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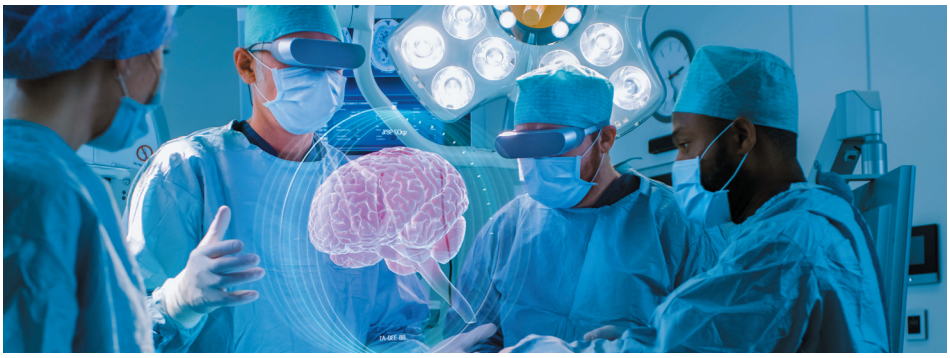
Artificial Intelligence, Patient Safety, and Achieving the Quintuple Aim in Anesthesiology

by Jonathan M. Tan, MD, MPH, MBI, FASA, and Maxime P. Cannesson, MD, PhD

INTRODUCTION

Anesthesiology as a specialty has a long history of innovation in technology development linked to improvements in patient safety. However, the speed of technological development in the past 20 years has been unprecedented. This is mostly related to the exponential growth of data and computer power leading to the application of artificial intelligence (AI) tools to the perioperative setting. Today, emerging technology in anesthesiology and perioperative medicine has a tremendous potential to improve patient safety and quality of care even further. The application of AI will improve patient safety by helping the individual clinician rapidly navigate data from disparate sources and by effectively assisting the clinician to synthesize and make better, more informed medical decisions within a complex health care system.[1-3] Furthermore, AI will be used to improve patient safety by its integration into the workflow of perioperative



patient safety and quality leaders, patient safety scientists, and health care system leaders. The role of AI towards improving patient safety extends from its ability to augment policy decisions designed to identify, assess, and mitigate threats to patient safety at scale.[4,5] In this brief review, we provide an overview of AI as an emerging technology and provide a practical framework for anesthesia professionals to understand the important relationship between AI and perioperative patient safety.

PATIENT SAFETY AND EMERGING TECHNOLOGIES IN A COMPLEX WORLD

Patient safety can be defined as the absence of preventable harm to a patient and minimizing the risk of harm in health care delivery.[6]

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Perioperative Considerations for Patients with Mpox (Monkeypox)

by Jonathan M. Tan, MD, MPH, MBI, FASA; Randy Loftus, MD; Sara McMannus, RN, BSN, MBA; Desiree Chappell, CRNA; Melanie Hollidge, MD, PhD; Michelle Beam, DO, MBA, FASA; Morgan Hellman, RN, BSN; Raquel Bartz, MD, MMCi; Richard A. Beers MD; and Jonathan E. Charnin, MD, FASA

INTRODUCTION

Mpox, previously known as Monkeypox, is a global health concern.[1] While first detected in humans in 1970 in the Republic of the Congo, its spread to nonendemic countries in 2022 led the World Health Organization (WHO) to establish emergency measures to mitigate development of a pandemic. As of November 7, 2022, the WHO has reported 78,474 confirmed cases and 3,685 probable cases within over 109

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countries. The United States is the most affected country with 28,651 reported cases.[2] The preferred name for this virus was changed by the WHO to Mpox in November of 2022. Health care providers are likely to encounter confirmed and/or suspected Mpox cases in the perioperative arena.

As leaders in patient safety, anesthesia professionals have an opportunity to leverage current evidence and create systems of care to improve the perioperative safety of patients through infection prevention. In this brief review, we provide a pragmatic framework for the perioperative care of the patient infected with Mpox by drawing on infection prevention and control principles and measures. We focus on pragmatic considerations based on the current literature, professional society statements, and current knowledge on the management of infection control of enveloped viruses in the perioperative environment.

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4. *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.

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AI May Aid Clinicians to Navigate Data and Execute More Effective Medical Decisions

From "AI and Safety," Page 1

As leaders in patient safety, anesthesia professionals have been at the forefront of research, quality improvement, adoption of technology, and incorporation of engineering principles to reduce harm and risk to patients. The challenge of delivering safe anesthesia care in modern-day perioperative medicine can become a patient safety concern on its own, as the complexity of patient conditions, speed of care delivery, scale of health systems, challenges in multispecialty communication, and sheer volume of data generated increases over time. The need for anesthesia care teams to scale their knowledge, presence, and effectiveness across the perioperative and health care environment has never been greater, especially at a time when the stress on the workforce is tremendous.

To respond to the current health care delivery challenges and continue to deliver on the promise of patient safety, anesthesia care teams need to understand emerging technologies and those that are available to help improve patient safety. AI is one of the major emerging technologies that has already changed the world outside health care and is on the precipice of more widespread adoption within health care. To responsibly advance the field of perioperative patient safety, anesthesia professionals need to understand the principles of AI, the possibilities, the risks, the ethics, and the use of AI in clinical practice. This will require the partnership and collaboration of a diverse team within health care including the ability for anesthesia professionals to communicate effectively with data scientists, computer scientists, data analysts, and artificial intelligence experts.

OVERVIEW OF ARTIFICIAL INTELLIGENCE APPLICATIONS IN ANESTHESIOLOGY

AI can be broadly defined as the ability of a computer or device to analyze a large volume of complex health care data, reveal knowledge, identify risks and opportunities, and support improved decision-making.[7] While the field of AI is rapidly evolving, major techniques used in health care include machine learning, natural language processing,[3] and combining AI with clinical decision support through the development of graphic user interfaces.

Machine learning is one of the most common forms of AI and can be considered a statistical technique for fitting models to data with the computer "learning" how to understand the data by using training datasets as examples.[8] Advanced forms of machine learning include neural networks and deep learning. Recent examples of machine learning in anesthesiology include studying which variables were predictive of postinduction hypotension using electronic health record data,[9] forecasting the bispectral index (BIS™, Medtronic, Dublin, Ireland) value based on the infusion history of propofol and remifentanil,[10] or prediction of postoperative in-hospital mortality using preoperative and intraoperative data.[11]

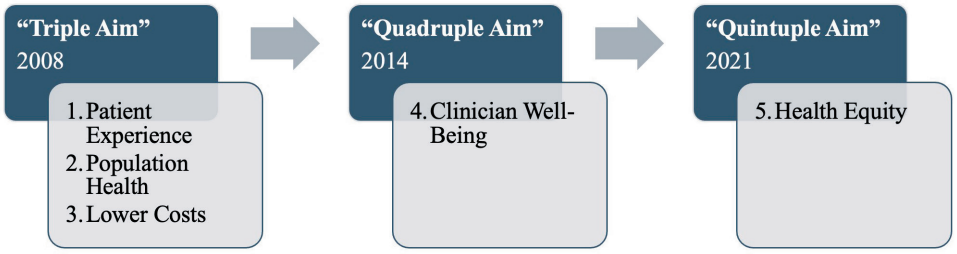

Figure 1: The evolution of the Quintuple Aim in health care delivery.

Natural language processing is a form of AI that can be used to extract relevant information from unstructured text data. For example, natural language processing was recently used in a retrospective study to assess whether unstructured free text of medical conditions in the electronic medical records could be extracted by a computer and used to generate an automated preanesthetic evaluation report. The results focused on how often the natural language processing software recognized medical conditions as compared to an anesthesia professional. The study suggested that natural language processing was able to pick up relevant conditions missed by the clinician in 16.57% of the cases, and missed relevant conditions noted by clinicians in only 2.19% of the cases.[12] The opportunities for using natural language processing to scale and augment the ability of an individual anesthesia professional in a complex care environment with limited staffing resources is a compelling use of AI for patient safety.

Artificial intelligence can also be used with clinical decision support systems, which can be found in modern anesthesia care where the anesthesia information management system can provide electronic reminders to the anesthesia team on perioperative antibiotic dosing, use of postoperative nausea and vomiting prophylaxis in high-risk patients, and assist with blood glucose management. A recent meta-analysis demonstrated that clinical decision support can enhance compliance with perioperative antibiotic prophylaxis.[13] Future roles of AI in clinical decision support to improve patient safety would include providing recommendations on the ideal antibiotic given the patient's electronic medical record information, medical history, and surgical procedure. AI can also be used to advance perioperative patient safety through earlier detection of clinical deterioration and provide clinical decision support for the optimal management of intraoperative physiologic changes.

THE QUINTUPLE AIM

Understanding the direct impact AI will have on perioperative patient safety can be seen through the lens of the Quintuple Aim (Figure 1). The Quintuple Aim is the proposed next step in improving patient safety and quality of care delivered. The Institute for Healthcare Improvement introduced the Triple Aim in 2008, as a framework to improve the patient experience, address population health, and lower costs as keys to health care transformation.[14] In 2014, the Quadruple Aim was introduced to include clinician well-being, in response to research demonstrating that clinician engagement and burnout led to more safety events and reduced quality of care.[15] Many accrediting groups such as the National Committee for Quality Assurance and the Joint Commission recognized the importance of delivering on the Triple and Quadruple Aim. In 2022, the Quintuple Aim was proposed to add a fifth aim: advancing health equity. This was a recognition that delivering high-quality and safe patient care for populations, and to achieve the other aims, meant a focus on actively measuring, studying, and addressing disparities.[16]

AI has a critical role to play in perioperative patient safety through the lens of the Quintuple Aim. In the complex modern health care delivery system, AI can help anesthesia professionals address the five aims of the Quintuple Aim, which could then translate to improved safety and quality of care in the perioperative continuum. Figure 2 provides a variety of potential examples of AI applications within the framework of the Quintuple Aim to improve patient safety and quality.

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AI Algorithms Require Transparency For Clinicians Regarding Their Function

From "AI and Safety," Preceding Page

BRINGING IT ALL TOGETHER

Harnessing AI to improve patient safety in anesthesiology will take a significant amount of work from individual clinicians, anesthesiology groups, health care systems, and regulatory agencies such as the US Food and Drug Administration (FDA). AI is not as widespread in clinical practice as some would have expected only five years ago. Furthermore, adoption of AI with patient safety science and practice will still require time to mature. Many events are portending the real integration of AI and perioperative patient safety. New regulatory pathways developed by the FDA in 2019 have reduced the regulatory barriers and subsequent financial uncertainty to allow companies to develop AI application in health care. Unlike traditional medical devices, the nature of software updates and other differences meant that AI and machine learning software needed to be regulated under its own pathway as a medical device. With more clarity on regulation and improved research and development in AI within health care, it is likely that deploying AI at the individual and health system level will increase.

Other important considerations of AI in healthcare include ensuring transparent levels of understanding about how algorithms are designed as well as minimizing and eliminating bias associated with AI algorithms.[17] For example, AI algorithms that help improve the performance of clinicians need to also be understood by the teams using them, which include a level of transparency in how the algorithms function.[18] In addition, particular attention to the foundational development of AI algorithms and the data used to generate AI tools needs to take place to reduce risks of race/ethnicity, socioeconomic, and statistical bias.[18-20]

CONCLUSION

To advance the field of anesthesiology and perioperative patient safety, emerging technologies such as AI will need to be learned and incorporated into the field of clinical anesthesiology. For AI to be effective, implementation of data-driven analytics with patient safety paradigms in anesthesiology will require organizations to innovate by supporting the development and building of multidisciplinary teams of clinicians, data scientists, engineers, informaticians, and patient safety scientists. As anesthesia care delivery continues to evolve, the multidisciplinary nature of perioperative patient safety will need to respond with an innovative multidisciplinary approach, team, and solution—one that harnesses the scalability and strengths of AI through the lens of the Quintuple Aim.

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	"The Quintuple Aim"				
	Patient Experience	**Population Health**	**Lower Costs**	**Clinician Well-Being**	**Health Equity**
Preoperative	• Leveraging AI for improved perioperative communication of important health and event notifications. • AI to drive text messaging to communicate perioperatively.	• Understanding population health risk factors to help with anesthesia and surgical scheduling and planning. • Leveraging large datasets to safely triage patients to an ambulatory surgery center.	• Use of AI to analyze factors related to operating room logistics such as OR time scheduling.	• AI algorithms to improve anesthesia staff scheduling on electronic platforms. • Optimizing staffing ratios based on predictive factors of patient perioperative risk and clinical load.	• Using AI to study demographic, socioeconomic, and environmental risk factors that may be predictive of perioperative morbidity and mortality.
Intraoperative	• Using AI to assist in a successful placement, on first attempt, of vascular access and nerve blocks using ultrasound guidance. • AI to assist in difficult airway management risk stratification.	• Use of AI to help inform which patients need type and screen and/or cross match.	• Use of AI for anesthesia depth monitoring and optimization to reduce waste.	• Use of AI to reduce cognitive load in clinical care environments with smart alarms and clinical decision support tools. • Decreasing unnecessary interactions with the electronic medical record through optimizing charting with natural language processing.	• AI recommendation algorithms to reduce variation in care among different populations.
Postoperative	• AI decision support for postoperative risk stratification and disposition to optimize inpatient and critical care resources.		• Leveraging AI to assist in optimizing hospital bed management efficiency including time to discharge.		• Using large datasets to study race/ethnicity disparities in care among a large health care system.[18]

Figure 2: Framework applying the Quintuple Aim in applications of artificial intelligence in anesthesiology addressing patient safety across the perioperative continuum.

Mpox is a Global Health Concern

From "Mpox," Page 1

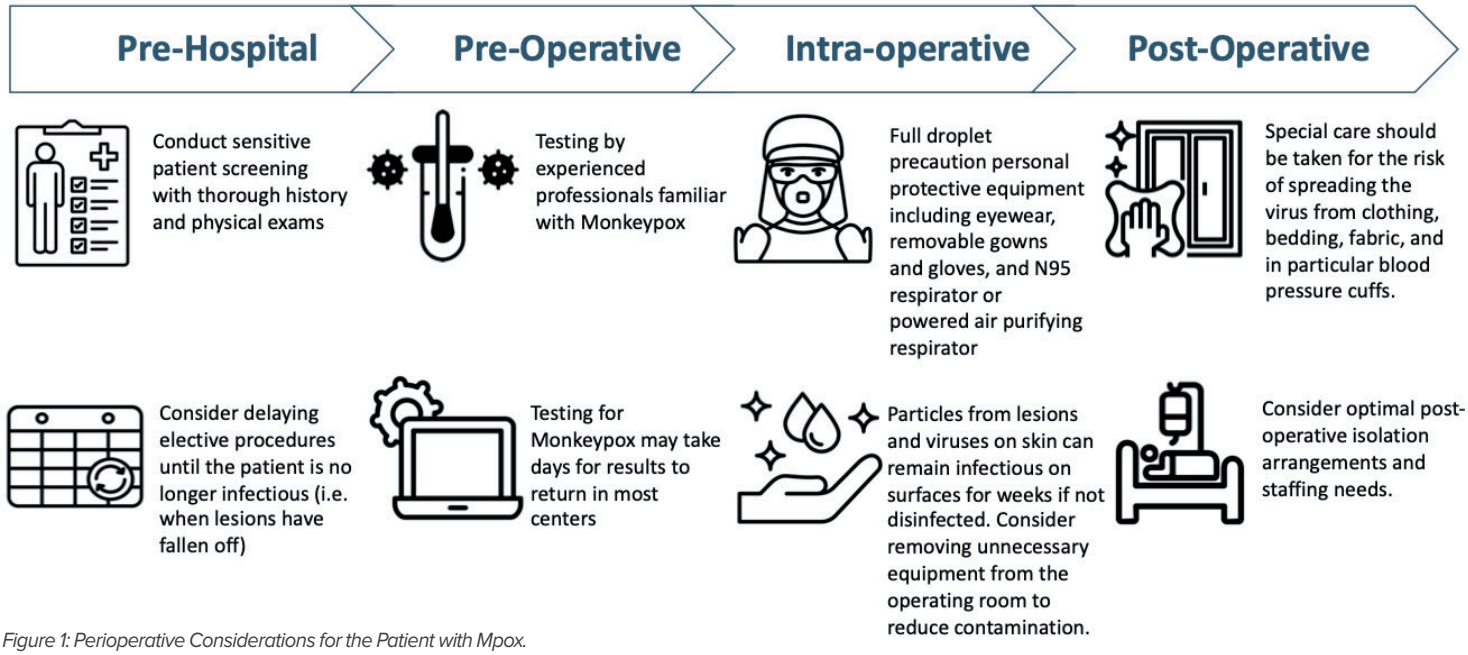

Figure 1: Perioperative Considerations for the Patient with Mpox.

Mpox, an enveloped, double-stranded DNA virus, is a member of the Poxviridae family and orthopoxvirus genus.[3] Two distinct viral subtypes include the Congo Basin and West African strains. While the West African subtype is the dominant strain worldwide,[4,5] with an estimated mortality rate of 1%,[6] the less dominant Congo Basin strain is reported to transmit more easily between humans and is associated with up to a 10% mortality rate.[7] Complications of Mpox can include secondary infections, bronchopneumonia, sepsis, encephalitis, and infection of the cornea with ensuing vision loss. Nosocomial transmission is rare, but it has been reported to occur through direct contact with affected skin or environmental surfaces and/or via respiratory droplets. These modes of transmission provide some urgency for anesthesia professionals to prepare for infection prevention in the anesthesia work environment.

The WHO issued guidelines for the clinical management and infection prevention and control for Mpox in June 2022.[8] General recommendations included contact and droplet precautions for any confirmed patient and the use of respirators and airborne precautions for aerosol-generating procedures. The American Society of Anesthesiologists and the Anesthesia Patient Safety Foundation provided a joint statement of support and recommendations on August 31, 2022.[9] Based on these guidelines, a pragmatic framework for the preparation and optimal care of patients with Mpox specific to the anesthesia work environment was developed (Figure 1). Important considerations include preoperative screening and testing, decision-making considerations as to proceed with or to delay elective surgery, and intra- and postoperative infection control measures.

Mpox Procedural Timing

Emergent Procedure—Any Status

Proceed with infection control precautions in all phases of care

Elective Procedure—Symptomatic

- Rash usually appears 1–4 days after prodromal symptoms
- Infectious Period is usually complete by 4 weeks after appearance of rash
- More time may be required

Elective Procedure—Exposed

Delay past the 21-day incubation period

- Screen for prodromal symptoms
- Test rashes for Mpox

Elective Procedure—Good to Go?

The patient is considered infectious until all the skin lesions have crusted over, fallen off and smooth skin appears underneath. The timing of this will vary between patients.

Figure 2: Procedural timing considerations for patients exposed or diagnosed with Mpox.

SCREENING AND ELECTIVE SURGERY CONSIDERATIONS

Ideally, adult and pediatric patients with Mpox, or Mpox exposure, will be identified preoperatively. In general, persons are considered exposed after direct contact with the skin lesions or bodily fluids of an infected individual or indirect contact through objects that contact skin lesions or bodily fluids (e.g., bed linens). Infected individuals may report a variety of constitutional symptoms including fever, malaise, weakness, lymphadenopathy,[10,11] and rash that may take 4 weeks to resolve; although some may present with minimal or no symptoms. Mpox infection is accompanied by skin lesions that may be widespread or limited to a few lesions. The lesions, often described as painful, often occur in the genital or anorectal areas, which can make screening potentially challenging. Thus, patients who report being exposed to Mpox or diagnosed with Mpox should have elective surgery deferred until there is no concern for transmission[9] (Figure 2).

The purpose of delaying an elective surgery is to reduce the risk of Mpox transmission. Defining the duration of an infectious period of Mpox can be challenging. The variable

See "Postexposure Vaccination," Next Page

Postexposure Vaccination for Mpox Prophylaxis is Available and Most Effective When Given Within 4 Days of Exposure

From "Postexposure Vaccination," Preceding Page

incubation period and the many weeks the rash may take to resolve make it difficult to estimate. This includes delaying an elective procedure for at least 21 days from the exposure, given the reported incubation period ranging from 4 to 21 days,[12] or, in the case of a rash, up to 4 weeks. The patient with Mpox-associated rash is no longer considered infectious when lesions have fallen off and are replaced with smooth skin. It is reasonable that patients that have active lesions and rashes consistent with Mpox not undergo elective surgery.

Importantly, if a concern for Mpox arises during the pre-operative exam, the interview should be interrupted, and appropriate personal protective equipment (PPE) donned. Care must be taken by health care professionals to not attach social stigmas with Mpox infections. Complaints of unexplained rectal or genital pain and/or perioral pustules or sores should prompt consideration for Mpox exposure or risk factors (Table 1). Integration of screening tools into electronic health record systems may facilitate perioperative screening and communication of patient risks.[13,14]

MPOX TESTING

Information on current recommendations is available on the Centers for Disease Control and Prevention website (https://www.cdc.gov/poxvirus/mpox/clinicians/index.html). Currently, routine testing for Mpox is not recommended. Mpox can be detected using polymerase chain reaction assays from DNA sampled from lesions. Blood testing is not recommended as Mpox virus remains in the blood for only a short period of time. Results from testing for Mpox may require days to return. If concern for Mpox develops intraoperatively, we recommend contacting your local infection control officer or infectious disease specialist as soon as possible to discuss how to prevent further exposures and inform health care workers who may have already been exposed. Postexposure vaccination for prophylaxis is available and requires utilization within 4 days of exposure to optimize prevention of disease. Vaccination between 4 and 14 days following the date of exposure is reasonable to consider, but less effective.[15]

OPERATING ROOM CONSIDERATIONS

Mpox is a large virus that is spread primarily cles from lesions and viruses on the skin can remain infectious on surfaces for extended durations without disinfection. For example, one study detected viable Mpox on a household surface 15 days after the infected individual left the home.[16] There is a risk of spreading the virus when clothing, bedding, or other fabric is moved. Caution should be taken in moving fabrics that have been in contact with the patient. Mpox virus has been isolated in samples obtained from the air during bed linen changes. Further caution includes monitors such as the blood pressure cuff. For example, care should be taken to avoid frequent and rapid removal of the blood pressure cuff as the process of removal can spread the virus. All fabric that has contacted the patient should be discarded in sealed waste bags to prevent aerosolization of viral particles.

Patients should undergo care in negative pressure rooms for aerosol generating procedures. Health care workers should have full droplet precaution PPE when caring for patients with Mpox. An N95 respirator or powered air purifying respirator (PAPR) is recommended. Protective eyewear is required, as is a removable protective gown and gloves. Unnecessary equipment should be removed from the operating room (OR), OR traffic should be limited, and multiple anesthetics in the same OR should be avoided. Evidence-based anesthesia work area infection control measures should be followed, including frequent hand hygiene and postinduction environmental cleaning.[17,18]

Mpox, an enveloped virus, is effectively inactivated via use of United States Environmental Protection Agency (EPA)-registered disinfectants. Examples of EPA-registered disinfectants that can be used for Mpox include cleaning solutions that have the active ingredients of isopropyl alcohol, quaternary ammonium, or ethyl alcohol. A comprehensive list of recommended products for disinfection can be found at the EPA website (https://www.epa.gov/pesticide-registration/disinfectants-emerging-viral-pathogens-evps-list-q).[19]

POSTOPERATIVE

An important consideration in the postoperative period is to attempt to minimize the transport and movement of infected patients and exposed health care providers across the health care system. Expedited dismissal from the OR should be considered when applicable. The surgical emergencies that may prompt patients with active Mpox to undergo surgery often require postoperative hospitalization or intensive care. Full PPE and isolation will need to be utilized in the care of these patients for transport and recovery. Health care workers that have unprotected exposure to patients with Mpox may require isolation for up to three weeks with those who develop lesions isolated until they are no longer infectious.[9]

CONCLUSION

Patients presenting with Mpox and/or exposure present unique perioperative considerations. Anesthesia care team providers can leverage current knowledge and pragmatic approaches for infection prevention and control to optimize perioperative patient and provider safety.

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Table 1: Clinical Questions to Help Guide Screening and Perioperative Decision-Making With Patients Suspected to Have Mpox.

Perioperative Clinical Questions:
1. Does the patient have a current or recent history of fevers, chills, malaise, headache, lymphadenopathy, flu-like symptoms?
2. Does the patient have a current or recent rash?
3. Where is the rash located?
4. What is the rash appearance?
5. Is the rash attributable to another known etiology?
6. Has the patient had recent contact with a known or suspected Mpox case?
7. Has the patient recently participated in large parties and gatherings involving intimate sexual contact?
8. What is the current epidemiology (incidence and prevalence) of Mpox in the region?

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Mpox (Cont'd)

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Desiree Chappell is on the Speakers Bureau for Medtronic and Edwards LifeSciences, and the Advisory Board for ProVation.

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REFERENCES

1. World Health Organization. WHO recommends new name for monkeypox disease. Accessed Dec 1, 2022, https://www.who.int/news/item/28-11-2022-who-recommends-new-name-for-monkeypox-disease.
2. World Health Organization. 2022 monkeypox outbreak: global trends. Updated November 8, 2022. Accessed November 8, 2022. https://worldhealthorg.shinyapps.io/mpx_global/.
3. Tiecco G, Degli Antoni M, Storti S, et al. Monkeypox, a literature review: what is new and where does this concerning virus come from? *Viruses*. 2022;14:1894. PMID: 36146705.
4. Hutson CL, Abel JA, Carroll DS, et al. Comparison of West African and Congo Basin monkeypox viruses in BALB/c and C57BL/6 mice. *PLoS One*. 2010;5:e8912. PMID: 20111702.
5. Forni D, Molteni C, Cagliani R, Sironi M. Geographic structuring and divergence time frame of monkeypox virus in the endemic region. *J Infect Dis.* 2022;Jul 14;jiac298. Online ahead of print. PMID: 35831941.
6. Huang Y, Mu L, Wang W. Monkeypox: epidemiology, pathogenesis, treatment and prevention. *Signal Transduct Target Ther.* 2022;7:373. PMID: 36319633.
7. McCarthy MW. Recent advances in the diagnosis monkeypox: implications for public health. *Expert Rev Mol Diagn*. 2022;22:739–744. PMID: 35997157.
8. World Health Organization. Clinical management and infection prevention and control for monkeypox: interim rapid response guidance. Accessed November 29, 2022, https://www.who.int/publications/i/item/WHO-MPX-Clinical-and-IPC-2022.1
9. American Society of Anesthesiologists. ASA/APSF Statement on Monkeypox. Accessed November 29, 2022, https://www.asahq.org/about-asa/newsroom/news-releases/2022/08/asa-apsf--statement-on-monkeypox.
10. Bayer-Garner IB. Monkeypox virus: histologic, immunohistochemical and electron-microscopic findings. *J Cutan Pathol*. 2005;32:28–34. PMID: 15660652.
11. Ranganath N, Tosh PK, O'Horo J, et al. Monkeypox 2022: gearing up for another potential public health crisis. *Mayo Clin Proc.* 2022;97:1694–1699. PMID: 35985857.
12. Alakunle E, Moens U, Nchinda G, Okeke MI. Monkeypox virus in Nigeria: infection biology, epidemiology, and evolution. *Viruses*. 2020;12:1257. PMID: 33167496.
13. Birkhead GS, Klompas M, Shah NR. Uses of electronic health records for public health surveillance to advance public health. *Annu Rev Public Health*. 2015;36:345–59. PMID: 25581157.
14. van den Blink A, Janssen LMJ, Hermanides J, et al. Evaluation of electronic screening in the preoperative process. *J Clin Anesth.* 2022;82:110941. PMID: 35939972.
15. Centers for Disease Control and Prevention. Mpox vaccine considerations. Accessed Nov 29, 2022, https://www.cdc.gov/poxvirus/monkeypox/clinicians/vaccines/vaccine-considerations.html.
16. Morgan CN, Whitehill F, Doty JB, et al. Environmental persistence of Monkeypox virus on surfaces in household of person with travel-associated infection, Dallas, Texas, USA, 2021. *Emerg Infect Dis.* 2022;28:1982–1989. PMID: 35951009.
17. Loftus RW, Dexter F, Goodheart MJ, et al. The effect of improving basic preventive measures in the perioperative arena on staphylococcus aureus transmission and surgical site infections: a randomized clinical trial. *JAMA Netw Open*. 2020 Mar 2;3(3):e201934. PMID: 32219407
18. Agency for Healthcare Research and Quality. Central line-associated bloodstream infections (CLABSI). Accessed July 26, 2022, https://www.ahrq.gov/topics/central-line-associated-bloodstream-infections-clabsi.html.
19. United States Environmental Protection Agency. Disinfectants for emerging viral pathogens (EVPs): List Q. Accessed Nov 29, 2022, https://www.epa.gov/pesticide-registration/disinfectants-emerging-viral-pathogens-evps-list-q.

AI and Safety References, Continued

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REFERENCES

1. Grossman LV, Choi SW, Collins S, et al. Implementation of acute care patient portals: recommendations on utility and use from six early adopters. *J Am Med Inform Assoc*. 2018;25:370–379. PMID: 29040634.
2. Macrae C. Governing the safety of artificial intelligence in healthcare. *BMJ Qual Saf.* 2019;28:495–498. PMID: 30979783.
3. Choudhury A, Asan O. Role of artificial intelligence in patient safety outcomes: systematic literature review. *JMIR Med Inform*. 2020;8:e18599. PMID: 32706688.
4. Dalal AK, Fuller T, Garabedian P, et al. Systems engineering and human factors support of a system of novel EHR-integrated tools to prevent harm in the hospital. *J Am Med Inform Assoc.* 2019;26:553–560. PMID: 30903660.
5. Maddox TM, Rumsfeld JS, Payne PRO. Questions for artificial intelligence in health care. *JAMA.* 2019;321:31–32. PMID: 30535130
6. World Health Organization. Patient Safety. Sept 13, 2019. Accessed November 8, 2022. https://www.who.int/news-room/fact-sheets/detail/patient-safety#:~:text=What%20is%20Patient%20Safety%3F,during%20provision%20of%20health%20care.
7. Hashimoto DA, Rosman G, Rus D, Meireles OR. Artificial intelligence in surgery: promises and perils. *Ann Surg*. 2018;268:70–76. PMID: 29389679.
8. Bi Q, Goodman KE, Kaminsky J, Lessler J. What is machine learning? A primer for the epidemiologist. *Am J Epidemiol*. 2019; 188: 2222–2239. PMID: 31509183.
9. Kendale S, Kulkarni P, Rosenberg AD, Wang J. Supervised machine-learning predictive analytics for prediction of postinduction hypotension. *Anesthesiology.* 2018;129:675–688. PMID: 30074930.
10. Lee HC, Ryu HG, Chung EJ, Jung CW. Prediction of bispectral index during target-controlled infusion of propofol and remifentanil: a deep learning approach. *Anesthesiology.* 2018;128:492–501. PMID: 28953500.
11. Lee CK, Hofer I, Gabel E, et al. Development and validation of a deep neural network model for prediction of postoperative in-hospital mortality. *Anesthesiology.* 2018;129:649–662. PMID: 29664888.
12. Suh HS, Tully JL, Meineke MN, et al. Identification of preanesthetic history elements by a natural language processing engine [published online ahead of print, 2022 Jul 15]. *Anesth Analg*. 2022 Dec 1;135:1162–1171. PMID: 35841317.
13. Simpao AF, Tan JM, Lingappan AM, et al. A systematic review of near real-time and point-of-care clinical decision support in anesthesia information management systems. *J Clin Monit Comput.* 2017;31:885–894. PMID: 27530457.
14. Berwick DM, Nolan TW, Whittington J. The triple aim: care, health, and cost. *Health Aff (Millwood).* 2008;27:759–769. PMID: 18474969.
15. Bodenheimer T, Sinsky C. From triple to quadruple aim: care of the patient requires care of the provider. Ann Fam Med. 2014;12:573–576. PMID: 25384822.
16. Nundy S, Cooper LA, Mate KS. The quintuple aim for health care improvement: a new imperative to advance health equity. *JAMA*. 2022;327:521–522. PMID: 35061006.
17. Canales C, Lee C, Cannesson M. Science without conscience is but the ruin of the soul: the ethics of big data and artificial intelligence in perioperative medicine. *Anesth Analg*. 2020;130:1234–1243. PMID: 32287130.
18. Diallo MS, Tan JM, Heitmiller ES, Vetter TR. Achieving greater health equity: an opportunity for anesthesiology. *Anesth Analg*. 2022;134:1175–1184. PMID: 35110516.
19. Amann J, Blasimme A, Vayena E, et al. Explainability for artificial intelligence in healthcare: a multidisciplinary perspective. *BMC Med Inform Decis Mak*. 2020; 310 (20). PMID: 33256715.
20. Parikh RB, Teeple S, Navathe AS. Addressing bias in artificial intelligence in health care. *JAMA*. 2019; 322:2377–2378. PMID: 31755905.

Dopamine-Antagonist Antiemetics in PONV Management: Entering a New Era?

by Connie Chung, MD, and Joseph W. Szokol, MD, JD, MBA

INTRODUCTION

In the second half of the last century, dopamine D_2-receptor antagonists were a mainstay of the management of post-operative nausea and vomiting (PONV).[1] However, at the start of the 21st century, they sharply declined in popularity, primarily as a result of growing safety concerns, not least of which was the imposition by the US Food and Drug Administration (FDA) of a black box warning on the most widely used agent in the class, droperidol.[1]

Currently there is renewed interest in this class of medications related, in part, to the introduction of a new agent, amisulpride, which was approved by the FDA for the prevention and treatment of PONV in 2020 and is the only approved agent for rescue treatment after failed prophylaxis.

Re-evaluation of the evidence around D_2-antagonists suggests they are not interchangeable in terms of either safety or efficacy, as this is an unusually heterogeneous class of drugs. There are at least three distinct structural sub-classes—substituted benzamides, butyrophenones and phenothiazines—with a wide range of pharmacologic properties and side effect profiles (Table 1).

SAFETY

D_2-antagonists originally used as antiemetics were classical neuroleptics and first-generation antipsychotics (FGA).[2] Central nervous system (CNS) penetration by D_2-antagonist antiemetics results in a wide range of effects. Sedation and neuropsychiatric effects such as dysphoria or cognitive impairment can occur.[2] Extrapyramidal symptoms (EPS) include tardive dyskinesia, dystonia, and akathisia.[2] Neuroleptic malignant syndrome (NMS) presents with fever, mental status changes, muscle rigidity, and autonomic instability, and antagonism of D_2-receptors in the pituitary results in hyperprolactinemia.[2] In addition, binding to potassium ion channels can result in QT prolongation and torsade de pointes.[2] Amisulpride is an "atypical" or second-generation antipsychotic with less brain penetration than FGAs,[3] resulting in a lower incidence of these adverse effects.[2]

Although some of the side effects of D_2-antagonists are dose-dependent, toxicity exists, and evidence is lacking on the impact of dose reduction on efficacy. Moreover, despite a reduction in frequency, adverse reactions like tardive dyskinesia, dysphoria, or torsade de pointes can have a high impact on patients. The crude incidence rate may not properly reflect the clinical burden. Therefore, it is essential to understand the relative risks of the available D_2-antagonists in order for providers to make optimal prescribing decisions.

BENZAMIDES

Amisulpride is a substituted benzamide D_2-antagonist and 5-HT_{2B} and 5-HT_{7A} serotonin antagonist with low blood-brain barrier penetration and lower affinity for adrenergic, histamine, and cholinergic receptors, resulting in a lower incidence of anticholinergic and sedative effects.[4] Amisulpride also has preferential binding in the limbic system, resulting in a lower incidence of EPS.[4] A 2020 Cochrane network meta-analysis reported that amisulpride had a comparable incidence of adverse events as compared to placebo.[5] Elevated prolactin levels from amisulpride do not exceed the norm for nonpregnant women,[6] and amisulpride does not meaningfully prolong the QT interval at doses used for PONV management due to its weaker affinity for potassium channels.[7] Recent studies have shown that amisulpride is effective in both preventing PONV[8] and as rescue treatment for PONV.[9] Another benzamide D_2-antagonist is metoclopramide, which is a weak D_2 and 5-HT_3 antagonist with dose dependent side effects that include sedation, EPS, and GI upset due to stimulation of gastric smooth muscle cells.[10] In the literature, metoclopramide may be useful in institutions where other D_2-antagonists are not available, but otherwise it may not be very efficacious in the management of PONV.[1]

BUTYROPHENONES

Droperidol is a butyrophenone D_2-antagonist and was used as a first-line agent for PONV prophylaxis in low doses in the past.[1] It produces sedation, dysphoria, anxiety, akathisia, and, most notably, QT prolongation.[11] Although instances of sudden cardiac death led to an FDA black box warning in 2001 and a significant decline in its use,[1] the 2020 Cochrane network meta-analysis reported that antiemetic doses of droperidol had a comparable incidence of adverse events to placebo.[5] Following the FDA black box warning on droperidol, there was increased interest in haloperidol, another butyrophenone, in the management of PONV.[1] Haloperidol produces sedation, EPS, neurotoxicity, and QT prolongation, and in 2007, the FDA updated labelling to warn providers that torsades de pointes and QT prolongation have been observed in patients receiving haloperidol, especially when administered via IV or in higher doses than recommended, emphasizing that haloperidol is not approved for IV administration for PONV treatment.[12] However, evidence suggests that low doses of IV haloperidol appear to be safe and effective when given as a single dose for PONV prophylaxis.[12]

Table 1: D_2 Subclass of Antiemetics

D_2 Subclass	Prototypical Agent	Key Pharmacologic Properties	Important Side Effects	Noteworthy
Benzamides	Amisulpride	Low CNS penetration, low affinity for potassium channels, and cholinergic, adrenergic, and histamine receptors	Mild prolactinemia, low incidence of EPS	FDA approved for use in PONV management
Butyrophenones	Droperidol	High CNS penetration, high affinity for potassium channels	Sedation, akathisia, QT prolongation	Black box warning, low doses effective in PONV management
Phenothiazines	Prochlorperazine	High affinity for cholinergic, adrenergic, and histamine receptors	Sedation, EPS, urinary retention, orthostatic hypotension	Use with caution in elderly patients

QT: refers to the interval between the Q and T points in the ECG
EPS: Extrapyramidal symptoms
PONV: Postoperative Nausea and Vomiting
CNS: Central Nervous System

See "Dopamine Antagonists," Next Page

D_2-receptor Antagonists Mainstay Management of Postoperative Nausea and Vomiting

From "Dopamine Antagonists," Preceding Page

PHENOTHIAZINES

Prochlorperazine is the most commonly used phenothiazine D_2-antagonist and FGA, producing sedation, EPS, anticholinergic effects (such as anorexia, blurred vision, constipation, dry mucosa, and urinary retention), antiadrenergic effects leading to orthostatic hypotension, and a decrease in the seizure threshold.[13] Promethazine is another phenothiazine D_2-antagonist and antihistamine that produces sedation, but IV formulations are irritating and corrosive, causing severe tissue damage upon extravasation from a vein.[14]

D_2 ANTAGONIST SIDE EFFECTS

D_2-antagonists can have notable drug interactions and are not recommended in patients with prolonged QT syndrome or taking drugs that prolong the QT interval, given the risk of further prolongation.[15] Ondansetron, a commonly used antiemetic, can also prolong the QT interval, but the QT prolongation induced by the combination of ondansetron and droperidol is not different from that induced by each drug alone.[1] D_2-antagonists can potentiate QT prolongation in patients taking drugs that reduce heart rate or induce hypokalemia, and combining D_2-antagonists with antipsychotics creates an additive risk for tardive dyskinesia and NMS.[15] In addition, patients taking dopamine agonists such as levodopa for Parkinson's or cabergoline for hyperprolactinemia should avoid D_2 antagonists.[15] Finally, D_2-antagonists should not be given with monoamine oxidase (MAO) inhibitors, as norepinephrine is broken down by MAO, and D_2-antagonism creates an accumulation of norepinephrine, leading to an exaggerated end-organ response.[16]

Best practices for postoperative brain health suggest that D_2-antagonist antiemetics should be used with caution or avoided in patients over 65 as they can produce central anticholinergic effects (phenothiazines), EPS (benzamides), and tardive dyskinesia, delirium, and NMS (butyrophenones).[17] Also, elderly patients with dementia may have an increased risk of cerebrovascular accident and an increased rate of cognitive decline and mortality with these medications.[17] Similar to adult patients, pediatric patients may experience EPS and QT prolongation with D_2-antagonists.[18]

PONV AND CLINICAL PRACTICE GUIDELINES

PONV contributes to prolonged postanesthesia care unit (PACU) stay, unanticipated hospital admission, and increased health care costs.[1] The fourth consensus guidelines for the management of PONV published in 2020 outline identification of high-risk patients, managing baseline PONV risks, choices for prophylaxis, and rescue treatments of PONV.[1] Two important conclusions from the guidelines should be highlighted here. Prevention of PONV should be considered an integral aspect of anesthesia, and therefore, patients with even one or two risk factors for PONV should receive multimodal PONV prophylaxis.[1] In addition, PONV treatment should consist of an antiemetic from a pharmacologic class that is different from the prophylactic drug initially given,[1] as there is no benefit of redosing ondansetron, despite its common practice.[1]

Various D_2-antagonists have been shown to play a beneficial role in both PONV prophylaxis and treatment in the literature. Numerous randomized controlled trials and retrospective database analyses demonstrate that combination regimens of non D_2-antagonist antiemetics with various older D_2-antagonists such as droperidol, haloperidol, and promethazine, are more effective than either agent alone.[5,19-21] However, the use of these agents has declined.[19] To date, amisulpride has been evaluated for the management of PONV in six clinical trials.[19,20] While five of the trials evaluated monotherapy and demonstrated amisulpride is superior to placebo in the prevention and treatment of PONV,[6,8,22,23] Kranke et al. demonstrated that the combination of amisulpride with ondansetron or dexamethasone was more effective than ondansetron or dexamethasone alone in reducing PONV and for rescue PONV treatment.[8]

CONCLUSION

Multimodal PONV prevention and management is critical, especially in enhanced recovery after surgery (ERAS) pathways, patients undergoing ambulatory surgery, and treatment of high-risk patients who have increased acuity and fragility. D_2-antagonists can play an effective role given the evidence in the literature, but they also have a wide range of side effects, limiting their use.[24] However, amisulpride is a D_2-antagonist with a favorable safety profile, as well as FDA approval for use in the prevention and management of PONV. Therefore, more studies are warranted to compare amisulpride to other single agent antiemetics and its use in combination therapy, as well as cost-benefit analyses.

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REFERENCES

1. Gan TJ, Belani KG, Bergese S, et al. Fourth consensus guidelines for the management of postoperative nausea and vomiting. *Anesth Analg.* 2020;131:411–448. PMID: 32467512.
2. Solmi M, Murru A, Pacchiarotti I, et al. Safety, tolerability, and risks associated with first- and second-generation antipsychotics: a state-of-the-art clinical review. *Ther Clin Risk Manag.* 2017;13:757–777. PMID: 28721057.
3. Natesan S, Reckless GE, Barlow KB, et al. Amisulpride the 'atypical' atypical antipsychotic—comparison to haloperidol, risperidone and clozapine. *Schizophr Res.* 2008;105:224–35. PMID: 18710798.
4. Smyla N, Koch T, Eberhart LH, Gehling M. An overview of intravenous amisulpride as a new therapeutic option for the prophylaxis and treatment of postoperative nausea and vomiting. *Expert Opin Pharmacother.* 2020;21:517–522 PMID: 31971450.
5. Weibel S, Rucker G, Eberhart LH, et. al. Drugs for preventing postoperative nausea and vomiting in adults after general anaesthesia: a network meta-analysis. *Cochrane Database Syst Rev.*2020;10:CD012859. PMID: 33170514.
6. Gan TJ, Kranke P, Minkowitz HS, et al. Intravenous amisulpride for the prevention of postoperative nausea and vomiting: two concurrent, randomized, double-blind, placebo-controlled trials. *Anesthesiology.* 2017;126:268–275. PMID: 27902493.
7. Fox GM, Albayaty M, Walker JL, et al. Intravenous amisulpride does not meaningfully prolong the QTc interval at doses effective for the management of postoperative nausea and vomiting. *Anesth Analg.* 2021;132:150–159. PMID: 31913911.
8. Kranke P, Bergese SD, Minkowitz HS, et al. Amisulpride prevents postoperative nausea and vomiting in patients at high risk: a randomized, double-blind, placebo-controlled trial. *Anesthesiology.* 2018;128:1099–1106. PMID: 29543631.
9. Habib AS, Kranke P, Bergese SD, et al. Amisulpride for the rescue treatment of postoperative nausea or vomiting in patients failing prophylaxis: a randomized, placebo-controlled phase III trial. *Anesthesiology.* 2019;130:203–212. PMID: 30475232.
10. Harrington RA, Hamilton CW, Brogden RN, et al. Metoclopramide. An updated review of its pharmacological properties and clinical use. *Drugs.* 1983;25:451–494. PMID: 6345129.
11. Lim BS, Pavy TJ, Lumsden G. The antiemetic and dysphoric effects of droperidol in the day surgery patient. *Anaesth Intensive Care.* 1999;27:371–374. PMID: 10470391.
12. Habib AS, Gan TJ. Haloperidol for postoperative nausea and vomiting: are we reinventing the wheel? *Anesth Analg.* 2008;106:1343–1345. PMID: 18420842.
13. Din L, Preuss CV. Prochlorperazine. In: StatPearls. Treasure Island (FL) 2022. PMID: 30725768.
14. Southard BT, Al Khalili Y. Promethazine. In: StatPearls. Treasure Island (FL) 2022. PMID: 31335081.
15. Chokhawala K, Stevens L. Antipsychotic Medications. In: StatPearls. Treasure Island (FL) 2022. PMID: 30137788.
16. Sub Laban T, Saadabadi A. Monoamine Oxidase Inhibitors (MAOI). In: StatPearls. Treasure Island (FL) 2022. PMID: 30969670.
17. Berger M, Schenning KJ, Brown CH 4th, et al. Best practices for postoperative brain health: recommendations from the fifth International Perioperative Neurotoxicity Working Group. *Anesth Analg.* 2018;127:1406–1413. PMID: 30303868.
18. Kovac AL. Management of postoperative nausea and vomiting in children. *Paediatr Drugs.* 2007;9:47–69. PMID: 17291136.
19. Haber SL, Graybill A, Minasian A. Amisulpride: a new drug for management of postoperative nausea and vomiting. *Ann Pharmacother.* 2021;55:1276–1282. PMID: 33412897.
20. Habib AS, Gan TJ. The effectiveness of rescue antiemetics after failure of prophylaxis with ondansetron or droperidol: a preliminary report. *J Clin Anesth.* 2005;17:62–65. PMID: 15721732.
21. Habib AS, Reuveni J, Taguchi A, et al. A comparison of ondansetron with promethazine for treating postoperative nausea and vomiting in patients who received prophylaxis with ondansetron: a retrospective database analysis. *Anesth Analg.* 2007;104:548–551. PMID: 17312206.
22. Kranke P, Eberhart L, Motsch J, et al. I.V. APD421 (amisulpride) prevents postoperative nausea and vomiting: a randomized, double-blind, placebo-controlled, multicentre trial. *Br J Anaesth.* 2013;111:938–945. PMID: 23872464.
23. Candiotti KA, Kranke P, Bergese SD, et al. Randomized, double-blind, placebo-controlled study of intravenous amisulpride as treatment of established postoperative nausea and vomiting in patients who have had no prior prophylaxis. *Anesth Analg.* 2019;128:1098–1105. PMID: 31094774.
24. Tan HS, Dewinter G, Habib AS. The next generation of antiemetics for the management of postoperative nausea and vomiting. *Best Pract Res Clin Anaesthesiol.* 2020;34:759–769. PMID: 33288125.

2023 President's Report: The Continued Quest *"that no one shall be harmed by anesthesia care"*

by Dan Cole, MD

I don't need to tell anyone reading this article that it has been quite a year in health care. With an environment defined by political polarization and its intersection with COVID, health and health care disparities, tenuous health care economics, burnout, and predictions of a "great resignation" where does patient safety fit into a strategic path forward?

Considering the complexity of systems of health care, it should not be surprising that safety problems are endemic in health care. We must work from a foundation of safety to achieve the purpose and goals of health care. Safety should be embedded in every decision and action we take. From a systems perspective, patients want to know that the care they receive is patient-centric, safe and reliable, and meets their quality expectations. They want to know that the health care providers caring for them are clinically competent, have interpersonal competence, and have primacy of the patient's interest. In a word, they want to trust the system and people that care for them.

So how are we doing with trust? A recent gallop poll found that in 2019, only 36% of individuals had "a great deal" or "quite a lot of confidence" in the medical system.[1] Due primarily to the heroic efforts of health care workers during the peak of the COVID pandemic, the number increased to 51% in 2020.[1] However, in 2021, in an environment of controversy regarding medical advice on wearing masks and vaccine mandates, the trust metric decreased to 44%.[1]

WE HAVE WORK TO DO!

This past year, the Anesthesia Patient Safety Foundation (APSF) has been laser-focused on our vision "that no one shall be harmed by anesthesia care." That vision should be entrenched throughout the experiences of the patient during the entire perioperative process, and beyond. In short, we aspire to a system without preventable harm, returning patients to their baseline or an improved state of physical, cognitive, and psychological health.

In February of 2022, we held a strategic planning session with the objective to innovate and seek new projects that would have high impact on fulfilling our vision. Although there were literally scores of ideas, we settled on three:

Daniel J. Cole, MD, Current APSF President

1. Develop two-way communication with patients. To that end, we have added the patient's voice to our discussions and decisions and are working on patient-facing material that patients can use to improve their perioperative experience.
2. Engage the next generation of anesthesia professionals. To accomplish this goal, we are in the development phase with the American Society of Anesthesiologists to provide basic educational modules on patient safety to all learners and early career anesthesia professionals.
3. Enhance the implementation of disruptive technology. The future of health care promises to add more robust data collection and advanced clinical decision support tools. Machine learning, artificial intelligence, and wearable sensors have already been introduced into the perioperative space. These innovations have great promise to improve quality and safety, but also have inherent risk if not implemented correctly. Our first step in this endeavor will be our 2023 Stoelting Consensus Conference, which will address this new era of health care safety issues as they relate to emerging technologies.

We continue to work the levers of action by which we turn ideas into action, and action into results. They include research, education, our *Newsletter*, other communication vehicles (e.g., social media), collaboration with other stakeholders in patient safety, and advocacy. With limited resources we will continue to strategically exercise these levers to make continued progress in the fight against preventable harm. Our focus over the next year will be directed at our ten priorities (https://www.apsf.org/patient-safety-priorities/). These include:

1. Culture of Safety
2. Teamwork
3. Clinical Deterioration
4. Non-Operating Room Anesthesia
5. Perioperative Brain Health
6. Opioid-Related Harm
7. Medication Safety
8. Infectious Diseases
9. Clinician Safety
10. Airway Management.

We have a deeply committed group of volunteers who I am confident will rise to the challenges of health care that will occur in the perioperative space over the next decade, and the solutions that patient safety engender. We rely on your financial support to achieve our goals, and we will use our resources wisely to ensure that anesthesiology remains a leader in perioperative safety to the benefit of our patients and providers. Sometimes it is best to resist change, sometimes to align with change, but we at the APSF will be proactive to continue our work to fulfill our vision "that no one shall be harmed by anesthesia care." It is indeed a sacred trust that we have with our patients and our goal is to further the foundation of trust on which our specialty has been built.

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REFERENCES

1. https://news.gallup.com/poll/352316/americans-confidence-major-institutions-dips.aspx. Acccessed on November 26, 2022.

Anesthesia Care for Patients With Limited English Proficiency

by Harrison Charwat, MD, and Meghan Lane-Fall, MD, MSHP, FCCM

Language barriers in health care are not benign, and they contribute to disparities in care and outcomes for patients who do not speak English well as compared to English-speaking patients. Individuals with "limited English proficiency" (LEP) are defined by the U.S. Department of Health and Human Services as those "who do not speak English as their primary language and who have a limited ability to read, write, speak, or understand English."[1] The Agency for Healthcare Research and Quality identified five high-risk scenarios for LEP patients: medication reconciliation, patient discharge, informed consent, emergency department care, and surgical care. Anesthesia professionals may be involved in every one of these high-risk scenarios.[2] LEP patients are at greater risk for surgical delays, surgical infections, falls, pressure ulcers, and readmissions.[3]

Linguists recognize more than 7,000 languages, and 1,333 of these are catalogued by the United States Census Bureau.[4] Although precise counts are elusive, the U.S. Census Bureau reports speakers from forty-two different language groups;[4] ten of the most common non-English languages spoken at home in the United States are shown in Table 1. As patients speaking these languages present for health care, it is important to recognize the unique needs of patients who do not speak the most common language(s) in any given setting. In the United States, English is the de facto language of government, health care, and commerce. In 2019, 21.5% of the U.S. population reported speaking a language other than English at home, and 8.2% of the US population were reported to have limited English proficiency.[5] Title VI of the U.S. Civil Rights Act of 1964 requires that recipients of federal financial assistance take reasonable steps to make their programs, services, and activities accessible by eligible persons with LEP.[6] Federal financial assistance programs include health care providers and hospitals who participate in CHIP, Medicaid, and Medicare. To make themselves accessible to LEP patients, hospitals must therefore provide translation of written word and interpretation of spoken word.

The United States Department of Health and Human Services (HHS) offers a free online educational program to assist organizations and individual providers in assessing their readiness to provide care for LEP patients and teaching the HHS Office of Minority Health Standards for Culturally and Linguistically Appropriate Services in Health and Health Care.[7] Below, we provide some important highlights of care for LEP patients.

Table 1: Languages Spoken by Those Who Speak Languages Other Than English at Home, United States.[11]

Language	# of Speakers in the United States (2018)	Percentage Change, 2010-2018
Spanish	41,460,427	+12%
Chinese (including Cantonese, Mandarin)	3,471,604	+24%
Tagalog	1,760,468	+12%
Vietnamese	1,542,473	+12%
French	1,232,173	-7%
Arabic	1,259,118	+46%
Korean	1,086,335	-4%
Russian	919,279	+8%
German	889,651	-17%
Hindi	874,314	+43%

https://cis.org/sites/default/files/2019-10/camarota-language-19_0.pdf

When providing care to LEP patients, clinicians must assess when interpretation services are needed. The Joint Commission states, "Because communication is a cornerstone of patient safety and quality care, every patient has the right to receive information in a manner he or she understands."[8] For optimal care, interpretation services should be involved any time there is a need for two-way communication with the patient. Interpretation can be provided in person by a trained clinician, trained clinical staff member, or dedicated interpreter. Additionally,

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Trained Interpretation Staff Are an Important Part of the Health Care Team

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there are many companies that provide either audiovisual or audio-only interpretation. Providers familiarize themselves with the specific resources available in their health care system.

Trained interpreters are part of the health care team and receive between 40 and 120 hours of training prior to their first day on the job. Untrained interpreters have been shown to make twice as many errors as trained interpreters.[9] To be eligible as a trained interpreter, an individual must speak English and the desired non-English language, as well as be versed in medical terminology in both languages. When interpretation services are being utilized, the health care professional should start the conversation by letting the interpreter know what to expect from the encounter prior to beginning a conversation. The conversation should be directly with the patient, not the interpreter. After the conversation, the interpreter's name or ID number should be documented in the chart for that patient encounter.

Sometimes, providers use suboptimal interpretation options including the patient's family members, staff members with limited fluency or medical language, Google Translate, or "just winging it." It can be especially tempting to use family members as interpreters given their familiarity with the patient, availability in the moment, and lack of cost. However, most family members lack the training of official interpreters, including knowledge about and sensitivity to confidentiality concerns.[2] Well-meaning family members may censor or change the information that the provider is sharing, which degrades the patient's individual autonomy. Family members may also participate in the discussion between provider and patient rather than acting solely as interpreter. Minor children are especially problematic interpreters given family power dynamics and their limited understanding of medicine or the overall situation; children should not be used as interpreters except in emergencies.[10] Some organizations allow patients to request a family member as an interpreter; this can be appropriate, but clinicians may have to make a judgment about the patient's level of autonomy when such a request is made. In keeping with patient autonomy, patients may reject the offer for professional interpretation services, but these services should still be offered in each interaction.

When caring for LEP patients, three foundational principles apply. First, these patients are limited in their English proficiency, which does not mean a complete lack of English understanding. Patients who are conversant in simple English (e.g., they can greet the health care team in English) may still need interpretation services for adequate understanding of their health care. Second, a patient's ability to speak English bears no relationship to their intelligence or medical sophistication. To reinforce this point, it can be helpful to imagine oneself as an anesthesia or perioperative professional seeking emergency care and not being able to communicate directly with the health care team. Third, every patient has the right to communicate directly with their health care team. To appropriately provide care to these patients, it is best to allot extra time while minimizing distractions. If possible, keeping the device for accessing remote interpretation services at the bedside can remove a barrier in use. Knowing the appropriate policies regarding interpretation can avoid awkward conversations with family members. Prescheduling in-person interpretation can streamline the entire process, especially for family meetings or other preplanned conversations. Partnerships with patients and between members of the care team can streamline care for LEP patients, enabling both efficient care and care that meets the needs of this vulnerable group.

As the United States continues to have a growing LEP population, clinicians will see increasing numbers of LEP patients. Having a plan in place for effectively communicating with LEP patients can help reduce strain on a provider while also maintaining a strong relationship with the patient. Trained interpretation staff are an important part of the health care team and allow patients to be truly informed throughout their medical journey. Providing interpretation services for patients should be considered an aspect of providing the compassionate patient-centered care to which clinicians aspire.

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REFERENCES

1. U.S. Department of Health and Human Services. Office for Civil Rights. Guidance to federal financial assistance recipients regarding Title VI and the prohibition against national origin discrimination affecting limited English proficient persons - summary. Updated 7/26/2013. Accessed April 7, 2022, https://www.hhs.gov/civil-rights/for-providers/laws-regulations-guidance/guidance-federal-financial-assistance-title-vi/index.html.
2. Betancourt JR, Renfrew MR, Green AR, Lopez L, Wasserman M. Improving patient safety systems for patients with limited English proficency: a guide for hospitals. 2012. 12-0041. Accessed December 8, 2022. https://www.nmhe.org/case-specific-resources/2020/5/21/improving-patient-safety-systems-for-patients-with-limited-english-proficiency-a-guide-for-hospitals-2014.
3. Betancourt JR, Tan-McGrory A. Creating a safe, high-quality healthcare system for all: meeting the needs of limited english proficient populations; comment on "Patient safety and healthcare quality: the case for language access." *Int J Health Policy Manag*. 2014;2:91–94. PMID: 24639984.
4. United States Census Bureau. About language use in the U.S. population. Updated 12/3/2021. Accessed April 7, 2022, https://www.census.gov/topics/population/language-use/about.html.
5. United States Census Bureau. Why we ask questions about...language spoken at home. Accessed April 7, 2022, https://www.census.gov/acs/www/about/why-we-ask-each-question/language/.
6. United States Department of Justice. Title VI of the Civil Rights Act of 1964. Accessed April 7, 2022, https://www.justice.gov/crt/fcs/TitleVI.
7. U.S. Department of Health and Human Services. The guide to providing effective communication and language assistance services. Accessed April 7, 2022, https://thinkculturalhealth.hhs.gov/education/communication-guide.
8. Joint Commission Division of Health Care Improvement. Overcoming the challenges of providing care to limited English proficient patients. Quick Safety: An advisory on safety & quality issues. 2021;13:1–3. Accessed April 7, 2022. https://www.jointcommission.org/-/media/tjc/newsletters/quick-safety-issue-13-lep-update-10-5-21.pdf.
9. Nápoles AM, Santoyo-Olsson J, Karliner LS, et al. Inaccurate language interpretation and its clinical significance in the medical encounters of Spanish-speaking Latinos. *Med Care*. 2015;53:940–947. PMID: 26465121.
10. Juckett G, Unger K. Appropriate use of medical interpreters. *Am Fam Physician*. 2014;90:476–480. PMID: 25369625.
11. Zeigler K, Camarota SA. 67.3 Million in the United States Spoke a Foreign Language at Home in 2018. Center for Immigration Studies; 2019. Accessed April 7, 2022. https://cis.org/sites/default/files/2019-10/camarota-language-19_0.pdf.

"Patient safety is not a fad. It is not a preoccupation of the past. It is not an objective that has been fulfilled or a reflection of a problem that has been solved. Patient safety is an ongoing necessity. It must be sustained by research, training, and daily application in the workplace."

—APSF Founding President "Jeep" Pierce, MD

Non-Operating Room Anesthesia: Closed Claim Review and Analysis

by Paul A. Lefebvre, JD

INTRODUCTION

With advancements in minimally invasive procedures and a desire to meet the needs of an ever-changing patient population, anesthesia professionals are increasingly asked to provide services outside the traditional operating room environment.[1,2] Our medical professional liability company is actively monitoring claim frequency and severity trends relating to adverse events occurring in non-operating room anesthesia (NORA) locations, such as endoscopy units, cardiac catheterization labs, interventional radiology suites, and office-based settings. We recently examined the last 200 claims that resulted in indemnity payments. Of these 200 claims, 28 involved procedures performed in NORA locations. While NORA cases made up only 14% of claims resulting in settlement or judgment, the average payment for NORA procedures was 44% higher than claims originating in the OR. Notably, we found that a higher percentage of paid NORA claims involved catastrophic injuries, such as brain injury and death, than claims arising in the OR.

In this article, we examine a case study and explore some of the unique challenges faced when defending anesthesia professionals in lawsuits stemming from adverse outcomes in NORA locations.

CASE STUDY

A 64-year-old male presented for elective colonoscopy. The patient's medical history was significant for morbid obesity, hypertension, diabetes, and obstructive sleep apnea. The anesthesia plan was intravenous sedation with an unsecured airway. Oxygen was delivered via nasal cannula at a rate of 4 liters per minute. Fifteen minutes into the procedure, the gastroenterologist noted the patient was hypotensive and had an arrhythmia, which developed into bradycardia. When the lights were turned back on, the patient appeared to be cyanotic. His oxygen saturation was 75% and he had a heart rate of 49. The anesthesia professional applied a face mask and increased the oxygen flow to 8 liters per minute. The patient's condition continued to deteriorate, and he went into asystole. A code was called, and the anesthesia professional secured the patient's airway. There was return of spontaneous circulation after several rounds of cardiopulmonary resuscitation (CPR). The patient was transferred to the ICU, where hypothermia protocol was initiated. A subsequent CT scan revealed diffuse brain swelling. The patient never regained consciousness, and his family elected to withdraw supportive measures. The patient passed away on postoperative day seven.

The patient's wife and adult children filed a lawsuit against the anesthesia professional and his practice group. The family alleged the anesthesia professional departed from the standard of care by (1) oversedating the patient, (2) failing to secure his airway in light of his high risk for obstruction, (3) failing to utilize capnography to measure qualitative $ETCO_2$, and (4) failing to timely recognize and manage the patient's respiratory depression. Defense experts refuted the allegations pertaining to the depth of sedation and airway support, and these claims gained little traction during the course of litigation. At his deposition, the anesthesia professional testified that he monitored the patient's gas exchange with capnography, but he neglected to document it in the record. While this issue complicated the defensibility of the case, defense counsel indicated it would not be an insurmountable hurdle if the jury found the anesthesia professional's testimony credible. However, the defense later learned that a nurse who witnessed the event was prepared to testify the anesthesia professional did not monitor the patient closely, and that he was showing the nurses pictures on his cellphone during the procedure. Defense counsel reported that the likelihood of prevailing at trial would be substantially diminished if this testimony reached a jury. Accordingly, the parties reached a settlement agreement within the anesthesia professional's policy limits.

CHALLENGES IN DEFENDING NORA CLAIMS

While data suggests NORA patients, on average, are older and more medically complex than the OR patient population,[3] our claims experience suggests this data does not align with the general public's perception of the risks associated with NORA procedures. Plaintiffs' attorneys regularly characterize NORA procedures as routine and low risk, contending the most plausible explanation for the adverse outcome was provider negligence. Tens of millions of procedures are performed outside the traditional OR setting annually in the United States.[4-6] Based on total volume of NORA procedures performed, many prospective jurors will have undergone a NORA procedure or accompanied a loved one to a procedure. If the procedure at issue was routine and low risk in the jurors' lived experiences, it becomes more challenging to rebut plaintiffs' generalizations and defend cases "on the medicine" with expert testimony.

Moreover, some NORA environments are prone to heightened scrutiny concerning production pressures and economic incentives, particularly in outpatient facilities with high procedure volumes. When a claim involves a code or another emergency, plaintiffs' attorneys commonly examine the facility's staffing and resources to assess whether appropriate personnel, equipment, and rescue medications were readily available. If they uncover any evidence intimating additional personnel or resources could have prevented a crisis or improved the patient's outcome, they will fold these allegations into a basic yet effective theme: economic gain took priority over patient safety.

Another frequent liability theory introduced in NORA claims is that the anesthesia professional failed to adopt proper patient selection criteria or consider alternative anesthesia plans. Plaintiffs' experts, who know the patient's outcome before forming their opinions, review medical records and deposition testimony through the lens of hindsight bias. Anesthesia professionals are often criticized for failing to appreciate the patient was high risk, or that they tailored the anesthesia plan to the facility's practice model rather than the individual patient's needs.

Lastly, we examined a relatively significant number of the NORA claims in which a proceduralist, nurse, and other provider involved in the patient's care made disparaging remarks about the anesthesia professional, often alleging the patient's adverse outcome was attributable to their lack of vigilance. This may be because NORA procedures can be an "away game" for anesthesia professionals. When NORA services are performed in new or unfamiliar settings, other members of the procedure team may be more inclined to point fingers or direct blame at anesthesia professionals if they work together infrequently and have not developed professional relationships.

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STRATEGIES TO ADVANCE PATIENT SAFETY IN NORA

The easiest decisions to defend are those that are made in the best interest of the patient's health and safety. To this end, anesthesia professionals should take sufficient time to perform a comprehensive preanesthesia evaluation and develop an anesthesia plan tailored to the patient based on the individual's medical history and the nature of the planned procedure. Anesthesia professionals should have autonomy to select the anesthesia plan best suited for the patient, and while the proceduralist may provide input, the anesthesia professional should ultimately make the decision.

Unfortunately, there is no such thing as a risk-free anesthetic, and patients can experience complications even under the safest circumstances. For this reason, anesthesia professionals should dedicate ample time to the informed consent process. It is important that anesthesia professionals highlight pertinent risks and give patients an opportunity to ask questions before the procedure. In the event of a catastrophic complication, professional negligence actions are brought by the patient's family members, who may not appreciate there were significant risks associated with the procedure. Accordingly, with the patient's permission, anesthesia professionals may consider including family members in the informed consent discussion if there is a heightened risk of complication.

Anesthesia professionals should ensure NORA locations have adequate staffing and resources to safely render anesthesia services. Emergency equipment and rescue medications should be properly maintained and readily accessible. In settings where cardiopulmonary arrest is very unlikely to occur, such as dental offices or freestanding endoscopy centers, members of the procedure team may benefit from having defined responsibilities in the event of an emergency. If practical, conducting periodic code simulations at these facilities can ensure the procedure team is better prepared should a real-life crisis arise.

Finally, anesthesia professionals should take the opportunity to get to know the other members of the procedure team when practicing in a new or unfamiliar environment. Everyone involved in the patient's care shares a common goal: to get the patient through the procedure safely and with the best possible outcome. Anesthesia professionals can reinforce this shared objective by actively communicating with other providers in the room, particularly during critical phases of the procedure, to demonstrate they are focused and engaged in the patient's care.

CONCLUSION

Thousands of NORA procedures are performed in the United States every day without complication, improving the lives of countless patients in the process. While our closed claims data suggests there is increased liability exposure when major complications occur during NORA procedures, the number of NORA claims as a percentage of total procedures performed remains small. Additionally, the incidence of NORA claims stemming from minor complications is quite low in our company's experience. However, when anesthesia professionals are named in lawsuits resulting from catastrophic complications during NORA procedures, they will often face unique challenges defending their care. By better understanding these common allegations and theories of liability, anesthesia professionals can work with other providers and facilities to avoid undue criticism, improve outcomes, and advance a culture of patient safety.

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The author has no conflicts of interest.

REFERENCES

1 Wong T, Georgiadis PL, Urman RD, Tsai MH. Non-operating room anesthesia: patient selection and special considerations. *Local Reg Anesth*. 2020;13:1-9. PMID: 32021414

2 Walls J, Weiss M. Safety in non-operating room anesthesia (NORA). *APSF Newsletter*. 2019;34:3-4,21. https://www.apsf.org/article/safety-in-non-operating-room-anesthesia-nora/ Accessed December 12, 2002.

3 Nagrebetsky A, Gabriel RA, Dutton RP, Urman RD. Growth of nonoperating room anesthesia care in the United States: a contemporary trends analysis. *Anesth Analg*. 2017;124:1261-1267. PMID: 27918331

4 Saltzman S, Weinstein M, Ali MA. Patients undergoing outpatient upper endoscopy and colonoscopy on the same day (double procedures) are at increased risk for adverse respiratory outcomes. *Am J Gastroenterol.* 2019;114:307-308. https://journals.lww.com/ajg/Abstract/2019/10001/531_Patients_Undergoing_Outpatient_Upper_Endoscopy.531.aspx. Accessed December 12, 2022.

5 Manda YR, Baradhi KM. Cardiac catheterization risks and complications. [Updated 2022 Jun 11]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan-. Available at: https://www.ncbi.nlm.nih.gov/books/NBK531461/. Accessed November 15, 2022.

6 Urman R, Shapiro F. Improving patient safety in the office: The Institute for Safety in Office-Based Surgery. *APSF Newsletter.* 2011;25:3-4. https://www.apsf.org/article/improving-patient-safety-in-the-office-the-institute-for-safety-in-office-based-surgery/. December 12, 2002.

Get Social With Us!

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 2023. Please follow us on Facebook at https://www.facebook.com/APSForg/ and on Twitter at https://twitter.com/APSForg. Also, connect with us on Linked In 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.

The Anesthesia Incident Reporting System (AIRS)

by Patrick Guffey MD, MHA, on behalf of the AIRS committee of the Anesthesia Quality Institute

INTRODUCTION TO ANESTHESIA INCIDENT REPORTING SYSTEM (AIRS)

The Anesthesia Incident Reporting System (AIRS) was created specifically to detect rare and novel adverse events that occur in national health care systems in the perioperative period. Events may encompass equipment malfunctions, medication errors, and rare complications in the nonoperating room setting. Over the last 11 years, thousands of detailed event reports and tens of thousands of cases of harm have been submitted, associating an anesthetic with a complication. AIRS uniquely serves as our "canary in the coal mine," letting us know when something new or rare is occurring across the country.

Shortly after the launch of AIRS, we received multiple reports of air embolus occurring during endoscopic retrograde cholangiopancreatography (ERCP). The AIRS committee published a case report in the ASA Monitor highlighting this rare, but potentially fatal complication with recommendations to assist in detection and prevention. Over the years these recommendations have been propagated through many educational channels, including the American Board of Anesthesiology's maintenance of certification questions. This event and a summary of it have also been presented in many Anesthesia Quality Institute (AQI) sponsored panels and other forums. As a result of this attention, ERCPs are now commonly performed with CO_2 insufflation to reduce the risk of this event, and gastroenterologists are more careful with dissection. Both parties are more mindful of the risk and better prepared to respond. While a voluntary event reporting system cannot completely determine the incidence of the event, we believe the prevalence may have decreased due to a paucity of reports over the past 10 years.

Without the original AIRS reports there may have been a significant delay in recognizing this complication and educating our specialty. The remainder of this article is a summary of the AIRS system and how the tool can be used to safely report adverse events in any anesthesia practice. It is a professional obligation for all of us, and one way we can work together to improve patient outcomes.

HISTORY OF INCIDENT REPORTING

Incident reporting began locally with initial adoption in the 1930s, typically surrounding unexplained deaths.[1] This expanded over time to cases of patient harm, and cases where patients were almost harmed (near miss) by an unsafe condition. Flanagan described the first

cases of anesthesia critical or incident reporting in 1954,[2] and this technique was introduced in the United States by Cooper et al in 1978.[3] Incident reporting is designed to improve patient safety by identifying hazards for improvement. This paradigm has been in use in other industries for much longer than health care and typically in highly reliable applications, such as aviation and nuclear power.

As expected, this work began with mortality and then slowly evolved to capture morbidity. The adoption of systems that capture near misses and unsafe conditions is limited to the current century. Many departments use a paper system to track and discuss cases at a morbidity and mortality conference. However, a formal process with reliable event capture including near misses and unsafe conditions is uncommon. Large hospitals tend to have a process for event reporting; however, as this system is typically not customized to the anesthesia community, the rate of use by anesthesia professionals is quite low.[4-7]

All clinicians learn from experience in their day-to-day practice. However, this approach has limitations. First, it may be difficult to draw conclusions from a single event. Root cause analysis can be difficult for a sole provider, and even in a group setting, there may be insufficient data to draw a conclusion due to multifactorial causes. Further, this requires that each anesthesia professional experience their own complications, as opposed to many of us learning from the experience of few.

NATIONAL REPORTING SYSTEMS

In order to allow for more robust data analysis, detection of rare events, and to leverage economies of scale, aggregation of events at the national level is desirable. This work began in Australia and New Zealand in 1988 and was later adapted to WebAIRS, a national repository of anesthesia events developed by the Australian and New Zealand Triparate Anesthesia Data Committee (ANZTADC).[5,8] In 2011, the Anesthesia Quality Institute (Schaumburg, IL) developed and launched the anesthesia incident reporting system (AIRS) in the United States.[5] This system was based on the anesthesia specific taxonomy developed by ANZTADC as well as the very robust local systems in place at the University of California, San Francisco, and Children's Hospital Colorado affiliated with The University of Colorado.[4,5]

THE SIGNIFICANCE OF THE PATIENT SAFETY AND QUALITY IMPROVEMENT ACT (PSQIA)

A common concern among physicians is the legal implications of reporting adverse events to local, regional, and national systems. In 2005, the Patient Safety and Quality Improvement Act (PSQIA) became law in the United States.[9] This law authorized the creation of Patient Safety Organizations (PSO), of which the AQI as the hosting entity of AIRS is a member. PSOs are fully authorized by federal law to collect patient data and protect it from legal disclosure to support quality improvement work. This law was absolutely critical to the development of AIRS. Data from AIRS is de-identified, and in accordance with the PSQIA, reported to the agency for health care research and quality (AHRQ), which allows the reports generated by AIRS to be used to improve health care overall in the United States. Over the last decade, PSOs have been collecting reports of patient harm, and successfully protecting their participants from discoverability.

TYPES OF AIRS CASES

Cases reported to AIRS are classified by type and specialty, among other considerations. As may not be expected, the majority of cases we receive are focused on three areas: equipment issues, infrastructure/systems concerns, and medications. Pulmonary, cardiac, and airway complications are a much smaller fraction of the reports. When asked as part of the reporting process, the contributing clinicians feel that the reported event was preventable by a three to one margin.

DISSEMINATION OF AIRS CASES

An important output of the AIRS system is monthly newsletter articles summarizing a case and the lessons learned. The AIRS committee members search for interesting and notable cases or trends and through a peer-reviewed

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Incident Reporting is Important to Detect, Analyze, and Learn from Adverse Events

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process at the committee level produce an article for the *ASA Newsletter*. The complete list of all case reports is available at https://www.aqihq.org/casereportsandcommittee.aspx. The articles may be read without subscription at this address.

REPORTING AIRS CASES

Cases of harm or notable near-misses can be reported at aqiairs.org by any member of the anesthesia care team, including trainees or students. The reporting form collects basic demographic information, patient details, and a description of the event. If the reporter prefers, the submission can be made completely anonymously. The form also has a section for lessons learned, and if the case was viewed as preventable by the reporting anesthesia team member.

In summary, incident reporting at the national level is an important tool to detect, analyze, and learn from adverse events, with the goal of not making the same mistake twice. The PSO framework provides a safe and legal construct to submit the details of an adverse event, protecting the reporting anesthesia professional while fostering quality improvement.

We can't fix what we can't detect. Please consider reporting events at aqiairs.org. Ultimately, our patients are the beneficiary of this work.

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REFERENCES

1. Beecher HK, Todd DP. A study of the deaths associated with anesthesia and surgery. *Ann Surg.* 1954;140:2–34. PMID: 13159140.
2. Flanagan JC. The critical incident technique. *Psychol Bull.* 1954;51:327–358. PMID: 13177800.
3. Cooper JB, Newbower RS, Long CD, McPeek B. Preventable anesthesia mishaps: a study of human factors. *Anesthesiology.* 1978;49:399–406. PMID: 727541.
4. Kaldjian LC, Jones EW, Wu BJ, et al. Reporting medical errors to improve patient safety: a survey of physicians in teaching hospitals. *Arch Intern Med.* 2008;168:40–46. PMID: 18195194.
5. Milch CE, Salem DN, Pauker SG. Voluntary electronic reporting of medical errors and adverse events. An analysis of 92,547 reports from 26 acute care hospitals. *J Gen Intern Med.* 2006;21:165–170. PMID: 16390502.
6. Guffey P, Szolnoki J, Caldwell J, Polaner D. Design and implementation of a near-miss reporting system at a large, academic pediatric anesthesia department. *Paediatr Anaesth.* 2011;21:810–814. PMID: 21535298.
7. Guffey P, Culwick MD, Merry AF. Incident reporting at the local and national level. *Int Anesthesiol Clin.* 2014;52:69–83. PMID: 24370721.
8. Gibbs NM, Culwick MD, Ferry AF, et al. Patient and procedural factors associated with an incrreased risk of harm or death in the first 4,000 incidents reported to webAIRS. *Anaesth Intensive Care.* 2017;45:159-165. PMID: 28267937.
9. Agency for Healthcare Research and Quality. The Patient Safety and Quality Improvement Act of 2005. June 2008. Accessed December 8, 2020. https://www.hhs.gov/hipaa/for-professionals/patient-safety/statute-and-rule/index.html

SELECTED REFERENCES FOR ADDITIONAL REVIEW

- Leape LL. Reporting of adverse events. *N Engl J Med.* 2002;347:1633-1638. PMID: 12432059.
- Cullen DJ, Bates DW, Small SD, et al. The incident reporting system does not detect adverse drug events: a problem for quality improvement. *Jt Comm J Qual Improv.* 1995;21:541–548. PMID: 8556111.
- Reason J. *Human Error.* Cambridge: Cambridge University Press; 1990.
- Rowin EJ, Lucier D, Pauker SG, et al. Does error and adverse event reporting by physicians and nurses differ? *Jt Comm J Qual Patient Saf.* 2008;34:537–545. PMID: 18792658.
- Runciman WB, AF Merry, Tito F. Error, blame, and the law in health care—an antipodean perspective. *Ann Intern Med.* 2003;138:974–979. PMID: 12809454.

Supraglottic Airway Devices (SADs) and Laparoscopic Surgery

by Shauna Schwartz, DO, and Yong G. Peng, MD, PhD, FASE, FASA

Supraglottic airway devices (SADs) continue to gain popularity and are increasingly used in anesthetic practices. However, the efficacy and safety of SADs for laparoscopic surgery are disputed. Although not traditionally used in laparoscopic surgery, SADs offer several benefits for appropriately selected patients.

EVOLUTION OF THE SAD

Since the invention of the first SAD, the device has undergone several design advancements that improve its safety profile.[1] The classic laryngeal mask airway developed by Teleflex (Wayne, PA) was one of the first SADs.[1] It had a relatively simple design, but it revolutionized the concept of airway management as it allows for a hands-free approach to ventilation and bypasses upper airway obstruction relative to the facemask.[1] Innovation has led to the creation of second-generation SADs, which allow for higher oropharyngeal leak pressures.[1] This improvement allows for better protection against regurgitated gastric contents and reduces aspiration risk.[1-3] In addition, it allows for the delivery of more successful positive pressure ventilation.[1,2]

SUPRAGLOTTIC AIRWAY AND HEMODYNAMICS

One potential benefit of SADs in laparoscopic surgery is improved hemodynamic stability.[3-5] In a study that assessed hemodynamics and catecholamine levels in obese patients undergoing laparoscopic gastric banding, patients randomized to receive an endotracheal tube (ETT) rather than a SAD had higher blood pressure and higher circulating catecholamine levels throughout the procedure than those in the SAD group.[4] High catecholamine levels can increase a patient's heart rate, which may impair myocardial oxygen delivery.[4] They also lead to a prothrombotic state.[4] The increase of catecholamines can exacerbate perioperative complications; therefore, SADs are an appealing alternative in certain high-risk populations. Placement of the SAD leads to less sympathetic stimulation and has the potential to require less anesthesia, avoiding reductions in systemic vascular resistance and myocardial depression.[5-7] The combination of a catecholamine surge and increased anesthetic requirements for ETTs can further lead to hemodynamic alterations that may not be well tolerated in certain patient populations.

COMPARING SAD VS. ETT OUTCOMES

Another potential benefit of SADs over ETTs is that SADs may be associated with less airway morbidity than the ETT.[5,6,8,9] The incidence of sore throat in the ambulatory surgical setting was found to be 45.5% in patients with an ETT compared to 17.5% in patients with an SAD.[9] In a meta-analysis of randomized controlled trials comparing the SAD and ETT in patients undergoing elective laparoscopic surgery, there was a higher incidence of laryngospasm, dysphagia, dysphonia, sore throat, and hoarseness in the ETT group.[8] Similarly, pediatric patients undergoing anesthesia with recent upper respiratory infections are at an increased risk for respiratory complications, such as bronchospasm and laryngospasm with an ETT vs. a SAD.[6,10] When pediatric patients, aged 3 months to 16 years, with a recent upper respiratory infection were randomized to receive a SAD vs. ETT for their anesthetic for a variety of elective surgical procedures, the patients who had an ETT had an increased incidence of bronchospasm and desaturation, defined as SpO_2 <90% during airway management as compared to those patients who had a SAD.[6] There is a reduced rate of laryngospasm, cough, and desaturation in pediatric patients undergoing laparoscopic hernia repair with SAD placement when compared to ETT placement.[11] Data suggests that SAD may reduce the risk of perioperative respiratory complications, even in a high risk group for bronchospasm, laryngospasm, and desaturation.[6,11] Furthermore, studies mentioned above suggest reduced patient airway complaints associated with SADs as well as a reduction in airway complications.

The reductions in airway morbidity and fewer hemodynamic disturbances may contribute to earlier discharge times in patients who undergo airway management with SADs.[4] In a randomized controlled trial that assessed postanesthesia care unit (PACU) and hospital length of stay, patients who received a SAD during their anesthetic for laparoscopic gastric banding met PACU discharge criteria 17 minutes earlier than those patients who received an ETT for their anesthetic.[4]

SAD AND VENTILATION DURING PNEUMOPERITONEUM

One of the challenging aspects of laparoscopic surgery is pneumoperitoneum. The physiological changes associated with a pneumoperitoneum may lead to increased abdominal pressure, reduced diaphragmatic excursion, and ultimately reduced respiratory compliance, which hinders the efficacy of ventilation and increases the likelihood of gastric regurgitation and the risk of aspiration.[3,12,13] However, newer SADs are designed to allow higher oropharyngeal leak pressure.[1,3,8] This is advantageous because it allows for improved ventilation, particularly when implementing positive pressure ventilation.[8,14] In a meta-analysis of randomized controlled trials comparing ETT to SAD in patients undergoing laparoscopic surgery, the studies found no difference in the incidence of oropharyngeal leak pressure or desaturation.[8]

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This suggests that effective ventilation is possible with SADs during pneumoperitoneum.[3,7,8,14-16] In another meta-analysis comparing randomized controlled trials, case-series, and large prospective observational studies, ventilation was found to be effective in 99.5% of patients with a SAD.[14] The only concerning subgroup of patients were those patients with BMI > 30 as they more likely to require ETT placement due to respiratory obstruction or an air leak.[14] These studies support the idea that adequate ventilation and oxygenation can be achieved while using a SAD for laparoscopic surgery in nonobese patients.

Another commonly cited disadvantage of SADs is gastric insufflation resulting from an insufficient adhesive seal.[5] With gastric insufflation there is a risk of aspiration,[5] which is one of the most cited contraindications for SAD placement, particularly in patients who are at increased risk (Table 1).[17] In patients with a high risk of aspiration, such as unfasted patients and those with a bowel obstruction, it is prudent to continue with ETT intubation. However, there are many studies with successful use of second-generation SADs in laparoscopic surgery without evidence of gastric insufflation or aspiration.[7,8,14] One of the greatest determinants of leak and gastric insufflation is the seal and positioning of the SAD.[3,5,18] When evaluated after gastric insufflation by a fiberoptic bronchoscope, 44% of first-generation SADs were found to be malpositioned.[18] However, properly positioned first-generation SADs showed only a 3% incidence of gastric insufflation.[18] Second-generation SADs were designed to reduce the risk of gastric insufflation by allowing for better seals and higher oropharyngeal leak pressures.[1,3,18] Thus, second-generation SADs reduce the potential risk of gastric reflux and aspiration when compared to first-generation SADs.[2,8,19] In addition, second-generation SADs are equipped with a gastric port that can drain gastric contents from the airway and serve as a conduit for gastric tube placement.[1,2] SADs have been successfully used without evidence of aspiration in appropriately selected patients undergoing laparoscopic surgery.[15]

CONCLUSION

Second-generation SADs are a safe alternative for laparoscopic surgeries in appropriately selected patients. They are better than the first-generation SADs at protecting against gastric insufflation and aspiration. They also have improved ventilation that is effective even with pneumoperitoneum (Table 2). Anesthesia professionals may need to discontinue the use of first-generation devices in laparoscopic surgery due to the lower oropharyngeal leak pressures and increased incidence of gastric insufflation if improperly sealed. Otherwise, SADs may offer a variety of benefits over ETTs in laparoscopic surgery including improved hemodynamic stability, a reduced risk of perioperative respiratory complications, reduced airway morbidity, and they may even contribute to earlier hospital discharge. Second-generation SADs have many benefits that warrant their use in laparoscopic surgery.

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Table 1: Patient Characteristics Indicating SAD Use[14,17,20]

Beneficial for:	Controversial for:	Contraindicated for:
• Fasted patients	• Patients with morbid obesity	• Unfasted patients
• Patients with a BMI <30	• Patients with a BMI >40	• Patients at high aspiration risk

BMI, body mass index; SAD, supraglottic airway device.

Table 2: Potential Benefits of SADs[1,2,4,6,9,17]

Potential Benefits	Added Potential Benefits of Second-generation SADs
• Reduced airway morbidity: sore throat, dysphagia, hoarseness	• Improved oropharyngeal leak pressure
• Improved hemodynamic stability	• Ability to provide PPV
• Reduced PACU and hospital stay	• Gastric drainage port
• Fewer respiratory complications	• Ability to pass orogastric tube

PACU, postanesthesia care unit; PPV, positive pressure ventilation; SAD, supraglottic airway device.

REFERENCES

1. Sharma B, Sahai C, Sood J. Extraglottic airway devices: technology update [published correction appears in *Med Devices (Auckl)*. 2018;11:27]. *Med Devices (Auckl)*. 2017;10:189–205. PMID: 28860875.
2. Shin HW, Yoo HN, Bae GE, et al. Comparison of oropharyngeal leak pressure and clinical performance of LMA ProSeal™ and i-gel® in adults: meta-analysis and systematic review. *J Int Med Res.* 2016;44:405–418. PMID: 27009026.
3. Zhang J, Drakeford PA, Ng V, et al. Ventilatory performance of AMBU® AuraGain™ and LMA® Supreme™ in laparoscopic surgery: a randomised controlled trial. *Anaesth Intensive Care.* 2021;49:395–403. PMID: 34550812.
4. Carron M, Veronese S, Gomiero W, et al. Hemodynamic and hormonal stress responses to endotracheal tube and ProSeal Laryngeal Mask Airway™ for laparoscopic gastric banding. *Anesthesiology.* 2012;117:309–320. PMID: 22614132.
5. Brimacombe J. The advantages of the LMA over the tracheal tube or facemask: a meta-analysis. *Can J Anaesth.* 1995;42:1017–1023. PMID: 8590490.
6. Tait AR, Pandit UA, Voepel-Lewis T, et al. Use of the laryngeal mask airway in children with upper respiratory tract infections: a comparison with endotracheal intubation. *Anesth Analg.* 1998;86:706–711. PMID: 9539588.
7. Ye Q, Wu D, Fang W, et al. Comparison of gastric insufflation using LMA-supreme and I-gel versus tracheal intubation in laparoscopic gynecological surgery by ultrasound: a randomized observational trial. *BMC Anesthesiol.* 2020;20:136. PMID: 32493213.
8. Park SK, Ko G, Choi GJ, et al. Comparison between supraglottic airway devices and endotracheal tubes in patients undergoing laparoscopic surgery: a systematic review and meta-analysis. *Medicine (Baltimore).* 2016;95:e4598. PMID: 27537593.
9. Higgins PP, Chung F, Mezei G. Postoperative sore throat after ambulatory surgery. *Br J Anaesth.* 2002;88:582–584. PMID: 12066737.
10. Cohen MM, Cameron CB. Should you cancel the operation when a child has an upper respiratory tract infection? *Anesth Analg.* 1991;72:282–288. PMID: 1994755.
11. Nevešćanin A, Vickov J, Elezović Baloević S, Pogorelić Z. Laryngeal mask airway versus tracheal intubation for laparoscopic hernia repair in children: analysis of respiratory complications. *J Laparoendosc Adv Surg Tech A.* 2020;30:76–80. PMID: 31613680.
12. Loring SH, Behazin N, Novero A, et al. Respiratory mechanical effects of surgical pneumoperitoneum in humans. *J Appl Physiol (1985).* 2014;117:1074–1079. PMID: 25213641.
13. Safran DB, Orlando R 3rd. Physiologic effects of pneumoperitoneum. *Am J Surg.* 1994;167:281–286. PMID: 8135322.
14. Beleña JM, Ochoa EJ, Núñez M, et al. Role of laryngeal mask airway in laparoscopic cholecystectomy. *World J Gastrointest Surg.* 2015;7:319–325. PMID: 26649155.
15. Maltby JR, Beriault MT, Watson NC, Fick GH. Gastric distension and ventilation during laparoscopic cholecystectomy: LMA-Classic vs. tracheal intubation. *Can J Anaesth.* 2000;47:622–626. PMID: 10930200.
16. Maltby JR, Beriault MT, Watson NC, et al. LMA-Classic and LMA-ProSeal are effective alternatives to endotracheal intubation for gynecologic laparoscopy. *Can J Anaesth.* 2003;50:71–77. PMID: 12514155.
17. Gordon J, Cooper RM, Parotto M. Supraglottic airway devices: indications, contraindications and management. *Minerva Anestesiol.* 2018;84:389–397. PMID: 29027772.
18. Latorre F, Eberle B, Weiler N, et al. Laryngeal mask airway position and the risk of gastric insufflation. *Anesth Analg.* 1998;86:867–871. PMID: 9539617.
19. Yoon SW, Kang H, Choi GJ, et al. Comparison of supraglottic airway devices in laparoscopic surgeries: a network meta-analysis. *J Clin Anesth.* 2019;55:52–66. PMID: 31871993.
20. Bernardini A, Natalini G. Risk of pulmonary aspiration with laryngeal mask airway and tracheal tube: analysis on 65 712 procedures with positive pressure ventilation. *Anaesthesia.* 2009;64(12):1289-1294. PMID: 19860753.

Using Data for Safety and Quality Improvement

by Holly B. Ende, MD, and Jonathan P. Wanderer, MD, MPhil

The delivery of safe and effective anesthesia care is grounded in the science of quality improvement, which relies on accurate and timely reporting of patient outcomes. In the era of the electronic health record (EHR) and growing national databases, mountains of data pertaining to patients and their care continue to accumulate, with the potential to guide patient safety initiatives now and into the future. Without extensive training in data science and informatics, anesthesia clinicians on the front lines of patient care may find it daunting to access, interpret, and use data from the EHR and other sources to support patient safety and quality initiatives. To be useful in improving patient care, data must be organized, structured, and given context and meaning. One way to achieve this transformation of data into information and knowledge is to create data models.[1] Data models can be a useful tool in the structuring, simplification, and operationalization of data in the real world.

Data models are a tool to standardize and add meaning to data, which in turn facilitates shared understanding and easy extraction and usage. Through behind the scenes mapping of key data points and subsequent validation, users can dramatically improve the ease of access to important data.[2,3] For example, if a quality director wanted to develop automated emails to retrieve EHR data for postoperative outcomes and distribute to clinicians weekly, he or she could use a data model to define and identify those outcomes.

At our institution, the Perioperative Data Warehouse (PDW) is a home-grown data repository which collects and stores data from multiple sources enabling easy access for operational, research, and quality initiatives. Data sources for these types of data warehouses can include electronic medical record (EMR) data, patient-reported data (e.g., patient surveys), and non-EMR data from providers (e.g., adverse event reporting). Collecting and combining data from these diverse sources into a common repository is a powerful way to invest upfront cost and energy to enable easy, efficient, and straightforward access to data by clinicians of all specialties and technology backgrounds. In the prior example, each outcome of interest (acute kidney injury, postoperative nausea and vomiting, reintubation, etc.) has already been defined, mapped, and validated within the PDW, making operational use of that data (e.g., providing automated weekly emails to clinicians) simple and streamlined.

In addition, quality improvement officers and researchers can easily access these data retrospectively to evaluate effectiveness of practice improvement initiatives. As an example, following implementation of an electronic reminder system to prompt clinicians to check intraoperative glucose in diabetic patients, researchers at our institution were able to easily monitor adherence and ultimately publish data showing not only increased rates of glucose monitoring, but also decreased rates of hyperglycemia and surgical site infections.[4] In another quality initiative on the labor and delivery unit, investigators demonstrated that a standardized algorithm approach to epidural top-ups for breakthrough labor pain subsequently resulted in a greater number of catheters replaced within 30 minutes of first administered top-up, reflecting more rapid identification of non-functioning catheters.

Data models can be internally developed or purchased from third-party vendors, but they are also available through many commercial EHRs, which use data models to create functionality for end users to access clinical and quality data without intensive or time-consuming training requirements. For example, Oracle Cerner (Austin, TX) and Epic Systems (Verona, WI), which are some commonly used EHRs in national health care systems, employ several user-friendly interfaces to allow clinicians to access patient data (Table 1).

Finally, those interested in understanding national trends in quality and safety data can turn to large national data sources such as the National Anesthesia Clinical Outcomes Registry (NACOR), the Multicenter Perioperative Outcomes Group (MPOG), or the National Surgical Quality Improvement Program (NSQIP). Each of these data sources has strengths and limitations, and those interested in employing these resources to answer questions related to quality must understand these limits. For example, NACOR, which is supported by the American Society of Anesthesiologists and includes data from millions of cases from thousands of practices throughout the United States, has robust capture of data elements related to billing, but non-uniform capture of outcome data elements. Keeping in mind the limits of accessing and analyzing data from these large national data sources, clinicians can appropriately use them to answer safety-related questions requiring longitudinal data, varying practice types, and large numbers of anesthetics. Such methodology has already been used to assess such questions as the effects of overlapping surgery, risk factors for pediatric intraoperative hypoglycemia, and postoperative pain and opioid use patterns.[6-8]

To power quality improvement initiatives and further patient safety during anesthetic care, it is imperative to have access to perioperative data and the skillsets to work with those data. While grappling with raw underlying data can be challenging, there are multiple tools available to users within EHRs that facilitate data analysis. Using a data model can make developing reports and retrieving data easier, but does require upfront effort to either develop a local data model or to perform the mapping and validation necessary to use an EHR vendor's data model. Ultimately, these approaches can be utilized synergistically to provide a comprehensive view of perioperative operations and anesthetic outcomes, transforming data into actionable knowledge that anesthesia professionals can use to drive practice improvement.

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Table 1. User-friendly interfaces for accessing patient data

PowerInsight Explorer	Cerner Millennium® business intelligence reporting tool that allows creation of real-time operational, clinical, and performance reports
Reporting Workbench	Epic tool that allows users to create custom reports using specific templates with criteria that define populations and data elements of interest (e.g., OR location, principal diagnosis, etc.)
Slicer Dicer	Epic tool that allows exploration of data through customizable searches which support multiple data models, including an anesthetic record data model

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APSF Awards 2023 Grant Recipients

by Yan Xiao, PhD

The APSF grant program supports and advances anesthesia patient safety culture, knowledge, and learning, a part of the APSF mission. The program has played an essential role in establishing and enhancing careers of many professionals conducting safety research and education. Since 1987, the ASPF has supported more than 130 anesthesia professionals with more than $14 million in funding.

The 2022–23 APSF investigator-initiated grant program received 30 letters of intent (LOI) from 17 organizations in the United States and Canada. The Scientific Evaluation Committee evaluated and scored these letters, with the assistance of external statistical reviewers. The LOIs receiving the five highest scores were invited to submit full proposals. Four full proposals were received and were discussed via a hybrid meeting of the Scientific Evaluation Committee on October 22, 2022. Two proposals were recommended for funding to the APSF Executive Committee and Board of Directors, and both received unanimous support. This year's recipients are Annery Garcia-Marcinkiewicz, MD, MSCE, from Children's Hospital of Philadelphia and Peter Schulman, MD, from Oregon Health & Science University. They provided the following description of their proposed work:

Annery Garcia-Marcinkiewicz, MD, MSCE

Assistant Professor of Anesthesiology and Critical Care, Children's Hospital of Philadelphia

Dr. Garcia-Marcinkiewicz's project is entitled ***"Nasotracheal Intubation with Videolaryngoscopy versus Direct Laryngoscopy in Infants (NasoVISI) Trial"***

Background: More than 32,000 infants undergo congenital heart surgery in the United States annually,[1] with approximately 50% of these patients requiring nasotracheal intubation (NTI). Direct laryngoscopy (DL) is the current standard of care for initial NTI attempts in these patients. Small infants are particularly vulnerable during tracheal intubation because of their rapid rate of oxygen desaturation. Securing the tracheal tube quickly and on the first attempt is the best practice to minimize complications. Our team established a multicenter registry to improve the quality of airway management in children with challenging airways and discovered that multiple tracheal intubation attempts are a key risk factor for severe adverse events such as cardiac arrest, laryngospasm, and severe hypoxemia.[2] Additionally, our most recent multicenter trial comparing videolaryngoscopy (VL) to DL in infants found that VL improves first attempt success rate and reduces severe complications when used for orotracheal intubation in infants with normal airways.[3] Infants presenting for cardiac surgery are a particularly vulnerable group who often require NTI. The short apnea tolerance time in such infants, particularly those with cardiovascular anomalies, creates a critical time-pressure to intubate. NTI with DL is the most common clinical practice in infants presenting for cardiac surgery, but often requires additional maneuvers such as the use of Magill forceps or external laryngeal manipulation, all of which can contribute to prolonged intubation time and complications. With DL, the supervising clinician is blind to what the trainee sees, which makes effective guidance and instrumentation difficult. Observational studies in adults suggest that the use of VL can provide higher NTI success rates and shorter intubation time compared to DL.[4] VL improves trainee coaching during tracheal intubation, and the shared view reassures the supervising clinician that the tracheal tube is being placed properly.[5] This is highly desirable in vulnerable cardiac infants. There is currently no published data on whether VL is more effective than DL at improving first-attempt NTI success rates and reducing complications in infants undergoing cardiac surgery. We hypothesize that reducing multiple attempts will enhance the safety of NTI in this vulnerable population.

Aims: This proposal seeks to reduce complications by reducing the number of NTI attempts in infants presenting for cardiothoracic procedures. We hypothesize that VL as the first attempted approach will be associated with an increased first-attempt success rate, a reduced number of tracheal intubation attempts, and reduced tracheal intubation-related complications, specifically intubation-associated hypoxemia. Reducing the number of attempts will enhance the safety of airway management in infants presenting for cardiac procedures and is well aligned with the mission of the Anesthesia Patient Safety Foundation.

Implications: Tracheal intubation is a high-risk procedure in infants because of their unique anatomy, high oxygen consumption, and smaller edema-prone airways all leading to very limited apnea tolerance. Hypoxemia and multiple attempts are important targets to enhance safety. Infants with cardiovascular anomalies are an extremely high-risk group due to their very limited physiologic reserves. Our proposed project will potentially lead to the reduction of multiple NTI attempts, consequent hypoxemia, and associated complications in these vulnerable infants.

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REFERENCES

1. Hofer IS, Gabel E, Pfeffer M, et al. A systematic approach to creation of a perioperative data warehouse. *Anesth Analg.* 2016;122:1880–1884. PMID: 27195633.
2. Epstein RH, Dexter F. Database quality and access issues relevant to research using anesthesia information management system data. *Anesth Analg.* 2018;127:105–114. PMID: 29596094.
3. Epstein RH, Hofer IS, Salari V, Gabel E. Successful implementation of a perioperative data warehouse using another hospital's published specification from Epic's electronic health record system. *Anesth Analg.* 2021;132:465–474. PMID: 32332291.
4. Ehrenfeld JM, Wanderer JP, Terekhov M, et a. A perioperative systems design to improve intraoperative glucose monitoring is associated with a reduction in surgical site infections in a diabetic patient population. *Anesthesiology.* 2017;126:431–440. PMID: 28106608.
5. Ende HB, Tran B, Thampy M, et al. Standardization of epidural top-ups for breakthrough labor pain results in a higher proportion of catheter replacements within 30min of the first bolus dose. *Int J Obstet Anesth.* 2021;47:103161. PMID: 33931311.
6. Sun E, Mello MM, Rishel CA, et al. Association of overlapping surgery with perioperative outcomes. *JAMA.* 2019;321:762–772. PMID: 30806696.
7. Riegger LQ, Leis AM, Golmirzaie KH, Malviya S. Risk factors for intraoperative hypoglycemia in children: a multicenter retrospective cohort study. *Anesth Analg.* 2021;132:1075–1083. PMID: 32639390.
8. Stuart AR, Kuck K, Naik BI, et al. Multicenter perioperative outcomes group enhanced observation study postoperative pain profiles, analgesic use, and transition to chronic pain and excessive and prolonged opioid use patterns methodology. *Anesth Analg.* 2020;130:1702–1708. PMID: 31986126.

APSF 2023 Grant Recipients (Cont'd)

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REFERENCES

1. The Society of Thoracic Surgeons. Congenital Heart Surgery Database, table 7 neo infant. https://www.sts.org/registries-research-center/sts-national-database/congenital-heart-surgery-database. Published 2020. Accessed February 17, 2022.
2. Fiadjoe JE, Nishisaki A, Jagannathan N, et al. Airway management complications in children with difficult tracheal intubation from the Pediatric Difficult Intubation (PeDI) registry: a prospective cohort analysis. *Lancet Respir Med*. 2016;4:37–48. PMID: 26705976.
3. Garcia-Marcinkiewicz AG, Kovatsis PG, Hunyady AI, et al. First-attempt success rate of video laryngoscopy in small infants (VISI): a multicentre, randomised controlled trial. *Lancet*. 2020;396:1905–1913. PMID: 33308472
4. Jiang J, Ma DX, Li B, Wu AS, Xue FS. Videolaryngoscopy versus direct laryngoscopy for nasotracheal intubation: A systematic review and meta-analysis of randomised controlled trials. *J Clin Anesth*. 2019;52:6–16. PMID: 30153543
5. Volz S, Stevens TP, Dadiz R. A randomized controlled trial: does coaching using video during direct laryngoscopy improve residents' success in neonatal intubations? *J Perinatol*. 2018;38:1074–1080. PMID: 29795452

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Peter Schulman, MD

Professor of Anesthesiology, Oregon Health and Science University

Dr. Schulman's project is entitled ***"Electromagnetic Interference with an Underbody Dispersive Electrode in Patients with Implantable Cardioverter Defibrillators Undergoing Surgery."***

Background: During a surgical procedure, the function of a cardiac implantable electronic device (CIED) may be disrupted by electromagnetic interference (EMI).[1] The consequences of EMI include hemodynamically significant bradycardia or asystole in the pacing-dependent patient, inappropriate shocks or antitachycardia pacing, direct damage to the CIED, and other less common, but clinically significant sequelae.[1] Failure to prevent or mitigate these effects might lead to patient injury and increased mortality.[2] Intraoperative EMI most often results from the use of monopolar electrosurgery (i.e., "cautery"). Monopolar electrosurgery requires a dispersive electrode to complete the electrical circuit. While a conventional dispersive electrode is applied directly to the patient's skin, an alternative "underbody" dispersive electrode is now being used with increasing frequency that is incorporated into a gel pad and placed directly on the operating table.[3] Because the surface area of the underbody electrode is substantially larger than a conventional electrode, some reports suggest that the use of an underbody dispersive electrode might be associated with an increased risk of EMI, but conclusive evidence is lacking.[3,4] As the use of underbody electrodes becomes more ubiquitous, it is imperative to better understand and quantify their associated risks for patients with CIEDs undergoing surgery.

Aims: This study will evaluate the risks of underbody dispersive electrode use in patients with implantable cardioverter defibrillators (ICDs) undergoing noncardiac surgery. Specifically, we will determine the risk of any EMI, and the risk of clinically meaningful EMI, from monopolar electrosurgery with use of an underbody dispersive electrode for patients with ICDs undergoing noncardiac surgery superior or inferior to the umbilicus. We will then compare the results to data obtained from a prior study that we conducted[5] to determine whether these risks are higher with an underbody dispersive electrode than with the use of an appropriately positioned conventional dispersive electrode.

Implications: A substantial number of patients with CIEDs undergo surgical procedures. Monopolar electrosurgery is required for most operations, and underbody dispersive electrode use is rapidly increasing. Determining the risk of EMI with underbody dispersive electrode use and comparing this risk to that of conventional dispersive electrode use will inform future practice recommendations, prevent adverse events, and improve perioperative care. If the risk of EMI is significantly higher with an underbody electrode, using a conventional, appropriately positioned dispersive electrode rather than an underbody electrode might obviate the need for CIED reprogramming in certain circumstances. Conversely, if the risk of EMI with an underbody electrode is not increased, this information could be used to assuage concerns about underbody electrode use for patients with CIEDs and to bolster the case that CIED reprogramming is typically not needed for inferior to the umbilicus surgery.

REFERENCES

1. Practice advisory for the perioperative management of patients with cardiac implantable electronic devices: pacemakers and implantable cardioverter–defibrillators 2020: an updated report by the American Society of Anesthesiologists Task Force on perioperative management of patients with cardiac implantable electronic devices. *Anesthesiology.* 2020;132:225–252. PMID: 32032098.
2. Rozner MA, Kahl EA, Schulman PM. Inappropriate implantable cardioverter-defibrillator therapy during surgery: an important and preventable complication. *J Cardiothorac Vasc Anesth.* 2017;31:1037–1041. PMID: 28216202.
3. Tully BW, Gerstein NS, Schulman PM. Electromagnetic interference with an underbody dispersive electrode in a patient with an implantable cardioverter-defibrillator undergoing noncardiac surgery: a case report. *A A Pract*. 2020;14:e01285. PMID: 32985854.
4. Singleton MJ, Fernando RJ, Bhave P, et al. Inappropriate implantable cardioverter-defibrillator therapy with the use of an underbody electrosurgery dispersive electrode. *J Cardiothorac Vasc Anesth.* 2021. PMID: 33745836.
5. Schulman PM, Treggiari MM, Yanez ND, et al. Electromagnetic interference with protocolized electrosurgery dispersive electrode positioning in patients with implantable cardioverter defibrillators. *Anesthesiology.* 2019;130:530–540. PMID: 30601218.

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The vision of the Anesthesia Patient Safety Foundation is to ensure that no one shall be harmed by anesthesia care.

& Mission

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The APSF Legacy Society: *A Remarkable Opportunity to Support a Noble Cause*

by Mark A. Warner, MD

Like many of you who are involved in your communities, I have served on a number of foundation boards locally, nationally, and within the specialty of anesthesiology. One of the most important roles for board members of these foundations is to ensure that the organizations have the resources needed to accomplish their vision and missions. For APSF, these are:

***Vision:** That no one shall be harmed by anesthesia care.*

***Mission:** The APSF's mission is to improve the safety of patients during anesthesia care by:*

- Identifying safety initiatives and creating recommendations to implement directly and with partner organizations
- Being a leading voice for anesthesia patient safety worldwide
- Supporting and advancing anesthesia patient safety culture, knowledge, and learning

What is more important in our clinical practices than ensuring that our patients are safe during their intraoperative and postoperative care?

Few foundations succeed long-term without sustained financial resources. For a lucky few, a consistent source of annual funding is available. For most, however, legacy funding (e.g., endowments) provides sustained support over the years and contributes to the success of the foundations in meeting their vision and mission.

For this reason, the **Anesthesia Patient Safety Foundation Legacy Society** was established in 2019. The society honors those who make a gift to the foundation through their estates, wills, or trusts. Legacy Society members help safeguard the future of patient safety by ensuring that the foundation's safety research and education programs and campaigns, as well as a national and international exchange of information and ideas, will continue on behalf of the profession about which we are so deeply passionate.

The APSF Legacy Society currently has 17 members. Their perspectives on the importance of supporting anesthesia patient safety initiatives can be viewed at https://www.apsf.org/donate/legacy-society/.

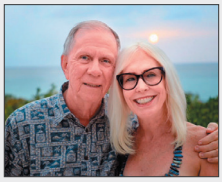
The APSF would love to have you become a Legacy Society Member. Legacy Society members are partners in the future of anesthesiology. To become an APSF Legacy Society member, simply contact me and express your interest in learning more about the society. I'd love to discuss the opportunity with you. You may reach me at warner@apsf.org.

Sara Moser, the APSF's Director of Development and I will work with you to complete a very simple Legacy Society membership form. You do not need to provide documentation of the gift type or amount. There is no minimum gift amount. Our current pledged gifts range from 5 to 7 figures in value. We only need to know that you plan on including APSF in your estate planning. Members of the Legacy Society will be noted on our website and in each issue of our *APSF Newsletter.*

Please consider becoming a member of the APSF Legacy Society. The vision and mission of APSF are noble causes.

Mark A. Warner, MD
Past President, APSF

The author has no conflicts of interest.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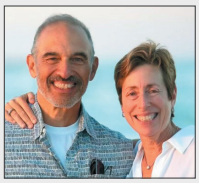
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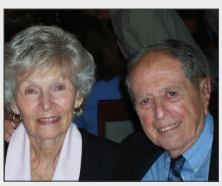
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Evolving Safety Challenges in Patients Presenting for Liver Transplantation Today: A Single-Center Experience

by Khoa Tran, MD; Ashraf Sedra, MD; and Joseph Szokol, MD, JD, MBA

INTRODUCTION

It has now been over 20 years since the Institute of Medicine published the paradigm-changing report "To Err is Human," which concluded that as many as 98,000 deaths occurred in hospitals each year due to errors in care.[1] Although the exact figure of anesthesia-related mortality is controversial, there is no question that our specialty has made remarkable gains in improving patient safety over the past two decades due to improvements in training, equipment, and standardized protocols. Safe management of orthotopic liver transplantation (OLT) patients, however, continues to be one of the most challenging perioperative cases for anesthesia professionals. OLT involves multidisciplinary collaboration, which includes surgical, anesthesia, nursing teams, as well as perfusionist and other specialized teams (e.g., blood bank, dialysis, and ICU). The procedure is technically complex, and the intraoperative course is associated with hemodynamic instability, acid-base and metabolic derangements, coagulation complications, wide fluid shifts, and is still associated with more intraoperative deaths than any other surgical procedure.[2]

Although success in liver transplantation has led to more liver transplantations being performed each year, the number of donated organs has reached a plateau. Adoption of the Model for End-Stage Liver Disease (MELD) based system in 2002 has led transplantation that prioritizes the "sickest first" (Table 1). Patients with high MELD scores are expected to have abnormal levels of bilirubin, creatinine, INR, sodium, or a combination of each (see Table 1). Abnormalities in each of these MELD components is associated with high perioperative risk in previous studies.[3] This has a profound effect on patients presenting for liver transplantation, particularly in populated areas where there are more transplantation centers. Such evolution in patient selection and the increasing severity of disease in patients at liver transplantation has posed many perioperative challenges to physicians who care for these patients.[4] Patients who present for liver transplant today have higher MELD scores and more advanced liver disease, more advanced age and preoperative comorbidities, more renal and electrolyte abnormalities, and higher requirements for intraoperative transfusions and vasopressors than patients who presented for liver transplant twenty years ago in the pre-MELD era.[3]

Table 1: MELD Score Components and 3 Month Mortality Prediction[5]

The MELD score calculation includes:
- Serum bilirubin (mg/dL)
- Serum creatinine (mg/dL)*
- INR
- Serum sodium (mEq/L)[6]

Candidates > 12 years old receive an initial MELD(i) score equal to:

MELD(i) = 0.957 × ln(Creatinine) + 0.378 × ln(bilirubin) + 1.120 × ln(INR) + 0.643

Then, round to the tenth decimal place and multiply by 10.

If MELD(i) > 11, perform additional MELD calculation as follows6:

MELD = MELD(i) + 1.32 × (137 – Na) – [0.033 × MELD(i) × (137 – Na)]

*If any of the following is true, use creatinine of 4.0 mg/dL:
- Creatinine >4.0 mg/dL.
- ≥2 dialysis treatments within the last 7 days.
- 24 hours of continuous veno-venous hemodialysis (CVVHD) within the last 7 days.

Additional rules:
- If bilirubin, creatinine, or INR <1.0, use 1.0 to avoid negative scores.
- If sodium <125 mEq/L, use 125. If sodium >137 mEq/L, use 137.
- Maximum MELD score = 40.

MELD SCORE	Mortality at 3 months
≤9	1.9%
10–19	6.0%
20–29	19.6%
30–39	52.6%
≥40	71.3%

Decisions on which patients are included on transplant waiting lists today may also be further distorted by intense competition in populated areas where there are more transplant centers. Our institution, the University of Southern California (USC), is a high-volume transplant center in the Los Angeles metropolitan area where there are three transplant centers located within a 20-mile radius. The combined volume of liver transplants performed at both Keck Hospital and Children's Hospital Los Angeles (CHLA) last calendar year adds up to the second-busiest liver transplant program in the nation according to data from the United Network for Organ Sharing. With local competition and prestige at stake, it is understood that centers may be motivated to perform more transplants, resulting in more challenging patients on the waiting list. Nevertheless, liver transplantation surgery today challenges the full capacities of the systems and processes involved in patient safety. This article describes a few of the processes developed at our institution and how they contribute to patient safety in a field that is becoming increasingly more challenging.

DEVELOPMENT OF DESIGNATED LIVER TRANSPLANT ANESTHESIA TEAMS

In 2011 the Organ Procurement and Transplant Network/United Network for Organ Sharing (OPTN/UNOS) required all transplant centers appoint a director of liver transplant anesthesia.[7] This declaration by a nationally recognized governing and regulatory body was the first step in acknowledging liver transplant anesthesiology as an independent subspeciality of anesthesiology. From here, the development of liver transplant anesthesia teams and transplant anesthesia fellowships followed. The value of dedicated anesthesia teams was further supported by evidence showing dedicated transplant teams reduced transfusion, time of postoperative ventilation, length of intensive care unit stay, and perioperative mortality.[8]

In addition to providing clinical care, members of the liver transplant anesthesia team are involved with various perioperative transplant surgery functions such as patient selection committees. The multidisciplinary committee includes transplant coordinators, surgeons, hepatologist, nephrologist, infectious disease specialists, anesthesia professionals, and social workers. At these weekly committees, we discuss the patient's liver history and other medical problems, and then discuss issues of social support, substance abuse, and finances. From here, the decision-making process involves an

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Liver Transplantation Poses Many Patient Safety Challenges

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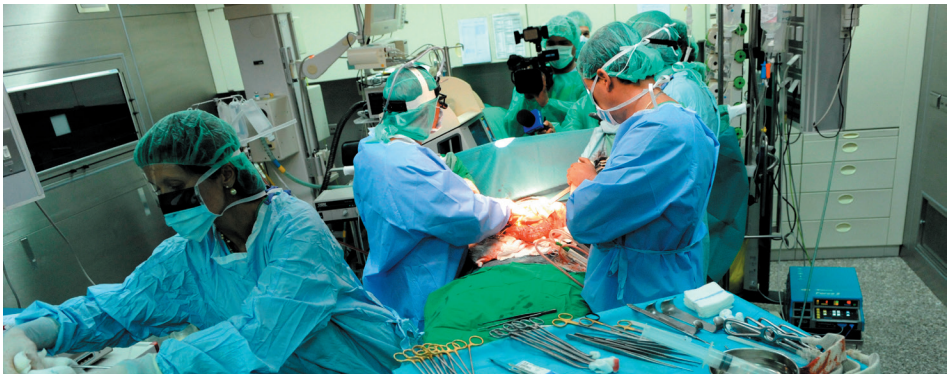
ordered review of possible reasons for exclusion. Routine involvement of the anesthesia team in the selection process allows us to formally evaluate patients before they present for liver transplant. If needed, patients may be referred to our preoperative clinic to allow a member of the anesthesia team to further evaluate the patient's physical status for liver transplant.

PRE-TRANSPLANT AND ABO VERIFICATION

Due to the complexity of coordination in transplant, additional safety verification processes are involved. Verification of blood type at multiple and defined points in the transplantation process ensures the safety and compatibility of our transplant donors and recipients. Vital information such as organ type, donor and recipient ID, donor and recipient ABO blood type, and recipient date of birth and medical record number will be verified during living donor registration, prior to living donor organ recovery, prior to organ receipt in the operating room (if recipient surgery begins prior to organ receipt in the operating room), and upon organ receipt in the operating room. Verification is required by two licensed health care professionals. If the recipient will begin prior to organ receipt in the operating room, verification must occur either prior to induction of anesthesia or prior to incision. Additionally, blood components are scanned using an electronic verification system intraoperatively. OLT can require up to 10 times as many units of blood products as a heart transplant.[9] Verification via barcode scanning allows for one-person verification and increases workflow efficiency while minimizing transfusion errors related to misidentification.

EVOLUTION OF PATIENT BLOOD MANAGEMENT PROGRAM AT KECK USC

Although blood transfusions are a lifesaving therapy for some patients, transfusions were identified as 1 of the top 5 overused procedures by the Joint Commission's Overuse Summit in 2012.[10] The Transfusion Free Surgery and Patient Blood Management Program at Keck USC was initially developed in 1997 to serve the specific needs of the Jehovah's Witness (JW) community. Our center gained national recognition after our transplantation team performed the first successful transfusion-free living donor liver transplantations in 1999 using techniques like acute normovolemic dilution. From 1999–2004, 27 liver transplantations, consisting of both living donors and deceased donors, were performed in JW patients at the USC-University Hospital.[11] The relative success of liver transplantation in JW patients has allowed the opportunity to critically assess the use of blood



products in surgery at large. What started at Keck USC as a narrowly focused initiative has expanded into a much broader mainstream program that serves non-JW patients. This development was driven by the concept that minimizing blood product administration enhances patient safety and reduces the cost and length of hospital stay. Higher rates of transfusion have been associated with increased length of hospital stay, higher rates of infection, graft failure, and mortality.[12]

Given that most of the evidence supporting a restrictive transfusion strategy has been published in the past decade, patient blood management programs have only recently gained popularity. Efforts to reduce overuse of transfusions through patient blood management programs at our institution have been successful. Currently, a retrospective study is being conducted during the writing of this article. Preliminary data collection reports a ~20% decrease in RBCs, platelets, and plasma utilization for liver transplant cases in 2021 compared to 2020, despite an increase in cases. Our reduction in transfusions in LT was a result of several key interventions implemented which will be discussed. First, a hospital-wide campaign to educate and promote change to the culture of liberal blood utilization practice was implemented. One successful strategy was adopting the "Why give 2 when 1 will do?" Choosing Wisely campaign to reduce orders of multi-unit RBC transfusions.[13] A widespread communication effort followed in our hospital newsletters and on computer screensavers to encourage single unit transfusions.

Another intervention that changed our transfusion practice at our institution was implementation of intraoperative thromboelastography (TEG). Despite the lack of large randomized clinical studies, viscoelastic tests have been a critical armamentarium for hemostatic control in liver transplantation since Thomas Starzl, MD, performed the first LT the 1960s.[14] Many transplant institutions have adopted viscoelastic tests like TEG in their clinical practice. However, it was only recently that TEG at our center was made expedient and efficient, both intraoperatively and postoperatively in the ICU, to allow for a rapid and real-time, qualitative assessment of the different components of hemostasis. Lastly, and perhaps most importantly, we believe our success in blood management is a result of improved communication between liver anesthesia and surgical teams over the progress of the case. For example, improved communication and use of TEG has allowed us to better distinguish surgical bleeding from bleeding due to coagulopathy, which helped reduce intraoperative transfusions. Overall, we hope to demonstrate how multidisciplinary teams can significantly reduce total blood product utilization in OLT.

THE ROLE OF INTRAOPERATIVE HEMODIALYSIS (HD) IN LIVER TRANSPLANTATION

Liver transplantation for patients with renal dysfunction is frequently complicated by major fluid shifts, acidosis, and electrolyte and coagulation abnormalities that require large volumes of blood products and crystalloid solutions. In the early years of OLT, liver transplant anesthesia professionals used to manage cases with renal failure with strict fluid management and continuous metabolic adjustments without the help of intraoperative hemodialysis (HD). However, despite vigilant monitoring of the patient's hemodynamics and metabolic derangements, the intraoperative course in many cases was complicated by the overwhelming fluid and metabolic changes that occur in patients with renal impairment or failure. The rationale behind the use of intraoperative renal replacement therapy during liver transplant for patients with renal failure is that the surgery is usually complicated by major hemodynamic instability, coagulation abnormalities, and metabolic derangements. At our center, liver transplant continues to be the only case that routinely uses intraoperative HD in anesthetic management.[15] Our institution was one of the first to demonstrate the safety and feasibility of intraoperative HD and adopt its use in the critically ill with high MELD (mean ~37) scores undergoing LT.[16]

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Liver Transplantation (Cont'd)

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The decision whether to use intraoperative HD during OLT is a collaborative one between the surgeon, anesthesia team, and nephrologist depending on the degree of renal dysfunction and the overall clinical picture including the need for postoperative renal replacement therapy. Generally, intraoperative HD will be used on patients with Glomerular Filtration Rate < 60 ml/min or serum creatinine >1.4 mg/dL. For those without permanent dialysis access, a dual-lumen HD catheter is inserted into the internal jugular, subclavian, or femoral vein. Prior to surgery, the nephrologist decides on the concentration of sodium, calcium, potassium, and bicarbonate in the dialysate solution for each patient based on their laboratory values. During the operation, the HD nurse works in close consultation with the anesthesia team. Half-hourly to hourly blood gases are drawn to help guide changes in the dialysate as needed (mainly adjustments to the bicarbonate and potassium levels).[17] The use of intraoperative HD aids in the management of temperature, acidosis, hyperkalemia, and volume overload, all of which are associated with intraoperative morbidity and mortality in patients undergoing liver transplant.[15] The anesthesia professional is acquainted with the various treatment options available (Table 2). With a thorough evaluation, monitoring, and continuous appropriate interventions, intraoperative HD can be used safely and effectively in critically ill patients undergoing LT with high MELD scores and renal dysfunction.

CONCLUSION

The changing face of patients presenting for liver transplantation today has posed many challenges to the systems and processes involved in patient safety. In this article, we reviewed a few of the processes implemented at our center that have allowed us to improve safety measures and outcomes in critically ill, high MELD patients undergoing liver transplant. In order to continue to improve patient safety in liver transplantation, more comprehensive data and studies are required to further characterize the evolving safety challenges in liver transplantation today.

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The authors have no conflicts of interest.

Table 2: Summary of Treatment Variations During Intraoperative HD

Temperature

- Dialysate temperature is kept between 37 to 37.5 degrees Celsius
- Aids in prevention of hypothermia-related coagulopathy and cold irrigation from graft

Sodium adjustments

- Routinely commenced at 138 mEq/L, may be adjusted between 130–138 mEq/L
- Careful monitoring may prevent rapid rise in serum sodium concentrations associated with CPM

Calcium adjustments

- Routinely commenced at 3.5 mEq/L, may be adjusted between 3–3.5 mEq/L
- Aids in the management of hypocalcemia secondary to massive blood transfusion

Potassium adjustments

- Routinely commenced with a dialysate with 3 mEq/L, may be adjusted between 1–4 mEq/L in the management of hyperkalemia secondary to massive blood transfusion and pre-existing renal dysfunction

Bicarbonate adjustments

- Routinely commenced with a dialysate with 35 mEq/L, may be adjusted between 25–35 mEq/L to aid in the treatment of refractory acidosis commonly seen in patients with renal dysfunction particularly during the anhepatic phase[18]

Ultrafiltration flow rates

- Typically, will aim to keep an even fluid balance unless otherwise instructed by the anesthesia team
- UFR may be increased in situations of volume overload for rapid volume removal, e.g., post-reperfusion right heart strain or graft congestion

HD, hemodialysis; CPM, central pontine myelinosis; UFR, ultrafiltration flow rate

REFERENCES

1. Kohn LT, Corrigan J, Donaldson MS. To err is human : building a safer health system. National Academy Press; 2000, p. 87. PMID: 25077248.
2. Butt Z, Parikh ND, Skaro AI, et al. Quality of life, risk assessment, and safety research in liver transplantation: new frontiers in health services and outcomes research. *Curr Opin Organ Transplant.* Jun 2012;17:241–247. PMID: 22476225.
3. Xia VW, Taniguchi M, Steadman RH. The changing face of patients presenting for liver transplantation. *Curr Opin Organ Transplant.* Jun 2008;13:280–284. PMID: 18685318.
4. Zarrinpar A, Busuttil RW. Liver transplantation: past, present and future. *Nat Rev Gastroenterol Hepatol*. July 2013;10:434–440. PMID: 23752825.
5. Kremers WK, van IJperen M, Kim WR, et al. MELD score as a predictor of pretransplant and posttransplant survival in OPTN/UNOS status 1 patients. *Hepatology*. 2004;39:764–769. PMID: 14999695.
6. OPTN 2016 MELD Policy Changes 2016. https://optn.transplant.hrsa.gov/news/meld-serum-sodium-policy-changes/. https://optn.transplant.hrsa.gov/media/eavh5bf3/optn_policies.pdf. Both accessed December 14, 2022.
7. Nguyen-Buckley C, Wray CL, Zerillo J, et al. Recommendations from the Society for the Advancement of Transplant Anesthesiology: liver transplant anesthesiology fellowship core competencies and milestones. *Semin Cardiothorac Vasc Anesth.* 2019;23:399–408. PMID: 31402752.
8. Hevesi ZG, Lopukhin SY, Mezrich JD, et al. Designated liver transplant anesthesia team reduces blood transfusion, need for mechanical ventilation, and duration of intensive care. *Liver Transpl*. 2009;15:460–465. PMID: 19399745.
9. Nedelcu E, Wright MF, Karp S, Cook M, et al. Quality improvement in transfusion practice of orthotopic liver transplantation reduces blood utilization, length of hospital stay, and cost. *Am J Clin Pathol.* 2019;151:395–402. PMID: 30535323.
10. Sadana D, Pratzer A, Scher LJ, et al. Promoting high-value practice by reducing unnecessary transfusions with a patient blood management program. *JAMA Intern Med.* 2018;178:116–122. PMID: 29159367.
11. Jabbour N, Gagandeep S, Mateo R, et al. Transfusion free surgery: single institution experience of 27 consecutive liver transplants in Jehovah's Witnesses. *J Am Coll Surg.* 2005;201:412–417. PMID: 16125075.
12. Tokin C, Almeda J, Jain S, et al. Blood-management programs: a clinical and administrative model with program implementation strategies. *Perm J. Winter* 2009;13:18–28. PMID: 21373242.
13. Podlasek SJ, Thakkar RN, Rotello LC, et al. Implementing a "Why give 2 when 1 will do?" Choosing Wisely campaign. *Transfusion.* 2016;56:2164. PMID: 27624209.
14. Sakai T. Viscoelastic testing in liver transplantation. *Transfusion*. 2020;60 Suppl 6:S61–S69. PMID: 33089935.
15. Sedra AH, Strum E. The role of intraoperative hemodialysis in liver transplant patients. *Curr Opin Organ Transplant.* 2011;16:323–325. PMID: 21543980.
16. Nadim MK, Annanthapanyasut W, Matsuoka L, et al. Intraoperative hemodialysis during liver transplantation: a decade of experience. *Liver Transpl*. 2014;20:756–764. PMID: 24634344.
17. Henson A, Carpenter S. Intra-operative hemodialysis during liver transplantation: an expanded role of the nephrology nurse. *Nephrol Nurs J.* 2010;37:351–353, 356; quiz 354. PMID: 20830942.
18. Vitin A, Muczynski K, Bakthavatsalam R, et al. Treatment of severe lactic acidosis during the pre-anhepatic stage of liver transplant surgery with intraoperative hemodialysis. *J Clin Anesth*. 2010;22:466–472. PMID: 20868970.

APSF Successfully Launches Low-Flow Anesthesia Course During ASA 2022 Meeting

(APSF.ORG/tei/lfa)

Ever wonder how much you can reduce fresh gas flow safely? Did you know that significantly reducing anesthetic pollution requires attention to lowering flows during not just the maintenance phase of an anesthetic, but induction and emergence as well? What about Compound A and sevoflurane—is it safe to deliver sevoflurane using a fresh gas flow less than 2 L/min? Does the choice of CO_2 absorbent matter as fresh gas flow is reduced? These and other questions are answered in the newly released APSF course on low-flow anesthesia.

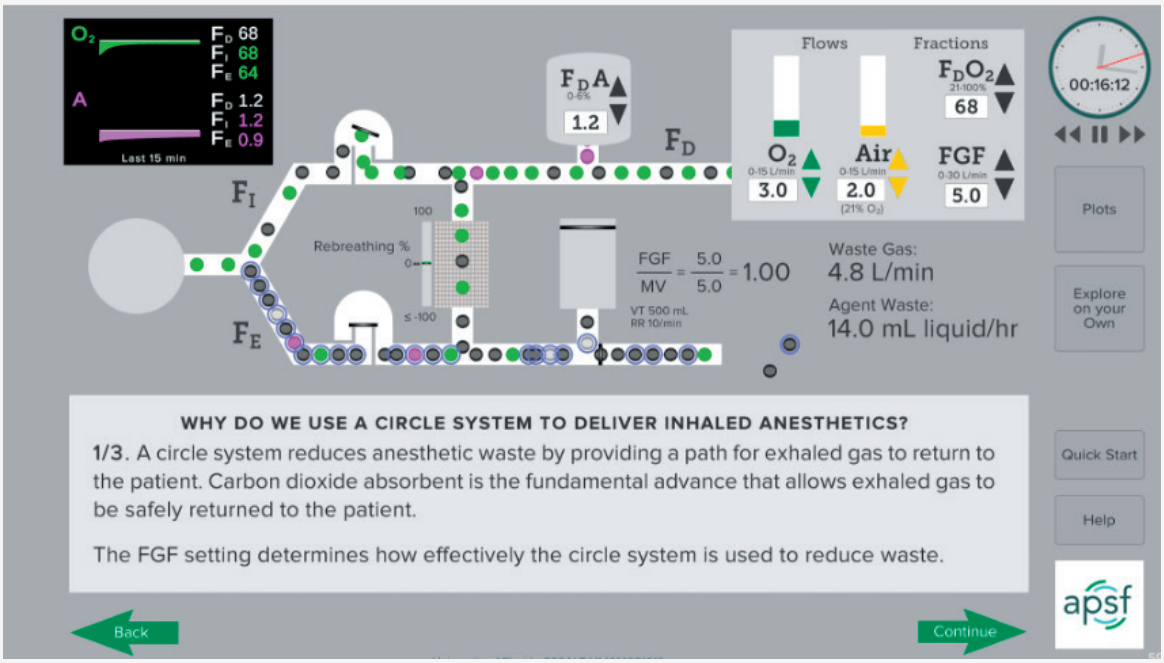
At the 2022 annual meeting of the American Society of Anesthesiologists (ASA), the Anesthesia Patient Safety Foundation (APSF), in collaboration with the ASA, launched its Technology Education Initiative with an inaugural course on Low-Flow Anesthesia. The course is intended to empower anesthesia professionals with the knowledge required to safely, effectively, and comfortably reduce fresh gas flow. The course utilizes guided simulation to help the learner understand the interaction between fresh gas flow setting and anesthetic waste and pollution (Figure 1). There is an emphasis on patient safety and the central role of monitoring oxygen and anesthetic concentrations to ensure safe and adequate oxygen and anesthetic delivery as fresh gas flow is reduced. Eight different topics, each requiring about 15 minutes, cover the essentials of low-flow anesthesia and strategies during each phase of the anesthetic. While the topics are recommended to be done in sequence, they do not need to be done all at the same time.

The course is available online through the ASA Education Center. Any anesthesia professional or interested party can take the course free of charge by creating a guest account if they are not an ASA member. Three continuing education credits are available for physicians, CRNAs, and CAAs. For those in the MOCA® process, all of the continuing medical education (CME) credits are patient safety-eligible. Although the actual course is hosted by the ASA, there is a landing page on the APSF website with expanded information on low-flow anesthesia. Interested professionals are encouraged to begin by accessing the APSF website at APSF.ORG/tei/lfa where you will find the following information:

- Introductory tour of the simulation platform
- Link to the course on the ASA website
- Supplemental information
  - Technology and Low-Flow Anesthesia Practice: Article describing the various tools available in different anesthesia machine models to support a low-flow practice.
  - Is Rebreathing Prevented when FGF Equals MV? Article describing the relationship between FGF, minute ventilation, and rebreathing.
  - Global Warming—Blame Anesthesia? Article describing the environmental rationale for practicing low-flow anesthesia.
  - Explore the Simulation on Your Own: This provides access to an unguided version of the anesthesia machine model and simulation where learners can trial different approaches to managing fresh gas flow during induction, maintenance, and emergence.
- Links to websites of anesthesia delivery system manufacturers for more detailed information about specific devices.

At the time of this writing, hundreds of anesthesia professionals have visited the APSF webpage and signed up for the course. The simulation approach is interactive and replaces traditional didactic teaching with a learning environment where the functions of the anesthesia machine can be readily visualized. Informative, available continuing education credits and it's FREE! Why wait? Sign up and take the course today.

APSF Technology Education Initiative—Low-Flow Anesthesia—Using the Circle System to Control Breathing



FD = Delivered Concentration
FI = Inspired Concentration
FE = Expired Concentration
FGF = Fresh Gas Flow
MV = Minute Ventilation

Figure 1. Snapshot of guided simulation from the APSF/ASA course on low-flow anesthesia. The user is guided on adjusting fresh gas flow, oxygen concentration, and vaporizer setting while visualizing the impact on anesthetic waste as well as the resulting concentrations of oxygen and anesthetic in the circuit. (APSF.ORG/tei/lfa)

Recognizing and Combating Cognitive Bias in Anesthesiology: Implications for Patient Safety

by George Tewfik, MD, MBA, FASA, CPE, MSBA; Stephen Rivoli, DO, MPH, MA, CPHQ, CPPS; and Monica W. Harbell, MD, FASA

A CASE VIGNETTE

After hearing the overhead page for emergency anesthesia help, an anesthesia professional rushed to the operating room with an Ear, Nose and Throat (ENT) case in progress. On arrival, she noted an asleep patient turned 90 degrees away from the anesthesia machine with an ENT laryngoscope in place with the following vital signs: 84% on the pulse oximeter and blood pressure 80/53 mmHg. She could hear the ventilator alarming, with "High Peak Inspiratory Pressure" flashing across the top of the screen. The anesthesia professional in the operating room at the time shared how the peak inspiratory pressures crept up quickly and ventilation was becoming difficult in the last several minutes. The patient had a history of asthma and despite bronchodilators and increased anesthetic, bronchospasm persisted. Another anesthesia professional auscultated and reported that there was no wheezing and no audible air movement; meanwhile, another colleague was preparing epinephrine. The anesthesia professional, who responded to the emergency anesthesia page, examined the patient from endotracheal tube to circuit to the machine and looked into the patient's mouth where she saw the small endotracheal tube kinked out of sight from the anesthesia team. She relieved the bend and the ventilator alarm ceased its high-pitched whine. As the oxygen saturation quickly climbed, her colleagues' faces showed both appreciation and embarrassment. How could they have missed that simple problem? The other emergency responders noted that they were so focused on assisting their colleague that they didn't question the working diagnosis of bronchospasm. The in-operating room anesthesia professional noted that the history, timing, and signs led him to believe bronchospasm had to be what was happening. The second anesthesia professional, taking in new information without context, was able to correctly diagnose the problem. Unbeknownst to these anesthesia professionals, they were suffering from the effects of cognitive bias.

Table 1: A sampling of cognitive bias that may occur in anesthesiology and the practice of perioperative medicine, including descriptions and examples of each type.

TYPE OF BIAS	DESCRIPTION	EXAMPLE
Anchoring bias[1]	Over-reliance on initial impressions and/or information, with an inability to incorporate new data	Operating room team fixated on bronchospasm as the cause of airway resistance after a nasotracheal intubation. It was found later that the tube was kinked.
Ascertainment bias[2]	Type of sampling error in which the results found are not truly representative of the intended target, and are influenced by observer	Post-induction blood pressure decreased and anesthesia professional attributed it to large dose of induction agent due to past experience. Anesthesia team failed to realize that patient was volume-depleted due to prolonged NPO state, and required aggressive hydration.
Availability bias[3]	Making decisions based on accessibility of data	Not changing choice of blood products for a bleeding patient due to length of time it takes to obtain thromboeslastogram.
Bandwagon effect/ Diagnostic momentum[4]	Inability to consider alternatives once a diagnosis or determination has been made	Belief that a patient is tachycardic is attributed to hypovolemia and continuing aggressive hydration, and later realizing that the patient has not had adequate pain control.
Confirmation bias[5]	Observing and/or seeking information to confirm one's own opinion, instead of seeking additional data	Repeating pressure measurements, changing cuff sizes and locations, in an effort to get a reassuring reading, instead of recognizing that patient is truly hypotensive—not a device error.
Framing effect[6]	Impact of decision-making on how information is presented, such as by a trusted source	A junior resident is told by (and believes) a chief resident that a patient does not have a post dural puncture headache, despite all signs and symptoms pointing to this diagnosis.
Search satisficing/ Premature closure[7]	Failing to continue to seek data once something has been identified	On emergence, accepting belief that patient is having delayed wakeup due to residual inhaled anesthetic instead of looking for other cause.

BACKGROUND

Cognitive biases affect clinicians by allowing a practitioner to create their own subjective reality, which may alter their own perception of a data point. This "systematic pattern of deviation from an established norm or rationality in judgment" may lead to alteration in one's practices, affecting one's behavior.[8] It is important to note that psychological deviation as a result of cognitive bias affects all humans—not just medical professional—and can cause errors in personalized medical care on an individual basis, or in public health policies, affecting whole populations.[9]

The effects of cognitive bias on errors in medicine have long been understood to affect patient safety.[10,11] Cognitive bias can cause significant impacts on decision-making for clinicians, including anesthesia professionals, potentially jeopardizing the lives of patients.[11,12] By first understanding cognitive biases and how they affect our practice, we may mitigate their effect and improve patient safety.

In the case presented, several cognitive biases were at play, including availability bias and bandwagon effect. Availability bias describes a psychological phenomenon in which decisions are made based on the data at hand, without seeking additional data.[13] The bandwagon effect, also known as diagnostic momentum, refers to an inability to consider alternatives once a diagnosis or determination has been made.[14] There are a variety of frequently observed biases that may afflict anesthesia professional (Table 1).[12,15]

See "Cognitive Bias," Next Page

The Effects of Cognitive Bias on Errors in Medicine Affect Patient Safety

From "Cognitive Bias," Preceding Page

THE EFFECTS OF COGNITIVE BIAS ON ERRORS

Errors that occur in the perioperative period often result from cognitive bias, with studies citing that as many as 32.7% of all postoperative complications are affected at least in part by bias.[16] Specific types of cognitive bias have been identified as factors contributing to errors in anesthetic care. Confirmation bias, for example, is the act of observing or seeking information to confirm one's own opinion, instead of seeking additional information that may challenge one's current belief. In a study of a series of esophageal intubations that resulted in catastrophic outcomes for patients,[17] signs such as observation of thoracic movement, auscultation of the chest, fogging in the endotracheal tube and perception of the tube passing vocal cords were used to "confirm" a practitioner's belief that successful intubation was achieved, instead of seeking the definitive capnography tracing to confirm tube placement.[18]

Different factors contribute to cognitive bias in health care professionals. These factors may be generally categorized into those affecting the health care professional, the patient, and systemic or external factors (Table 2). For example, factors such as cognitive overload, fatigue, and sleep deprivation have been shown to have a deleterious effect on health care professionals, increasing the risk of cognitive bias leading to errors and lapses in patient safety.[19] Furthermore, a variety of irrational factors influence clinical decision-making in anesthesiology, including framing, personal preferences, emotions, feedback, and loss aversion.[20]

Table 2: Factors that may cause cognitive bias in anesthesiology, including those directly attributed to the patient, clinician, or systemic design. These are all potentially affected by external factors such as overconfidence and loss aversion.

CLINICIAN	PATIENT	SYSTEMIC	EXTERNAL
Cognitive load Fatigue Personal Considerations (e.g., emotions	Complex patient Numerous comorbidities Incomplete information	Design of workflow Time considerations Information flow between providers Information technology Environment limitations Poor communication/ collaboration Poor support culture	Overconfidence Framing Personal preferences Emotions Feedback Shift of memory Anchoring Loss aversion

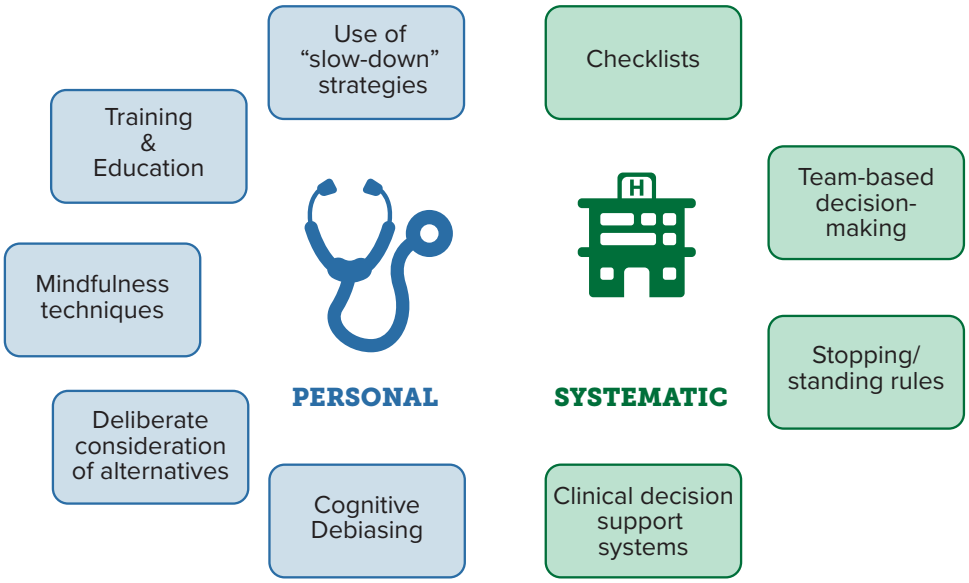


Figure 1: Strategies that may enable medical professionals to combat bias, via prevention, recognition, and active interventions to mitigate their effect in a real-time basis.

REDUCING COGNITIVE BIAS

It is important to reduce diagnostic error attributed to cognitive bias when possible. There are several main categories of effective cognitive interventions: 1) improvement of knowledge and experience via tools such as simulation, feedback, and education, 2) improvement of reasoning and decision-making skills using tools such as reflective practice and metacognitive review, and 3) improvement of assistance in decision-making with aids such as electronic health records and integrated decision support.[21]

It is likely that the most important approach to reducing cognitive bias is promotion of awareness of such confounding factors by medical personnel. Awareness by anesthesia professionals may be achieved by using learning material, scholarly publications, didactics, and simulation.[22] Fixation errors, for example, are a type of error in which focus is placed on one aspect of a situation, while ignoring other, more relevant information.[22] These errors may be caused by anchoring bias, and may be avoided via awareness of such potential errors leading to strategies such as ruling out the worst case scenario, understanding that first assumptions may be wrong, consideration of artifacts as the last explanation of a problem, and avoiding use of a prior conclusion with current team members.[22] Nonetheless, awareness alone is not sufficient to combat bias. Past literature has described a "bias blind spot," a phenomenon in which a person experiences a false sense of invulnerability from bias, which is more common in providers with greater cognitive sophistication.[20]

Strategies that may be employed to reduce cognitive bias can often be categorized into interventions that affect a clinician on a personal basis versus those that are implemented on a systematic or system-wide basis (Figure 1). Individual-level strategies include training and education, mindfulness techniques, and deliberate consideration of alternatives.[23] Systematic strategies include use of checklists, team-based decision-making, and clinical decision support systems, such as integrated prompts in electronic health records.[23] Decision-making checklists, modeled after those used in the aviation industry, reduce the risk of adverse events in the operating room.[22] In a simulated setting, checklists were shown to result in a 6-fold reduction in failure to adhere to critical steps in managing a crisis, even while adjusting for learning or fatigue effects.[23]

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Cognitive Bias (Cont'd)

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Unfortunately, there are limitations with all of these strategies, namely the lack of objective evidence to support several of these methods. Stopping and standing rules, which are constructs designed to determine when information-gathering can stop, have no published evidence to support their utilization. Similarly, the use of "must-not-miss alternatives," where one considers diagnoses that must be considered before making a final diagnosis, are also not supported by published evidence. In addition, there seems to be a separation between the efficacy of such strategies to improve diagnostic acumen and treatment or patient outcomes. For example, despite the implementation of clinical decision support systems, such as those to increase adherence to best practices and reduce medication errors, there is little evidence that they improve clinical diagnosis.[23] This may be due to limited study of their effect on patient outcomes, as many studies of clinical decision support systems focus specifically on metrics to assess if new interventions achieve a desired endpoint, such as prompting the order of a laboratory test or imaging study rather than impact on clinical diagnosis.[24]

COMBATING COGNITIVE BIAS IN ANESTHESIOLOGY

We advocate for a two-step approach to recognizing and combating cognitive bias on a daily basis in the practice of anesthesiology. The first step is education and awareness. It is critically important that anesthesia professionals understand that these biases exist and that they can affect patient care. It's critical to remember that bias often affects medical practitioners in detection of changes in patients, diagnosis of clinical conditions, and treatment of pathologies. Although awareness alone is not enough to combat bias, it is a critical first step to addressing the issue and developing strategies to be cognizant of its impact on patient care and safety.

Next, it is important to combat bias both on a personal level and system-wide, which will often require customized interventions. Solutions are not universal, and must be individualized to different institutions, teams, and situations. For example, the bandwagon effect may be combatted successfully in one institution by intraoperative consultation with one's colleagues. Conversely, in a smaller institution, with limited personnel, diagnostic momentum may be more successfully avoided by using checklists or cognitive aids in collaboration with other perioperative providers. On a departmental and institutional level, the role that cognitive

bias may have played in an adverse event should be considered in each adverse event review. Anesthesia groups should consider the use of simulation for both trainees and practicing clinicians to create educational scenarios to demonstrate cognitive bias in action, and strategies to combat it. Simulation has been shown to be particularly useful in modeling team-based situational awareness and facilitating interdisciplinary communication—both important tools to combating cognitive bias, especially in challenging situations.[25] Although there is not one universal approach that avoids cognitive bias in the practice of perioperative medicine, a combination of vigilance and thoughtful interventions offers a significant opportunity to improve quality of anesthesia services and patient safety.

Anesthesia professionals are susceptible to cognitive biases which can negatively impact patient care and contribute to medical errors. Anesthesiology necessitates a great deal of preparation for emergencies, which tend to occur infrequently, but quickly. It is important not to neglect the mental and systematic preparation required to avoid cognitive bias. Anesthesia professionals should receive training in recognizing and combating cognitive biases. Strategies to combat cognitive biases should be implemented at both individual and institutional levels to improve patient safety.

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REFERENCES

1. Tversky A, Kahneman D. Judgment under uncertainty: heuristics and biases. *Science*. 1974 Sep 27;185(4157):1124-31. doi: 10.1126/science.185.4157.1124. PMID: 17835457
2. Catalogue of Biases Collaboration, Spencer EA, Brassey J. Ascertainment bias. In: Catalogue Of Bias 2017: https://catalogofbias.org/biases/ascertainment-bias/. Accessed December 14, 2022.
3. Fares WH. The 'availability' bias: underappreciated but with major potential implications. *Crit Care*. 2014 Mar 12;18(2):118. doi: 10.1186/cc13763. PMID: 25029621
4. O'Connor N, Clark S. Beware bandwagons! The bandwagon phenomenon in medicine, psychiatry and management. *Australas Psychiatry*. 2019 Dec;27(6):603-606. doi: 10.1177/1039856219848829. Epub 2019 Jun 5. PMID: 31165616
5. Mendel R, Traut-Mattausch E, Jonas E, et al. Confirmation bias: why psychiatrists stick to wrong preliminary diagnoses. *Psychol Med*. 2011 Dec;41(12):2651-9. doi: 10.1017/S0033291711000808. Epub 2011 May 20. PMID: 21733217
6. Gong J, Zhang Y, Yang Z, et al. The framing effect in medical decision-making: a review of the literature. *Psychol Health Med*. 2013;18(6):645-53. Epub 2013 Feb 6. PMID: 23387993
7. Croskerry P. Achieving quality in clinical decision making: cognitive strategies and detection of bias. *Acad Emerg Med*. 2002 Nov;9(11):1184-204. PMID: 12414468
8. Landucci F, Lamperti M. A pandemic of cognitive bias. *Intensive Care Med*. 2021;47:636–637. PMID: 33108517
9. Lechanoine F, Gangi K. COVID-19: pandemic of cognitive biases impacting human behaviors and decision-making of public health policies. *Front Public Health*. 2020;8:613290. PMID: 33330346
10. Croskerry P. The importance of cognitive errors in diagnosis and strategies to minimize them. *Acad Med*. 2003;78:775–80. PMID: 12915363
11. Saposnik G, Redelmeier D, Ruff CC, Tobler PN. Cognitive biases associated with medical decisions: a systematic review. *BMC Med Inform Decis Mak*. 2016;16:138. PMID: 27809908
12. Beldhuis IE, Marapin RS, Jiang YY, et al. Cognitive biases, environmental, patient and personal factors associated with critical care decision making: a scoping review. *J Crit Care*. 2021;64:144–153. PMID: 33906103
13. Fares WH. The 'availability' bias: underappreciated but with major potential implications. *Crit Care*. 2014;18:118. PMID: 25029621
14. Whelehan DF, Conlon KC, Ridgway PF. Medicine and heuristics: cognitive biases and medical decision-making. *Ir J Med Sci*. 2020;189:1477–1484. PMID: 32409947
15. Stiegler MP, Neelankavil JP, Canales C, Dhillon A. Cognitive errors detected in anaesthesiology: a literature review and pilot study. *Br J Anaesth*. 2012;108:229–235. PMID: 22157846
16. Antonacci AC, Dechario SP, Antonacci C, et al. Cognitive bias impact on management of postoperative complications, medical error, and standard of care. *J Surg Res*. 2021;258:47–53. PMID: 32987224
17. Jafferji D, Morris R, Levy N. Reducing the risk of confirmation bias in unrecognised oesophageal intubation. *Br J Anaesth*. 2019; 22:e66-e8. PMID: 30857612
18. Dale W, Hemmerich J, Moliski E, Schwarze ML, Tung A. Effect of specialty and recent experience on perioperative decision-making for abdominal aortic aneurysm repair. *J Am Geriatr Soc*. 2012;60:1889–1894. PMID: 23016733
19. Croskerry P, Singhal G, Mamede S. Cognitive debiasing 1: origins of bias and theory of debiasing. *BMJ Qual Saf*. 2013;22 Suppl 2(Suppl 2):ii58–ii64. PMID: 23882089
20. Stiegler MP, Tung A. Cognitive processes in anesthesiology decision making. *Anesthesiology*. 2014;120:204–217. PMID: 24212195
21. Graber ML, Kissam S, Payne VL, et al. Cognitive interventions to reduce diagnostic error: a narrative review. *BMJ Qual Saf*. 2012;21:535–557. PMID: 22543420

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Cognitive Bias (Cont'd)

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22. Ortega R, Nasrullah K. On reducing fixation errors. *APSF Newsletter.* 2019;33:102–103.
23. Webster CS, Taylor S, Weller JM. Cognitive biases in diagnosis and decision making during anaesthesia and intensive care. *BJA Educ.* 2021;21:420–425. PMID: 34707887
24. Kawamoto K, Houlihan CA, Balas EA, Lobach DF. Improving clinical practice using clinical decision support systems: a systematic review of trials to identify features critical to success. *BMJ.* 2005;330:765–768. PMID: 15767266
25. Rosenman ED, Dixon AJ, Webb JM, et al. A simulation-based approach to measuring team situational awareness in emergency medicine: a multicenter, observational study. *Acad Emerg Med.* 2018;25:196–204. PMID: 28715105

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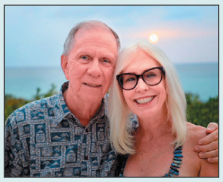
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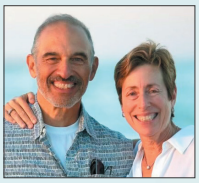
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