of Medicine defined six domains for improving the health care system. Health care should be safe, effective, patient-centered, timely, efficient, and equitable.¹ Anesthesia professionals have long been acknowledged as leaders in patient safety,² and they have worked to achieve the quadruple aim of promoting better patient outcomes, improving patient satisfaction, lowering clinician burnout, and lowering costs.³ While the safety of medicine and anesthesiology has significantly improved over the last century,⁴ we have not seen equivalent gains in equitable care, which is defined as care does not vary in quality based on personal characteristics such as gender, ethnicity, geographic location, or socioeconomic status.¹

The United States Centers for Disease Control and Prevention defines disparities as preventable differences in the burden of disease, injury, violence, or opportunities to achieve opti-

mal health that are experienced by socially disadvantaged populations.⁵ A large share of negative health outcomes occurs within a small subset of our patient population.⁶ Far too often, whether it is infant or maternal mortality, cardiovascular disease and its complications, or unmanaged acute and chronic pain, this population subset disproportionately consists of people of diverse backgrounds.⁶ Furthermore, racial and ethnic disparities have been identified in anesthesiology.

Several studies have focused on the racial and ethnic differences in the management of pain for surgical procedures or during labor and delivery.⁷⁻¹⁰ Neuraxial labor analgesia is the most effective treatment modality in the management of labor pain.⁷ Both the American Congress of Obstetricians and Gynecologists and the American Society of Anesthesiologists promote the use of neuraxial analgesia due to its efficacy and safety, both for the mother and her neonate.⁸



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APSF Initiative on Medical Technology Education

"The Anesthesia Patient Safety Foundation believes that anesthesia professionals should be competent to use advanced medical technology to provide safe patient care."

—APSF Newsletter, Winter 2013.

by Jeffrey Feldman, MD, MSE, and Samsun Lampotang, PhD, FSSH, FAIMBE

The APSF has recognized for many years that understanding how to use medical technology is fundamental to patient safety.¹ In an effort to promote that understanding, APSF is pleased to announce a new educational program on the use of medical technology. APSF

has partnered with the University of Florida Center for Safety, Simulation and Advanced Learning Technologies under the direction of Sem Lampotang, PhD, to develop a web-based educational program. This program will be available to all anesthesia professionals and requires only an internet connection and web browser to access the content. Continuing education credits are intended to be offered.

Two topics have been chosen for the initial educational offerings—Low-Flow Anesthesia and Quantitative Neuromuscular Transmission Monitoring. The recognition that inhaled

anesthetic agents are greenhouse gases that contribute to global warming has created a growing interest in the practice of Low-Flow Anesthesia. While the technique can be safely and effectively practiced, there are patient safety implications. The goal of the Low-Flow education is to empower anesthesia professionals with the knowledge required to safely, effectively, and comfortably reduce fresh gas flow and the environmental impact of their practice. Neuromuscular blockade monitoring has long been considered essential to safe patient care when administering muscle relaxants.²

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Guide for Authors

A more detailed Guide to Authors with specific requirements for submissions can be found online at <https://www.apsf.org/authorguide>

The *APSF Newsletter* is the official journal of the Anesthesia Patient Safety Foundation. It is widely distributed to a variety of anesthesia professionals, perioperative providers, key industry representatives, and risk managers. Therefore, we strongly encourage publication of those articles that emphasize and include the multidisciplinary, multiprofessional approach to patient safety. It is published three times a year (February, June, and October). **Deadlines for each issue are as follows: 1) February Issue: November 15th, 2) June Issue: March 15th, 3) October Issue: July 15th.** The content of the newsletter typically focuses on anesthesia-related perioperative patient safety. Decisions regarding content and acceptance of submissions for publication are the responsibility of the editors.

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Types of articles include (1) review articles, Pro/Con Debates and Editorials, (2) Q and As, (3) Letters to the Editor, (4) Rapid Response, and (5) Conference reports.

- Review articles, invited Pro/Con debates, and Editorials are original manuscripts. They should focus on patient safety issues and have appropriate referencing. The articles should be limited to 2,000 words with no more than 25 references. Figures and/or tables are strongly encouraged.
- Q&A articles are submitted by readers regarding anesthesia patient safety questions to knowledgeable experts or designated consultants to provide a response. The articles should be limited to 750 words.
- Letters to the editor are welcome and should be limited to 500 words. Please include references when appropriate.
- Rapid Response* (to questions from readers), formerly known as, "Dear SIRS," which was the "Safety Information Response System," is a column that allows for expeditious communication of technology-related safety concerns raised by our readers, with input and response from manufacturers and industry representatives. Jeffrey Feldman, MD, current chair of the Committee on Technology, oversees the column and coordinates the readers' inquiries and the response from industry.

Commercial products are not advertised or endorsed by the *APSF Newsletter*; however, upon exclusive consideration from the editors, articles about certain novel and important safety-related technological advances may be published. The authors should have no commercial ties to, or financial interest in, the technology or commercial product.

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Racial and Ethnic Disparities Exist in the Rates of Neuraxial Anesthesia for Cesarean Delivery

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Yet, despite 60% of delivering women using neuraxial labor analgesia for pain control in the US,⁹ Black and Hispanic women are less likely to use neuraxial labor analgesia for pain control in labor when compared to non-Hispanic White women (62%, 48% and 69%, respectively).¹⁰⁻¹² Among Hispanic women, there is an additional difference in the use of neuraxial labor analgesia based on primary spoken language, with primarily Spanish-speaking women being less likely to both anticipate (adjusted odds ratio 0.70 [97.5% CI: 0.53-0.92]) and use (adjusted odds ratio 0.88 [97.5% CI: 0.78-0.99]) neuraxial analgesia compared to English-speaking Hispanic women.¹³ These differences in neuraxial labor analgesia use may have safety implications at the time of cesarean delivery. Neuraxial anesthesia is the preferred mode of anesthesia for cesarean deliveries because of the multiple maternal and neonatal benefits of neuraxial anesthesia compared to general anesthesia.¹⁴⁻¹⁶ Yet, racial and ethnic disparities exist in the rates of neuraxial anesthesia for cesarean delivery,^{7,8} with the rate of general anesthesia use being almost double for black women compared to non-Hispanic White women (11.3% versus 5.2%).^{7,8} Little information exists about why this discrepancy exists (e.g., differences in risk factors for general anesthesia by race/ethnicity, etc.) as most studies on racial and ethnic discrepancies between modes of anesthesia for cesarean delivery have been population-level studies. These are a few examples of the many studies which have documented racial and ethnic disparities in health care.

Understanding the root causes of the disparities is fundamental to building effective interventions. Disparities can arise at the patient-, provider-, or health care system-level.¹⁷ At the patient-level, considerations such as health literacy, patient’s understanding of their medical condition and treatment choices, and primary spoken language can all contribute to disparities. At the provider level, knowledge of treatment options and provider bias may also contribute to disparities. At the health care systems level, there may be differences based on the hospitals’ resources.

Given the multiple levels from which disparities can arise, it is important to measure the differences by race/ethnicity, and track changes as interventions are implemented. The gold standard is to have patients self-identify their race and ethnicity. Other strategies, such as staff identification or use of patient surnames have been proven to be inaccurate.^{18,19} In one



study, which compared hospital staff’s accuracy with identification of patient’s race and ethnicity, compared to patient self-reported race and ethnicity, which were collected for a different purpose, the range of agreement was imperfect for all racial and ethnic groups.¹⁸ The hospital staff could select race and ethnicity from six categories (Hispanic, American Indian, Black/African American, Asian, White, and unknown/missing). The agreement was best for White patients (76%), but decreased with the other racial and ethnic groups 68% for Black/African American, 57% for Hispanics, 33% for Asians, and 1% for American Indians.¹⁸ Ensuring accurate race/ethnicity and language data is critical for building dashboards to evaluate disparities in local care. While anesthesia professionals may not be directly collecting this information, it is imperative that they work with hospital leadership to ensure that this data is being accurately collected.

Clinicians should also be trained in the use of shared decision-making (SDM). Shared decision-making allows active discussion between patients and providers. In SDM, providers share relevant risks, benefits, and alternatives of treatments with the patient. In addition, the patient also shares personal information and beliefs that would make a treatment more or less desirable.^{20,21} Given that anesthesia professionals often do not have the luxury of pre-existing relationships with a patient, this may be a way to garner trust and understand any fears or mis-

conceptions held by the patient. Some groups have long-standing historical distrust of the medical establishment. One of the most glaring examples underlying this distrust is the infamous Tuskegee Study, where Black men were denied treatment for syphilis and deceived by clinicians and the US government.²² Consequently many Black patients come into the medical system with trust deficit. Therefore an “equal” amount of time and level of engagement from a physician—especially one of a different racial background—may not engender an equivalent degree of trust in all patients. Strategies to enhance trust and communication between patients and their providers are important for achieving equity. Incorporating opportunities to build rapport and discuss treatment options with patients preoperatively, such as through a preoperative clinic, may be one way to begin to build trust and engage patients prior to the day of surgery.

Additional solutions to reduce disparities can be identified at the patient-, provider-, and health care systems-level. In addition to using shared decision-making, it is important that providers counsel patients in their preferred spoken language, and use professional interpreters for communication with patients of limited-English proficiency.²³ Also, ensuring patient educational material is both readable, and meets patient’s health literacy needs, will improve patient-provider communication.^{24,25}

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A Focus on Diversity, Equity, and Inclusion Will Improve Patient Safety, Quality, and Outcome

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At the provider-level, raising awareness of disparities and creating a culture of equity can be achieved through education, departmental surveys, needs assessments, and creating forums for open dialogue.²⁶ Furthermore, anesthesiology departments incorporate best practices for workforce diversity and engage in mentorship programs, such as the Doctors Back to School Program,²⁷ that will help expose premedical students, as well as medical students to our field. In addition, the Diversity in Nurse Anesthesia Program focuses on educating, empowering, and mentoring underserved populations with information to enhance a career in anesthesia.²⁸ This list is not comprehensive, but meant to illustrate several of the tangible ways that anesthesia professionals can engage in reducing disparities.

Anesthesia professionals are leaders in improving patient safety by identifying problems and potential solutions, testing them, and scaling effective interventions. Our field has expanded its scope beyond the operating room into the preoperative and postoperative setting. Addressing disparities should be the next horizon for our specialty. Whether our patients have language barriers, or are differently abled, or come from communities who have long experienced discrimination within the health care systems, ample evidence exists that a focus on diversity, equity, and inclusion will improve patient safety, quality, and outcomes.

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The authors have no conflicts of interest.

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Technology Education

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Technology for neuromuscular transmission monitoring continues to advance and this educational program will help the practitioner develop an understanding of the latest technologies and their potential to enhance the safe use of muscle relaxants.

APSF has engaged with several companies who manufacture technologies relevant to these educational topics. APSF does not, however, promote any particular device or manufacturer. The educational content will be device agnostic. APSF will allow links to educational content on company websites that are device specific. This should facilitate access for users to device specific knowledge. APSF will not, however, have any responsibility for the content presented through those industry web links.

Look for the details of this exciting program in the October issue of the 2022 APSF Newsletter.

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Anesthesia Patient Safety Foundation Update: 2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway

by John E. Fiadjoe, MD, and David Mercier, MD

The recently published 2022 ASA guidelines for managing the difficult airway are a significant change from previous guidelines. These changes are meant to assist clinicians in decision-making. As airway management equipment improves, human factor concerns, team-based performance, and cognitive errors remain hurdles to safe airway management. Change can be difficult and, in this article, the authors highlight some of the important changes to the guidelines.

Robert Glazer, founder and chairman of the Board of a global partner marketing agency, shares a blog every Friday called “Friday Forward,” which we highly recommend (<https://www.robertglazer.com/fridayfwd/>). In it, he described the four stages of change:

1. *Confusion and surprise*—“Huh? why did you change that?”
2. *Reacting to differences*—“Why is this different, not sure I like that.”
3. *Pining for the past*—“Oh, I wish I had the old version back, this sucks.”
4. *Adaptation and acceptance*—“Hmm, this may actually be better, I think I like it.”

Many of you may have had one of these reactions to the new ASA practice guidelines for managing the difficult airway. Regardless of which stage of change you’re in, this article will highlight changes to the guidelines and usher you closer to the final stage of change.

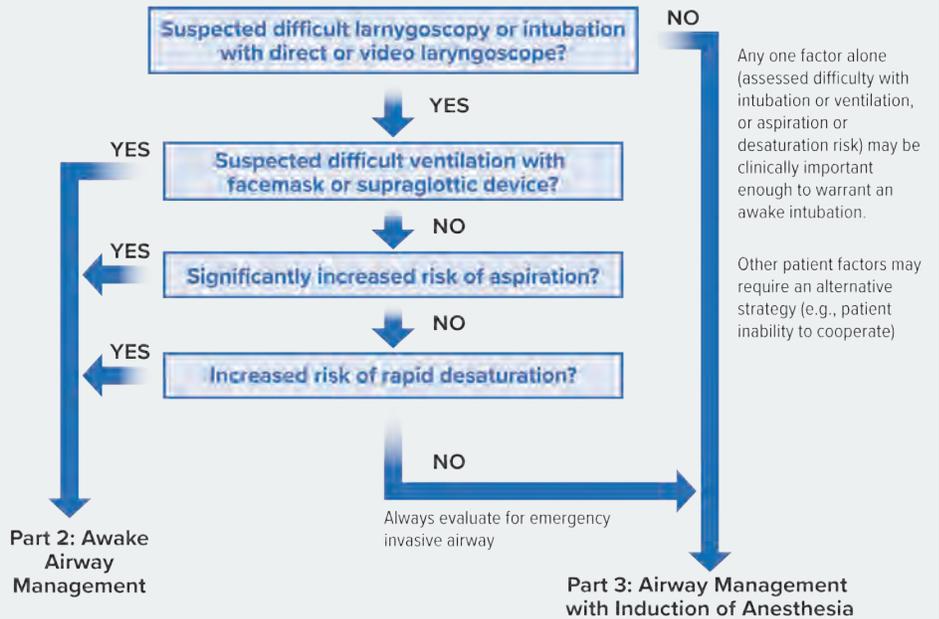
GUIDELINE HISTORY

The initial ASA Practice Guidelines for Management of the Difficult Airway were published in 1993. Since then, the ASA Committee on Standards and Practice Parameters (now the Committee on Practice Parameters) has been tasked with reviewing each guideline published by the various task forces every five years. Additionally, each guideline must undergo a complete revision at least every ten years. This version, published in January 2022, is the revision of the 2013 ASA Guidelines.¹ This article summarizes the fundamental changes to the previous guidelines and emphasizes important considerations to enhance patient safety in airway management.

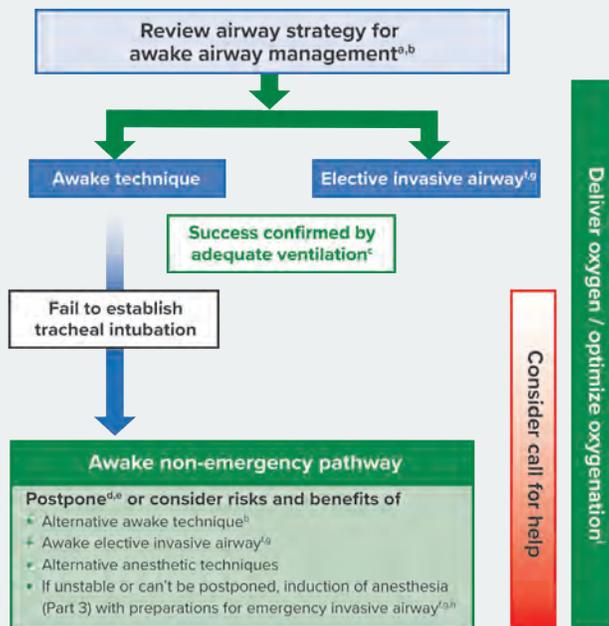
See “Difficult Airway Guidelines,” Next Page

Part 1: Pre-Airway Management Decision-Making Tool (planning)

This tool can be used to choose between the awake or post-induction airway strategy. Each assessment should be made by the clinician managing the airway, using their techniques of choice.^a



Part 2: Awake Airway Management



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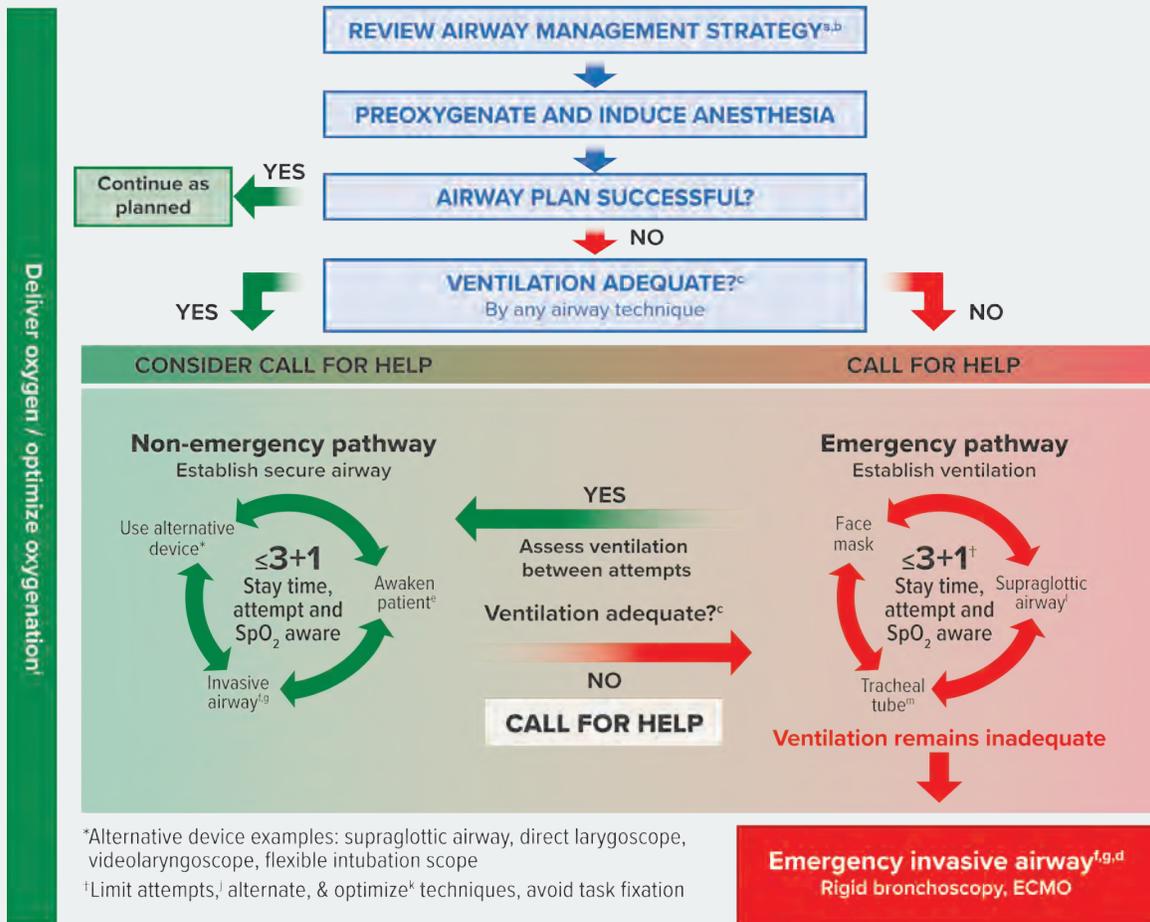
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Figure 1, Parts 1 and 2: Difficult Airway Infographic for Adult Patients.

The Updated Guidelines Focus on Time Elapsed During Airway Management

From “Difficult Airway Guidelines,” Preceding Page

Part 3: Airway Management with Induction of Anesthesia



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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,

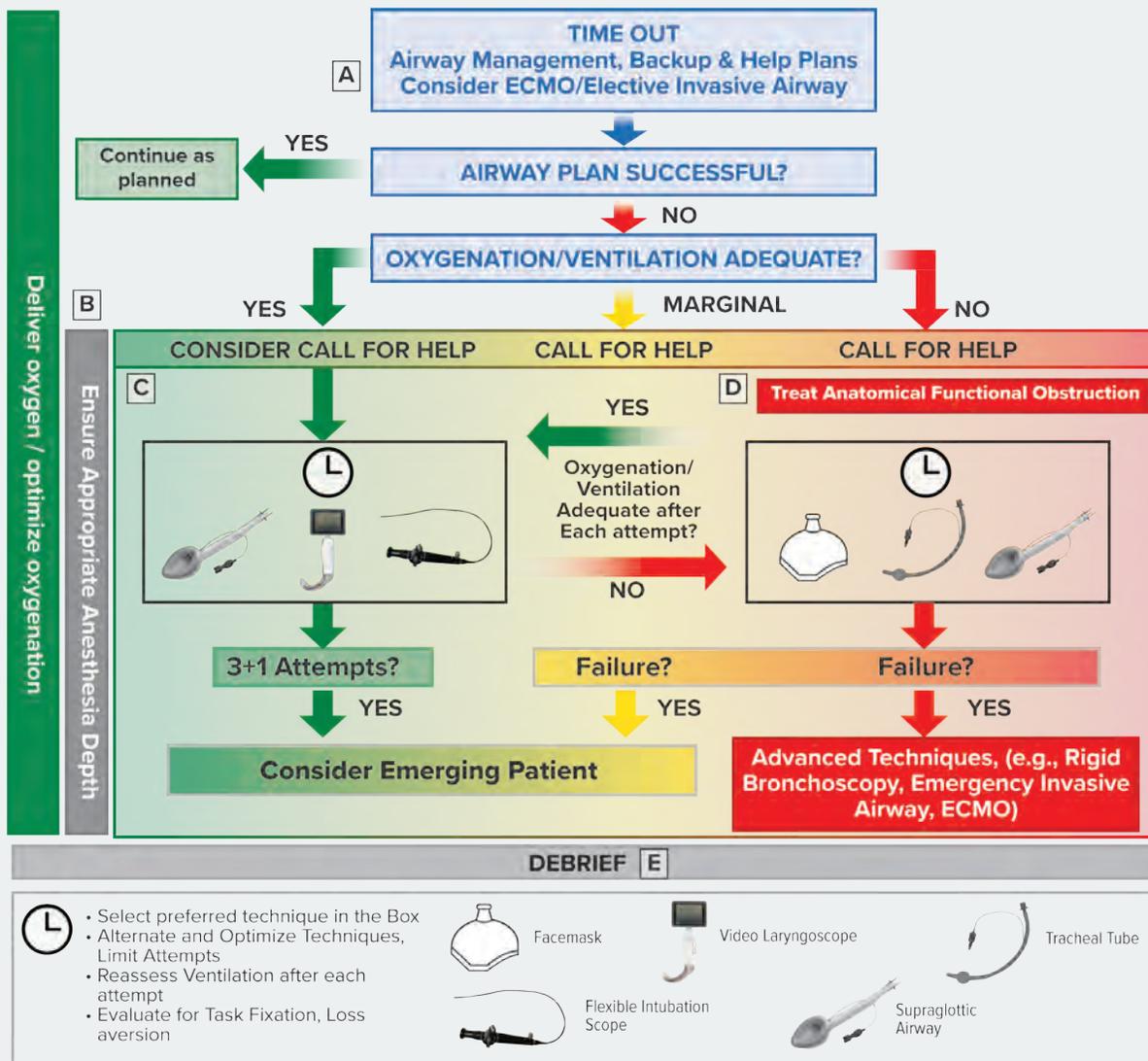
large-bore cannula cricothyroidotomy, or surgical tracheostomy. Elective invasive airways include the above, retrograde wire-guided intubation, and percutaneous tracheostomy. Other options include rigid bronchoscopy and ECMO. **g.** Invasive airway is performed by an individual trained in invasive airway 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.

Figure 1, Part 3: Difficult Airway Infographic for Adult Patients.

New Airway Guidelines Are the First to Include Both Adult and Pediatric Airway Management

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Difficult Airway Infographic: Pediatric Patients



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. Non-emergency 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 morbidity or mortality.

Developed in collaboration with the Society for Pediatric Anesthesia and the Pediatric Difficult Intubation Collaborative: John E. Fiadjoe, MD; Thomas Engelhardt, MD, PhD, FRCA; Nicola Disma, MD; Narasimhan Jagannathan, MD, MBA; Britta S. von Ungern-Sternberg, MD, PhD, DEAA, FANZCA; and Pete G. Kovatsis, MD, FAAP.

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Figure 2: Difficult Airway Infographic: Pediatric Patients

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Difficult Airway Guidelines (Cont'd)

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NEW INTERNATIONAL PERSPECTIVES

The guidelines were developed by a task force of 15 members, including anesthesiologists and methodologists representing the United States, India, Ireland, Italy, Switzerland, and several subspecialty organizations.

GUIDANCE FOR BOTH PEDIATRIC PATIENTS AND ADULTS

Traditionally, these guidelines have focused on adult airway management. However, anesthesia professionals are increasingly managing children. These guidelines include evidence and expert opinion on pediatric difficult airway management, which is a significant change that makes the guidelines more comprehensive.

NEW TECHNOLOGY, LITERATURE, AND EXPERT OPINION EVIDENCE

This update summarizes evidence from reviewing thousands of abstracts pared down to 560 references. Additionally, this iteration surveyed expert consultants, ASA members, and ten participating organizations on topics where the scientific evidence was scant or equivocal. It also updates the equipment and technology available for standard and difficult airway management.

EMPHASIS ON OXYGEN DELIVERY AND CO₂ CONFIRMATION

This version emphasizes oxygen administration throughout difficult airway management and during extubation. Additionally, it emphasizes using capnography to confirm tracheal intubation as in previous versions.

SITUATIONAL AWARENESS OF ATTEMPTS, THE PASSAGE OF TIME, AND OXYGEN SATURATION

These updated guidelines emphasize the importance of paying attention to the elapsed time during airway management. Too often, a team can suffer from task fixation, leading to multiple attempts using a single approach and failure to consider alternatives. Additionally, awareness of the oxygen saturation can enable early intervention and decision-making and limit the number of attempts. This increased situational awareness may help clinicians progress steadily through their planned airway management and recognize the need for a surgical airway earlier. A team-centered approach is best, and one approach is to assign an observer not involved with direct airway management as the arbiter of task fixation.

PRE-INDUCTION DECISION CHART FOR AWAKE VS. ASLEEP AIRWAY MANAGEMENT

Previous guidelines have been valuable for planning and identifying potential obstacles in developing a difficult airway management strategy. They included questions that helped with decision-making regarding awake airway management. However, judgment errors (i.e., not performing awake intubation when indicated) have led to failed airway securement, according to several reviews.^{2,3} To further support decision-making, this update includes a decision tree to aid in determining when awake airway management is indicated (Figure 1, Part 1). This decision tree is an extension and evolution of a work product published in 2004 by a task force member and adapted for the 2022 ASA algorithm.⁴ Awake intubation of the adult patient should be considered when there is (1) difficult ventilation (face mask/supraglottic airway), (2) increased risk of aspiration, (3) intolerance of brief apnea, or (4) expected difficulty with emergency invasive airway access.

Additionally, the new figures directly address the unanticipated difficult airway by including entry points after failed intubation after routine induction.

NEW ALGORITHMS AND INFOGRAPHICS FOR ADULT AND PEDIATRIC DIFFICULT AIRWAY MANAGEMENT

Tremendous time and effort were spent improving the new infographic's flow and “real-time” usability. The new algorithm now includes a section that includes options involved in deciding to proceed with an awake airway (Figure 1, Part 2) as well as a section that is more amenable to “real-time” use (Figure 1, Part 3). The graphical design flows more like a cognitive aid than an algorithm, but requires review and familiarity before real-time use.

Both infographics are color-coded to represent the ability to ventilate. Green represents easy ventilation, yellow marginal, and red impossible ventilation. A time-out should occur before the start of airway management to discuss the care plan.

The team should identify the primary airway manager, the backup airway manager, the equipment to be used, and the person available to help if feasible. Both infographics highlight the importance of assessing ventilation after each attempt or intervention; the results of this assessment may move the clinician to a different point in the algorithm.

The pediatric algorithm highlights three main tools for managing a child with a difficult airway: the supraglottic airway (SGA), flexible intubation scope (FIS), and video laryngoscopy (VL) (Figure 2). These devices can be combined (e.g., FIS + SGA or FIS + VL) if they fail individually. These tools are most applicable to use in the easy ventilation zone; however, when ventilation is difficult, the clinician should focus on their best attempts to reestablish ventilation using a facemask, supraglottic airway device, and adjuncts, as well as their best attempt to perform tracheal intubation with the technique most likely to be successful. Both infographics highlight the importance of limiting attempts. The pediatric algorithm highlights the importance of distinguishing between functional and anatomical obstruction as their treatments differ. Drugs are required for functional obstruction and devices such as oropharyngeal, nasopharyngeal, and supraglottic airway devices for anatomic obstruction. A team debrief should be considered after airway management to codify lessons learned, allow team members to express any difficult emotions, and identify gaps for improvement.

PEDIATRIC HIGHLIGHTS

The early consideration of extracorporeal membrane oxygenation (ECMO) is highlighted in pediatric airway management. Airway management after inhaled induction is typical, while awake intubation is not commonly performed in children. The guidelines emphasize the importance of maintaining an adequate depth of anesthesia with ventilation assessment after every intubation attempt. The minimum number of attempts should be performed. Other rescue techniques to consider include rigid bronchoscopy by a clinician familiar with the method. Airway exchange catheters should be used with caution in children and used by clinicians experienced with their use. There is a small margin for error, and potential severe outcomes such as pneumothorax and pneumomediastinum may occur if the catheter perforates the airway.

DEVICES AND TECHNOLOGY

Meta-analyses of randomized trials have demonstrated that video-assisted laryngoscopy in patients with predicted difficult airways improves laryngeal views and first-attempt intubation success compared to direct laryngoscopy.⁵⁻¹⁵ These results were equivocal when comparing video-assisted laryngoscopy to flexible intubation scopes. Interestingly, randomized studies were also equivocal for the same outcomes when

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ASA Difficult Airway Algorithm for Adult Patients

Pre-Intubation: Before attempting intubation, choose between either an awake or post-induction airway strategy. Choice of strategy and technique should be made by the clinician managing the airway.¹

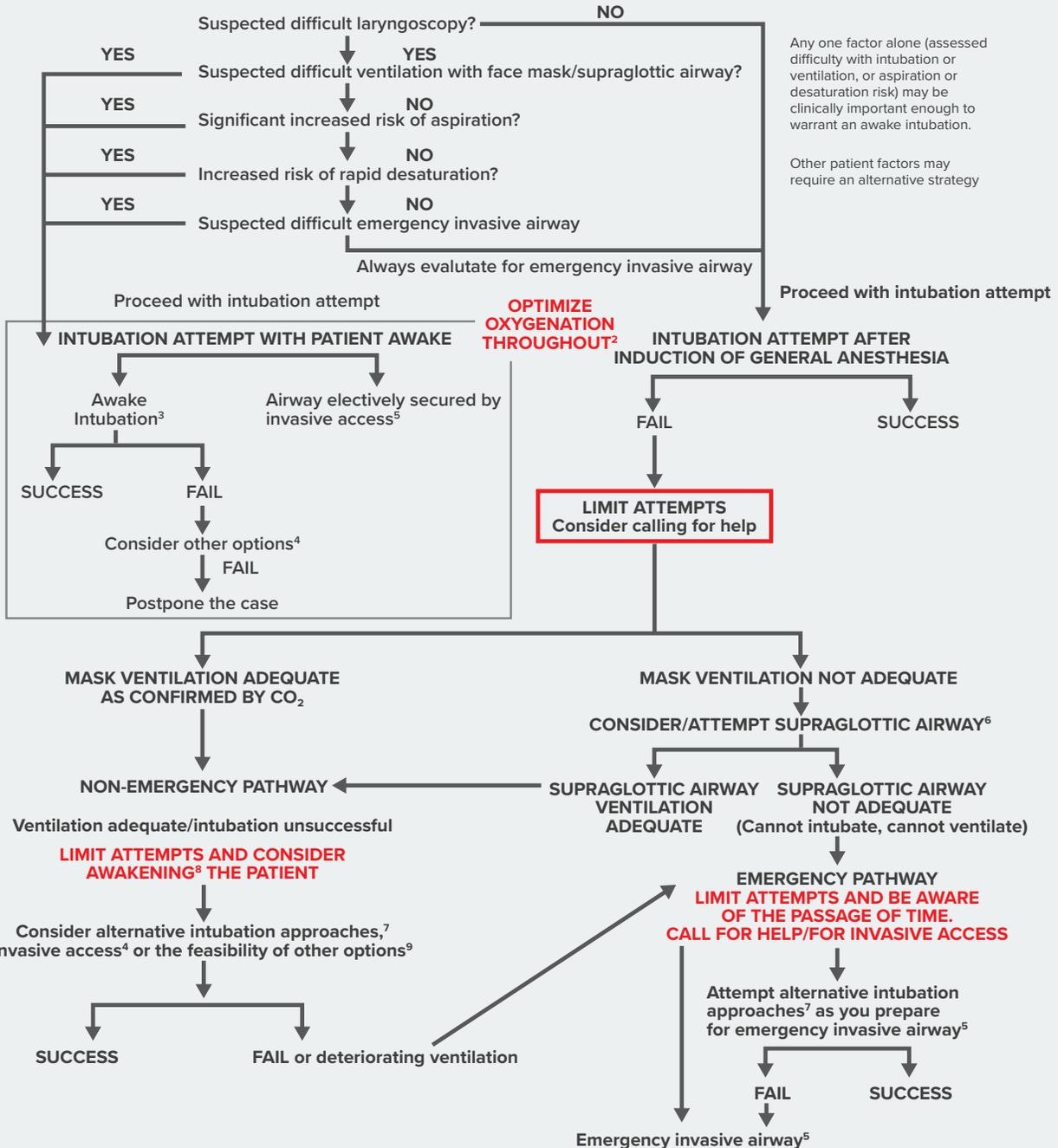


Figure 3. Difficult airway algorithm: Adult patients. 1. The airway manager's choice of airway strategy and techniques should be based on their previous experience; available resources, including equipment, availability and competency of help; and the context in which airway management will occur. 2. 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.

Figure 3: ASA Difficult Airway Algorithm: Adult Patients.

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ASA Difficult Airway Algorithm for Pediatric Patients

Pre-Intubation: Before attempting intubation, choose between either an awake or post-induction airway strategy. Choice of strategy and technique should be made by the clinician managing the airway.¹

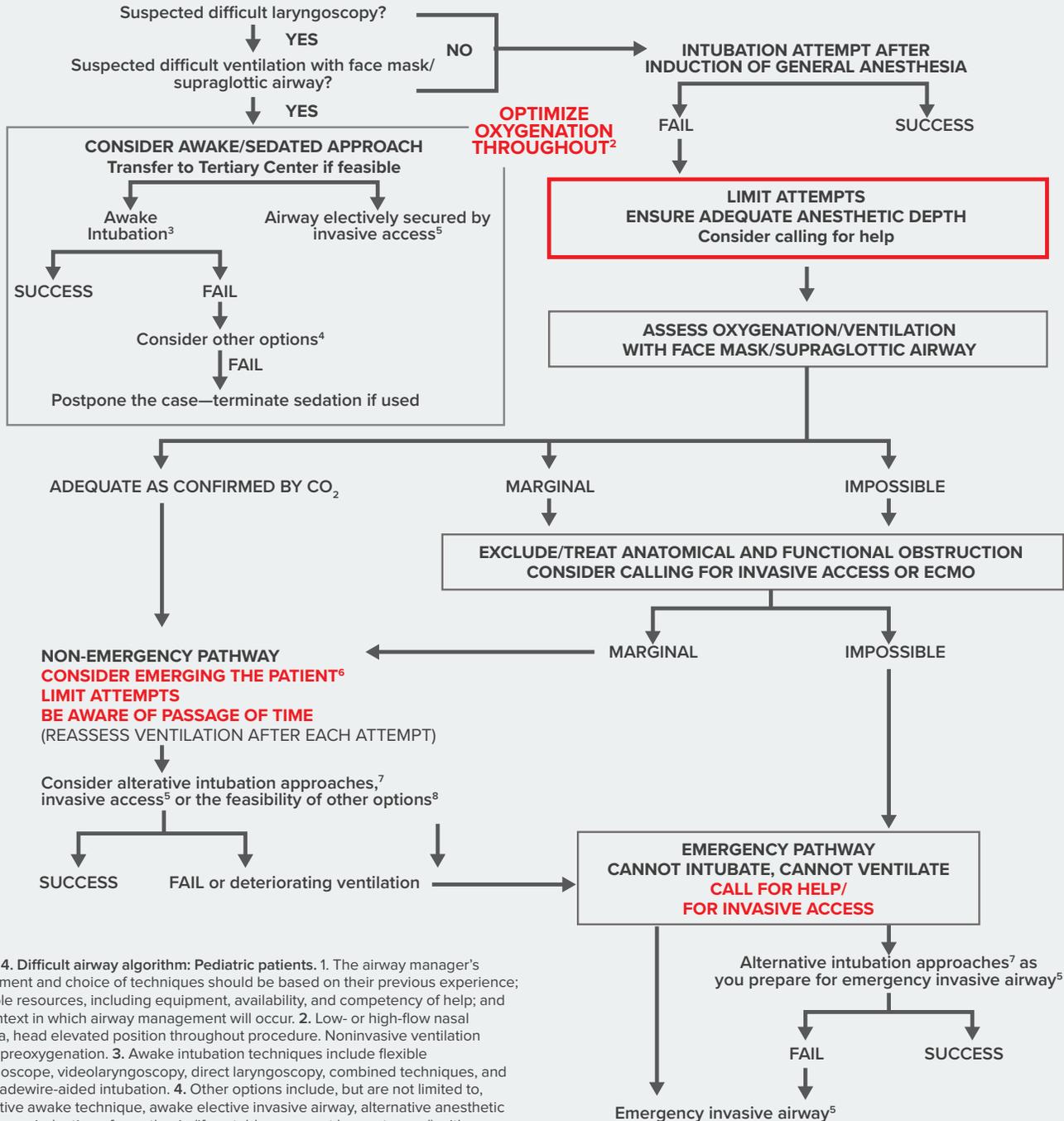


Figure 4. Difficult airway algorithm: Pediatric patients. 1. The airway manager’s assessment and choice of techniques should be based on their previous experience; available resources, including equipment, availability, and competency of help; and the context in which airway management will occur. 2. 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.

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Difficult Airway Guidelines (Cont'd)

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hyperangulated video laryngoscopes were compared to non-angulated video laryngoscopes in anticipated difficult airway patients.¹³ Combination techniques may improve intubation success in patients with anticipated difficult airways. For example, using a flexible intubation scope through a supraglottic airway had a higher first-attempt success rate than using the flexible intubation scope alone.¹⁶⁻¹⁹

EXTUBATION AND DOCUMENTATION

The guidelines highlight the importance of having an extubation strategy and preparing for reintubation if necessary. Consideration should be given to the personnel, the extubation location, and the equipment available. After extubation of difficult airway patients, clinicians should consider using an airway exchange catheter or laryngeal mask to allow rapid reintubation. The guidelines highlight the importance of communication and documentation. The clinical management must be communicated to the patient and documented in a letter. The patient should be encouraged to register with an emergency notification service. A detailed note should be added to the medical record.

ASA HOUSE OF DELEGATES (HOD) APPROVAL

The ASA HOD must approve all work products from the ASA Committee on Standards and Practice Parameters. A working draft of the guidelines was placed on the ASA website for all to review. All submitted comments were considered for inclusion. Interestingly, one of the common comments was that a portion of the ASA membership preferred the previous black and white algorithm style. Therefore, the algorithm was mainly kept in its original form with some minor modifications (Figure 3 and 4) after ASA HOD approval at the ASA annual meeting in October 2021.

CONCLUSIONS

These new guidelines are the first to include evidence from both adults and pediatric airway management. Although cloaked in the same garments (style, process and format) they radically depart from previous versions. They highlight the importance of risk assessment, provide a new decision tree to help determine when to consider awake airway management, awareness of task fixation and time passage, limiting the number of tracheal intubation attempts, and assessing ventilation after every intervention. Finally, they highlight the need to confirm intubation with capnography, plan for extubation, document the airway management in the medi-

cal record, and provide documentation to the patient. Welcome to the final stage of change.

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Patient Safety and Low-Flow Anesthesia

by Jeffrey M. Feldman, MD, MSE, and Samsun Lampotang, PhD, FSSH, FAIMBE

The benefits of low-flow anesthesia are well established and include reduced inhaled anesthetic waste, decreased cost, and fewer greenhouse gas effects.¹ For the individual patient, low-flow anesthesia reduces loss of heat and humidity from the lungs.² This article will highlight the common safety concerns of low-flow anesthesia. This is not intended to be a comprehensive guide to practicing low-flow anesthesia, which is well-described in the literature,³ and is a topic that will be covered in the upcoming APSF-ASA medical technology training initiative. (See announcement on page 43.) The good news is that the risks of adopting low-flow anesthesia are readily managed, and patient safety concerns should not be a barrier to reducing fresh gas flow.

The “circle system” was designed to reduce anesthetic waste by allowing exhaled anesthetic agent to return to the patient in the inspired gases (Figure 1). Carbon dioxide (CO₂) absorption is fundamental to the design of the circle system. While CO₂ absorbents are necessary for safe use of the circle system, the presence of an absorbent does not guarantee the circle system is actually reducing waste. Effectively reducing waste requires the anesthesia professional to reduce fresh gas flow in a manner that allows exhaled gases to return to the patient.⁴

Low-flow anesthesia is sometimes described as a total fresh gas flow of 1 liter/min. In practice

however, low-flow anesthesia is not a single number. Depending upon the circumstances, 1 liter/min can be too much to achieve the desired degree of waste reduction, or too little to maintain an adequate concentration of oxygen or anesthetic in the circuit. For purposes of this discussion, the authors define the current practice of low-flow anesthesia as: *Reducing fresh gas flow below minute ventilation to the lowest level consistent with equipment capabilities and provider comfort while ensuring safe and effective care for the patient.* While reducing fresh gas flow unquestionably reduces waste, cost, and pollution, it is not without consequences that have implications for patient safety.

Effective oxygen delivery requires an inspired oxygen concentration that will maintain the desired concentration of oxygen in the blood. Anesthetic agent requirements are dictated by the need to maintain an adequate level of hypnosis and physiologic stability in the face of surgical stimulation and trauma. As fresh gas flow is reduced and rebreathing increases, the concentrations delivered in the fresh gas and the concentrations inspired by the patient can be quite different. Furthermore, gas and agent concentrations change in the circuit more slowly as fresh gas flow is reduced. Managing the relationship between delivered and inspired concentrations is the art and practice

of low-flow anesthesia. It is important to note that control of carbon dioxide concentration is determined by minute ventilation and is unaffected by fresh gas flow.

ENSURING ADEQUATE OXYGEN DELIVERY

Concern for inadequate oxygen delivery leading to hypoxemia or inadvertent low inspired concentration of oxygen is reasonable as fresh gas flow is reduced. The concentration of oxygen in the exhaled gas (F_EO₂) is always less than the inspired concentration (F_IO₂) due to the patient’s oxygen consumption. As the percentage of rebreathed gas increases, F_EO₂ mixes with the oxygen delivered to the patient in the fresh gas (F_DO₂) to yield the F_IO₂. The more exhaled gas is allowed to return to the patient, the greater the impact of F_EO₂ on F_IO₂ (Figure 1).

Continuous monitoring of inspired oxygen concentration is essential to the safe and effective practice of low-flow anesthesia. As flows are reduced, the practitioner estimates the delivered oxygen concentration (F_DO₂) that will maintain the desired inspired concentration (F_IO₂). Ultimately, the patient’s oxygen consumption and any leaks in the circuit will determine the F_IO₂ delivered to the patient.

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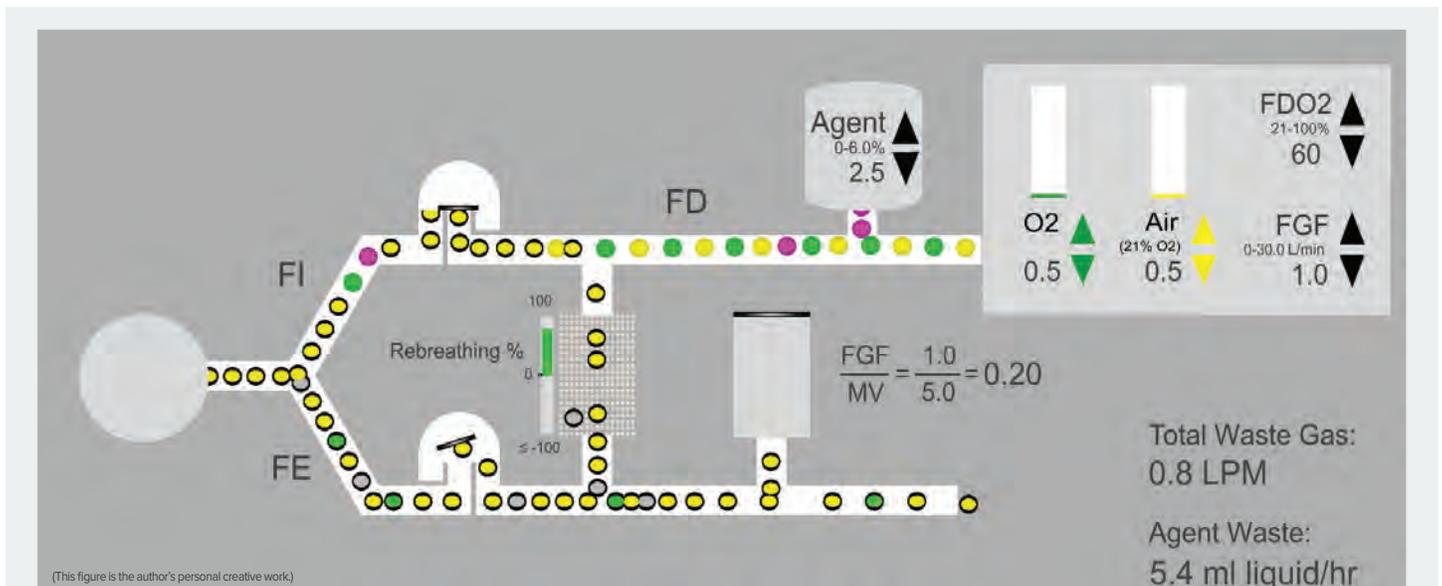


Figure 1: Idealized schematic of a circle system where FGF is a fraction of the minute ventilation at 1 L/min—0.5 L/min Air and O₂ respectively. Air = Yellow circles, Oxygen = Green circles, and Agent = purple circles. Circles with the black border = exhaled gases or anesthetic, some of which return to the inspired limb. Note that due to recirculation of exhaled gases, the concentration of oxygen and anesthetic delivered in the fresh gas flow (F_DO₂ 60% and F_DA 2.5%) will be different from the inspired concentrations (F_IO₂ and F_IA) due to mixing of fresh gas with exhaled gases (F_EO₂ and F_EA). The exact concentration differences will depend upon the phase of the procedure with the difference diminishing over time. F_D = delivered fraction, F_I = inspired fraction; F_E = expired fraction; FGF = fresh gas flow; MV = minute ventilation.

Continuous Monitoring of Inspired and Expired Anesthetic Agent Concentration Is Essential to Safe Practice of Low-Flow Anesthesia

From “Low-Flow Anesthesia,” Preceding Page

Continuous F_{iO_2} monitoring will help to guide adjustments to fresh gas flow. Since the F_{iO_2} changes slowly at low fresh gas flow, a low oxygen concentration alarm can be set above the minimum safe level to provide a notification if F_{iO_2} is heading lower than desired.

Managing inspired oxygen concentration during low-flow anesthesia is relatively straightforward since oxygen consumption is fairly constant during a procedure. Managing inspired anesthetic agent concentration is a bit more challenging since the uptake of agent falls exponentially over time.

ENSURING ADEQUATE INSPIRED ANESTHETIC AGENT CONCENTRATION

As mentioned previously, safe anesthetic agent delivery requires that the patient have a sufficient concentration to be unaware, but not so much that physiologic stability is threatened. Similar to the case of oxygen, the expired concentration of anesthetic agent (F_{EAgent}) will always be less than the inspired concentration of agent (F_{iAgent}) due to uptake, except during emergence. Early in the procedure, when uptake of agent is high, the difference between F_{EAgent} and F_{iAgent} can be substantial. For that reason, it is more difficult to reduce flows during induction and maintain the desired anesthetic concentration compared with the maintenance phase of the anesthetic when uptake has slowed and F_{EAgent} approaches F_{iAgent} .

Continuous monitoring of inspired and expired anesthetic agent concentration is essential to the safe and effective practice of low-flow anesthesia. The difference between inspired and expired anesthetic agent concentration indicates the rate of uptake. As the difference narrows, uptake is slowing and it is easier to reduce flows and maintain the desired anesthetic concentration in the circuit. While the Delivered agent concentration, F_{DAgent} , is determined by the vaporizer setting, the F_{iAgent} indicates what is being inspired by the patient. As flows are reduced, it may be necessary to increase the vaporizer setting above the Minimum Alveolar Concentration (MAC) concentration desired in the patient to maintain the F_{iAgent} and F_{EAgent} at the desired levels. Like oxygen delivery, setting the vaporizer is an estimate by the low-flow practitioner, and continuous agent concentration monitoring becomes essential to guiding vaporizer and fresh gas flow settings.

MANAGING FRESH GAS FLOW WHEN CHANGING OXYGEN AND AGENT CONCENTRATIONS

One major challenge to the practice of low-flow anesthesia is the rate of change of oxygen and agent concentrations in the circuit. The time constant for the rate of change is the internal volume of the anesthesia machine and breathing circuit in liters divided by the fresh gas flow in L/min. The internal volume can be 5 liters or more so that a fresh gas flow of 1 L/min could result in a time constant of 5 minutes, and it can take four-time constants to get close to equilibrium.

As fresh gas flow is reduced, concentrations of oxygen and anesthetic will change more slowly to reach a new equilibrium. As a result, the practitioner may change the gas mixture or

vaporizer setting, but the ultimate impact on concentrations in the circuit will not be apparent for several minutes. This is another reason for continuous monitoring of oxygen and agent concentrations in the circuit as well as the use of high and low alarm limits to draw attention to slow changes that might otherwise go unnoticed. Indeed, it may be necessary to increase the total fresh gas flow to ensure that oxygen and agent concentrations change more quickly if needed.

DOES SEVOFLURANE HAVE A MINIMUM SAFE FRESH GAS FLOW?

The package insert for sevoflurane indicates that sevoflurane is safe when fresh gas flow is not less than 1 L/min for up to 2 MAC-Hours or not less than 2 L/min for longer procedures.⁵

See “Low-Flow Anesthesia,” Next Page

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Eliminating KOH and Limiting NaOH to Less than 2% Yields an Absorbent That Does Not Produce Compound A

From “Low-Flow Anesthesia,” Preceding Page

This recommendation is neither scientifically sound nor consistent with a modern practice of low-flow anesthesia. Nevertheless, given the FDA labelling, practitioners may be understandably reluctant to reduce flows to less than these recommendations and deliver sevoflurane “off-label.” In another article on page 57 of this *Newsletter*, Brian Thomas JD, vice-president for Risk Management, Preferred Physicians Medical, provides some guidance on the actual medicolegal concerns associated with off-label medication administration. This article will briefly review the science that clearly indicates a lower flow limit for sevoflurane is unnecessary.

The major concern for reducing flows when using sevoflurane is the accumulation of Compound A in the circuit and the potential for renal toxicity. While there is no question that sevoflurane can interact with some absorbent formulations to produce Compound A, it has never been shown to result in renal toxicity in humans.⁵ Furthermore, subsequent to the FDA labelling of sevoflurane, it was clearly shown that Compound A results from the interaction of sevoflurane with absorbents that contain strong bases like potassium hydroxide (KOH) and sodium hydroxide (NaOH).⁷ It has also been shown that eliminating the KOH and limiting the NaOH to less than 2% yields an effective absorbent that does not produce Compound A.⁸ In short, while

there is no substantiated concern for patient injury from Compound A, there is no risk of Compound A production when using one of the many carbon dioxide absorbents available that limit the strong base to NaOH <2%. Every absorbent has a safety data sheet that is readily available on the internet and indicates the chemical composition of the absorbent (Figure 2). Any fresh gas flow can be used safely when administering sevoflurane subject to the considerations for oxygen concentration noted previously.

CONCLUSION

The practice of safe and effective low-flow anesthesia is an art that requires the practitioner to understand the capabilities and limitations of the circle system, set fresh gas flow and vaporizer concentrations to estimate patient needs, and continuously monitor the concentrations that result in the circuit. Interested in reducing the waste and pollution in your practice of inhaled anesthetic delivery? Look for the APSF-ASA course on low-flow anesthesia to be available on the APSF website in the fall of 2022.

Jeffrey Feldman, MD, MSE, is chair, APSF Committee on Technology and professor of Clinical Anesthesiology at Children’s Hospital of Philadelphia Perelman School of Medicine.

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Dr. Feldman is a consultant for Medtronic, Becton-Dickinson, and Micropore. Dr. Lampotang has no conflicts of interest.

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Composition / Information on Ingredients

2.2 Chemical Characterization (Preparation):

Soda lime containing calcium dihydroxide, calcium chloride, sodium hydroxide, 14–18% water and the indicator ethylviolet.

CAS No.	Designation acc. to EC Directive	Content	Unit	Ident. Symbol	R-Phrases
1305-62-0	Calcium dihydroxide / Calcium hydroxide (Ca(OH) ₂) (EINECS-Nr. 215-137-3)	74–82	w/w per cent	X _i	R 41
10043-52-4	Calcium chloride	3–5	w/w per cent	X _i	R 36
1310-73-2	Sodium hydroxide	0.5–1	w/w per cent	C	R 35
2390-59-2	Ethyl Violet	<0.1	w/w per cent	X _n	R 22–41

2.3 Additional Information:

Drägerisorb® Free contents no ozone-depleting chemicals and no volatile organic chemicals (VOCs). During the manufacturing process for Drägerisorb® Free no ozone-depleting chemicals and no volatile organic chemicals (VOCs) were used.

Abbreviations: CAS No = unique identifier for all compounds published by the Chemical Abstracts Service; Compound names are *Designation according to European Commission Directive*; W/W = Weight by weight expressed as a percentage eg. 1% is 1 gram of the substance in 100g of the material; R-phrase = defined by the European Union Directive 67/548/EEC and describe special risks attributed to chemical preparations. (e.g., R-36 means irritating to the eyes)

Figure 2: Snapshot of medical safety data sheet for Drägerisorb Free. Note that the chemical composition is clearly noted, the sodium hydroxide concentration is 0.5-2%. From https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6812422/pdf/MSDS/MSD_SDS71242.pdf. Accessed 4/4/2022. Similar safety data sheets can be found in the public domain for any commercially available CO₂ absorbent.

Off-Label Low-Flow Sevoflurane: Regulatory Red Herring or Liability Landmine?

by Brian Thomas, JD

Administration of sevoflurane at low-flow rates remains a controversial practice due to the low-flow limits described in the Food and Drug Administration's (FDA) required labeling. Specifically, the labeling in the United States requires no less than 1 L/min for up to 2 Minimum Alveolar Concentration (MAC)-Hours and no less than 2 L/min during longer exposures.¹ While there is substantial evidence that Compound A is not toxic to humans and many carbon dioxide absorbents do not produce Compound A, the language in the labeling continues to influence practice.² Labeling requirements create confusion about whether or not prescribing or administering a drug in an "off-label" manner (e.g., for a purpose not approved by the FDA) is safe and meets the standard of care.* This article will address whether administering sevoflurane at off-label low-flow rates increases anesthesia professionals' potential liability exposure in the event of an adverse outcome.

FDA APPROVAL AND OFF-LABEL USE

The FDA "plays a role in almost every aspect of the approval, marketing, labeling, advertising, and promotion of both over-the-counter and prescription drugs."³ To approve a drug, the FDA must obtain sufficient information based on clinical testing to determine: 1) if the drug is safe and effective for the proposed use(s) and whether the benefits of the drug outweigh its risks; 2) whether the proposed labeling is appropriate and what (if anything) should be changed; and 3) whether the methods used in manufacturing the drug and the controls used to maintain its quality are adequate.⁴

Once a drug is approved for a specific purpose, the drug can be used for any treatment even if the FDA did not approve that treatment. Using the drug for a purpose not indicated on its FDA-approved label is called an "off-label" practice.⁵ Off-label use is allowed by law in the context of therapy, but not allowed for research. The distinction between off-label use and research is important as the FDA closely regulates the development and clinical investigation (i.e., "research") of new drugs. The FDA does



not, however, regulate the practice of medicine, and anesthesia professionals are allowed to prescribe approved drugs for off-label use if such prescriptions do not qualify as "research."⁶

POTENTIAL MALPRACTICE LIABILITY

The most likely cause of action against an anesthesia professional who prescribes or administers a drug for an allegedly improper off-label use is the lack of informed consent.[†]

INFORMED CONSENT

In the United States, the doctrine of informed consent generally requires an anesthesia professional to provide the patient or their legal surrogate with material information regarding the proposed treatment, the alternatives to treatment (including no treatment), the risks and potential benefits of the proposed treatment and alternatives. Given that information, the patient or their legal surrogate must be allowed to determine whether to consent to the proposed or alternative treatment. Most states apply the "reasonable anesthesia professional" standard when determining whether an adequate informed consent discussion was provided. This standard requires a determination

by the jury or judge whether a reasonable anesthesia professional would have provided the material information necessary for the patient to make an informed decision.

In applying the doctrine of informed consent to off-label drug prescription or administration, many state courts have held that anesthesia professionals and other health care providers do not have to disclose to patients that a proposed use is off-label. For example, in one seminal appellate case, the court held:

"The decision whether or not to use a drug for an off-label purpose is a matter of medical judgment, not of regulatory approval. By analogy, the off-label use of a medical device is also a matter of medical judgment, and as such, subjects an [anesthesia professional] to professional liability for exercising professional medical judgment. Off-label use of a medical device is not a material risk inherently involved in a proposed therapy which an [anesthesia professional] should have disclosed to a patient prior to the therapy."⁷

Most states' informed consent laws limit an anesthesia professional's duty to providing medical information. In those states, the courts have held as a matter of law that there is no duty obligating an anesthesia professional to discuss the FDA regulatory status of drugs or products being used for a particular treatment, nor does a drug or product's legal status (e.g., FDA-approved or off-label) affect the nature of the treatment.⁸

However, a minority of states apply a "reasonable patient or person" standard of review for informed consent. That is, would a reasonable patient or person have considered the fact that a drug or medical device was going to be administered or used in an off-label manner material information for purposes of consenting to the treatment? Even in those states, the plaintiff would still need to prove that had the patient known the drug prescribed or administered was off-label, the patient would have refused the treatment.⁹

Plaintiff attorneys continue to file lack of informed consent cases based on the fact that an anesthesia professional did not inform his or her client that the drug was administered in an

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* "Medical standard of care" is a legal term that is generally defined as the level and type of care that a reasonably competent and skilled anesthesia professional, with a similar background and in the same medical community (specialty), would have provided under the same or similar circumstances.

† If informed consent is not obtained, an anesthesia professional can be exposed to civil liability. Performing an invasive procedure without a patient's consent is battery, an intentional tort, for which monetary damages may be awarded. If an anesthesia professional failed to inform a patient about risks of a procedure and alternative treatments, he or she may be liable for negligence if the patient is injured as a result of the treatment.

Anesthesia Professionals Are Allowed to Administer “Off Label” Drugs If Such Drugs Do Not Qualify As “Research”

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off-label manner. A layperson on a jury could give great deference to the fact the FDA did not approve the use for which the anesthesia professional prescribed or administered the drug, even though such use may be widely accepted.¹⁰ Additionally, plaintiff attorneys will have little difficulty identifying anesthesiology experts to testify that the administration of sevoflurane off-label for low-flow anesthesia is below the standard of care based, at least in part, on the manufacturer’s and FDA’s warning label recommending against fresh flow rates < 1 L/min. However, if the anesthesia professional’s care was appropriate, most of these cases are defensible and do not result in settlement or ever make it to trial.

CONCLUSION

Anesthesia professionals have safely prescribed and administered a multitude of drugs off-label for decades. A review of Preferred Physicians Medical’s 4,594 anesthesia closed claim files from 1987 to March 10, 2022, did not identify any claims with allegations of patient

injury or death involving low-flow sevoflurane anesthesia. The FDA does not regulate the practice of medicine, and anesthesia professionals are allowed to prescribe and administer drugs for off-label uses if such drugs do not qualify as “research.” Like all medical judgments, a decision to administer a drug “off-label” becomes a risk-benefit decision. While the off-label use of a drug may potentially increase the risk of liability, that risk may be mitigated by an adequate informed consent process and adherence to the standard of care. In summary, litigation involving allegations of negligence due to off-label administration of drugs is uncommon and, in most cases, defensible on behalf of anesthesia professionals.

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The author has no conflicts of interest.

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Anesthesia Pain and Safety Considerations in Cancer Patients

by Dylan Irvine, BSCh, and Jeffrey Huang, MD

INTRODUCTION:

The subspecialty of onco-anesthesia has gradually gained traction over the past few years. In addition to the comorbid diseases that some cancer patients present with, the interactions and consequences of their antineoplastic regimens must also be considered when devising an anesthetic plan. These new risks challenge the onco-anesthesia professionals with how to manage their patients safely. Preoperative considerations include the effect of chemotherapeutics on anesthesia administration. Intraoperative considerations include assessing the risks of intraoperative hypothermia in cancer patients, patient positioning and peripheral nerve injury considerations, and monitoring of an anesthetized patient. Postoperative considerations include managing the compound effects of postoperative pain with existing pain from a malignancy, as well as the associations between patient psychological support and postsurgical outcomes.

PREOPERATION CONSIDERATIONS

Effect of Chemotherapeutics on Anesthesia Administration—Cardiac and Pulmonary Considerations

The anesthesia professional must consider a specialized approach to anesthesia administration in patients undergoing chemotherapy treatment who require an elective or emergency surgery. Two of the most common systems affected by toxicities to chemotherapeutics

include the cardiac and pulmonary systems, with the degree of toxicity depending on the specific agents employed, the dosage, and duration of use.¹ Common chemotherapeutics associated with cardiac toxicity include busulfan, cisplatin, cyclophosphamide, doxorubicin, and 5-fluorouracil.¹ For such patients, cardiac and respiratory function should be carefully evaluated prior to the anesthetic to identify the onset and etiology of potential complications. In an emergency situation, the use of Point of Care Ultrasound (PoCUS) can provide anesthesia professionals information regarding volume status, cardiac function, and respiratory function² in patients who do not have adequate preoperative assessment.

Patients treated with anthracycline chemotherapy, a family of drugs extracted from *Streptomyces spp.* such as doxorubicin, may develop acute intraoperative left ventricular failure refractory to beta-adrenergic receptor agonists.¹ This acute onset left ventricular failure is likely due to the risk of chemotherapy-induced cardiotoxicity associated with this drug class, which limits their use in some patients.³ In patients who develop chemotherapy-induced cardiotoxicity, the administration of phosphodiesterase inhibitors are indicated.¹

Common chemotherapeutics associated with pulmonary toxicity include methotrexate, bleomycin, busulfan, cyclophosphamide, cytarabine, and carmustine.¹ Patients can

suffer pulmonary complications, such as dose-dependent interstitial pneumonitis and pulmonary veno-occlusive disease.¹ Initial presentation may be limited to dry cough, breathlessness with exercise, and minimal changes on chest radiograph.⁴ However, postoperatively, these patients may require a period of mechanical ventilation.⁴ A high concentration of inspired oxygen has been shown to increase the risk of patients developing bleomycin-induced lung injury.⁴ Therefore, it has been recommended that reduced intraoperative and postoperative oxygen concentration should be used in patients being treated with bleomycin to reduce the risk of respiratory complications.^{4,5}

INTRAOPERATIVE CONSIDERATIONS

Intraoperative Hypothermia in Cancer Patients

Between 50%–70% of all surgical patients will experience intraoperative hypothermia.⁶ Surgical duration, age, and baseline body temperature have been identified as risk factors for developing intraoperative hypothermia.⁷ Cancer patients undergoing surgical treatment are often subject to increased surgical and anesthesia duration, and therefore may be at increased risk of developing intraoperative hypothermia (core body temperature < 36.0° C during surgery⁸). Intraoperative hypothermia is associated with longer surgical recovery time for general anesthesia, arrhythmias, coagulopathies, longer duration of intubation, and increased postoperative length of hospitalization, compared to normothermic intraoperative patients.⁶ Hypothermia during cancer resection has been shown to have significant negative effects on postoperative immune function and cytokine levels, particularly in patients undergoing surgery for gastrointestinal cancer.⁶ Cancer patients with intraoperative hypothermia may suffer from an increased incidence of postoperative complications of any types, as well as a higher pathologic state and higher recurrence rate within 12 months, relative to normothermic patients.⁸

Consequently, for anesthesia duration longer than 60 minutes, intraoperative warming should occur through convective heating using a forced-air warming blanket.⁹ Intraoperative infusions or transfusions should be warmed.⁹ Postoperatively, patients should be thermally insulated to prevent the development of

See “Cancer Patients” Next Page



A Multimodal Analgesic Approach For Managing Cancer Patients' Pain is Preferred in the Perioperative Period

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hypothermia and medications such as clonidine or meperidine can be administered to control shivering.⁹ Dexmedetomidine displays similar efficacy to antishivering agents such as clonidine or meperidine, but may increase the risk of sedation, hypotension, dry mouth, and bradycardia.¹⁰

Intraoperative Patient Positioning and Peripheral Nerve Injury Prevention

In tumor resection surgeries, nerve injury can often occur because of compression and impingement on neural structures due to tumor tissue. Inappropriate patient positioning can lead to peripheral nerve injury as well. The ulnar nerve, brachial plexus, and common peroneal nerve are the most vulnerable to injury during surgery.¹¹ Anesthesia professionals should be vigilant during the initial positioning and during the surgery.¹¹ The use of padded arm boards or padding placed around the elbow has been shown to reduce the risk of upper extremity neuropathy perioperatively.¹² Other padding can be strategically placed to limit the pressure of hard surfaces on the fibular head, which has been used to reduce the risk of peroneal neuropathy.¹²

Intraoperative Monitoring in an Anesthetized Cancer Patient

Intraoperative monitoring of high-risk patients (high-risk patients are defined by patient history, comorbidities, age, body mass index, ASA status, frailty, poor mobility, presence of terminal illness, and surgery type and complexity) may allow anesthesia professionals to detect the onset and etiology of shock states earlier so that targeted interventions can be implemented. In hemodynamically stable patients, continuous electrocardiographic mon-

itoring, noninvasive blood pressure measurements, end tidal carbon dioxide monitoring, and peripheral pulse oximetry can be adequate intraoperatively.² In hemodynamically unstable patients, an arterial line for continuous invasive blood pressure measurement and arterial blood gas analysis should be considered by anesthesia professionals.² Implementation of PoCUS into clinical practice may provide additional information regarding volume status, cardiac function, lung status, and respiratory function, and is emerging as a fundamental approach for earlier detection of intra-abdominal or intrathoracic bleeding or fluid deficiency.²

POSTOPERATION CONSIDERATIONS: The Compound Effect of Postoperative Pain with Existing Pain Due to a Malignancy

The complexity of postoperative pain management for cancer patients is important for anesthesia professionals to consider. Barriers to adequate pain relief among cancer patients may be political (e.g., availability to opioids), prescriber-related (e.g., insufficient education around pain assessment and management, apprehension in prescribing opioids to patients, concerns relating to respiratory depression or excessive sedation), or patient-motivated (e.g., fear of addiction, fear that treatment implies final stages of life, fear of side effects).¹³ Pharmacologic management of mild cancer pain often involves nonopioid analgesia such as paracetamol/acetaminophen and/or non-steroidal anti-inflammatory drugs (NSAIDs). Treatment of moderate and severe cancer pain can involve the prescription of “weak,” or less potent opioids and “strong,” or more potent opioids, respectively.¹³ In postoperative cancer patients, pain management becomes more complicated due to the potential compounding

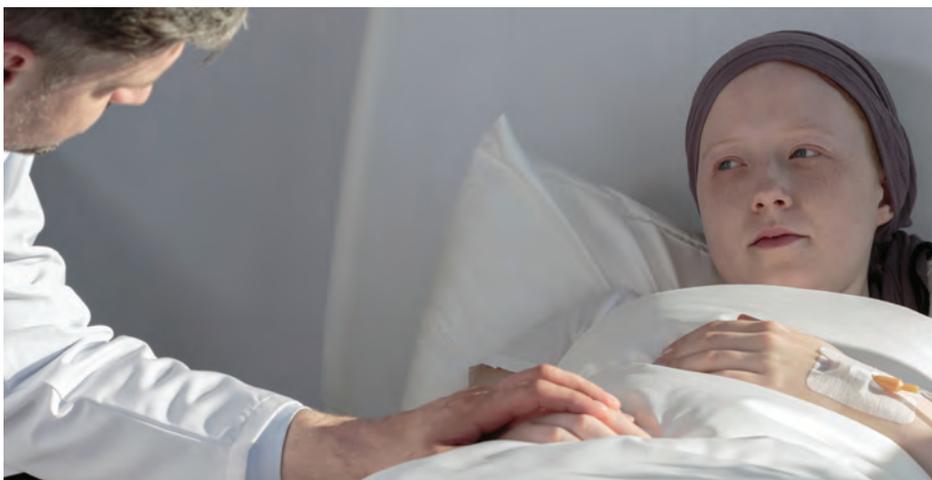
effect from existing cancer pain, and the pain that can be manifested during the postsurgical period. Persistent postsurgical severe pain has been witnessed in 5–10% of cancer patients, which is often the result of nerve injury followed by central sensitization in response to trauma.¹⁴

Many cancer patients have been on long-term and high-dose opioids; thus, their opioid requirements throughout the perioperative period will be increased.¹⁵ In these patients, multimodal analgesia strategies are important for providing a baseline of nonopioid analgesia, such as through the administration of paracetamol/NSAIDs and alpha-2-delta subunit modulators such as gabapentin.¹⁵ Perioperative intravenous ketamine reduces postoperative pain medication requirement and pain intensity.¹⁶ In a meta-analysis, it has been shown that the benefits of intraoperative lidocaine infusion to reduce pain are not yet confirmed.¹⁷

Alternatively, local anesthetic infusion with a long-term catheter placement has been shown to decrease the incidence of chronic pain postoperatively.¹⁸ Peripheral nerve blocks are also utilized for regional anesthesia postoperatively, and the complications, performance time, and local anesthetic requirements have been improved through the application of PoCUS.¹⁸ An advantage of peripheral nerve blocks in managing postoperative pain relative to central neuraxial blocks or general anesthesia is a reduction of systemic side effects such as sympathetic blockage and urinary retention.¹⁸ More recently, the emergence of fascial plane blocks has further expanded the applications of regional anesthesia in terms of managing postoperative pain for conditions involving the thorax and abdomen.¹⁹

Patient Psychological Considerations

Psychological distress, in particular, depression, in postoperative cancer patients is an emerging issue in the management of such patients. In these patients, referral and access to psychological support and counseling is important in improving patient outcomes. A study of cancer patients who underwent curative surgical resection for primary lung cancer demonstrates that depression and anxiety following surgery were aggravated by the presence of residual symptoms present following surgical intervention.²⁰ In this study, thoracotomy, postoperative dyspnea, severe pain, and diabetes mellitus were identified as risk factors for postoperative depression, after controlling for the presence of preoperative depression.²⁰



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Challenges Faced By Onco-Anesthesia Professionals In Safely Managing Cancer Patients Are Complex

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Providing access to psychological counseling is important at all stages of cancer treatment.²¹ Patients have shown benefit from psychological counseling at all stages of cancer care, from initial diagnosis to treatment and managing long-term functional effects.²¹ Psychological distress is also common in breast cancer patients who have undergone mastectomy. Compared to controls, the incidence of depression in patients who underwent mastectomy for breast cancer was significantly increased for up to three years following mastectomy, especially in younger adults.²² Overcoming and preventing postoperative depression in these patients through psychological counseling may improve morbidity and mortality in these patients.

CONCLUSION

The challenges faced by onco-anesthesia professionals in safely managing cancer patients perioperatively are diverse and complex. However, proper considerations of the potential risks between anesthesia administration and antineoplastic regimens must be taken to ensure the best quality of care while supporting these vulnerable patients.

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The authors have no conflicts of interest.

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Managing COVID-19 in the Perioperative Setting

by Jeremy Laney, MD, and Joseph W. Szokol, MD, FASA

For the past 2 years, the COVID-19 pandemic has bequeathed a plethora of barriers and unleashed its desolation on nearly every person on the planet. Infections have surpassed 445 million globally along with an excess of 5.9 million deaths;^{1,2} and these numbers continue to climb as the globalized vaccine efforts lag. Health care systems worldwide confronted unique challenges as hospital beds became saturated with infected patients during various surges throughout the pandemic. The challenge for health care systems to mitigate risks to patients while providing standard services remains, as immunization for SARS-CoV-2 continues to propagate and the in-hospital census of infected patients fluctuates.

Health care systems need to return to normalcy and provide surgical and procedural services safely, while mitigating the risk to SARS-CoV-2 positive patients. Determining the optimal timing of procedures for patients who have recovered from COVID-19 infection and the appropriate level of preoperative evaluation are challenging given the current lack of evidence or precedent for this disease. According to the Joint Statement Created by the APSF and ASA, “Elective surgeries should be performed for patients who have recovered from COVID-19 infection only when the anesthesia professional and surgeon or proceduralist agree jointly to proceed.”³ This should be done in conjunction with shared decision-making with the patient.

The most robust data analyzing perioperative outcomes of patients with SARS-CoV-2 infection emerged from the COVIDSurg Collaborative and



GlobalSurg Collaborative study.⁴ This was an international, prospective, cohort study that included a total of 140,231 patients in 1,674 hospitals throughout 116 countries. They assessed the postoperative complications in patients with a diagnosis of SARS-CoV-2 infection with a primary outcome measure of 30-day postoperative mortality and a secondary outcome measure of 30-day postoperative complications (defined as pneumonia, acute respiratory distress syndrome, and unexpected postoperative ventilation). For patients with a SARS-CoV-2 diagnosis prior to surgical intervention, the mortality rates were as follows: 9.1% 0–2 weeks prior, 6.9% 3–4 weeks prior, 5.5% 5–6 weeks prior and 2.0% at ≥7 weeks (Figure 1). The mortality rates in the ≥7

weeks group demonstrated no significant difference when compared to the noninfected control group. Amongst the SARS-CoV-2 positive subjects, symptomatic patients demonstrated a significantly higher 30-day mortality rate across all time interval subgroups, when compared to those who were asymptomatic or had resolution of symptoms at the time of surgery. SARS-CoV-2 infected patients 0–2 weeks, 3–4 weeks, and 5–6 weeks prior to surgery demonstrated higher rates of postoperative pulmonary complications as well, and those with ongoing symptoms demonstrated the greatest risk. The ≥7 weeks subgroup complication rates mirrored that of the noninfected subjects.⁴

The beginning of the COVID-19 pandemic resulted in an overwhelming amount of admissions. Attempts to minimize in-hospital transmissions coupled with the lack of initial data on elective surgical risk for COVID-19 positive patients discussed in the previous section caused millions of cancellations and delays of elective surgeries worldwide. The National Institute for Health Research (NIHR) unit on Global Surgery collected data from 1,674 hospitals to address the perioperative risk of SARS-CoV-2 infected patients. This dataset delivers valuable information to providers responsible for mitigating risk to surgical candidates. Nonetheless, the large-scale study is not without its limitations. The diagnosis of a SARS-CoV-2 infection was not standardized and relies on the unique preoperative testing strategies of each institution, leaving the true time from infection-to-surgery in question.

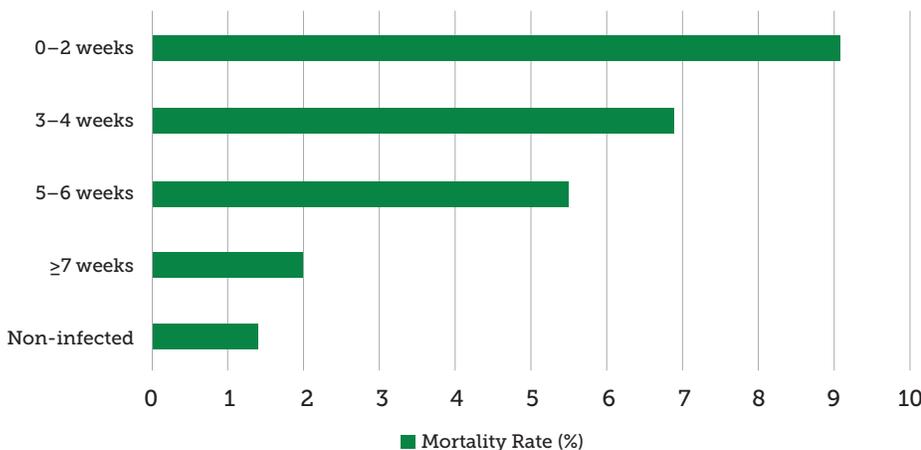


Figure 1: Mortality rates of patients with SARS-CoV-2 diagnosis prior to undergoing surgery.

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Managing COVID in the Perioperative Setting

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Given the reliance on a single routine preoperative test, it is likely that a subgroup of subjects who recently recovered from a previous SARS-CoV-2 infection were misclassified as not infected. The pragmatic difficulties associated with conducting a cohort study of this scale rendered limitations in important subanalysis; assessing outcomes amongst groups controlling for type of surgery, type of anesthesia, airway device used, and chronic comorbidities would have been ideal with this dataset. The secondary outcomes measured in the study assessed the rates of pulmonary complications; however, it is well established that SARS-CoV-2 can cause an array of systemic complications including: thromboembolic events, myocarditis, overt stroke, cognitive deficiencies, and kidney injury.⁵ Lastly, data for this study were collected in October of 2020, prior to widespread vaccine distribution efforts and the emergence of a number of variants. As immunization propagates, through inoculation and infection, these outcomes will likely change.

Subsequent studies aimed at assessing similar findings have replicated the outcomes found in the COVIDSurg Collaborative study. Deng et al., recently published a retrospective study suggesting worse postoperative outcomes in those patients who had surgery within 8 weeks of SARS-CoV-2 diagnosis.⁶ In addition, the authors reported that a shorter time interval between diagnosis and intervention correlated with a higher rate of postoperative respiratory complications.⁶

The American Society of Anesthesiologists (ASA) and the American Patient Safety Foundation (APSF) released a joint statement in March of 2021 (recently updated in February 2022) with recommendations advising clinicians of the appropriate timing of elective surgeries in SARS-CoV-2 infected patients. Based on the accumulated data at that time, the statement issued the following recommended waiting times for infected patients:

- 4 weeks for asymptomatic patients or recovered from mild nonrespiratory symptoms
- 6 weeks for symptomatic patients who did not require hospitalization
- 8–10 weeks for a symptomatic patient who is diabetic, immunocompromised, or hospitalized
- 12 weeks for patients admitted to the Intensive Care Unit due to COVID-19 infection.³

These recommendations are not comprehensive and may not reflect patient demographics that providers will inevitably

encounter. They are fluid recommendations that offer providers a framework to help estimate a risk/benefit ratio to decipher the appropriate timing of intervention patients need. The United Kingdom released similar guidelines, in February 2022, from a conglomerate of multidisciplinary perioperative specialists with analogous recommendations, discouraging operative intervention within 7 weeks of SARS-CoV-2 diagnosis.⁷

Although there is increasing information to address the timing of surgery after COVID-19 infection, the data and science unfortunately continues to lag behind the emerging variants, and data that supports the premise that vaccinated patients have a lower a risk of postoperative complications as compared to unvaccinated patients.⁸ According to the CDC, the Omicron variant causes less severe disease, and is more likely to reside in the oro- and nasopharynx without infiltration and damage to the lungs.⁹ Perioperative providers used these observations to prematurely conclude that the vaccinated patients recovering from Omicron should be at less risk for adverse events. However plausible, such a conclusion remains unproven. While there continues to be emerging data that can provide clinicians and patients with improved management strategies, health care providers will continue to require more data to fill in the knowledge gaps of the nuanced subanalyses.

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The authors have no conflicts of interest.

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A Patient's Right to Refuse Medical Treatment

by Brian Thomas, JD

The following information is a limited overview of competent adult patients' right to refuse blood and blood products based on their religious beliefs. The right to refuse medical treatment is a very complex area of the law. It should be noted that this overview is not intended as legal advice. Statements of law and legal opinion should be carefully reviewed considering more recent statutory enactments and case law. Also, different standards may apply depending on the jurisdiction in which you practice.

INTRODUCTION

The right to refuse medical treatment is generally based on the common law right of self-determination of one's body, the ethical principle of respect for autonomy,¹ and the doctrine of informed consent.² Further, the right to refuse treatment has also derived from a federal and state constitutional right to privacy.³ The United States Supreme Court has also held that a competent person has a liberty interest in the Due Process Clause in refusing any unwanted medical treatment.⁴ The right to refuse medical treatment may also be based upon the freedom of religion.⁵ Competent patients have the right to refuse any medical treatment, including blood and blood product transfusions, for themselves.⁶ Accordingly, a competent adult patient who does not want to receive blood or blood products should be required to sign a release that explains the risks inherent in refusing treatment and holds harmless any health care providers, hospital, facility, and any of their employees and agents from all liability arising out of the refusal of treatment. However, as the following case study highlights, even when competent adult patients or their legal representatives are provided with comprehensive informed consent discussions of the risks of refusing blood and blood products and those communications are documented in the medical record, that does not necessarily prevent litigation from being filed against those health care providers in the event of patient injury or death.

CASE STUDY

A 54-year-old male patient with a history of nausea, fatigue, and multiple syncopal episodes arrived via ambulance at the hospital emergency department. The patient was a Jehovah's Witness and advised his providers he did not want to receive blood or blood products. His hemoglobin (Hgb) was 9.5.

After the patient was observed for approximately six hours, the clinical decision unit determined the patient should undergo esophagogastroduodenoscopy (EGD). While preparing for that procedure, the patient experienced hypotension and an increased heart rate upon attempting to stand. Because of this episode and his decreasing Hgb, an intensive care unit (ICU) consult was ordered.



The ICU staff evaluated the patient and noted that he was more hemodynamically stable while he was lying down. A progress note entered by the ICU attending indicated the gastroenterologist discussed the endoscopy with anesthesia but stated that "anesthesia determined the patient is currently too unstable to undergo the procedure at this time." An ICU resident documented that he called the anesthesiologist and discussed the case, but the anesthesiologist was unwilling to take the patient for the endoscopy. The ICU staff then administered IV fluids in an effort to stabilize the patient for EGD, but his condition worsened over the next few hours.

An emergent EGD was ultimately performed bedside on the day of admission. The EGD revealed clotted blood in the gastric fundus and a bleeding ulcer in the intestine, which were coagulated by the endoscopist.

The following day the patient's condition deteriorated, and he became more hemodynamically unstable; his Hgb dropped to 3.5, and he was intubated and sedated. An exploratory laparotomy was performed, and a 2-cm oozing ulcer was found on the medial wall of the duodenum. The ulcer was sutured and over-sewn

by the surgeon. Another anesthesiologist administered the general anesthetic for the second procedure. He noted that the patient's power of attorney (POA) consented to the surgery and again refused blood products. The anesthesiologist noted in the preanesthesia evaluation that he informed the POA that without blood transfusion, the patient would probably not survive the surgery. The patient was assessed as an American Society of Anesthesiologists Physical Status 5E.

On the following day, the patient was administered 5 units of Hemopure®, a blood alternative, which increased his Hgb to 4.5. The patient survived the procedure and was returned to ICU. However, the patient went into cardiac arrest later that morning; resuscitation efforts were aborted following a discussion with the patient's mother, and he expired.

The patient's mother sued the emergency room physician, ICU resident, ICU physician, gastroenterologist, anesthesiologist, and the hospital. The plaintiff alleged the defendants breached the standard of care by failing to treat the patient's internal bleeding in a timely manner.

See "Right-to-Refuse," Next Page

Risk Management Strategies for Providers Who Provide Medical Care to Those Patients Who Refuse Medical Treatment

From “Right-to-Refuse,” Preceding Page

Plaintiff alleged the defendants should have performed the EGD and laparotomy sooner. Plaintiff retained three experts to support her theory: an internal medicine expert, a gastroenterology expert, and an anesthesiology expert. All three experts opined that the defendants breached the standard of care by failing to treat the patient before his blood count dropped so low.

The defendants moved for summary judgment disposition under state law.* The defendants argued that, even if defendants were negligent, the doctrine of avoidable consequences precluded the plaintiff from recovering an award. Defendants noted that, under the doctrine of avoidable consequences, a party could not recover for losses that they could have avoided through reasonable effort or expenditure. The defendants argued that the patient could have avoided death had he accepted a blood transfusion—a minimally invasive treatment with little risk.

The trial court granted the defendants’ motion for summary judgment. The court ruled that by rejecting a blood transfusion, the patient had failed to take advantage of objectively reasonable means to avoid the consequences of the defendants’ alleged negligent conduct. The court found that the blood transfusion was a minimally invasive procedure and that all three of the plaintiff’s expert witnesses agreed that it would likely have saved the patient’s life. Plaintiff appealed the trial court’s decision to the state’s court of appeals. The court of appeals affirmed the lower court’s ruling resulting in the final dismissal of this litigation.

The right to refuse medical treatment generally is a very complex area of the law. Due to conflicting legal precedents, the validity of the refusal of treatment depends on the patient’s situation. For example, if the patient is a minor, courts have generally ordered that blood transfusions be administered in life-threatening cases over the objections of parents who based their decision on religious grounds. State laws vary and are less clear for a minor in a less than life-threatening situation. If the minor is a teenager, joint refusal of the patient and the parents would likely be valid.

*Grounds for summary judgment disposition vary pursuant to federal and state law. The grounds for the summary judgment motion being granted in this case were, “the opposing party has failed to state a claim on which relief can be granted,” and “there is no genuine issue as to any material fact, and the moving party is entitled to judgment as a matter of law.”

Table 1: Depicts risk management strategies for providers managing patients who refuse medical treatment.

Risk Management Strategies and Considerations for Patients Who Refuse Medical Treatment ⁷	
1.	Educate the patient or their legal representative as much as possible about the treatment recommendations and the risks of refusing treatment
2.	Attempt to discover the patient’s reasons for refusing care and discuss these with the patient to determine if there are ways to compromise so the patient can receive care that is in their best interests
3.	With the patient’s permission, speak with family, legal representatives, or clergy to determine if that might help the patient reconsider their refusal of treatment
4.	Consider a mental health referral if the patient has overwhelming anxieties about receiving care or shows psychiatric comorbidities and is willing to be evaluated
5.	Document your efforts to educate the patient, the rationale for your recommended treatment, and the patient’s refusal of care
6.	Have the patient sign a release that explains the risks inherent in refusing treatment and holds harmless the health care providers and facility from all liability arising out of the refusal of treatment

For these reasons, anesthesia and other health care professionals should seek the advice and assistance of legal counsel when caring for a patient who refuses medical treatment (Table 1). Also, hospitals and facilities need to develop a response in advance of a medical emergency because of these same complexities. If procedures are not already in place, it may be impossible to marshal the necessary resources within the time required by a medical emergency.

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Patient Safety and Quantitative Neuromuscular Transmission Monitoring in 2022

by Lawrence Caruso, MD, Samsun Lampotang, PhD, FSSH, FAIMBE, and Nikolaus Gravenstein, MD

Historically, intermediate-acting neuromuscular blockade has been accomplished by population-based dosing accompanied by clinical signs and/or subjective (qualitative) electrical stimulus-based twitch monitoring. Somewhat surprisingly, neuromuscular transmission (NMT) monitoring is still not a formally articulated basic anesthesia monitoring standard of care when an intermediate-acting neuromuscular blocker (NMB) is administered.¹ Recently, the Anesthesia Patient Safety Foundation (APSF) Committee on Technology advocated for NMT monitoring when an intermediate-acting muscle relaxant is used.² The recommendation for NMT monitoring arises from accumulated experiences of residual neuromuscular blockade in postoperative patients, which is not a rare phenomenon. Such patients are subjected to the postoperative physiologic and psychologic risks associated with chemically induced weakness. The psychologic risk is obvious, whereas the physiologic ones can be obvious or subtler, but include hypoxemia, respiratory distress, need for supplemental oxygen, impaired upper airway protection, and longer recovery room stay.³ Residual neuromuscular blockade is most prevalent when a patient is assessed as being “clinically strong” before or after neuromuscular blockade reversal by using only clinical indicators (e.g., adequate tidal volume, grip strength, and/or five-second head lift). The practice of using only clinical monitoring for neuromuscular blockade and assessment of recovery persists despite ample documentation that residual neuromuscular blockade happens in approximately one in five patients on postanesthesia care unit arrival.⁴ Residual neuromuscular blockade is defined as when the ratio of the fourth to the first twitch height/excursion (T4/T1) is < 0.9 after intermediate-acting muscle relaxant administration.⁵

With the growing ubiquity of nerve stimulators, there has been a steady move toward titration of NMBs against a motor response to an electrical stimulus. The stimulus is applied most commonly over the ulnar nerve to enable stimulation and assessment of a hypothermic response or periorbitally to assess the orbicularis oculi or levator palpebrae response. Actually, monitoring the motor response to an electrical stimulus is a significant step forward over only dosing and reversing NMBs based on elapsed time, clinical response, and patient weight. Moving from clinical monitoring to train-of-four (TOF) NMT monitoring represents the initial next step in advancing the sophistication of NMT monitoring. TOF monitoring has been extensively studied; thus, we know that with no twitch response, there is nearly 100% neuromuscular receptor blockade (NMRB), with 1 twitch 90% NMRB, 2 twitches 80% NMRB, 3

twitches 75% NMRB, and still 0–75% NMRB with 4 twitches.⁶

To obtain a more nuanced assessment, the medical professional assesses the T4/T1 ratio. The target ratio is at least 0.9 for typical adequate clinical reversal.⁷ Although the T4/T1 ratio can be assessed by visual inspection, palpation, or electronically, it is well described that visual and tactile assessment of the T4/T1 ratio is remarkably imprecise and unable to reliably discriminate between a ratio of 0.4 and >0.9.⁸ This is of clinical consequence and explains the advocacy for implementing quantitative T4/T1 NMT monitoring (QNMT). In QNMT, the device reports a twitch count and then an objective T4/T1 ratio once there are at least 4 twitches. This allows objective verification that a ratio of at least 0.9 has been reestablished after spontaneous or pharmacologically reversed recovery. As a small aside, it is noteworthy that a baseline T4/T1 ratio is actually greater than 1. This is because the release of acetylcholine into the neuromuscular junction is not completely cleared between the TOF twitches; therefore, there is some potentiation. If a QNMT monitoring device is not available, then achieving sustained 5-s tetanus at 100 Hz approximates a T4/T1 ratio of roughly 0.9. Conversely, using 50-Hz tetanus is inadequate to assess adequate recovery/reversal, and it may be no better than using qualitative TOF.⁹

Over the last 6 years, a new molecule, sugammadex, has become available to reverse neuromuscular blockade. Sugammadex encapsulates several of the intermediate-action NMBs (i.e., rocuronium and vecuronium). Unlike neostigmine, which creates a competitive antagonism by increasing acetylcholine in the neuromuscular junction, sugammadex does not have a ceiling effect. Despite the rapid and largely reliable pharmacodynamics of sugammadex, NMT still plays an important role to verify that the target T4/T1 ratio is >0.9 or that a sustained tetanus at 100 Hz has been achieved after sugammadex administration, as advised in the package insert.¹⁰ Skipping this step unnecessarily puts our patients in harm’s way. As one of our mentors used to say, the operating room is no place for optimism.

In fall of 2022, the APSF has included a QNMT module in the Technology Education Initiative to help provide clinicians with a better understanding and mental model for NMT monitoring and QNMT monitoring, NMB dosing, redosing, pharmacodynamics, interaction of volatile anesthetics with neuromuscular blockade, and reversal of neuromuscular blockade.

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Perioperative Considerations of Cannabis Use on Anesthesia Administration

by Dylan Irvine, BSCh, Tricia Meyer, PharmD, MS, John Williams, MD, and Jeffrey Huang, MD

INTRODUCTION

As of 2018, an estimated 9.5% of the United States adult population were cannabis users.¹ This percentage has likely continued to increase with the use of both recreational and medicinal cannabis in the United States. The use of medical cannabis is currently legal in 37 states, and recreational cannabis use is legal in 18 states, although cannabis use remains illegal federally. With the increasing prevalence of cannabis use among adults, it is important that anesthesia professionals recognize the potential cardiopulmonary, gastrointestinal, and central nervous system effects of cannabis use when providing perioperative care to those patients who consume cannabis.²

PHARMACOLOGICAL CONSIDERATIONS

The cannabis plant contains more than 500 compounds including cannabinoids, terpenoids, and flavonoids.³ The main cannabinoids are delta-9-tetrahydrocannabinol (THC) and cannabidiol (CBD). THC is the major psychoactive component responsible for the properties of sedation, analgesia, and euphoria. Cannabis refers to all products derived from this plant and marijuana refers to the parts of the plant (dried leaves, flowers, stems, and seeds) that contain substantial amounts of THC.⁴

The strength of cannabis is measured by the concentration of THC. The amount of THC in marijuana has been increasing, which may contribute to the increase in emergency room visits.⁵ The THC potency in confiscated marijuana samples from the Drug Enforcement Agency has increased from 3% in 1980 to 12% in 2012.⁵ The primary reason for the increase in THC strength is a more potent form of cannabis called sinsemilla. Sinsemilla is the female cannabis plant that has not been pollinated and now constitutes the major proportion of seized products.^{3,5} Additionally, more marijuana extracts and resins are being produced that contain 3–5 times more THC than the plant itself.^{3,5}

The mechanism of action of the cannabinoids is binding and acting as a partial agonist on two types of G-coupled cannabinoid receptors, called cannabinoid receptor type 1 (CB1) and type 2 (CB2).^{6,7} The CB1 receptors are found, in the largest concentrations, in the brain and nervous system tissue, and less in the liver, adipose tissue, and vascular endothelium.^{6,7} The CB2 receptors are found predominantly in



immune cells such as macrophages and mast cells.^{6,7} Activation of CB1 inhibits the release of several neurotransmitters including acetylcholine, L-glutamate, gamma-aminobutyric acid (GABA), norepinephrine, dopamine, and serotonin.^{6,7}

Individuals typically intake marijuana through inhalation (smoking or vaporization) or ingestion of an edible product. The pharmacokinetics can be variable depending on the method of administration.^{6,7} THC is quickly transferred from the lungs to the bloodstream during smoking, and the onset of psychoactive effects occurs rapidly, within seconds to minutes. The psychoactive effects of THC from inhalation reach a maximum in 15 to 30 minutes and begin to taper off at 2–3 hours. However, the duration of action may be up to four hours. These effects mirror plasma THC concentrations.^{6–8} A small amount of inhaled THC, approximately 2 to 3 mg, may produce effects in a naïve user.⁸ Pulmonary bioavailability varies from 10 to 35 percent of an inhaled dose and is determined by the depth of inhalation along with the length of time of inhalation and breath-holding.^{7,8} Smoking is the most common route of intake, however; vaporization is on the increase.^{8,9} Similar psychoactive effects are experienced through vaporization although it may reduce exposure to by-products of combustion.^{7–9} However, possibly harmful and carcinogenic aerosols may be present in flavored cannabis vaping products.¹⁰ Orally ingested cannabis has a later onset of action ranging from 60–120 minutes. Cannabis has low bioavailability because of degradation in gastric acid and first-pass metabolism in the liver.⁷ The inexperienced user may encounter psychotropic effects with 5 to 20 mg of ingested THC.⁸ Orally ingested cannabis

reaches its peak effect at approximately 120 minutes and can last up to 4 to 6 hours. The elimination half-life of THC is difficult to measure and is slow, with times ranging from 25 to 36 hours. The slow-release occurs from lipid storage areas and enterohepatic circulation. The elimination half-life increases in regular cannabis users.⁷

THC has high lipophilicity and distributes to highly perfused tissues. It is also highly protein-bound (95 to 99 percent) mainly to lipoproteins and has a volume of distribution of 2.5 to 3.0 L/kg.⁷

Information regarding drug interactions with cannabis is limited as is with many naturally occurring compounds due to the complexity of the plant, variability in the THC content of available products, and lack of studies resulting from difficulty in studying a Schedule I drug. Some information is available through the prescribing information of cannabinoid-derived pharmaceutical medications.⁶

THC is mainly metabolized in the liver through the P450 complex as are many anesthesia drugs, and, therefore, there is a potential for pharmacokinetic drug interactions through either the inhibition or induction of these enzymes (Table 1).^{6,7,11} The few cannabis and cannabidiol metabolic drug interactions reported in the literature include increased effects of clobazam, warfarin, and hexobarbital, and a decreased effect of theophylline.^{12–15} There can also be additive pharmacodynamic effects with other agents having similar physiological properties such as sedation with central nervous system depressant drugs, including benzodiazepines, opioids, and volatile agents.^{6,7}

Table 1: Pharmacokinetic Drug Interactions With THC and Their Consequences^{6,7,11–15}

Increased effects of clobazam, warfarin, hexobarbital.

Decreased effects of theophylline.

Additive pharmacodynamic effects with other agents having similar physiological properties, such as sedation with CNS depressant drugs, including benzodiazepines, opioids, and volatile agents.

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Cannabis and Anesthesia

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PREOPERATIVE CONSIDERATIONS

There are some important preoperative considerations for patients that are cannabis users. First, it is important to take a good medical history, including the history of cannabis use (Table 2). The anesthesia professional should consider the composition of the products used, a history of adverse effects, the dose consumed, the effects caused by missed doses, and the time since last exposure.¹⁶ Understanding these factors is important in order to assess the risks of cardiovascular and respiratory problems, the potential for withdrawal symptoms (Table 3a), the effects of THC administration on delayed gastric emptying, and the risks associated with anesthesia administration during cannabis intoxication.¹⁶

The use of cannabis preoperatively may lead to significant safety issues for the patient and health care providers.¹ Preoperatively, it is essential to assess for the signs and symptoms of acute cannabis intoxication, as acute intoxication poses the largest risk to anesthesia administration.¹⁷ Patients with symptoms of acute cannabis intoxication (Table 3b) are more likely to emerge from anesthesia violently.¹⁷ Among cannabis users who have a history of angina, it is important to inquire about angina-free functional capacity during cannabis use.¹⁸ In patients with an elevated risk of coronary artery disease, there is an increased risk of myocardial infarction in the first hour following the use of cannabis, and thus elective surgeries should be delayed by at least one hour following cannabis use in these patients.¹⁸ Preoperative cardiac function tests and cardiology consultation may be required. Cannabis has the potential to inhibit P450 enzymes.^{6,11} The patients on anticoagulation and antiplatelet medications should be evaluated for coagulation function. Preoperative lab tests may include PTT, INR, and platelet function tests.

INTRAOPERATIVE CONSIDERATIONS

The current literature is lacking clinical guidance regarding intraoperative anesthesia management in cannabis users. Some research suggests that patients who regularly use cannabis may require larger induction and maintenance doses of anesthesia intraoperatively.¹⁶ Among some patients undergoing sedation for endoscopy procedures, there may be an association between cannabis use and higher intraoperative dose requirements of propofol to achieve adequate sedation, but these claims have not yet been supported by well-designed studies.¹⁹ A recent retrospective study assess-

Table 2: Perioperative Considerations of Preoperative Cannabis Use on Anesthesia Administration and Postoperative Pain Management^{1,2,16-24}

PreOperative Considerations
Assess for signs of cannabis intoxication.
Obtain comprehensive history of product composition, history of adverse effects, dose consumed, the effects caused by missed doses, and the time since last exposure.
Obtain history of angina and increased risk of coronary artery disease.
Evaluate for coagulation dysfunction (e.g., PTT, INR, and platelet function tests).
Consider delaying elective surgeries following acute patient consumption of cannabis
IntraOperative Considerations
Preoperative cannabis use may lead to tolerance to sevoflurane.
Care with intraoperative utilization of sympathomimetics and beta-blockers.
Increased risk of airway hyperactivity.
PostOperative Considerations
More likely to report higher postoperative pain scores and increased analgesic requirements.
Monitor for signs of cannabis withdrawal.

Table 3a: Cannabis Withdrawal Symptoms¹⁶

Anger	Decreased appetite	Malaise
Irritability	Feelings of depression	Abdominal pain
Nervousness/anxiety	Chills	Sweating
Insomnia	Nightmares	Tremors

Table 3b: Symptoms of acute cannabis intoxication.¹⁷

Increased anxiety	Paranoia	Psychosis
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ing the impact of preoperative cannabis use in patients undergoing open reduction and internal fixation of tibia fractures specifically provided some evidence to suggest minimal effect of preoperative cannabis use on anesthetic dosing intraoperatively.²⁰ Among the study cohort of 118 patients, of which more than 25% reported cannabis use prior to surgery, there was no significant difference in total propofol, dexmedetomidine, etomidate, ketamine, desflurane, midazolam, and fentanyl doses administered between those who used cannabis prior to surgery and those who did not (patients were classified as cannabis users if they self-reported any cannabis products use in the month prior to surgery, and nonusers if they did not use any cannabis products the month before surgery).²⁰ The only agent for which there was a significant difference observed between these two groups was sevoflurane, where the average total volume of sevoflurane administered intraoperatively was significantly higher among the

group who used cannabis (37.4 ml vs 25 ml, $p=0.023$).²⁰ This study suggests that preoperative use of cannabis may lead to increased tolerance to sevoflurane, although the study has some notable limitations including its retrospective study design, and small sample size. Thus, future research is needed to verify these findings.²⁰

Anesthesia professionals should take extra caution when using intraoperative sympathomimetics and beta-blockers among those using cannabis due to potential inhibition of CYP-450.¹⁶ Furthermore, patients must be carefully monitored intraoperatively for signs of hemodynamic instability and signs of myocardial infarction or stroke. Anesthesia professionals should be prepared to manage airway hyperactivity intraoperatively if the patients do not have a secure airway due to potential airway irritation caused by preoperative cannabis use.¹⁶

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Perioperative Considerations in Those Patients Who Consume Cannabis

From “Cannabis and Anesthesia,” Preceding Page

POSTOPERATIVE CONSIDERATIONS

Postoperatively, there are two main considerations for patients who are cannabis users: challenges in the management of postoperative pain, and managing withdrawal symptoms.¹⁶ Several studies have demonstrated that cannabis users are more likely to report higher pain scores, poorer sleep, and require a greater quantity of analgesic medications in the immediate postoperative period than nonusers.^{21,22} Therefore, multimodal analgesia and appropriate opioid dosing should be considered for these patients.¹⁶ It is also important to monitor cannabis users for signs and symptoms of withdrawal postoperatively (Table 3a).²³ Withdrawal onset can take place within 1–2 days of the last cannabis use and last 1–2 weeks; thus, health care providers should monitor for signs of cannabis withdrawal in postoperative patients until cannabis use is resumed.¹⁶ Postoperative shivering, hypothermia, and increased platelet aggregation have also been documented among cannabis users.²⁴ Postoperative hypothermia and shivering is thought to be mediated by CB1 receptor activation and, thus, are not suspected to be due to withdrawal symptoms.²⁵ Increased platelet aggregation is likely due to CB1 and CB2 receptors existing on platelet membranes by a high dose of THC.²⁴

CONCLUSION

The increasing use of cannabis, both medically and recreationally, has resulted in new and important perioperative considerations for anesthesia professionals (Table 2). Having a better understanding of the possible effects of cannabis use perioperatively can help providers mitigate perioperative risk and better manage postoperative pain in patients receiving anesthesia.

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Highlights from the ISMP Summit: The Future of Perioperative Medication Safety: *Charting Our Path Forward*

by Elizabeth Rebello, Rph, MD, CPPS, CMQ, FASA, and JW Beard, MD

The Institute for Safe Medication Practices (ISMP) convened on November 10–11, 2021, as a virtual national summit on Perioperative Medication Safety. The intent of the summit was to leverage the current understanding of the causes of medication errors and known successful mitigations to develop additional preventative strategies to further reduce patient harm in the perioperative clinical setting. The summit was attended by approximately 80 stakeholders from various backgrounds including anesthesia professionals, perioperative nurses, pharmacists, industry representatives from both drug manufacturing and equipment related to medication safety, and ISMP staff. The Anesthesia Patient Safety Foundation (APSF) served as a sponsor of the conference along with a number of companies interested in this topic.

The conference began with an overview of summit objectives followed by five presentations on the Current State of Perioperative Medication Safety, Barriers to Safety with a focus of Reporting and Culture, the survey results of the ISMP Medication Safety Self-Assessment for Perioperative Settings, and the survey results of the Levels of Agreement from summit attendees prior to the summit.^{1,2} The main areas of focus of the conference consisted of medication labeling and packaging in the perioperative setting and the adoption of safety technology in the perioperative space. There were several areas of consensus. For example, 97% of summit respondents agreed or strongly agreed that smart infusion pumps should be used for continuous medication infusions, and 81% agreed that barcode scanning for medication administration should be used in the PACU and postoperative care areas.² There were also areas of less agreement such as the use of barcode scanning technology in intraoperative and intraprocedural locations to verify medications prior to administration (63%) and the use of smart pumps in all perioperative settings, including intraoperatively, for intravenous hydrating solutions (68%).²

It was recognized by summit attendees that agreement in principle on the use of medication error reduction technologies does not consistently translate to utilization within procedural areas. A self-assessment survey of 98 hospitals and 33 ambulatory centers was conducted by

¹ISMP. Presummit Survey Results: Level of Agreement.

Table 1. Sample Breakout Questions

Breakout Session #1: Labeling	
1.	Should handwritten labels ever be used for routine medication labeling?
2.	Should printing labels be considered best practice?
3.	Are you handwriting your own label now? If so, why?
4.	How do we get practitioners to recognize the risk associated with nonstandard labeling practices and adopt safe labeling expectations?
Breakout Session #2: Barcode Scanning	
1.	Are there general organizational expectations for barcode scanning use for medication administration in your facility (outside of the intraoperative setting) for all medication and fluids?
2.	Is there currently an expectation for barcode scanning use during medication administration in your intraoperative settings?
3.	What workflow concerns do you have about the use of Barcode Medication Administration (BCMA) intraoperatively for medication use?
Breakout Session #3: Smart Infusion Pump Integration and Optimization	
1.	Are there challenges with patient transfer from the operating room to another level of care when there are different infusion devices?
2.	Do you believe there are benefits of smart infusion pump integration with the Electronic Health Record?
3.	What type of training and competency assessments are provided related to smart infusion pump use? For nurses? For anesthesia providers? For nonanesthesia sedation providers?

ISMP to evaluate technology availability and utilization.¹ Responses demonstrated that 93% of hospitals and only 35% of ambulatory centers had access to smart infusion pumps.¹ In addition, 87% of hospitals and only 12% of ambulatory centers indicated that barcode scanning was available for medication administration.¹ While smart pumps and barcode scanning were available in many facilities, this did not consistently translate to implementation. Barriers to adoption of technologies were explored such as cost and provider preferences and opportunities to advance safety were discussed including expanding technology availability and education.

There were several presentations in each area of focus, including case studies, followed by breakout group discussions on topics of Labeling, Barcode Medication Administration (BCMA), and Smart infusion pump technology (Table 1) with 4–5 groups and 12–15 participants per group. The breakout groups were led by a facilitator with specific questions to generate discussion (Table 1). Each breakout group reported back key points to the main audience.

Discussion points to highlight include the preference of labeling syringes in concentration per ml by anesthesia professionals to reduce the potential of a mathematical error while administering medications in the perioperative environment, the lack of support/resources for BCMA especially in ambulatory surgery centers and procedural locations, and the lack of smart pump standardization within different locations of the hospital.

Important takeaway points from the conference consisted of recognizing rank order of error reduction strategies in terms of leverage (low to high), level of effectiveness (least to most) and ease of implementation. Preferences among stakeholders attending the meeting for drug labeling consisted of concentration per mL versus the current way of total drug per total volume. The labeling discussions addressed issues related to manufacturer labeling of vials, ampules, infusions, and pre-filled syringes. Advantages of BCMA technology such as interfacing with the Electronic Health Record (EHR) were discussed along

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APSF Sponsors ISMP Summit on Medication Safety

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with challenges for ambulatory surgical suites and other practice settings where these resources may be cost prohibitive. Smart Pump technology was reviewed, revealing a range of practices within various settings. For example, summit attendees indicated that having available smart pumps does not necessarily indicate that the drug library is updated regularly or that clinicians utilize the drug library when its available for an infusing medication. Having an infusion pump Dose Error Reduction System, commonly known as a "drug library," that is consistent within the practice setting was considered a minimal smart pump requirement. Smart pump integration with BCMA and bi-directional communication with the EHR are considered potential future procedural location technologies.

The conference concluded with discussion on consensus building on topics including improving safety culture and medication error reporting in the perioperative area, utilizing innovation to address unmet needs and challenges, and to develop consensus guidelines around perioperative medication safety.

At the time of publication of this article, draft guidelines are under review by conference participants. Once this input is received, ISMP will post the full draft guidelines for public comment. After the public comments have been reviewed internally, ISMP will then publish the final guidelines. APSF members were participants in the conference and will be included in the reviews. APSF members will utilize internal organizational discussion to provide recommendations consistent with APSF current expert opinion. Final ISMP guidelines release is expected in late 2022.

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The authors have no conflicts of interest.

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*Allison Bechtel, MD
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LETTER TO THE EDITOR:

The Impact of Health Disparities in Patient Safety

by Lilibeth Fermín, MD, MBA; Luis E. Tollinche, MD, FASA; Judith L. P. Handley, MD; and Amy Lu, MD, MPH

The recent COVID-19 pandemic has highlighted the health disadvantage of the most vulnerable members of the society.¹ The literature about health disparities in the perioperative setting and their impact in patient safety is growing. Different authorities, like the executive branch of government and physicians’ organizations, have raised concern about the negative environment fostered by health disparities in patient experience and outcomes.²⁻⁴

The latest National Healthcare Quality and Disparities Report shows that health care disparities are present in the US population, mainly among the poor and uninsured. The report stated, “Blacks and American Indians and Alaska Natives received lower quality care than Whites for 40% of quality measures.” The patient safety measures in which Black adults received worse care than Whites during the 2016–2018 period included postoperative physiologic and metabolic derangements per 1,000 elective surgical hospital discharges, sepsis diagnoses per 1,000 elective-surgery admissions, postoperative pulmonary embolism per 1,000 surgical hospital discharges, and postoperative acute kidney injury requiring dialysis per 1,000 elective surgical hospital discharges.⁵

While we cannot change the socioeconomic conditions of our individual patients, as members of the anesthesia care team we are charged with delivering equal treatment to our patients.

Health disparities place the vulnerable population at risk during health care interactions. Delayed or inadequate diagnosis, inappropriate coordination of care, fragmented communication, and lack of a safety culture that embraces



patient individuality and promotes family engagement fosters an unsafe environment.⁶

Global equity in health delivery should be our goal, and we want to provide possible solutions to the problem in the perioperative environment. Some researchers believe that unequal health treatment can be attributed to the hospital in which the patient receives care while others favor individual-provider factors as the source of disparities.^{7,8} The American Society of Anesthesiologists, the American Association of Nurse Anesthesiology, the American Academy of Anesthesiologist Assistants, and the American Board of Anesthesiology have published

statements acknowledging racial and ethnic disparities in anesthesia care and promoting health equity.^{9,10} Health care providers do not exist in isolation. Clinicians are part of a community and some of their behaviors are products of cultural imprinting. As members of the wider population, providers can unconsciously display the same implicit bias reflected in members of their community.^{11,12} Bias, implicit bias, and stereotyping are some of the attitudes that need to be mitigated and abolished in order to prevent disparities in health care. Implicit bias is an unconscious, unjustified, negative attitude or feeling towards an individual of a certain group, while explicit bias is a conscious prejudicial evaluation.^{7,13,14}

The latest National Healthcare Quality and Disparities Report advocates for a more diverse workforce in order to promote better access, improve communication, and meet the underserved community needs.⁵ Researchers have seen higher participation in preventive screenings with physician-patient gender concordance, and enhanced patient experience with patient-physician racial concordance.^{15,16} Diversity is also needed in the anesthesiology field, where 74% of active anesthesiologists are male, and 65% of

Table 1: Suggestions to Mitigate Health Disparities

Clinician Level	System Level
Recognize personal bias	Create a culture of equity
Encourage intrinsic motivation to change behavior	Provide health equity training
Participate in continuing education about health disparities	Encourage health equity initiatives in research, and clinical field
Engage in community outreach initiatives	Provide financial incentives for measures that are linked to health equity
Advocate for health equity at a legislative level	Promote governance that supports health equity and patient safety

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Health Disparities in the Perioperative Space

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residents and fellows are male.¹⁷ A change in recruitment and promotion practices could create a more diverse and inclusive workforce in anesthesiology departments.¹⁸

It is imperative for anesthesia professionals to be aware of the impact of structural inequities and social determinants of health on clinical outcomes and in patient care. This includes training in cultural competency and cultural humility and supporting promotion of health literacy efforts for our patients. It is also important to promote continuing education about health disparities, inclusion of minorities in research, increase health workers’ diversity, enforce diversity training in medical and nursing schools, and mitigate clinicians’ implicit bias (Table 1).^{19,20} Perioperative clinicians will be at the forefront of improving care and patient outcomes by expanding our knowledge of health disparities. But the change of behaviors ingrained in society and the aftermath of unequal policies require interventions at individual, health systems, and legislative levels. The behavioral modifications required in the fight against health disparities can be facilitated by applying existing models like the behavioral change wheel and the transtheoretical model of change.^{21,22} The behavioral change wheel includes education, training, and environmental restructuring among useful interventions.²¹

A silver lining from the COVID pandemic has been the renewed emphases on health equity, one of the six aims of quality as defined by the Institute of Medicine.²³ Health disparities are inherently a public health emergency and a patient safety issue. The discipline of anesthesiology has led the field of patient safety in health care for decades. As such, it is appropriate for our specialty to take on health disparities as a clarion call for our patients in order to continue to safeguard care throughout the perioperative continuum.

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LETTER TO THE EDITOR:

Sustainable Health Care Must Be the Next Patient Safety Movement

by Jonathon P. McBride, MD, MS, and Matthew J. Meyer, MD

The harm done by health-care-related pollution is equivalent to the medical errors that sparked the patient safety movement.¹ Anesthetic gas are one of the largest and most modifiable sources of health care sector greenhouse gas (GHG) emissions.² Anesthesia professionals have the opportunity to lead the health care sector’s response to pollution and climate change.

Last summer, an older woman living in the usually mild climate of British Columbia suffered dyspnea following an extraordinary heatwave—her physician diagnosed her with “climate change.”³ While she is the first known to receive the diagnosis of climate change, she is not the first patient whose health has suffered because of climate change.⁴ She will not be the last.

Climate change is already affecting the health of our patients. Yet, the health care sector is just beginning to understand the impact of environmental health on population health, and to evaluate its large contribution to global emissions and climate-related morbidity.^{4,6}

IMPACT OF ANESTHESIOLOGY ON OUR ENVIRONMENT

The modern health care sector is responsible for an estimated 8.5% of United States GHG emissions; pollution that harms the very people the health care sector cares for (Figure 1).^{6,7} It is essential for the entire health care sector to evaluate and reduce its impact on the environment. Responding to climate change, and its downstream population health impact, is an opportunity for anesthesia professionals to lead on patient safety once again.

Pharmaceutical-related emissions account for approximately 20% of health care sector GHG emissions, more than food service, construction, or transportation.⁶ Volatile anesthetics and nitrous oxide can trap hundreds to thousands of times more energy than carbon dioxide.⁸ One study found anesthetic gasses could be the source of over 50% of the GHG footprint of the entire operating room (OR) suite.²

Desflurane⁹ and nitrous oxide¹⁰ have the highest impact on climate change due to their energy trapping ability and the concentration at which they are used clinically; sevoflurane is the least harmful, but still multiple times worse than the potent GHG methane. In a study comparing the GHG emissions per Minimum Alveolar Concentration (MAC)-hour of anesthesia, propofol is orders of magnitude less impactful on the climate than any volatile anesthetic.⁸

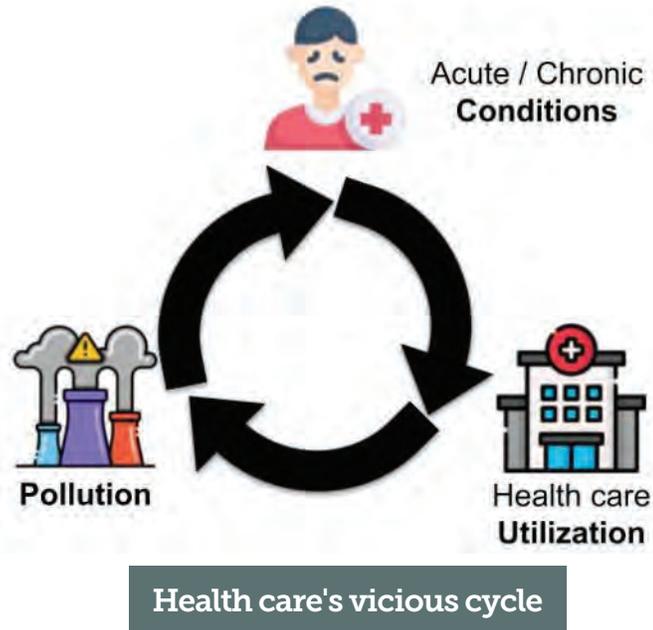


Figure 1: **Health care's vicious cycle.** Pollution causes and exacerbates acute and chronic conditions, which require health care and health care contributes to pollution. Pollution is a patient safety issue.

Opportunities to reduce the impact of anesthesia care on the global environment

- Avoid desflurane⁹ and nitrous oxide¹⁰ unless clinically necessary
- Check for leaks in existing nitrous oxide piping.¹¹ Eliminate nitrous oxide piping from new buildings
- Consider the use of propofol for general anesthesia⁸
- If volatile anesthetics are indicated, use low fresh-gas-flows to reduce the unnecessary consumption of volatile anesthetics¹²
- Advocate for pharmaceutical and medical supply vendors to focus on sustainability, and to design products for the circular economy¹⁸

Figure 2: Opportunities to reduce the impact of anesthesia care on the global environment.

Adding to the harm of nitrous oxide, a recent study found intrahospital delivery of nitrous oxide to be dangerously inefficient with upwards of 70% of procured nitrous oxide being lost via leakage.¹¹ The loss of nitrous oxide from hospital storage to OR utilization is a potential patient and occupational safety issue.

Making modifications to the delivery of anesthesia care (Figure 2) provides an opportunity to reduce our profession’s environmental impact and provide higher value patient care. For example, a multidisciplinary OR green team including anesthesia professionals at the Uni-

versity of Wisconsin Health educated the anesthesiology department on anesthetic gas waste, low-flow anesthesia,¹² and differential GHG emissions of volatile anesthetics. Within three years they reduced their GHG emissions 64% per case while saving \$25,000 per month.¹³ Furthermore, even if a health system institutes sustainable anesthesia practices like low fresh gas flows (<1L per minute), reusable instruments, and the elimination of desflurane and nitrous oxide, there is still an opportunity for the attentive, individual anesthesia professional to make a notable impact.¹⁴

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Anesthesia Professionals Can Reduce Environmental Harm and Improve Patient Safety

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HOW TO GET INVOLVED?

As global priorities shift and patients and organizations demand a more sustainable economy, health care will have to change. The current practice of medicine is unsustainable. In an unprecedented call to action, over 200 medical journals, including the *New England Journal of Medicine*, and *The Lancet*, published an editorial calling for emergency action to reduce greenhouse gas emissions and limit future harm.^{4,15}

Climate change and environmental pollution are global, existential problems that require coordinated and collective action that can provoke anxiety and concern.¹⁶ There are many great organizations leading health care’s response to the climate crisis: Healthcare without Harm, Practice Green Health, and The Medical Society Consortium on Climate and Health. These three organizations lead the sustainable health movement in the United States. In addition, Medical Students for a Sustainable Future is a student-led organization for climate and health advocacy.

To be leaders in sustainable health care, anesthesia professionals must reduce the harm of their own practice and begin to advocate for more sustainable health systems. Health care institutions have both great responsibility and great ability. The health care sector is responsible for one-sixth of the entire US GDP; creating sustainable health care systems¹⁷ can catalyze change throughout the entire economy. Anesthesia professionals have the opportunity to

reduce the environmental harm of our practice and again take a leading role in this next patient safety movement.

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Matthew J. Meyer, MD, has consulted for Dialectica and received speaking fees from Takeda Pharmaceutical for a science forum on sustainability. Dr. Meyer has intellectual property related to perioperative efficiency and sustainability. Matthew J. Meyer, MD, is on the steering-committee of Virginia Clinicians for Climate Action. Jonathon P. McBride, MD, is a member of White Coats for Planetary Health and Medical Students for a Sustainable Future.

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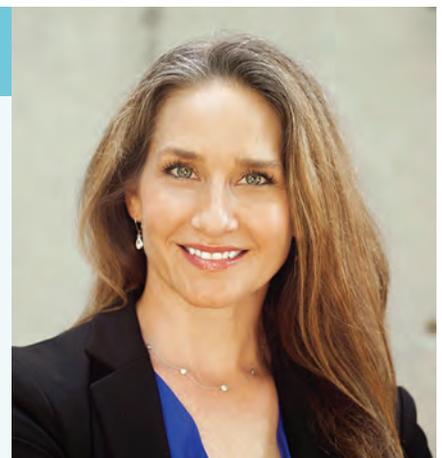
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The APSF is eager to connect with patient safety enthusiasts across the internet on our social media platforms. Over the past year, we have made a concerted effort to grow our audience and identify the best content for our community. We’ve seen increases in followers and engagement by several thousand percent, and we hope to see that trajectory continue into 2022. Please follow us on Facebook at <https://www.facebook.com/APSForg/> and on Twitter at <https://twitter.com/APSForg>. Also, connect with us on LinkedIn at <https://www.linkedin.com/company/anesthesia-patient-safety-foundation-apsf->. We want to hear from you, so please tag us to share your patient-safety-related work, including your academic articles and presentations. We’ll share those highlights with our community. If you are interested in joining our efforts to amplify the reach of APSF across the internet by becoming an Ambassador, please reach out via email to Marjorie Stiegler, MD, our Director of Digital Strategy and Social Media at stiegler@apsf.org, Emily Methangkool, MD, the APSF Ambassador Program Director at methangkool@apsf.org, or Amy Pearson, Social Media Manager at pearson@apsf.org. We look forward to seeing you online!



Marjorie Stiegler, MD, APSF Director of Digital Strategy and Social Media.

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For more information about planned giving, please contact Sara Moser, APSF Director of Development at: moser@apsf.org.

