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Leading Infinitely in Perioperative Care: an Anesthesia-Led Relational Leadership Model

by Matt Sherrer, MD, MBA, FASA; Juhan Paiste, MD, MBA, CPE; Dan Berkowitz, MB, BCh; and Rick Dutton, MD, MBA

INTRODUCTION

Originally founded in 1994 under the name Cadabra, the company we now know as Amazon completely revolutionized the way we shop. With a staggering market capitalization of $2.4 trillion,[1] Amazon's relentless commitment to innovation is perhaps best embodied in its newest fulfillment facility in Shreveport, LA. Here, a trio of robotic arms with names like Robin, Cardinal, and Sparrow retrieve and package items from Amazon's Sequoia multistory inventory platform, which are then transported to loading docks and loaded onto Rivian electric delivery vehicles by Proteus, Amazon's first fully autonomous mobile robot.[2]

While this relentless pursuit of technological innovation recalls images from our favorite science fiction movies, Amazon was originally a small online bookseller in the garage of founder Jeff Bezos' rental home in Bellevue, WA. Before its explosive expansion, Amazon was intensely and passionately focused on gaining the trust of a single subset of customers: online book enthusiasts.[3] Before *crossing the chasm* from that of a small online bookseller to a global marketplace serving millions of customers, Amazon was unwaveringly and singularly focused on serving its niche market of book enthusiast customers. Anesthesia leaders need to do the same: focus intensely on the relationships we

Sparrow is Amazon's new intelligent robotic system.

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Perioperative Management and Infection Control for Patients with Measles

by Brendan Wanta, MD; Jonathan Charnin, MD, FASA; Randy Loftus, MD; Jonathan Tan, MD, MPH, MBI, FASA; Melanie Hollidge, MD; Desiree Chappell, CRNA; Sara McMannus, RN, BSN, MBA; Aranya Bagchi, MD; Caitlin Bissel; Michelle Beam, DO, MBA, FASA, FACHE; Rich Beers, MD; and Raquel Bartz, MD

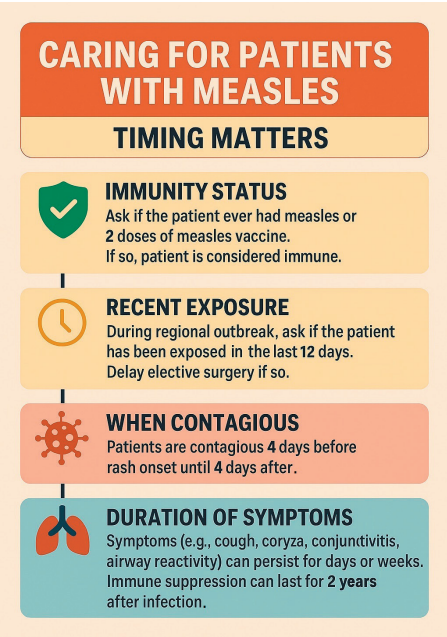

Figure 1: Measles Timing Facts. Created with the assistance of Microsoft Copilot.

Measles, also called rubeola, is a highly contagious viral illness caused by a paramyxovirus from the genus *Morbillivirus*. It is recognized as one of the most transmissible viruses, spreading easily through respiratory droplets, aerosols, or direct contact with bodily secretions. Following exposure, symptoms such as fever, cough, coryza, and conjunctivitis generally develop within 7 to 14 days, with an incubation period typically lasting 11 to 12 days (Figure 1).[1] Although effective vaccines are available, measles has resurged both in the United States and worldwide, largely due to declining vaccination rates and increased travel to regions where the virus remains endemic. In the United States, the Centers for Disease Control (CDC) reports 1753 confirmed measles cases as of November 2025; most of these were associated with 45 outbreaks (clusters of 3 or mores cases). For comparison, 16 outbreaks were reported in 2024.[2]

A review of the clinical features of measles may be helpful in perioperative management (Table 1). Following initial flu-like symptoms, including cough, coryza, and conjunctivitis, patients with measles develop Koplik spots (tiny white spots inside the mouth) (Figure 2) and a maculopapular rash that spreads from the face downward. Individuals are contagious from four days before to four days after rash onset.[3] Complications, such as otitis media, pneumonia, diarrhea, stomatitis, keratoconjunctivitis, encephalitis, and subacute sclerosing panencephalitis (SSPE) can occur—particularly in infants, and in pregnant, immunocompromised, and malnourished individuals.[4] Measles infection can also result in prolonged immune suppression, increasing vulnerability to secondary infections and sepsis for months to years postinfection.[5]

More than just an inconvenience, measles can kill. The mortality rate of measles is as low as 0.1% in high-income countries, but the mortality rate in low- or middle-income countries can reach 1.3%.[6] There are no antiviral treatments for measles. Supportive care can be provided. Hydration and antipyretics are routinely used to

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The *APSF Newsletter* is the official journal of the Anesthesia Patient Safety Foundation. It is widely distributed to a variety of anesthesia professionals, perioperative clinicians, key industry representatives, and risk managers, and is available free of charge in digital format to other interested persons, including members of the public. The content of the *Newsletter* typically focuses on anesthesia related perioperative patient safety issues.

The *Newsletter* is published three times a year (February, June, and October). Deadlines for each issue are as follows:

November 1 for the February issue

March 1 for the June issue, and

July 1 for the October issue

However, authors should feel free to submit manuscript at any time for review.

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Types of Articles

1. Review article (invited or unsolicited)

a. All submissions should focus on perioperative patient safety issues.
b. Articles should be limited to 2,000 words and no nore than 25 freferences.
c. Figures and/or tables are strongly encouraged.

2. Case Reports

a. Case reports should focus on novel perioperative patient safety cases.
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d. Authors should follow the CARE guidelines and the CARE checklist should be provided as an additional file.

3. Letters to the Editor

a. A letter to the editor can either comment on a past article or a current perioperative patient safety issue.
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a. The purpose of this column is to allow expeditious communication of technology-related safety concerns raised by our readers, with input and response from manufacturers and industry representatives.
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Teams Achieve High Performance and Safety by Prioritizing Communication and Trust

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cultivate across the health care system to move beyond our role solely as *perioperative* patient safety experts and onto the application of our skills, wisdom, and experience to the health care team *as a whole*. We previously wrote about "Infinite Anesthesia," but now we need to think infinitely bigger.[4]

CROSSING THE CHASM

In his 1991 book, *Crossing the Chasm: Marketing and Selling High Tech Products to Mainstream Customers*,[5] marketing strategist Geoffrey Moore laid out a strategic framework for businesses aiming to achieve broad-scale adoption of their products. According to Moore, there are distinct and pivotal stages in the technology adoption lifecycle, with each requiring a different playbook to navigate unique challenges and opportunities. At its core, the crossing the chasm framework demands an understanding of and distinction between those customers who want the newest things and those who want complete solutions and convenience. These customers can be represented by a bell-shaped curve (Figure 1), where only the smallest percentage are true tech enthusiasts and innovators, and slightly more are visionaries and early adopters. To gain market penetration, Moore contends that crossing the chasm from early adopters to mainstream customers—the much larger subset of the more pragmatic but swayable early majority—represents a hurdle that many companies fail to cross. However, companies that cross this chasm by winning over early adopters will attain widespread adoption by the more pragmatic crowd of early and late adopters and laggards. Moore calls this cascading wave of rapid and widespread adoption the "tornado," but it is only achieved after focusing on the "lead bowling pin" represented by specific niche markets (deemed "pragmatists in pain") that value and very much need the company's unique offering. Widespread adoption occurs when companies focus intently and unwaveringly on finding and serving these customers first, ignoring skeptics.[5]

The *Infinite Game*[6] author Simon Sinek references the work of Everett Rogers[7] and Frank Bass[8] in discussing "The Law of Diffusion of Innovation," using a similar bell-shaped curve to emphasize that for new ideas or new ways of thinking to stick, innovators should aim for 15–18% market penetration. Crossing this chasm requires an intense initial focus on the 12.5% subset of early adopters. It is only when this subset adopts the idea that the larger segment of the curve represented by the early majority will buy in. Once this tipping point is achieved and the chasm is crossed, new ideas will spread to pragmatists in the late majority and even to the laggards who loudly oppose culture change.[9] Both Moore and Sinek emphasize the need to serve these pivotal early adopters with an emphasis on gaining trust and building relationships.

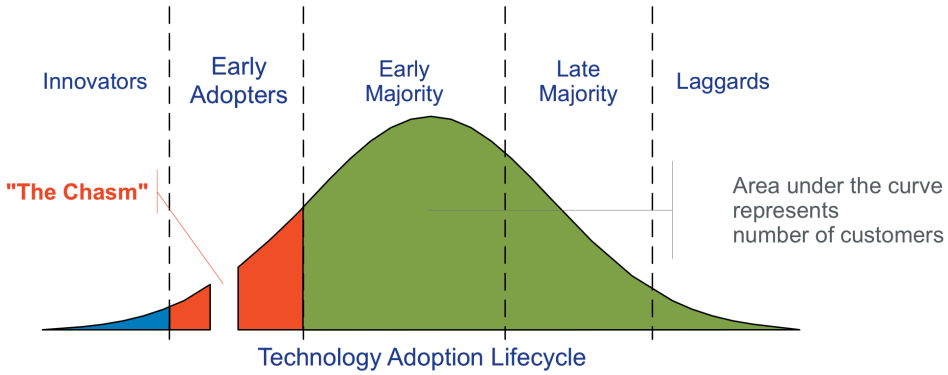

Figure 1: Depiction of the Technology Adoption Lifecycle, adapted from Gregory Moore's Crossing the Chasm. Source: https://commons.wikimedia.org/wiki/File:Technology-Adoption-Lifecycle.png.

TRUSTING RELATIONSHIPS

The topic of trust in the perioperative space has received significant attention. It would be convenient if trust in health care teams had an agreed-upon definition and validated metrics, but this is sadly not the case; a universal definition is hard to find. Further, the Joint Commission attributes up to 70% of serious medical errors to poor communication.[10] Fortunately, the pursuit of a collaborative conflict culture, where team members engage in active listening, open discussion, and demonstrations of mutual respect, has recently been shown to promote civility in health care teams, potentially mitigating the threat of incivility-related patient harm. This focus on multidisciplinary professional relationships encourages productive conflict built upon empathy, humility, and openness to differing opinions.[11] By resisting the urge to focus on in-group preservation and instead emphasizing health care professionals' common bonds in delivering outstanding patient care and our shared fate in the health care system, teams under the overarching umbrella of a collaborative conflict culture achieve high performance and safety by prioritizing civil communication and cultivating trust.[12]

Interestingly, there has been increasing emphasis on the role of relational leadership in health care. Existing issues of constrained resources, decreasing reimbursement, workforce shortages, etc., were only made worse by the COVID-19 pandemic, forcing leaders to work across silos in new and innovative ways. Relational leadership encourages leaders in complex environments to build and sustain collaborative relationships with individuals and groups across health care systems to incorporate multiple perspectives into decision-making. This focus on long-term organizational health vs. the short-term bottom line is key to sustaining and building resilient organizations.[13] Authors have previously argued that anesthesia leaders make outstanding health system leaders because our jobs intrinsically demand clear communication, consensus-building, and collaboration, and our clinical work encompasses every kind of patient and procedure.[14] Further, when it comes to patient safety, no other specialty can approach the near six sigma level of safety that "team anesthesia" has created.[4] Stated differently, no one in health care does "team" like "team anesthesia." While most health care workers know their specific niche, no other group of specialists spans the gamut of specialty touchpoints like anesthesia professionals. Breadth of knowledge and diverse experiences are often key to successful leadership, especially in complex and unpredictable environments,[15] allowing anesthesia leaders to cultivate trusting relationships across health care systems in a way that few other leaders can. We would argue that it is these trusting relationships that allow anesthesia leaders to identify other "pragmatists in pain"—*or early adopters*—across our health systems. Furthermore, the cultivation of these trusting relationships allows us to lead effectively in areas we have previously never considered. By reenvisioning anesthesiology's role from volume-based perioperative professional to orchestrator of value across the care continuum, we can better serve our colleagues and health systems, delivering measurable improvements in patient experience, safety, and efficiency.

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Anesthesia Leaders Can Help Unlock Operational, Financial, and Clinical Gains Across the Health System

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THE PATH FORWARD: LEAD INFINITELY

We recently suggested that anesthesia care teams should embrace an infinite mindset to navigate the complexities and challenges of the perioperative space.[4] A pillar of Sinek's infinite game mindset is building trusting teams in pursuit of a just cause. We suggested a new approach to perioperative care entitled "Infinite Anesthesia" with a stated just cause of creating "a mutually supportive workspace that maximizes patient care with every encounter—in a way that appreciates every team member."[4] The Infinite Anesthesia culture of "trust and teamwork" encourages all anesthesia professionals to see one another as respected fellow players in the infinite game of perioperative patient care, rather than rivals, highlighted by intentional and respectful interprofessional dialogue, learning, and team building.[4]

Our experience over the past year and a half shows us that, while the proposed just cause is indeed inclusive and idealistic, it is not inclusive or idealistic *enough*. Since the concept of "Infinite Anesthesia" was proposed, hospitals across the country have reached out for information and consultation. The model has even been applied to current anesthesia practices internationally, specifically in the United Kingdom, where an infinite game approach of a tiered system with levels of care based on surgical risk and clinical training has been suggested to decrease surgical wait lists.[16] In our own institution, we put our theories into practice with a workshop series entitled "LEAD INFINITELY."[17] Beginning with anesthetists, anesthesiologists, and perioperative nursing and now extending to proceduralists and surgeons, our workshop series based on the infinite mindset approach has reach over 300 perioperative clinicians this year alone. With sessions on collective intelligence and teaming, humility, civility, discovery driven planning, and the infinite game mindset (Table 1), this workshop series has grown steadily at our institution and is now gaining traction in other hospitals across the country. Given that workplace engagement has been shown to promote employee retention,[18] the goal of this series is to bring front-line care teams together to educate on leadership and teamwork principles while also strengthening bonds and building respectful and trusting professional relationships. Teams attend this workshop series *together*, as group discussion and planning are incorporated into every session. Teams graduate from this series equipped with a strategic plan to optimize the patient care their teams deliver by forging trusting and respectful professional relationships to enhance team communication and performance.[17]

Further education related to this approach is now being requested by surgical subspecialties, medical proceduralists such as cardiologists and gastroenterologists, obstetricians and neonatologists, as well as hospital medicine physicians. To meet this demand, single-day workshops incorporating any and/or all of the original five topics are now offered to departments across the institution and customized to the needs of local leadership. Further, school of medicine faculty affairs leaders are now promoting this series to all faculty in both the clinical and research domains and incorporating it into the onboarding process for new hires. Finally, research is now underway to elucidate participants' perceptions of the course and its impact on daily practice and culture. Initial feedback has included comments that the material is "engaging, relevant, and helpful" and that the message is one that "many need to hear."[17]

While the original "Infinite Anesthesia"[4] call was to include all anesthesia care team members, we now suggest this concept should include ALL health care teams. Infinite leadership has the potential to catalyze transformation far beyond the confines of the perioperative space. While the original call was idealistic, we now argue that it was not big and bold enough. Anesthesia leaders see the inner workings of the health care system like few others can. We do teams as well as anyone in health care. We should therefore, LEAD in health care like no other group can. Our respectful, trusting, and inclusive care team approach is relevant across all health care settings, and our relationships give us the access and credibility to spread our message FAR beyond the perioperative space. We know where the pain points to operational efficiency lie, and we know the key early adopters we need to target to cross the chasm and broadly spread our patient safety efforts.

"Infinite *Anesthesia*"[4] is too small a concept. We need to think bigger and more boldly. We invite our surgical and medical colleagues and health system partners to join the "Lead Infinitely"[17] movement, not as passive stakeholders but as active co-leaders. By embracing infinite leadership, anesthesia leaders can help unlock operational, financial, and clinical gains across the health system. The "Lead Infinitely"[17] movement is not ours to own, but ours to share. This movement is not about protecting turf but about building up new leaders across the health care system, regardless of specialty, to deliver and diffuse the just cause of mutually supportive workspaces that maximize patient care while appreciating every team member. The opportunity is big—and the need is urgent. We encourage our anesthesia colleagues in hospital systems across the country and the globe to LEAD INFINITELY,[17] both in anesthesia and beyond.

Table 1: Lead Infinitely Workshop Series.

Leading Collectively	Teaming, collective intelligence, and the mutual learning mindset
Leading with Humility	Finding balance between professional will and personal humility
Leading with Civility	The price of incivility and benefits of civility in health care teams
Leading with Discovery	Managing change through the concepts of discovery driven planning, and "idea flow"
Leading Infinitely	Pursuing a just cause, building trusting teams, studying worthy rivals, preparing for existential flexibility, and demonstrating the courage to lead

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Matthew Sherrer, Juhan Paiste, and Dan E. Berkowitz report no conflicts of interest. Richard P. Dutton is a shareholder in US Anesthesia Partners.

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Mutually Supportive Workplaces Maximize Patient Care

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Clinicians Should Wear Full Protective Gear to Care for Measles Patients Even if Fully Immunized

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manage fever and prevent dehydration, while carefully monitoring for secondary bacterial infections, such as pneumonia or otitis media. Vitamin A is recommended, especially for children who might be deficient, to reduce ocular complications of measles.[7]

For much of human history, immunity to measles was only available to those who survived the infection. Reports of symptoms consistent with measles infection date back to antiquity, with well-documented outbreaks recorded as early as the 1700s.[8] Before the introduction of measles vaccines in 1963, nearly everyone was exposed to the virus at some point in their lives. Individuals who survive measles usually develop lifelong immunity; however, sustained protective antibody levels may require occasional re-exposure to the virus. Receiving two doses of the measles vaccine generally provides lifelong immunity, though some people, particularly as they age, may not maintain adequate antibody levels. Anesthesia professionals are generally considered immune to measles either through prior infection or completion of the recommended vaccination series.[9]

To reduce illness and complications, many industrialized countries have implemented mandatory measles vaccination policies. Maintaining high vaccination rates can effectively halt the endemic spread of the virus.[6] The United States declared measles eliminated in 2000.[7] However, travelers returning from areas where measles remains endemic continue to reintroduce the virus, resulting in new outbreaks.

ANESTHETIC CONSIDERATIONS

If a patient needs to undergo surgery during an active measles infection, anesthesia professionals need to remain alert for airway challenges and respiratory difficulties. There are few reports of specific problems during anesthesia for a measles patient, which may be because because precautions were appropriately taken.

When planning to anesthetize a patient with measles, one needs to consider the safety of the operating room team and other patients. Measles is highly contagious and both contact and airborne precautions are recommended with N95 or powered air purifying respirator, eye protection, gown, gloves, and hat (Figure 3).[10] Although anesthesia professionals are considered immune, full personal protective gear is recommended, as immunized health care workers who have not used full protective equipment have developed measles.[11]

Disinfecting an area where a patient with active measles has been treated is important to

Table 1: Summary of Considerations for Perioperative Measles.

Consideration	Key Points
Epidemiology	Sporadic cases and outbreaks of measles are increasing in the U.S.
Transmission & Risk	Measles is highly contagious and spreads via secretions, droplets, and aerosols, which can linger in the air for hours. High risk for anesthesia professionals caring for infected patients.
Reporting Requirements	Many governments require immediate reporting of suspected or confirmed measles cases, regardless of day or hour.
Infectious Period	Measles is transmissible from 4 days before to 4 days after rash onset. Complications (e.g., pneumonia) may last longer and increase perioperative risk.
Elective Procedures	Defer elective procedures until after the infectious period and symptom resolution.
Urgent/Emergent Procedures	May proceed with caution; anticipate airway difficulties (mucosal swelling) and implement strict infection control measures.
Prevention & Post-Exposure Actions	Measles vaccine is effective. Postexposure prophylaxis with vaccine or immune globulin is also effective.

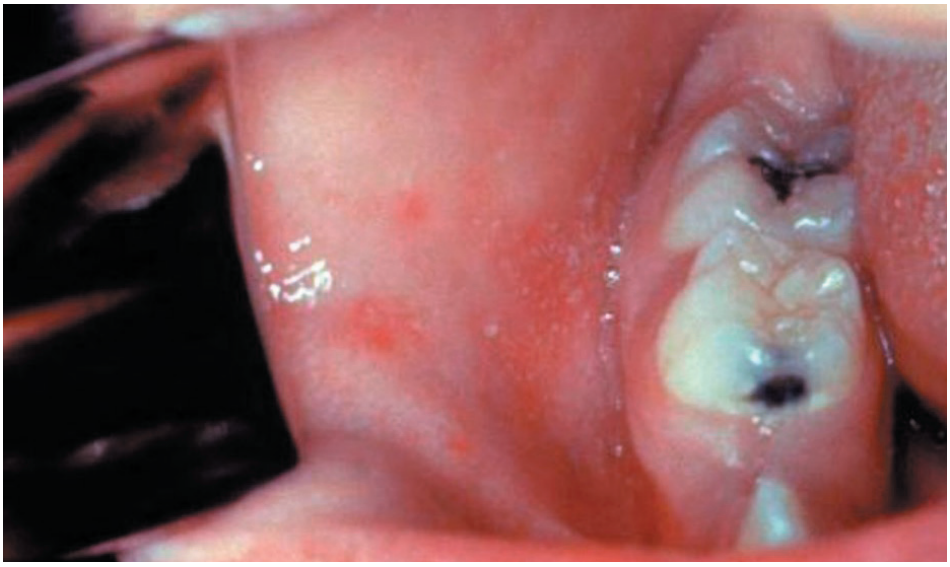

Figure 2: "Koplik spots" are irregular, bright red spots with bluish-white centers that appear on the cheeks and tongue mucosa indicating measles onset.
(Public Domain image; accessed from CDC on 11/19/2025 http://phil.cdc.gov/PHIL_Images/20040908/4f54ee8f0e5f49f58aaa30c1bc6413ba/6111_lores.jpg)

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Immune Globulin Should Be Administered Within 6 Days of Measles Exposure

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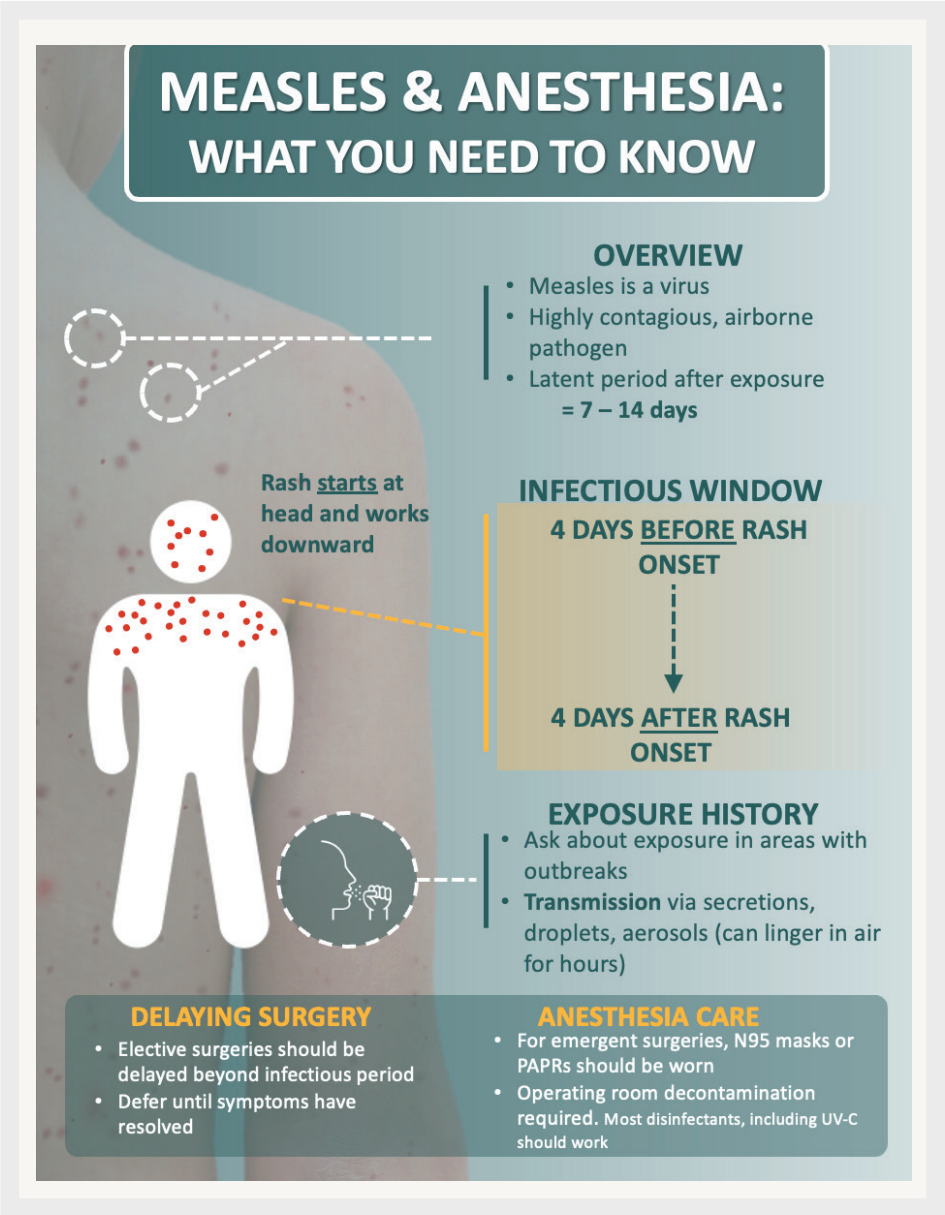

Figure 3: Important Perioperative Considerations for Measles. Created with the assistance of Microsoft Copilot.

prevent further transmission of the virus. There are no published guidelines for operating room disinfection after a patient who is contagious for measles has received surgical care. Since measles is an enveloped virus, alcohol, chlorine, hydrogen peroxide, and ammonium-based cleaners are all considered effective for decontamination (nonenveloped viruses are more challenging to decontaminate). Heat or ultraviolet light treatments may also be effective.[12]

Although there are no antiviral treatments for measles, if a team member is exposed to measles but has uncertain immunity, there are preventative options. Because measles has an incubation time of several days, it is possible to utilize postexposure prophylaxis. Postexposure vaccination and post-exposure antibody administration are both effective at preventing or mitigating subsequent infection. It is recommended that unvaccinated or undervaccinated persons should receive the measles vaccine within 72 hours after exposure. For those with contraindications to the vaccine—such as immunocompromised individuals, pregnant persons, or infants younger than 6 months—human immune globulin is recommended within 6 days after exposure.[13]

Due to the difficulty of preventing the spread of measles, elective surgery should be postponed until the patient with measles has recovered and is no longer infectious, which is defined as at least four days after rash onset. This reduces the risk of transmission within health care settings and allows time for the wide range of acute complications to resolve.[14]

Emergency procedures can be conducted for patients with current or recent measles. The team should enforce strict contact and airborne precautions with N95 masks and, if possible, a negative-pressure room before surgery and during recovery should be utilized. It is best to limit staff to those confirmed immune if possible. The anesthesia plan should anticipate airway challenges including the potential for swollen and friable airway tissues. Preoperative assessment must include screening for measles complications and verifying the immunity of operating room staff. Postexposure prophylaxis (measles vaccine or immune globulin, depending on risk factors and timing) should be considered for exposed, nonimmune contacts.[12]

The period of immune suppression that follows measles infection is also a consideration. After recovering from measles there remains an increased risk of secondary infections and delayed wound healing.[4] While there is no universally agreed-upon timeframe for deferral beyond the infectious period, increased monitoring may be necessary for several weeks to months following infection, particularly in high-risk individuals.

In summary, effective management of measles exposure in surgical settings requires a comprehensive approach that prioritizes infection identification, timely postexposure prophylaxis, and an understanding of the disease's impact on perioperative care (Table 1). While supportive treatment remains the cornerstone for measles, careful consideration of patient immune status and appropriate surgical timing are crucial to minimizing complications and transmission risks. Continued vigilance, up-to-date protocols, and enhanced staff awareness will help safeguard both patients and health care professionals, ultimately supporting optimal outcomes in the perioperative environment.

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Negative Pressure Rooms Should be Used Before and After Surgery

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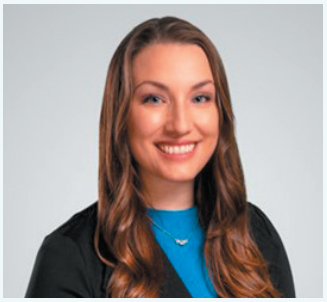

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Cannabis and Anesthesia: A 2025 Update on Perioperative Considerations

by Dylan Irvine, DO; Tricia Meyer, PharmD, MS; Imani Thornton, MD FASA; and Jeffrey Huang, MD, MS, FASA

In recent years, adult cannabis use in the United States has increased appreciably with the concurrent expansion of state legalization. As of mid-2025, medical cannabis is authorized in 40 states as well as the District of Columbia and several U.S. territories, and recreational adult use is legal in 24 states and the District of Columbia.[1] Given the rising prevalence of cannabis consumption, anesthesia professionals must remain cognizant of the systemic effects of cannabis in the perioperative setting. Current evidence suggests that cannabis use may alter anesthetic drug requirements, and may influence cardiovascular physiology and postoperative pain responses.[2-5] Comprehensive preoperative screening and individualized anesthetic management are, therefore, warranted in patients who use cannabis. In 2023, we released an article that discussed the perioperative considerations of cannabis use on anesthesia administration.[6] Given the abundance of new research and information available on this topic, an update is necessary.

PHARMACOLOGICAL CONSIDERATIONS

The most commonly known botanical cannabinoids are the phytocannabinoids tetrahydrocannabinol (THC) and cannabidiol (CBD).[7,8] THC is the principal psychoactive compound found in the Cannabis sativa plant *(C. sativa)*. CBD is also an active cannabinoid; however, it is not mind-altering. While there are other species of the cannabis plant, *C. sativa* is typically one of the most commonly occurring subspecies.[7-9] The plant itself has a complex pharmacology with numerous other cannabinoids and phytocannabinoids, although not all have been thoroughly studied to determine how they interact within the body and other pharmacological properties.[7-10]

Cannabinoids bind to specific receptors in the body known as cannabinoid receptors. There are two receptors: cannabinoid receptor type 1 (CB_1) and type 2 (CB_2). The receptors are part of the endocannabinoid system (ECS) and located throughout the body and brain.[8,11,12] The ECS plays a role in regulating learning and memory, emotional processing, sleep, temperature control, pain control, inflammatory and immune responses, and appetite.[12,13] CB_1 is involved with the nervous system, motor function, memory, analgesia and others. The CB_2 receptors have a role in anti-inflammatory and pro-inflammatory reactions.[8,11,12] Endogenous endocannabinoid stimulation of CB_1 receptors does not cause the level of euphoria normally seen with THC/marijuana.[12-15] Additionally, there is a rapid breakdown of endocannabinoids by enzymes. Some researchers postulate that the blissful and well-being feeling some individuals have when running (runner's high) may result from the release of endocannabinoids rather than from endorphins.[13]

Phytocannabinoids have been shown to be partial agonists, full agonists, or antagonists, at the cannabinoid receptors.[11,15] Down regulation of CB receptors can potentially occur with THC, acting as a partial agonist, and can facilitate tolerance and decreased effects.[14-18] Therapeutic actions of THC and CBD include analgesic, antiemetic, anti-inflammatory, antiseizure, and neuroprotective effects. The method of cannabis use is an important determinant of its effects and plasma levels. Inhaling or smoking cannabis will result in THC being detectable in the plasma within seconds of inhalation. Following a 5–7-minute smoking episode with the equivalent of 10–15 mg of THC, the peak plasma levels will be 100 µg/L. After use of the drug, metabolites will appear in the urine and feces as glucuronide conjugates. Some metabolites can be found in the urine for up to 2 weeks.[14,15,19,20]

Individuals with acute intoxication from THC and/or THC/CBD extracts may have increased disinhibition, impaired memory, and other impairments in learning, attention, attentional bias, and psychomotor function.[21] Adverse effects of cannabinoids can range from mild to severe depending on the concentration, route of administration, and prior exposure to the drugs. The effects may involve euphoria, anxiolysis, tachycardia, sensory amplification, postural hypotension, conjunctivitis, hunger, and dry throat, mouth, and eyes. Serious symptoms can include panic attacks, myoclonus, psychosis, hyperemesis, hypertension, tremors, seizures, inhalation burns, hallucinations, unconsciousness, acute respiratory distress syndrome, and bronchospasm.[11,14,15] Some adverse reactions can have ongoing or long-term effects even after discontinuing the substance.[15,16,19,20]

Although THC has less metabolic drug-drug interaction potential than CBD, it does have more pharmacodynamic potential for interactions. There is a paucity of studies on actual drug interactions with THC and many of the considerations are theoretical based on the

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known actions of THC in the body. THC has wide pharmacological action, which can increase the likelihood of drug-drug interactions (DDI). These interactions can involve absorption, metabolism, excretion, or pharmacodynamic effects. The action of THC can be intensified or dampened by some prescription drugs. Additionally, some drugs may have their pharmacological action (including side effects) affected by THC.[14,15] For example, numerous prescription medications can produce adverse drug reactions when used with cannabinoids. The most common drugs to cause serious DDIs with cannabis/cannabinoids are warfarin, valproate, tacrolimus, and sirolimus. Adverse events such as bleeding, altered mental status, higher anesthetic requirement, and gastrointestinal distress have been reported.[21] There is a free online tool (www.CANN-DIR.psu.edu) to help clinicians determine possible cannabinoid DDI with common prescription medications.[22]

CYP inhibitors may also increase the bioavailability of THC and therefore increase either desired or unwanted effects. Conversely, CYP inducers may decrease the effects of THC (Table 1).

Table 1: Medications that May Alter the Bioavailability of THC.[14,15]

CYP3A4 Inhibitors	CYP2C9 Inhibitors
• Protease Inhibitors • Ketoconazole • Nefazodone • Amiodarone • Verapamil • Cimetidine • Imatinib • Tamoxifen	• Luvoxamine • Fluoxetine • Proton Pump Inhibitors • Ketoconazole • Clopidogrel • Fluconazole • Fluorouracil
CYP3A4 Inducers	**CYP2C9 Inducers**
• Phenytoin • Carbamazepine • Topiramate • Rifampicin • Pioglitazone	• Phenytoin • Carbamazepine • Phenobarbital • Rifampin • St. John's Wort

PREOPERATIVE CONSIDERATIONS

Patients who use cannabis warrant particular preoperative evaluation to ensure safe administration of anesthesia (Table 2). A thorough medical history should document the type and composition of cannabis products, route and frequency of use, usual dose, any adverse reactions, time since last use, whether symptoms emerge if a dose is missed, as well as concomitant use of alcohol, opioids, or sedatives.[10,11,23-25] This information helps identify cardiovascular and respiratory risks, possible withdrawal, delayed gastric emptying from THC, and anesthetic challenges during intoxication.[24,25] Evidence indicates that cannabis use is linked to higher rates of perioperative complications, including cardiopulmonary events and wound-related issues.[10,11] However, currently there are no strong, evidence-based guidelines on how long prior to surgery patients should discontinue using cannabis products.

Acute cannabis intoxication represents the most significant anesthetic risk and can precipitate emergence agitation or hemodynamic instability.[24,25] Patients demonstrating symptoms such as anxiety, paranoia, or psychosis should have elective procedures postponed until they are clinically sober. Cannabis use shortly before surgery may transiently increase myocardial infarction risk, particularly in patients with coronary disease. In these cases, elective procedures should be delayed and may warrant further workup for symptomatic or high-risk individuals.[24-27] Preoperative counseling should address temporary cessation of cannabis, document use in the medical record, and consider implications for postoperative analgesic management.

INTRAOPERATIVE CONSIDERATIONS

Evidence guiding intraoperative anesthetic management for patients who use cannabis is limited. Recent studies suggest chronic cannabis exposure can alter anesthetic drug requirements. Regular cannabis users can require higher doses of propofol for induction or procedural sedation.[27,28] Anesthesia professionals should carefully titrate medications and monitor for exaggerated cardiovascular or airway responses.

Increased requirements for intravenous anesthetics, particularly propofol, among cannabis users during general anesthesia and sedation have been demonstrated in two meta-analyses—one including 8 studies with 2,268 patients,[27] and another encompassing 11 studies with 4,199 patients.[28] Similarly, increased requirements for inhalational anesthetic agents among cannabis users have been reported in two retrospective studies.[29,30] Consistent with these findings, recent observational reviews suggest that cannabis users may require higher doses of both intravenous and volatile anesthetic agents.[31,32] Moreover, a recent prospective study reported that marijuana users required significantly higher doses of sedative agents, including fentanyl, midazolam, and propofol.[33]

Given the inhibitory effects of cannabinoids on cytochrome P450 enzymes and possible interactions with sympathomimetics or beta-blockers, anesthesia professionals should exercise caution when administering vasoactive agents in cannabis users.[34] Intraoperative vigilance is necessary for detecting hemodynamic instability, myocardial ischemia, or cerebrovascular events. Moreover, patients who inhale cannabis may exhibit airway hyperreactivity, which can increase the risk of bronchospasm or exaggerated airway responses.

Although the evidence remains preliminary, anesthetic management plans for cannabis users should anticipate the possibility of increased medication requirements, and the need to titrate dosing carefully to effect and to maintain heightened monitoring for cardiovascular or airway complications. Additional high-quality studies are needed to confirm these associations and guide formal clinical recommendations.

POSTOPERATIVE CONSIDERATIONS

In the postoperative period, cannabis use has been linked to higher postoperative opioid consumption and increased pain scores compared with nonusers. In a large multicenter

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Cannabis Use Associated with Higher Postoperative Pain Scores

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cohort study, cannabis users demonstrated an increase in postoperative opioid consumption (95% CI 1.22–1.38), along with a mean increase of 0.57 points in time-weighted average pain scores, compared to nonusers.[35] These findings underscore the importance of multimodal analgesia strategies in this population.[36]

Withdrawal is another important consideration for patients who frequently use cannabis. Withdrawal onset typically occurs within 1 to 2 days after last use and can persist for 1 to 2 weeks, with symptoms such as irritability, sleep disturbances, nausea, and anxiety.[6,37] Historically, postoperative hypothermia and shivering have been observed among cannabis users, likely mediated by CB_1 receptor activity rather than withdrawal effects.[6,37]

CONCLUSION

The expansion of medical and recreational cannabis use has created challenges for perioperative care. Emerging evidence from the past year highlights the influence that cannabis use may have on anesthetic requirements, such as higher doses of hypnotic and volatile agents. Cannabis can also alter pharmacokinetics through cytochrome P450 interactions, which may contribute to an increase in postoperative analgesic needs. Preoperative evaluation should screen for cannabis use and assess cardiovascular, respiratory, and withdrawal risks. Intraoperative management requires individualized dosing, vigilant monitoring, and preparation for possible hemodynamic or airway complications. Postoperatively, clinicians must anticipate elevated analgesic requirements and should monitor for withdrawal symptoms. As cannabis use continues to rise and new research is conducted, anesthesia professionals must stay informed of new data to optimize perioperative safety and patient care.

Table 2: Summary of Perioperative Anesthetic Considerations for Cannabis Users.

Considerations	Recommendations	References
Preoperative		
Solicit history of cannabis use	• Document type of products, route and frequency, dose, time of last use, presence of withdrawal symptoms • Ask about concomitant use with other products, and if any adverse reactions have occurred	10, 11, 23, 24, 25
Be aware of acute intoxication	• Can precipitate emergence agitation or hemodynamic instability • May present as anxiety, paranoia • Elective procedures should be postponed until patient is clinically sober, especially in those with coronary disease/cardiac history	3, 24, 25, 26
Intraoperative		
Higher anesthetic requirement	• Regular use may increase propofol dose required for induction and procedure sedation • May require higher doses of IV and volatile agents to achieve adequate anesthetic depth	27, 28, 29, 30, 31, 32, 33
Possible drug-drug interactions	• Drug- drug interactions may occur and either blunt or potentiate the effects of cannabis, particularly with sympathomimetics/vasoactive agents, and CYP inducers/inhibitors	14, 15, 21, 34
Cardiopulmonary complications	• Monitor for cardiopulmonary complications and be prepared to intervene • Increased risk of airway reactivity and bronchospasm	6, 23, 37
Postoperative		
Analgesic requirements and pain scores	• Heightened postoperative pain scores and opioid consumption may be seen in cannabis users • Multimodal analgesia strategies, nonopioid adjuncts	35, 36
Monitor for signs of withdrawal	• Typically occurs 1–2 days after last use • Can present as irritability, nausea, anxiety	6, 37

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Cannabis Users Require Increased Intravenous Anesthetics

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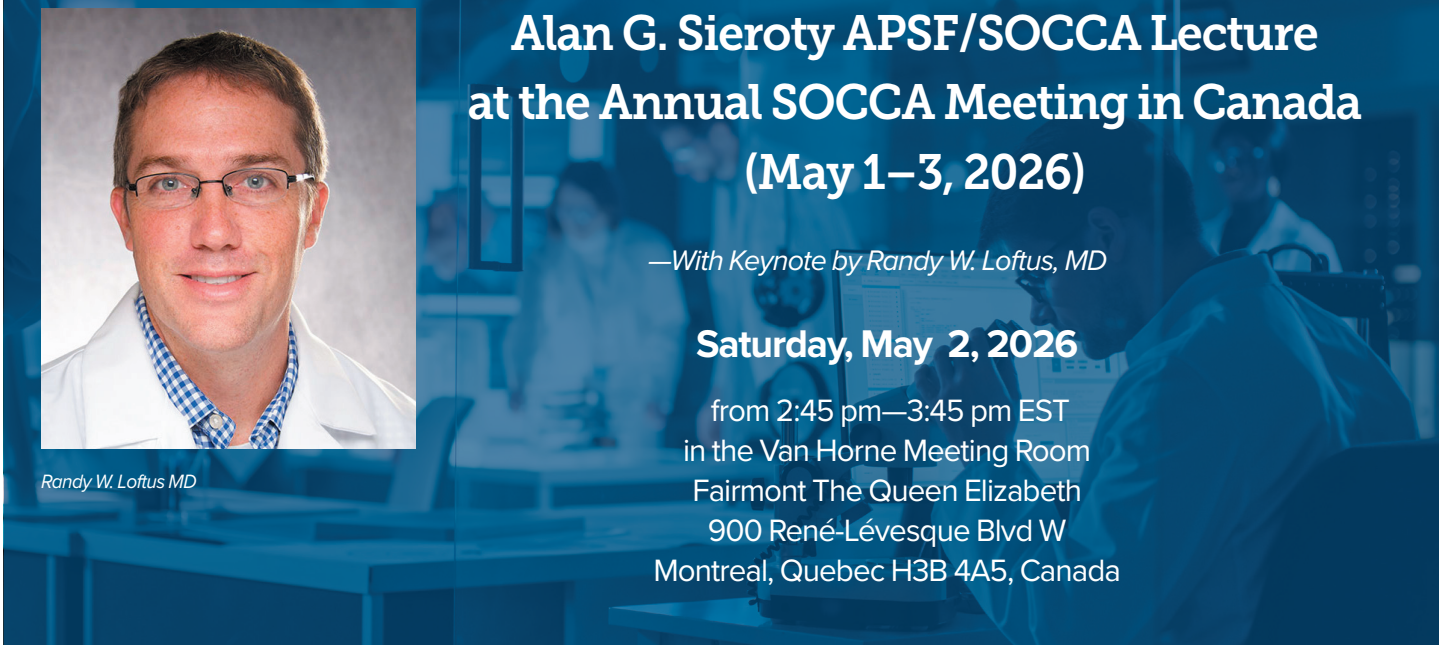

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RAPID Response
to questions from readers

Moisture, Mold, and More in GE Operating Room Ventilators: System Response and Mitigation

by Sandeep Narayan, MD, and Katie Passaretti, MD

Dear Rapid Response:

In the same week, two GE HealthCare Aisys CS^2 anesthesia workstations (GE HealthCare, Madison WI) in a single facility within Advocate Health, a 69-hospital health care system across 6 states, were found to have black particles on the EZChange module (Figure 1) of the Advanced Breathing System (ABS), raising concern for mold growth (Figure 2). The EZChange module supports continued ventilation of the patient while the CO_2 absorbent canister is exchanged.[1] The mold-like particles were initially identified during investigations into a failed daily checkout and a flow sensor failure alarm event. A multidisciplinary team including anesthesia professionals, infection prevention, technicians, administration, and clinical engineering was convened to investigate further across the health care system.

Inspection of 300 GE HealthCare Operating Room (OR) anesthesia workstations found 21 units (7%), including Aisys CS^2 and Avance CS^2 models, with potential mold. Multiple additional workstations showed significant moisture accumulation within the internal components of the ventilators. Cultures were taken of the mold-like substance from 3 ventilators, two of which grew *Cladosporium spp.* and the other *Alterneria*. One hundred eighty-eight additional GE HealthCare anesthesia workstations in non-OR areas were evaluated and did not demonstrate evidence for moisture or mold. Outreach to peers in other health care systems revealed similar reports of mold growth in GE HealthCare anesthesia workstations, and one health system reported mold reappearance as soon as 18 days after sterilization. We decided to implement moisture and mold checks every 1–2 weeks in our system to identify any mold regrowth. Another health system which had implemented all moisture mitigation solutions reported no mold growth in GE HealthCare anesthesia workstations. This information guided our discussions with GE HealthCare.

A literature review and assessment of patient risk was immediately performed when the findings were reported. Prior research on

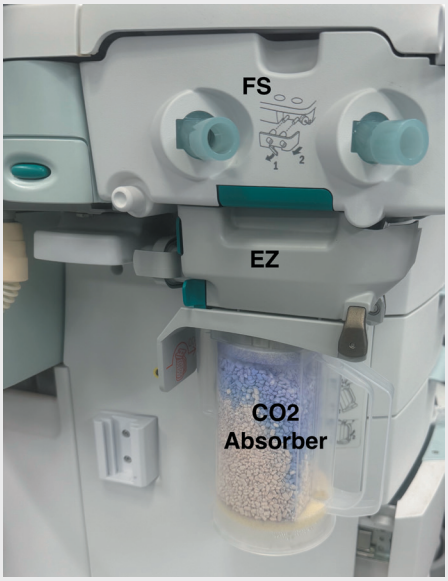

Figure 1: Depiction of the flow sensor unit (FS), EZChange module (EZ) and CO_2 absorber in GE Ventilators. The circuit has been removed in this picture.

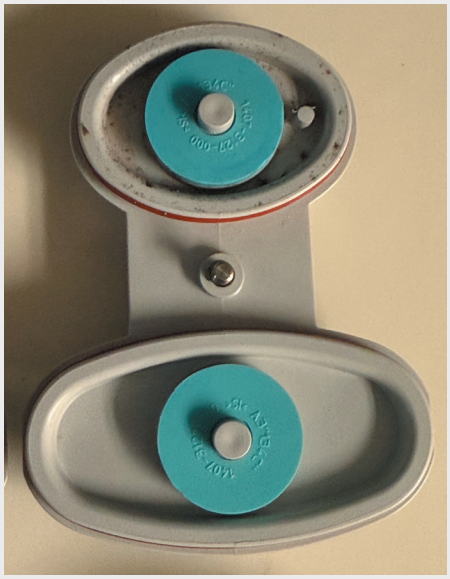

Figure 2: Black particles concerning for mold around the valve in the EZChange module where moisture-containing gas leaves the absorbent canister.

ventilator contamination and patient risk is limited. APSF has previously reported that infectious risk from contaminated anesthesia ventilators is low. This is due in part to the caustic nature of the CO_2 absorbent, which is hostile to pathogens, and also to the effectiveness of filters in the breathing circuit.[2] Fungal and bacterial growth in anesthesia breathing circuits has been documented; however, these findings were largely attributed to ineffective reprocessing methods and introduction of organisms during air drying.[3] No correlation between organisms in the circuits and patients who developed postoperative pneumonia have been found, and there was no difference in contamination between high and low fresh gas flow rates.[4]

Evaluation of anesthesia practices revealed that all Advocate Health sites routinely use a new heat and moisture exchange filter (HMEF) with each case and replace it intraoperatively if it becomes saturated or visibly contaminated. HMEF, a high efficiency viral filter with 99.99% efficiency, effectively filters fungal organisms, which are significantly larger than viral particles.[2] We reviewed six months of patient respiratory cultures from 19 facilities within our system, focusing on non-*Aspergillus* mold growth. Some of these sites used GE HealthCare anesthesia workstations, while others used workstations from other vendors. Regardless of the type of workstation used at the site, non-*Aspergillus* mold species were rarely identified in patient's respiratory cultures. Additionally, no association was found between patients with mold in respiratory cultures and the presence of a recent operative procedure. Based on our internal practice review and review of the literature, risk to patients was deemed minimal. Nevertheless, all anesthesia workstations with concern for mold growth were taken out of service immediately for sterilization per the manufacturer's instructions for use.[5]

GE HealthCare was notified of the findings and provided support through virtual and in-person site visits and emails to help determine

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RAPID Response
to questions from readers

Moisture Can Accummulate in the Anesthesia Breathing Circuit

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root causes and mitigation strategies to prevent future occurrences. Since moisture accumulation in the EZChange module was deemed to be a root cause for mold growth, guidance was provided on sterilization and moisture mitigation solutions. GE HealthCare provided a contact person for each region within our system to address ongoing concerns for mold growth in anesthesia workstations. We initially encountered variable communication on ideal moisture mitigation strategies. Specifically, there were different messages about the priorities for proposed solutions and the impact of filters in the breathing circuit. Other health systems reported lack of clarity from GE on remediation of moisture and mold.

Moisture can accumulate in the anesthesia breathing circuit from two sources—the patient and the reaction of absorbent with exhaled CO_2. Exhaled gas contains 100% humidity, and the absorbent reaction generates heat and water. When an HMEF is placed at the y-piece, a significant amount of exhaled moisture is absorbed and prevented from entering the breathing circuit. The amount of moisture created by the absorbent reaction is highly dependent upon fresh gas flow. When fresh gas flow exceeds minute ventilation, exhaled gas is not rebreathed and there is little to no CO_2 reacting with the absorbent. As fresh gas flow is reduced below minute ventilation, the amount of exhaled gas returning to the patient increases and therefore more CO_2 reacts with the absorbent creating moisture in the circuit. Our investigation found that even at a fresh gas flow of 2 L/min, there is enough rebreathing to allow moisture to accumulate in the circuit. Ambient temperature also plays a role in moisture accumulation with colder temperatures causing moisture to condense in the circuit. Moisture mitigation was therefore a key focus of prevention especially given our desire to practice low-flow anesthesia.

INVESTIGATION FINDINGS

- Most end-users lacked awareness that moisture accumulation could be an issue in anesthesia workstations.
- While a few sites within our system had implemented some moisture mitigation practices, most were unaware of optional moisture mitigation steps that can be employed such as:
  - Add-on condenser for drainage of excess moisture
  - Removal of the breathing circuit overnight
  - Removal of the flow sensor overnight
- Although lower fresh gas flow rates are associated with increased rebreathing, and, therefore, moisture accumulation,[6-8] mold and moisture were found in ventilators regardless of whether sites routinely practiced low-flow ventilation as part of sustainability efforts.

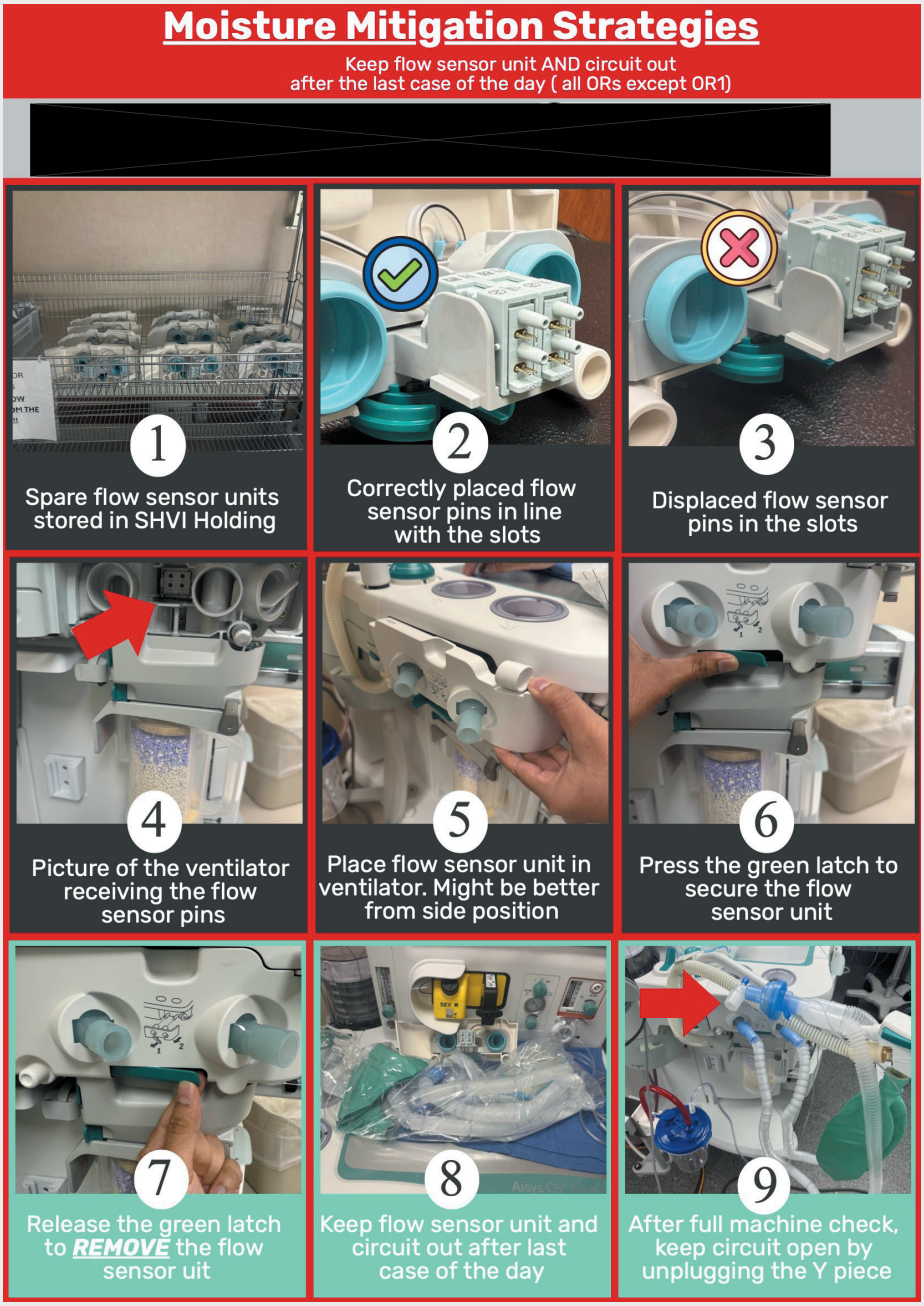

Figure 3: Educational flyer on moisture mitigation for anesthesia professionals and technicians.

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RAPID Response
to questions from readers

Anesthesia Machines Should Be Assessed for Moisture and Mold

From "Moisture and Mold," Preceding Page

- Excess moisture accumulation was more common in workstations exposed to higher case volumes and longer surgical durations.
- There are no specific guidelines from manufacturers on sterilization frequency, and facilities lacked a standardized process or adequate training for sterilizing the ABS.

PRACTICE CHANGES IMPLEMENTED IN THE SYSTEM

1. Extensive anesthesia professional and technician education was provided through grand rounds, emails, and virtual and in-person meetings. Anesthesia professionals were specifically educated on weekly mold and moisture checks and daily moisture mitigation steps, which included removing the breathing circuit and flow sensors overnight (Figures 3 and 4).
2. Flow sensor and ABS inventory were performed at all practice locations and, where needed, additional components to support moisture mitigation and sterilization were purchased to minimize the risk of interrupting patient care due to moisture and mold.
3. Sites with GE HealthCare anesthesia workstations were instructed on how to inspect the ABS for moisture or mold every 1–2 weeks to monitor for regrowth and confirm mitigation effectiveness (Figure 4).
   a. Non-OR areas with shorter case durations, less ventilator utilization, and no initial moisture or mold issues were not required to perform ongoing assessments.
   b. Assessments were discontinued once the individual site had no units with moisture or mold for two audit cycles.
4. Despite routine removal of flow sensors and breathing circuits overnight, higher surgical volume sites continued to identify moisture within the ABS, albeit at a lower frequency.
5. Add-on condenser elements for all OR anesthesia workstations are being purchased from GE HealthCare. This additional step was deemed necessary due to continued moisture accumulation despite a change in practice and the likely increase in complex and longer surgical cases.
6. A multidisciplinary team established an internal procedure and assigned responsibility for monitoring moisture accumulation, assembly/disassembly of ventilators, and sterilization.
7. Annual sterilization of all OR ventilators was also implemented as part of our annual preventative maintenance.
8. GE HealthCare hosted live webinars and developed video-based training for sterile processing and clinical engineering teams on assembly, disassembly, and sterilization of the ventilators

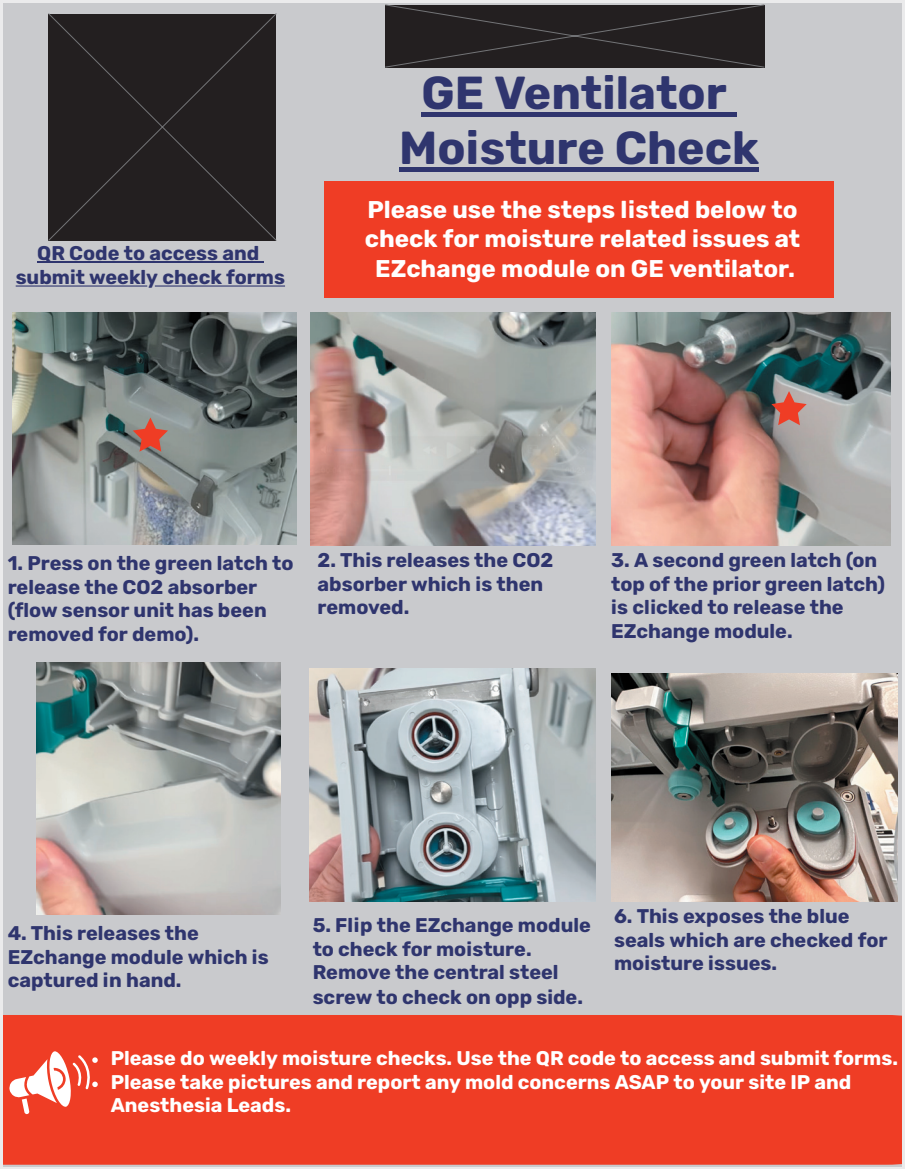

Figure 4: 1–2 weekly Moisture and Mold check flyer.

CONCLUSION

In our multistate health care system, we found GE HealthCare anesthesia workstations to accumulate moisture leading to mold growth, especially in sites that have not implemented moisture mitigation practices deemed optional by the manufacturer. Unless excessive moisture results in alarms potentially triggering manual evaluation, there is no externally visible way to see mold has grown, nor any internal trigger to alert biologic growth within our work-

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RAPID Response
to questions from readers

Anesthesia Professionals Should be Educated about the Risk of Moisture Accumulation

From "Moisture and Mold," Preceding Page

stations. While our assessment revealed minimal infectious risk to patients given the routine use of HMEF filters between the patient and ventilator components, sites should assess their risk based on local practices. It is important to note that this moisture accumulation could impact flow sensors, reducing the accuracy of tidal volume measurements.

Education of anesthesia professionals using GE anesthesia workstations on the potential for and impact of moisture accumulation, in addition to the need to implement moisture mitigation solutions, is needed. While lower fresh gas flow rates increase rebreathing and the potential for moisture retention, increasing fresh gas flow to eliminate rebreathing and moisture production is not a useful strategy. Fresh gas flows required to eliminate rebreathing must exceed minute ventilation creating substantial anesthetic gas waste, increased expense, and a negative impact on the environment.[7] A practice of low-flow anesthesia can be done safely and effectively once strategies for moisture mitigation are employed.

Sterilization of OR anesthesia workstations is a complex and coordinated effort that needs education and involvement of multiple teams. It is essential to balance and weigh the need for sterilization against the workload and impact on the internal components from sterilization and disassembly and reassembly of the ABS units.

QUESTIONS TO GE HEALTHCARE

1. While newer models of GE anesthesia workstations are designed with a built-in condenser, GE HealthCare designates the condenser as an optional product for older models. We have continued to see mold growth despite implementing two moisture mitigation solutions that included removing the flow sensor and circuits overnight. Based on our experience that moisture accumulated despite daily moisture mitigation practices, we believe the condenser is a necessary moisture mitigation solution for all compatible older models and not an optional product.
2. During discussions with other health systems using GE workstations, some sites reported implementing all moisture mitigation solutions while others were not aware of moisture mitigation solutions and their importance. Could GE HealthCare share what initiatives have been undertaken or are being planned to ensure a comprehensive and consistent moisture mitigation education for all clinical sites in the country?

QUESTIONS TO APSF

1. Please educate on the need for multiple filter use for each patient. Is it necessary to have both HMEF and expiratory filters for all patients? If a site decides to use just one filter, which filter is the preferred filter for adult and pediatric populations?
2. Please educate on the need for moisture mitigation when using non-GE HealthCare ventilator brands.
3. Is there any evidence or guidance on moisture levels that are safe within ventilators and breathing circuits?
4. Please provide guidance on OR ventilator sterilization frequency. Should this be a part of yearly preventative maintenance?

Sandeep Narayan, MD, is an anesthesiologist with Scope Anesthesia of North Carolia, PLLC and is an adjunct assistant professor at Wake Forest University School of Medicine.

Katie Passaretti, MD, is the chief infection prevention officer for Advocate Health and is a professor of internal medicine in the Section of Infectious Disease at Wake Forest University School of Medicine.

The authors report no conflicts of interest.

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RAPID Response
to questions from readers

Moisture and Mold: APSF Response

Moisture and Mold in the Anesthesia Workstation

by Jeffrey Feldman, MD, MSE, FASA

Editor's Note: We are pleased to be able to publish the Rapid Response report from Drs. Narayan and Passaretti on their investigation and management of moisture and mold in the anesthesia workstation, along with the accompanying guidance from the manufacturer, GE HealthCare. The report raised several questions for APSF. Here are the responses to those questions:

Question 1:

Please educate on the need for multiple filter use for each patient—is it necessary to have both HME filters and expiratory filters for all patients? If a site decides to use just one filter, which filter is the preferred filter for adult and pediatric populations?

Answer: The short answer is that APSF recommends a pleated filter be located between the expiratory limb and the breathing circuit. A high-quality filter in that location should prevent respiratory pathogens (bacteria, viruses, and molds) from entering the anesthesia machine. It is not uncommon to place another pleated filter between the machine and the inspiratory limb as a safety against pathogens from the machine getting to the patient, but there is little evidence to suggest this is a significant patient safety concern. Heat and moisture exchange devices placed at the airway often include filters effective for bacteria and viral pathogens although they are not as effective as the pleated filters. The sampling tube for sidestream gas analysis can also bring pathogens into the machine, which can be prevented by using an HME filter at the airway. Many sidestream devices also have internal filters—check with the manufacturer to confirm. APSF has two resources that were published during the COVID-19 pandemic that provide additional details which are germane to this discussion.

- FAQ on Anesthesia Machine Use, Protection, and Decontamination During the COVID-19 Pandemic
- HEPA Filters. Do We Really Know Enough?—Breathing System Filters in the Era of COVID-19

Question 2:

Please educate on the need for moisture mitigation when using non-GE HealthCare ventilator brands.

Answer: The authors are correct to observe that anesthesia machines from different manufacturers vary in the approach to moisture mitigation. Water traps and heating elements in the breathing circuit are commonly used. There are too many anesthesia machines in use to provide a detailed explanation for every machine. Manufacturers are a reliable source of information on how to approach moisture mitigation in a specific machine. The clinical impact of moisture in the circuit depends upon both anesthesia machine design and clinical practices. Reducing fresh gas flow consistent with a low-flow anesthesia practice can be done safely with attention to moisture mitigation but will increase the amount of moisture in the circuit. Clinicians are advised to understand the best practices for moisture mitigation based upon clinical practice and the specific devices they use.

Question 3:

Is there any evidence or guidance on moisture levels that are safe within ventilators and breathing circuits?

Answer: I am not aware of specific moisture levels that are considered safe. Moisture is desirable in the breathing circuit if it prevents drying of secretions and the respiratory mucosa, but it becomes unsafe when moisture interferes with sensor measurements or results in growth of pathogens. Heat and moisture exchange filters are a useful barrier for keeping the lungs moist and reducing the amount of moisture entering the machine. They will not, however, reduce the moisture created by carbon dioxide absorption.

Question 4:

Please provide guidance on OR ventilator sterilization frequency. Should this be a part of yearly preventative maintenance?

Answer: After discussing this question with the Emergency Care Research Institute (ECRI) and anesthesia machine manufacturers, we could not identify a rationale for recommending a specific interval for OR ventilator sterilization. While the manufacturers provide specific guidance to sterilize the breathing circuits, it is a time-consuming process, which introduces cost and complexity to practice. In reality, the anesthesia breathing circuit is never a sterile component and is always exposed to organisms and contaminants in the environment. Reasonable indications for sterilization would include visible internal contamination of the circuit or perhaps after caring for a patient with a pathogen known to be transmitted through the respiratory system, e.g., tuberculosis.

Jeffrey Feldman, MD, MSE, FASA, is professor of clinical anesthesiology (retired) at Perelman School of Medicine and Children's Hospital of Philadelphia. He is also the chair of the APSF Committee on Technology.

Dr Feldman has compensated consulting relationships with Micropore Inc., Blink Device Company, Draeger Medical, and GE HealthCare.

RAPID Response
to questions from readers

GE HealthCare Response to APSF Submission on Moisture and Mold in GE HealthCare Anesthesia Workstations

by Robert Myers and John Beard, MD

DEAR RAPID RESPONSE:

GE HealthCare appreciates the opportunity to respond to the submission titled "OR Ventilators—Moisture, Mold, and More in GE Operating Room Ventilators: System Response and Mitigation" authored by Drs. Sandeep Narayan, MD, and Katie Passaretti, MD. We commend Advocate Health for this thorough investigation and commitment to patient safety.

We have reviewed the Advocate Health report on moisture accumulation and mold growth in GE HealthCare anesthesia workstations, specifically the Aisys CS^2 and Avance CS^2 models. Moisture accumulation is an inherent characteristic of all modern anesthesia rebreathing systems. Moisture originates from two primary sources: patient exhalation, which is saturated with water vapor, and the chemical reaction of CO_2 absorption, which produces heat and water. These factors are not unique to GE HealthCare systems. If not proactively addressed through moisture management and reprocessing, moisture can lead to microbial growth, particularly in warm environments.

GE HealthCare anesthesia machines include features and recommended equipment maintenance instructions to effectively manage foreseeable moisture accumulation.

DESIGN AND MOISTURE MANAGEMENT FEATURES

GE HealthCare anesthesia machines are designed with breathing systems to support low-flow anesthesia and are verified to operate in environments with 100% humidity. To manage moisture accumulation, several optional components are available, including:

- Condensers to collect and drain excess moisture.
- Heat and Moisture Exchange (HME) filters to reduce moisture entering the breathing circuit.

These components are described as optional in our User's Reference Manuals[1,2] (URMs), as their use is dependent on clinical practice and institutional protocols. The newest models of GE HealthCare anesthesia machines include a condenser within the CO_2 absorbent canister, which eliminates the need for an additional condenser component.

MAINTENANCE, REPROCESSING, AND STERILIZATION PRACTICES

GE HealthCare URMs state that anesthesia breathing systems are not sterile and require routine maintenance and reprocessing. Disconnection of the breathing circuit and air drying of the breathing system are two commonly employed maintenance strategies. While we do not mandate a fixed reprocessing frequency, we recommend that institutions follow local infection prevention policies and clinical usage patterns. We recommend the use of inspiratory and expiratory bacterial/viral filters to reduce contamination risk and provide guidance on cleaning and sterilization in our URMs,[3] as well as on our website.[4] Additionally, we offer training resources, including on-site training, webinars, and instructional videos, to support proper maintenance and sterilization procedures.

MOISTURE ACCUMULATION AND MICROBIAL GROWTH

We appreciate the authors' investigation, which identified mold in anesthesia workstations and noted regrowth in some cases after reprocessing. We also admire the epidemiologic investigation, which did not identify these mold species in patient specimens in the health system. The identification of *Cladosporium spp.* and *Alternaria* is consistent with environmental fungi, which may be found in the hospital environment. We agree with the authors' conclusion that patient risk is minimal, especially with the use of bacterial/viral filters. GE HealthCare is aware of no adverse events reported with this issue and supports continued vigilance and routine inspection of workstations, particularly in OR settings where low-flows and long-duration anesthetics are common, creating the conditions for moisture accumulation.

COMMUNICATION AND EDUCATION

GE HealthCare thanks the authors for feedback on our communication and education deployment across their sites. GE HealthCare is working to optimize the effectiveness of our customer support to ensure the most effective utilization of our equipment. We are expanding our educational outreach to emphasize the moisture mitigation strategies referenced above as technology supporting low-flow practice, such as End-tidal Control*, becomes more widely implemented.

IMPACT ON VENTILATOR PERFORMANCE

Moisture accumulation is not expected to impact ventilator performance. In rare cases, moisture in sensing lines could affect flow sensor performance and tidal volume measurement. To mitigate this impact, our systems are equipped with cross-checks and alarms (e.g., "Calibrate, dry, or replace flow sensors") to alert users to potential issues. Importantly, PAW (airway pressure) measurements remain unaffected due to the location of the measurement port. Furthermore, machine design places flow sensors in an elevated position to be free from moisture in the gas pathway.

RESPONSE TO SPECIFIC QUESTIONS

- Optional condenser: GE HealthCare offers condensers as optional accessories for Aisys CS^2 and Avance CS^2 models. As moisture accumulation is dependent on clinical practice, the condenser is not required by all customers—it is offered as an optional accessory if additional moisture management is needed.
- Education Initiatives: GE HealthCare is continually enhancing its training programs and documentation to ensure consistent understanding of moisture mitigation strategies across all customer sites.

See "Ventilator Moisture," Next Page

RAPID Response
to questions from readers

Moisture Accumulation Does Not Impact Ventilator Performance

From "Ventilator Moisture," Preceding Page

- Inspiratory/Expiratory Filters and Moisture: These filters are primarily designed to prevent microbial contamination, not to manage moisture. HME filters are more effective for moisture control.

CONCLUSION

GE HealthCare is grateful to participate in this discussion of moisture accumulation in anesthetic breathing systems. We value the collaboration with Advocate Health and APSF to identify and address issues proactively while expanding knowledge to the medical community. We encourage all users to consult our URMs and reach out to our support teams for guidance on best practices for moisture management and workstation maintenance.

Sincerely,

Robert Meyers, principal mechanical engineer of GE Healthcare.

John Beard, MD, chief medical officer, patient care solutions of GE Healthcare.

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** End-tidal Control in the United States is indicated for patients 18 years of age and older.*

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Allison Bechtel, MD
APSF Podcast Director

Pain During Cesarean Delivery—Improving Patient Safety by Bringing the Patients and Anesthesia Professionals into the Conversation

by Heather C. Nixon, MD; Rachel Waldinger, MD, MPH; and Nakia Hunter, MD

Pain during cesarean delivery (PDCD) has long been an underrecognized and undertreated aspect of obstetric anesthesia care that negatively impacts women's experiences of birth. Although decades of medical research have sought to determine the optimal neuraxial techniques, ideal medication combinations, risk factors for failed spinal anesthesia, and risks for failed labor epidural conversion to surgical anesthesia, we have missed how inadequately addressed pain during cesarean delivery is a patient safety issue and has real and sometimes devastating consequences. Research now demonstrates that birth trauma, including PDCD, may lead to real short- and long-term psychological damage. Post-traumatic stress disorder (PTSD) may develop following physical or emotionally traumatic births. Other long-term consequences include postpartum depression, poor infant bonding, poor breast feeding, intimate partner relational dissatisfaction, and overall negative feelings about birth for new mothers.[1-3] It is only by listening to patients, learning from their experiences, and encouraging clinician conversations that we can begin to address the problem.

THE SCOPE OF THE PROBLEM

The concept of inadequate surgical anesthesia for cesarean delivery is not new. In existing literature, the incidences of failed spinal, epidural, or neuraxial anesthesia vary widely depending on the variables used to define the term. For example, some studies capture the incidence of failed neuraxial anesthesia by measuring the rate of intraoperative conversion to general anesthesia or the need for neuraxial replacement, while others have more inclusive criteria including the administration of intravenous pain medications. Depending on the definitions used, the rates of neuraxial anesthesia failure range from 1% to 24%, with epidural anesthesia (especially conversion of labor analgesic catheters) having a higher failure rate than spinal anesthesia or combined spinal epidural anesthesia.[4-6] However, these studies may underreport the incidence of PDCD as they rely on surrogate markers of pain. We have failed to capture PDCD that is not recognized by the anesthesia professional or is undertreated.

Little published data exists regarding patient-reported PDCD. A recently published systematic review and meta-analysis identified 34 publications for review that included patient-reported pain.[7] Although there was significant variability in how the studies collected patient pain assessments, the overall pooled incidence of PDCD was 17% (spinal anesthesia 14% and labor epidural catheter conversion 33%). These results indicate that between 1 in 7 and 1 in 3 parturients undergoing cesarean delivery with neuraxial anesthesia will experience pain. This makes PDCD the most common anesthetic complication experienced by patients who have a cesarean delivery.

"THE RETRIEVALS"—LESSONS LEARNED FROM PATIENTS TO IMPROVE SAFETY

In July 2025, *The New York Times* and Serial Productions released its second season of the podcast "The Retrievals" by Susan Burton. This season focused completely on the problem of pain during cesarean delivery and its impact on patients by telling the stories of two patients, Clara and Susanna, and their consequential experiences with undertreated PDCD. In addition, the podcast shared anesthesia professional experiences and honest conversations about why PDCD happens.[8] The podcast gave a voice to patients' experiences of cesarean deliveries as well as to anesthesia professionals' frustrations with this difficult challenge.

The patient and clinician stories are woven together to highlight why PDCD has been an accepted outcome and how bias, culture, fear, and poor communication promote the problem of PDCD. Here are some safety lessons we can learn from their stories and emerging literature on this important patient safety issue.

BIAS

Gender discrepancies in pain treatment are prevalent in health care with studies indicating women's pain is less likely to be treated than men's and more likely to be attributed to anxiety or emotional distress.[9,10] This bias may ultimately lead to undertreated pain and the dismissal of distress.

This may be a common phenomenon. Two recent studies have highlighted that both anesthesia and obstetric professionals may misattribute a parturient's reaction to pain as a manifestation of anxiety.[11,12] Clinicians in these studies could not reliably recognize a patient's experience of pain by observation alone, and this resulted in patients with pain not receiving pain medications and the overuse of anxiolytics.

Another bias we must confront in obstetric anesthesiology is clinician confidence that neuraxial blocks will reliably provide adequate pain relief during cesarean delivery. In Episode 2 of the podcast, Susanna discussed this very failure by her anesthetist and how it affected her: "I was lying on my back, looking up into the face of someone who was convinced that the block would be working. He was the expert, the person with authority." This

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Pain During Cesarean Delivery Can Impact a Patient's Birth Experience

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is a common theme among women who report intraoperative pain. Analysis of litigation claims related to PDCD clearly show that in 33% of claims the plaintiff indicated their anesthesia professional did not acknowledge or believe their pain, failed to accept the block was inadequate, or failed to offer general anesthesia in a timely manner.[13]

CULTURE

The safe culture emphasizes collaborative team practice to optimize patient outcomes. However, health care remains a hierarchical system in many settings. In the operating room, the anesthesia professional is responsible for the anesthetic management of the patient, and the the team often defers to their expertise. Patient safety, however, is everyone's responsibility and safe systems encourage all clinicians to feel secure in respectfully challenging a clinical decision and expressing concerns.[14,15]

Culture may also extend into a unit's shared expectations or language. The word "pressure" is often used by anesthesia professionals to describe the sensations a patient may feel during a cesarean delivery. However, the misuse or overuse of this word can be very harmful to patients as it may inadvertently rename a sensation that is painful to patients as something more innocuous. This word demonstrates how the culture of accepting patient pain and renaming it with the word "pressure" is possible.

FEAR OF COMPLICATIONS

In pregnancy, it has long been taught that neuraxial anesthesia is safer and more desirable than general anesthesia for cesarean delivery. This fear of complications is grounded in the historical context of concerns for maternal aspiration, failed airway with hypoxic injury, awareness under general anesthesia, increased postpartum hemorrhage, worse fetal outcomes, and poorer postoperative pain control.[16,17] It is unsurprising that both obstetric and anesthesia professionals are fearful of general anesthesia. However, these are extremely rare complications given current practice and need to be balanced with the extremely common complication of PDCD and its mental health sequelae.[17,18] We need to confront this dogma with current data to allow for better decision-making.

COMMUNICATION

In "The Retrievals" Podcast, Susanna repeatedly notes how communication with her anesthesia professionals during her delivery and in the postpartum course negatively impacted her. The first miscommunication she notes is regarding testing her spinal block. She recalls she was not sure how to answer certain questions, and she felt pressured to give the right response despite feeling unsure. During her cesarean delivery, she noted she was embarrassed that she needed to ask to stop the surgery, and she believed she was experiencing more pain than was expected of her. While she was in pain, she remembers her anesthesia professional offering her general anesthesia, but Susanna noted the discussion was not framed in a way that presented general anesthesia as an appropriate choice; she had the impression that "she was expected to cope." During her postpartum recovery care, Susanna attempted to express her emotional distress from her experience; however, her clinician dismissed her concerns by highlighting that she had a healthy baby and "that's all that really matters." Susanna's voice should be a strong reminder that words matter. How we frame patient choices and how we validate experiences affect how patients are psychologically supported and may impact shared decision-making.

The concept of shared decision-making is an ethical framework that recognizes a patient's personal priorities and values can and should impact their care. Communication that focuses solely on the fetal outcome may negatively impact shared decision-making and limit a full and unbiased presentation of treatment options. True shared decision-making may be hindered if a clinician wrongly assumed a patient would want to be awake for their cesarean delivery, would refuse supplemental medication that may impact their child or affect their memory, or would choose to prioritize their fetus over their own emotional well-being. Communication with subtle bias does not allow for an honest exchange of information or the expression of personal autonomy.

SOLUTIONS

Currently, no evidence-based or definitive guidelines exist regarding how to recognize or appropriately treat intraoperative pain during cesarean delivery. Several organizations, including the American Society of Anesthesiologists and the Obstetric Anesthetist Association (OAA), have published statements and guidelines to help anesthesia professionals navigate pain during cesarean delivery.[19,20] Several other publications provide an organized approach to decrease PDCD and psychological harm for patients.[21-23]

It is time to start finding better ways to listen to our patients to get firsthand accounts of how health care professional biases and failures in communications lead to long-term consequences in patients' mental health. We need to talk about this topic more freely, learn from our experiences and prioritize maternal mental health as well as medical health. Fear of complications does influence clinician decision-making, and misconceptions and misattributions have led to the widespread cultural normalization of pain during cesarean delivery, and how the medical culture has discouraged fully validating patients' experiences.

Knowledge is power. Sharing these conversations and voices via a wide audience may impart a better understanding of the issues sur-

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rounding PDCD and add urgency to solving the problems. We may not be able to prevent all pain from occurring, but going forward, we can change the recognition, experience, and treatment of pain to improve the childbirth experience for millions of patients.

WHAT CAN WE LEARN FROM THE PATIENT AND CLINICIAN VOICES?

- Clinicians who care for obstetric patients must confront personal and systemic biases that impede the recognition and management of intraoperative pain.
- Tools are needed to foster communication between patients and anesthesia professionals about the high risk of PDCD, the treatments available, and the risks associated with treatment.
- Techniques should be in place to reliably test neuraxial blocks prior to beginning surgery.
- Identify PDCD via objective criteria (such as intraoperative pain scores), and escalate care via shared decision-making.
- When patient pain is identified, the entire delivery team should prioritize treatment by stopping the surgery (if possible), optimizing neuraxial anesthesia, utilizing adjuncts, allowing time for treatment, and possibly converting to general anesthesia based on the clinical situation and patient preferences.
- Systems should be in place to safely perform general anesthesia during cesarean deliveries including the availability of video laryngoscopes, supraglottic airway devices, and trained staff who can assist anesthesiology professionals with intubation. Trained newborn resuscitation teams should be available. Evidence-based protocols to minimize maternal complications like postpartum hemorrhage and awareness under anesthesia should be in place.
- Patients should be encouraged to speak up about their concerns, questions, fears, and past experiences. Anesthesia professionals should encourage those conversations.

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Reduce Burnout, Improve Safety and Efficiency: Consider Prosocial Behavior

by Jeffrey Feldman, MD, MSE, FASA; Ramona Houmanfar, PhD; Mary Fearon, RN, MSN; John M. Flynn, MD; Jeffrey B. Cooper, PhD;, Stuart Libman, MD; Caoimhe Duffy MD MSc CPPS FCAI; Lisa Spruce, DNP, RN, CNOR, CNS-CP, EBP-C, APRN, FAAN; and Della Lin, MS, MD, FASA

PROSOCIALITY: ANY BEHAVIOR ORIENTED TOWARD THE WELFARE OF OTHERS OR ONE'S GROUP AS A WHOLE

More than ever, perioperative services must use time and human resources efficiently. Demand for health care services continues to grow while staffing shortages are stressing an already vulnerable system. Burnout rates are high and increasing, putting more pressure on those who remain, leading to more burnout. These challenges can limit the ability to provide services and make it difficult to achieve and sustain efficiency and patient safety targets. New approaches are needed to foster a stable engaged workforce and mitigate ongoing quality and safety problems.[1] There is evidence from sectors other than health care that "prosocial" behaviors among people who work together lead to effective teamwork and greater satisfaction for everyone.[2] We describe the essence of prosocial behaviors and how these behaviors can be fostered to enhance team collaboration in procedural care. Our goal is to raise awareness of the need for cultural change to address ongoing workforce and efficiency challenges. To begin, here is an example of behaviors you may recognize in a typical operating room and will likely agree are counterproductive to not only providing safe, effective, and efficient care but also to simply having a nice day.

A surgeon has scheduled three procedures during an 8-hour block of surgical time. Two are robotic prostatectomies and one just a "short" cystoscopy case. The nursing team consists of an experienced circulating nurse and a relatively new scrub technician. The anesthesiologist is responsible for managing two operating rooms along with a CRNA in each room. The CRNA assigned to the robotic cases is an experienced traveling CRNA working for four weeks in the facility. The first patient was identified to have a difficult airway in the preoperative review the day before the procedure.

The surgeon arrives in the morning 20 minutes before the scheduled start time and tells the circulating nurse that they have to start and finish the day "on time" so she can get to a meeting with the chair of surgery. The nurse responds he has been asked to stay late all week for long cases and cannot stay late today. In addition, the same nurse is instructing the scrub tech on preparing and managing the robot and asks the anesthesia team not to bring the patient to the room until they are ready. The anesthesiologist tells the team he will be starting his other room first to reduce the time pressure when caring for the patient with the difficult airway. The patient is brought to the room almost 10 minutes after the scheduled start time and the surgeon asks why the case is starting "late." The surgeon also questions if the fiberoptic-guided intubation will take extra time. The anesthesiologist and CRNA have not worked together previously, and it takes about 30 minutes for the patient to be anesthetized and intubated. The surgeon comments that the day will never be able to finish on time if the remaining cases take this long to get started.

This vignette illustrates the "production pressure" that is common in procedural areas. Some degree of production pressure can be helpful to keeping the care team focused on working productively together. Counterproductive behaviors fostered by production pressure set the stage for reduced efficiency, staff burnout, decreased staff retention, and avoidable patient harm.[3] The unique needs of each patient require the team of caregivers at the bedside to be empowered to make decisions that support safe and efficient care.

Caring for a patient requiring a procedure is a team sport. In addition to the primary proceduralist/surgeon, the team also includes nurses, technicians, and anesthesia professionals during the procedure and numerous other personnel readying the patient, ordering and preparing instruments and supplies and cleaning the environment. There are examples of procedural areas where the proceduralist/surgeon, nurses, technicians, and anesthesia professionals and other personnel involved in providing care work well as a team. Well-functioning teams are more likely to be present in environments where a group of people work together regularly and develop shared expertise and camaraderie. More typically, especially as health systems have expanded, the team consists of people who may or may not know each other well, nor work together on a regular basis. While these people may have a shared knowledge of the requirements to complete the procedure safely and effectively, it can be challenging for them to coordinate their efforts and collaborate.

ENHANCING PROCEDURAL TEAM PERFORMANCE IS NOT A NEW CONCEPT

There is extensive literature investigating the performance of procedural care teams and interventions for improvement, e.g., briefings, checklists, team training and debriefing, but rigorous studies are lacking.[4,5] One study of patients undergoing spinal fusion for idiopathic scoliosis found a positive correlation between team consistency and heightened efficiency.[6] Other studies have provided evidence that familiarity between the team members enables safer care and team collaboration.[7-9]

Despite the lack of strong evidence, there is general recognition that some interventions can be effective for improving procedural team performance. The Association of Operating Room Nurses (AORN) has published a comprehensive guide of strategies intended to enhance team communication in the operating room.[10] The improvement strategy does not have to be complex; simple interventions may have a positive impact on both teams and patients. For example, the use of a compassionate pause as a moment of reflection for surgical teams at a time-out can be a useful method for enhancing bonds between team members.[11] While it may be advantageous to schedule people to work together frequently, it can be difficult in a larger organization to match the individual needs for work scheduling with procedural block times. The use of temporary or traveling staff further impedes organizational efforts to foster team familiarity.

PROSOCIAL CONCEPTS AND PROCEDURAL PATIENT CARE

We offer for consideration a model not yet applied in perioperative care that could foster more collaborative working relationships and the benefits that would ensue. The model arises from the work of Elinor Ostrom, who was awarded the 2009 Nobel Prize in Economics for her research on group collaboration. Ostrom described a set of Core Design Principles (CDPs) that are common to groups of people who successfully share a common limited

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There Is Extensive Literature Investigating the Performance of Procedural Care Teams

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resource.[12] David Sloan-Wilson generalized the CDPs and applied them to understanding any group where there is a shared common goal (Table 1).[2] These CDPs can be used to analyze how well the team in our vignette is likely to function as a group, and also to identify opportunities for improvement. In this example, both positive and negative behaviors that influence the CDPs are described (Table 2). While there are examples where the group complies with a specific CDP, there are numerous opportunities for improvement.

From the behavioral science perspective, well-being can be analyzed by measuring the coercive control in one's environment specifically, the opportunities for individuals to influence their environment, and access to positive consequences. For example, if we consider the original vignette, we can see the coercive forces on the team members from production pressure and the hierarchical relationships. The individual opportunities to influence the environment are limited for the nurse by the training needs, for the anesthesiologist by the need to care for another patient, for the nurse anesthetist due to a temporary status, and for the surgeon by the need to use block time completely in order to provide timely care to patients. While the group likely seeks access to the same positive consequences of safe and effective care completed in timely fashion, there are many factors that conspire against achieving that goal. When successful, the prosocial approach enhances the well-being of workers and consumers as well as organizational financial goals.[13,14]

Returning to our vignette, we can imagine that beginning the day with verbal recognition by each of the team members of the pressures they feel collectively can foster individual engagement in the team effort. Similarly, preplanning between and among the team members can reduce the impact of production pressure and allow for each individual to exert some influence on how the work will be accomplished.

Defining the CDPs for effective group collaboration provides a validated scientific foundation for prosocial change. Acceptance and Commitment Training (ACT) is useful for realizing such positive change at individual, group, and organizational levels.[15] ACT is a validated methodology for managing burnout and negative behaviors in the service of maintaining healthy, cooperative working environments.[16-18] A useful tool for applying ACT training to both individual and group behaviors is the ACT

Table 1: Core Design Principles for Successful Group Collaboration.

Ostrom Principles	Generalized Prosocial Principles	Adaptive Impact
Clearly defined boundaries	Shared identity and purpose	**A group that works for all:** Defines the group and its culture as purposeful, equitable with a power arrangement appropriate for the mission.
Proportional equivalence of benefits and costs	Equitable distribution of costs and benefits	
Collective choice arrangements	Fair and inclusive decision-making	
Monitoring	Monitoring agreed behaviors (transparency)	**All working for the group:** Ensures effectiveness within groups by utilizing reciprocity, reputation, and trust to balance individual and collective interests.
Graduated sanctions	Graduated response to helpful and unhelpful behaviors	
Conflict resolution and mechanisms	Fast and fair conflict resolution	
Minimal recognition of rights to organize	Authority to self-govern	**Working with other groups:** Ensures effectiveness between groups by balancing interests and supporting shared power.
Polycentric governance	Collaborative relations with other groups	

Ostrom's eight core design principles and generalized versions oriented towards prosocial behavior. (Adapted with permission from Paul Atkins)

Table 2: Core Design Principles Applied to the Problem of OR efficiency.

CDP	Positive Contributor to CDP	Negative Contributor to CDP
Is there shared identity and purpose?	Commitment to the patient's safety and outcome	Shared team identity is questionable Efficiency and safety goals are in conflict
Is there equitable distribution of contributions and benefits?	Shared benefit of employment	Inequalities in the team especially hierarchy and autonomy Surgeon's work extends beyond the procedure
Is there fair and inclusive decision-making?	Morning huddle used for team to review the needs of the day	Procedures planned without input from the rest of the team
Monitoring of agreed behaviors	Efficiency metrics typically tracked	Unacceptable behaviors are not well defined nor consistently monitored
Gradual responding to helpful and unhelpful behavior	Emphasis on psychological safety to empower all personnel.	No accepted standard for responding to behaviors that impede patient care goals
Is there fast and fair conflict resolution?		No formal process for addressing staff conflicts that impede team performance
Authority to self-govern	OR teams typically control the activities of the day without close management of tasks and patient flow	OR team has limited ability to impact system problems that impede performance
Collaborative relations with other groups		Communication between the intra- procedure team and the pre- and post-procedure teams typically not well integrated

Analysis of common procedural team dynamics for compliance with Ostrom's core design principles. Examples of positive and negative contributors to each of the core design principles are provided.

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Teams Should be Trained to Recognize Counterproductive Behaviors

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Matrix.[15] As an analytical tool, the ACT Matrix becomes a procedure for analyzing the environment and understanding behaviors that move away from or towards desired goals. Essential to that process is training individuals to notice when their behavior is counterproductive and develop the psychological flexibility to adopt productive behaviors.

We can apply the ACT matrix to the group highlighted in our vignette to describe the current state and define a more desirable future state (Figure 1).

POTENTIAL FOR PROSOCIAL CHANGE IN THE OPERATING ROOM

Changing established cultures requires engaging the people involved to recognize the limitations of existing culture and the potential value of making a change. The current shortage of staff leading to the burnout syndrome in health care can be a motivating change. In addition, efficiency goals continue to increase as more people require care and organizations struggle to remain profitable. Teaming has been promoted as an active process, essential to the success of every organization where groups of people need to work together to meet targets for success.[19]

The potential value of prosocial change is to create a culture that fosters highly functional teams that maximize efficiency AND derive job satisfaction from collegial relationships and collectively achieving shared goals. While this type of culture is clearly desirable and has been applied successfully in many venues, the process required to achieve such change in procedural areas in health care is unclear. It's worth our time and effort to try new methods for reducing burnout, increasing job satisfaction, and providing safe, efficient care.

THE FUTURE STATE

Changing the established periprocedural culture will be challenging, but we can imagine how embedded prosocial behaviors might alter the perioperative vignette. As before, the scenario is an 8-hour block where three cases have been scheduled- two robotic prostatectomies and a cystoscopy.

The day prior to the OR day, all professionals to be involved with the cases are scheduled and notified. The surgeon sends a group text acknowledging that the schedule is ambitious and indicates that she will be available at the start of the day to help the team manage the day. Nursing leadership ensures that the circulator and scrub tech have an opportunity to discuss the setup for the next day in advance. The anesthesia team reviews the patient together and plans to manage a fiberoptic-guided intubation. The anesthesiologist communicates with the team in his other room with the goal of minimizing any delay to the start of the robotic cases.

On the morning of the procedure, the team huddles 20 minutes prior to the anticipated start of the case. At that point, the patient has been evaluated in the preop area by both the surgeon and anesthesiologist. The circulator is instructing the new scrub tech on preparing a robotic procedure, reinforcing the discussion from the prior day. The nurse anesthetist brings the

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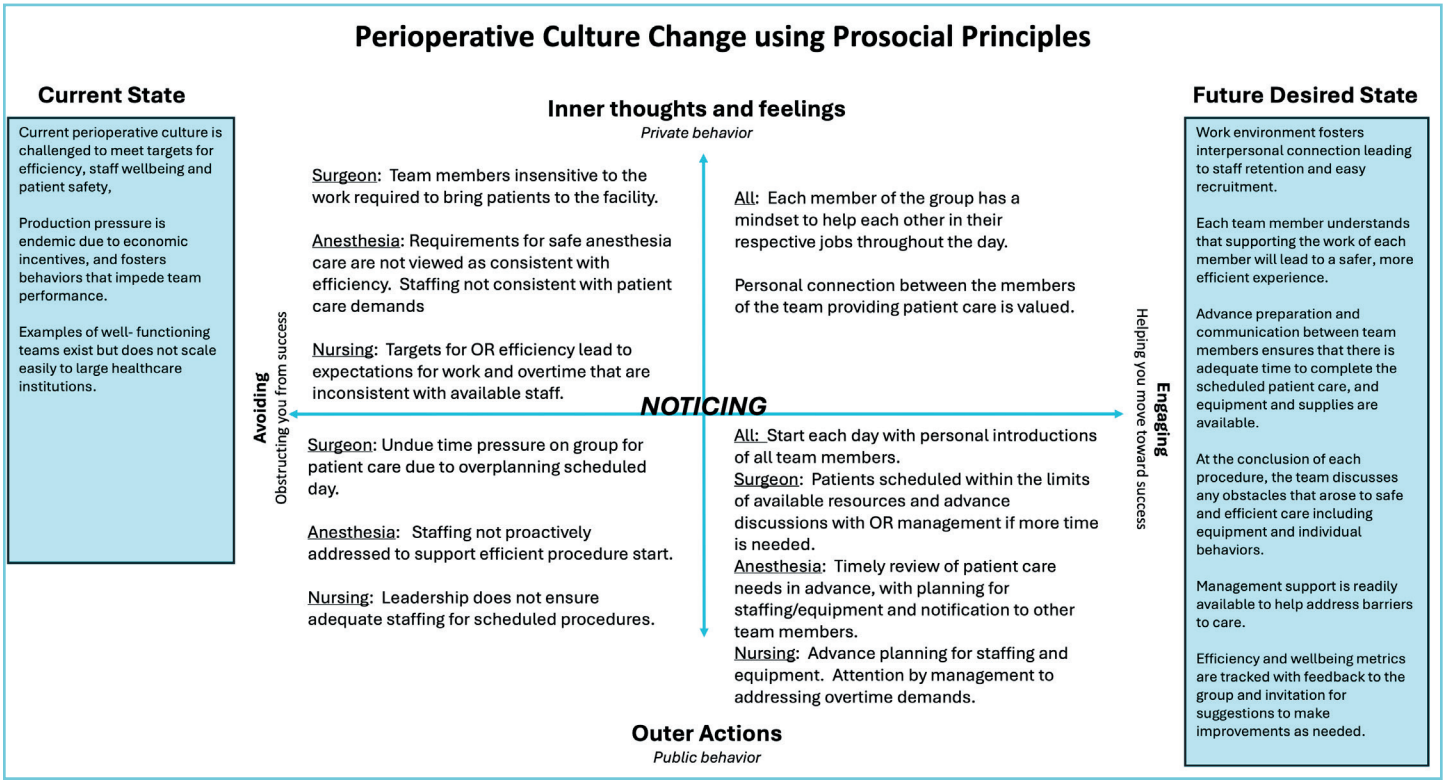

Figure 1: ACT Matrix applied to a procedural team helps to understand the behaviors required to move from the current state to a more desired future state. Specific behaviors move the individual or group towards the desired future state (engaging) or away from the current state (avoiding) as indicated by the horizontal axis. The vertical axis indicates differences between "Outer" or observable behaviors and "Inner" behaviors or what we experience. Avoiding-behaviors are typically self-interested; engaging behaviors are prosocial, intended to foster the group mission. The individual action of NOTICING these behaviors and developing the psychological flexibility to replace avoiding behaviors with engaging behaviors is central to ACT training. Special thanks to Dr. Kevin Polk and colleagues for their original formulation. (Adapted with permission from Paul Atkins.)

Team Efficiency, Staff Wellness, and Retention Can Be Used to Assess Impact

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patient into the room on time, is well-prepared for induction and intubation after the prior discussion with the anesthesiologist, and can begin monitoring and sedating the patient. The anesthesiologist joins 10 minutes later after starting the other room. During the process of induction and fiberoptic intubation, the surgeon (who has remained in the room) offers to assist the anesthesia team so the circulator and scrub tech can continue to prepare equipment for the procedure.

As the timeout checklist begins, the surgeon states, "Let's take a moment to ensure we are all set for the day. If anyone has any concerns or needs support, now is the time to speak up." The circulating nurse introduces the scrub tech who is in training by name, and the anesthesiologist introduces the visiting nurse anesthetist. These new team members are welcomed and encouraged to ask any questions. The anesthesiologist indicates he is covering two rooms and identifies the need for communication to coordinate the work in both rooms throughout the day.

Towards the end of the second case, the procedure time is running longer than expected, and the surgeon invites the team to discuss any challenges to starting the last case and completing the day on time. The circulator states that he can stay for a short time after the scheduled day to take care of the patient, but the surgeon encourages them to speak to nursing leadership before starting the case to ensure there is relief if needed. The team works quickly to turn over the operating room and begin the last case. Despite their efforts, the last case runs 30 minutes late, but everyone wants to finish the day together. As the anesthesia team exits the room with the patient, everyone expresses appreciation for the communication and teamwork during the day.

It is easy to pen a "Hollywood" ending to this story since it is not a sequence of actual events. Nevertheless, the behaviors described in the second vignette, where people proactively plan how to work together, are not part of the routine culture in many or most procedural areas; these behaviors are born of a prosocial approach to the work where all team members act in ways that demonstrate mutual respect and support in the service of safe and effective patient care.

Team efficiency and staff wellness and retention are measurable and can be used to assess impact. It is time to look more critically at our existing culture and to evaluate the potential impact of validated tools like prosocial culture change to foster team engagement and performance.

This article introduces the science and methods of prosocial change. More detailed information can be found at Prosocial World.

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Perioperative Safety and Quality in Low- and Middle-Income Countries

by Ying Eva Lu-Boettcher, MD, FASA, and Kathryn Kelly Ann McQueen, MD, MPH, FASA, FISS

Despite many international efforts, ensuring perioperative patient safety across different regions worldwide remains a major challenge. While only 6% of all surgical procedures occur in low- and middle- income countries (LMICs), over 50% of the perioperative death and disability resulting from surgery occurs in these nations.[1] An estimated 95% of the annual deaths in patients under 20 years old are considered avoidable if surgical care were improved at community and district hospitals in these LMICs.[2]

In many LMICs, patient safety is at risk due to workforce shortages, inadequate training of anesthesia professionals, and limited access to patient safety monitors and essential medicines. This article explores recent key advances in anesthesia quality and safety initiatives in LMICs in the context of challenges and future outlooks.

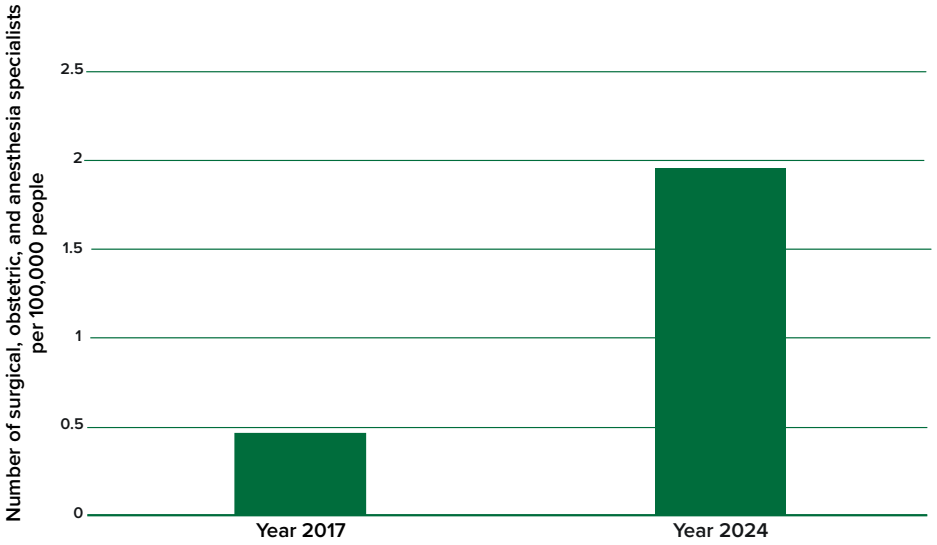

Figure 1: Effect of NSOAP implementation in Tanzania on number of surgical, obstetric, and anesthesia specialists per 100,000 people in 2017 (before implementation of NSOAP) compared to 2024 (after implementation).[9]

ANESTHESIOLOGY WORKFORCE SHORTAGES

Globally, recent surveys reveal that of the 550,134 anesthesia professionals around the world, only 15% practice in LMICs secondary to inadequate infrastructure to support a certified, trained, or licensed workforce in these nations.[3,4] In 2015, the Lancet Commission for Global Surgery (LCoGS) concluded that upwards of 5 billion people do not have access to safe, affordable surgical and anesthesia care when needed.[5] Anesthesia and surgical workforce availability is one of the key indicators of underpreparedness.[5] The authors also cite significant delays in accessing surgical care, which can arise from financial or geographic restrictions, limited specialized workforce, low awareness of available services, and low confidence in those services.[5] Moreover, a recent report by Hendel et al. indicated that only 39% of the LMICs identified by the World Bank have representative anesthesia societies, posing significant difficulty to tracking anesthesia professionals in these countries.[6] Of the LMICs with anesthesia societies such as Mozambique, Ethiopia, and Rwanda, there are about 0.3–0.6 anesthesia professionals available per 10,000 people, compared to 38.5 anesthesia professionals per 10,000 people in the high-income country of Australia.[6]

The lack of trained surgeons, obstetricians, and anesthesia professionals poses major patient safety concerns. In a publication that analyzed 11,422 surgical patients from 247 hospitals across Africa, these hospitals averaged 0.7 specialist surgeons, obstetricians, and anesthesia professionals per 100,000 patients. Cesarean deliveries were the most frequent procedure (33%). Overall, postoperative complications occurred in 18.2% of patients, with a 2.1% mortality rate. Despite generally low surgical risk, postoperative mortality in Africa was double the global average. Among cesarean deliveries, complication and mortality rates were 26.9% and 8.4%, respectively.[7]

Recent efforts to improve training of anesthesia professionals, credentialing, national tracking of anesthesia personnel, and access to safer services are underway. National policy frameworks have emerged as crucial tools to address this gap, particularly through the development of National, Surgical, Obstetric, and Anesthesia Plans (NSOAPs) and increased support from international organizations like the World Health Organization (WHO), the International Federation of Nurse Anesthetists (IFNA), and the World Federation of Societies of Anesthesiologists (WFSA). Several LMICs, such as Tanzania, Ethiopia, Nigeria, Rwanda, Senegal, and Zambia, have developed and implemented NSOAPs to improve access to surgical, obstetric, and anesthesia services, focusing on increasing clinician numbers, surgical volume, and tracking perioperative outcomes as a quality measure. In Tanzania, for example, 19.3% of all deaths are attributable to diseases amenable to surgery in a nation where 85% of cesarean deliveries and 71% of nonobstetric procedures are provided by nonphysician clinicians such as clinical officers and assistant medical officers.[8] The Tanzanian NSOAP set a goal to raise the number of specialist surgical, obstetric, and anesthesia (SOA) professionals from 0.46 per 100,000 people in year 2017 to 2.27 per 100,000 by year 2025 (Figure 1). In 2024, SOA professionals had increased to 1.96 per 100,000 population in Tanzania.[9]

Challenges to implementing NSOAPs include a lack of awareness and a lack of a governance structure at the regional level.[9] NSOAPs are important as they address workforce and other anesthesia and patient safety variables; however, tracking workforce has not been successful in all settings. Establishing a workforce baseline of health care professionals was a primary goal of NSOAPs. Additional reports from countries implementing NSOAPs are still needed to elucidate progress and regional challenges.[9] As a reference, the LCoGS recommends that countries achieve a specialist surgical workforce (surgeons, anesthesia professionals, obstetricians) ratio of at least 20 specialists per 100,000 people by 2030.[10] Ensuring a robust workforce of trained and credentialed anesthesia professionals is essential for improving access to surgery, creating a culture of patient safety, and ensuring best outcomes for patients.

ACCESS TO SAFETY MONITORING AND ESSENTIAL MEDICINES:

In many LMICs, the challenge of ensuring patient safety and decreasing perioperative

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Patient Safety can be Impacted by Limited Access to Essential Equipment

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mortality is impacted by limited access to essential equipment such as pulse oximetry, oxygen, and rescue medications. While the WFSA and the WHO recommend pulse oximetry, oxygen, rescue medication, and capnography for each anesthetic, access to these resources has proven challenging with the expansion of basic surgical services into district-level hospitals (outside of major cities) in LMICs.[11] These hospitals may not have trained anesthesia professionals, and those providing anesthesia may be working without basic monitors and medications, thereby compromising patient safety.

The WHO and the WFSA have both supported initiatives aimed at addressing these gaps. In particular, the WHO has endorsed organizations like Lifebox, a nonprofit organization established by Atul Gawande in collaboration with the Association of Anaesthetists of Great Britain and Ireland (AAGBI), the WFSA, and the Harvard School of Public Health. Lifebox focuses on providing affordable patient safety equipment—such as pulse oximeters and capnography devices—and promoting patient safety tools, including the WHO Surgical Safety Checklist.[12] However, since Ministries of Health have not consistently addressed equipment and medication shortages, challenges persist, especially in communities removed from larger cities. Additionally, the WHO Surgical Safety Checklist has not been universally adopted, even in high-income countries.[13,14] The use of the Surgical Safety Checklist has produced significant benefits across hospitals of various socioeconomic levels, such as a 47% reduction in major surgical mortality. The rates of overall complications, surgical-site infections, and unplanned reoperations also declined significantly.[15] Access to important safety monitors and essential medicines, along with creating a culture of safety that embraces the use of checklists and other reminders of common pitfalls, are the greatest needs for providing consistent anesthesia care across countries and regions.

GLOBAL ANESTHESIA SAFETY ASSESSMENT TOOLS

To provide guidance in assessing and improving the quality of global anesthesia care, the WFSA and the WHO developed the International Standards for a Safe Practice of Anaesthesia (ISSPA), first published in 1992.[16] This set of guidelines aim to assist anesthesiology departments, institutions, health care professionals, and policymakers in establishing and evaluating their compliance with international quality anesthesia care standards. The amended 2018 version of ISSPA covers recommendations for standardized professional training, facilities, equipment, medications, monitoring, and anesthesia management, and has been recommended as an assessment tool that promotes alignment with global anesthesia care standards.[16]

Recent literature has addressed the successes and challenges of efforts to align with ISSPA. In a 2024 report from the largest health care system in Morocco, a lower-middle income country, the percentages of anesthetic cases that met ISSPA standards were addressed.[17] High compliance was noted for pre-anesthetic visits (89.6%), checklist completion (89.6%), and record keeping (79.6%). Lower compliance was found for postanesthesia care units (58.8%), nurse training (10.5%), premedication use (26.2%), and intraoperative neuromuscular monitoring. A 2020 report from a major hospital system in Cambodia, another lower-income country, showed high compliance in one-to-one patient care, preoperative evaluation, and basic monitoring (pulse oximetry, ECG, blood pressure). Low compliance was noted in the availability of CO_2 detectors, temperature and neuromuscular monitoring, defibrillators, fluid equipment, capnography, and continuing education.[18] From these recent reports, it is evident that challenges are region-specific, institutionally variable, and highly dependent on leadership resources. Continued publication on these topics will help elucidate future global advances and challenges in incorporating ISSPA into anesthesia infrastructure.

QUALITY IMPROVEMENT BARRIERS AND TRACKING OF SURGICAL AND ANESTHESIA OUTCOMES DATA

In the last few years, perioperative research studies from LMICs such as Brazil, China, and India have been increasing. Despite this growth, large-scale studies from African regions have remained sparse. The bulk of existing research has focused on short-term surgical results and the patterns of diseases managed through surgery, while relatively few investigations have explored the specific challenges encountered in low-resource environments.[19] LMICs often lack infrastructure and means to collect risk-adjusted surgical outcomes data.[1,20] To improve surgical outcomes tracking in LMICs, a multidisciplinary understanding of the current practices and challenges to collecting data is needed.

In 2024, a multidisciplinary team from high-income and LMIC surgical settings conducted the first large-scale survey of stakeholders in LMICs regarding surgical data collection. A comprehensive survey was sent to perioperative personnel (surgeons, anesthesia professionals, anesthesia/surgical trainees, and administrators) to elucidate facilitating factors and barriers to collecting surgical outcomes data.[1] Less than half of respondents reported having mentorship or research training, and 86.7% said their department offered little or no protected research time. Other major barriers to research included heavy clinical workloads, research costs, and poor medical documentation.[1]

FUTURE DIRECTIONS AND NEXT STEPS

The opportunity for improving perioperative outcomes in LMICs has never been greater. Thanks to the efforts of the Lancet Commission on Global Surgery and the World Bank's Disease Control Priorities in Developing Countries, there is a universal commitment to scaling up surgical care in LMICs. This overarching commitment to increasing access to surgery, however, must be accompanied by a commitment to the necessary resources—human, functional and available equipment, medications, and system processes committed to best outcomes and patient safety. Additionally, the collection of data and tracking of outcomes is essential for quality improvement and to understand the impact of additional system level improvements over time.

The WHO and WFSA guidelines and recommendations have been impactful in encouraging National Ministries of Health to invest appropriately for patient safety and best perioperative outcomes. Scaling up to recommended equipment, medications, and processes in every location, however, has been unpredictable and slow in most LMICs. This has resulted in persistently poorer than expected outcomes for even healthy patients in LMICs. Recommendations for the future, therefore, include universal compliance with highly recommended resources and processes, increased workforce, and the tracking of indicators such as perioperative mortality rate over time.

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There are Significant Barriers to Quality Improvement in Low- and Middle-Income Countries

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Reusable vs. Single-Use Airway Devices in Humanitarian Anesthesia: Lessons from Continuing Promise 2025 Aboard the *USNS Comfort*

by LCDR Matthew McGee, MD, MC, USN

The provision of safe anesthesia in resource-constrained humanitarian settings requires careful consideration of equipment selection, balancing clinical efficacy with logistical constraints and environmental stewardship. Continuing Promise, a recurring humanitarian mission that began in 2007, aims to provide medical assistance throughout the Caribbean, Central, and South America. During the 16th iteration of this mission, our anesthesia team aboard the *USNS Comfort* confronted a fundamental question with significant patient safety implications: Should airway equipment prioritize reusable or single-use devices?

This decision extends beyond simple cost considerations. In humanitarian anesthesia, equipment choices intersect with infection control protocols, environmental sustainability, supply chain reliability, and the long-term impact on host communities. As global health initiatives expand, this issue merits careful examination through the lens of patient safety and ethical practice.

SUSTAINABILITY AND ETHICAL CONSIDERATIONS

Humanitarian anesthesia must reconcile immediate patient safety requirements with long-term environmental and ethical responsibilities. Single-use devices may offer superior performance, consistency, and simplified infection control, but also contribute to environmental impacts and strain local waste management systems. Single use laryngoscope handles alone contribute 16–25 times more greenhouse gas emissions when compared to their reusable counterparts.[1] Conversely, reusable equipment reduces waste generation but may compromise safety due to sterilization limitations and performance degradation.

The ethical imperative extends beyond immediate patient care to encompass our responsibility to host communities. Exporting unsustainable care models that burden local systems with unmanageable medical waste undermines humanitarian principles and long-term relationships.

AIRWAY EQUIPMENT CONSIDERATIONS IN HUMANITARIAN SETTINGS

Modern airway management tools, including laryngoscopes, video laryngoscopes, and rigid stylets, are available in both reusable and disposable configurations. While U.S. hospitals typically base equipment decisions on infection control policies, institutional preference, or cost-effectiveness, humanitarian deployments present a fundamentally different calculus involving availability, durability, sterilization capacity, and waste management.[2]

REUSABLE EQUIPMENT: DURABILITY AND STERILIZATION ISSUES

Our experience with reusable GlideRite® stylets revealed significant concerns regarding durability and performance consistency. Multiple sterilization cycles and routine handling led to progressive deformation, rendering stylets difficult or impossible to use effectively. During two unanticipated difficult airway scenarios, we were compelled to switch from reusable to single-use stylets mid-procedure—a delay that could compromise patient safety in time-critical situations.

Utilizing measurement standards similar to those described previously,[3] our team documented significant curvature variations between least and most deformed reusable stylets. Our single-use stylets demonstrated consistent handle-to-tip angles averaging 14.92 degrees. In contrast, our 10 reusable stylets showed significant variation, ranging from 10.52 degrees (straighter) to 19.28 degrees (more curved), with statistical significance ($p < 0.0001$) (Figures 1 and 2). This corresponded to tip location differences ranging from -19 mm to +31.8 mm when compared to a new single-use stylet baseline. Considering that the average adult male glottis measures 21.5 mm in anteroposterior width,[4] these variations represent clinically significant deviations—potentially displacing the stylet tip by nearly two glottic widths in either direction.

These distortions posed significant risks to our ability to deliver safe and efficient care, particularly when managing complex airways. Despite stringent preoperative screening to avoid anticipated difficult airways, we encountered unanticipated difficult airway scenarios that required immediate equipment changes. The unreliability of deformed reusable equipment in these critical moments highlighted how equipment failure can directly compromise patient safety when seconds matter.

STERILIZATION INFRASTRUCTURE LIMITATIONS

Reusable direct laryngoscope blades required nightly reprocessing to ensure adequate supply for the following day's cases.

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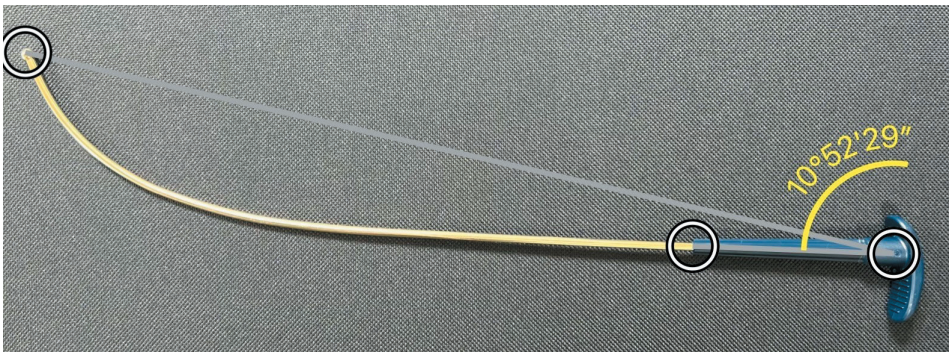

Figure 1: Measurement methodology showing handle to tip angulation to quantify deformation of reusable stylets.

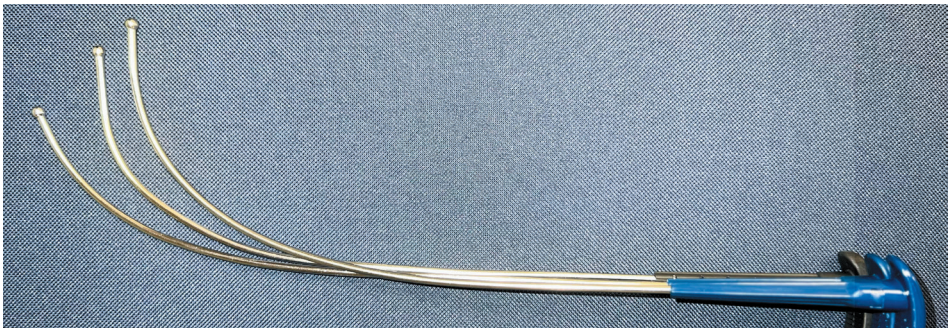

Figure 2: Comparison of single-use stylet with two reusable stylets showing varying degrees of curvature deformation.

Humanitarian Anesthesia Must Reconcile Patient Safety with Ethical Responsibilities

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While manageable with our 3–4 operating rooms, any increase in surgical volume could have resulted in anesthesia delays: an unacceptable compromise to patient safety and operational efficiency, potentially impacting the number of cases that could be accomplished in the humanitarian mission.

Centralized sterilization processes can create additional vulnerabilities, including equipment maintenance issues, interdepartmental backlogs, and environmental control problems affecting storage conditions.[4] These bottlenecks forced airway management planning around sterilizer availability rather than patient needs.

SINGLE-USE EQUIPMENT: PERFORMANCE AND ENVIRONMENTAL TRADE-OFFS

Clinical Advantages

Single-use GlideScope® stylets demonstrated consistent performance, maintained their designed curvature, and provided immediate readiness—particularly valuable during emergency airway management. The absence of disposable direct laryngoscope blades represented a missed opportunity to eliminate performance degradation and reprocessing delays.

Waste Management Challenges

The environmental impact of single-use devices became immediately apparent in the shipboard setting. Waste segregation, separating plastic from paper and metal components, was mandatory for proper disposal. Many host nations required meticulous waste separation as a prerequisite for acceptance, and robust disposal infrastructure was challenging to achieve.

To minimize environmental impact, we utilized the shipboard incinerator for paper products whenever possible. However, the accumulation of medical-grade plastics created both logistical challenges and ethical concerns, particularly when operating in communities ill-equipped to manage such waste streams.

Supply and Cost Limitations

Single-use disposable equipment is preferentially affected by supply chain issues. Despite extensive predeployment planning, our single-use videolaryngoscope blades arrived only days before departure for the three-month mission. The absence of reusable backup systems created unnecessary predeployment stress and highlighted a critical principle: availability supersedes preference in austere environments. Equipment that may be considered outdated in well-resourced facilities becomes invaluable if it is immediately available and sterilizable.

Midmission depletion of disposable stylets could force reliance on compromised reusable equipment, demonstrating the vulnerability inherent in single-source supply strategies. This underscores the critical importance of redundant equipment planning in austere environments. In a cost-conscious humanitarian setting, reusable airway equipment may offer up to a 10-fold cost reduction[5] over the course of multiple humanitarian missions.

EVIDENCE-BASED RECOMMENDATIONS

Based on our experience and existing literature, we propose the following patient safety-focused strategies:

1. **Hybrid Equipment Strategy**
   Maintain both reusable and single-use options for critical airway tools. This approach provides operational flexibility to respond to case complexity variations, sterilization delays, and supply chain disruptions while maintaining consistent patient safety standards.
2. **Enhanced Equipment Monitoring Protocols**
   Implement systematic inspection protocols for reusable devices, such as rigid stylets prone to deformation. Staff training should emphasize recognition of subtle performance degradation that may not be visually apparent but could compromise clinical effectiveness.
3. **Redundant Supply Chain Planning**
   Build significant cushion into equipment procurement, particularly for single-use devices. When primary supplies are depleted, alternative equipment options ensure continuity of safe care without compromising clinical standards.
4. **Pre-Deployment Waste Management Planning**
   Coordinate with host nations regarding waste acceptance and disposal capabilities before deployment. Establish agreements for proper medical waste handling that minimize environmental impact while ensuring compliance with local regulations.

CONCLUSION

Airway management in humanitarian settings extends beyond technical proficiency to encompass systems thinking, environmental stewardship, and ethical responsibility. The choice between reusable and single-use equipment cannot be reduced to a binary decision but requires nuanced evaluation of clinical requirements, local context, and long-term impact.

Continuing Promise 2025 reinforced that every clinical decision—from stylet selection to waste disposal—carries implications extending far beyond the immediate patient encounter. As the global health community continues to expand humanitarian efforts, anesthesia professionals must lead in developing solutions that protect both individual patients and the communities we serve.

The path forward requires continued dialogue between clinical practitioners, equipment manufacturers, and global health organizations to develop sustainable solutions that prioritize patient safety without compromising environmental responsibility. Our commitment to "First, do no harm" must encompass not only the patient on the operating table but also the world we leave behind.

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Matthew McGee reports no conflicts of interest.

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APSF Awards 2026 Grant Recipients

by Yan Xiao, PhD

Over the past 40 years, the APSF grant programs have been key to the mission of APSF to support and advance anesthesia patient safety culture, knowledge, and learning. The programs stimulate and fund studies to improve patient safety and lead to prevention of mortality and morbidity resulting from anesthesia mishaps. Through the programs, ASPF has supported more than 140 anesthesiologists and other researchers with nearly $14 million in funding. The programs have played an essential role in establishing and enhancing careers of many anesthesia and other professionals in conducting safety research and education. The 2025 Mentored Research Training Grant (MRTG) program, jointly funded with the Foundation for Anesthesia Education and Research (FAER), received five letters of intent from four organizations. Full proposals from two principal investigators were invited. One full proposal was received, but it was not recommended for funding after review by the joint FAER/APSF review team. The 2025–2026 APSF investigator-initiated research (IIR) grant program received 29 letters of intent from 21 organizations in the United States and Canada. The multidisciplinary Scientific Evaluation Committee (SEC) reviewed these letters, with the assistance of external statistical experts. Six teams were invited to submit full proposals, which were reviewed and discussed by the SEC for their potential impact on anesthesia patient safety and scientific rigor in a hybrid meeting on October 11, 2025. Two proposals were recommended for funding to the APSF Board of Directors and received unanimous support. This year's recipients are Alexander Nagrebetsky, MD, MSc, from Massachusetts General Hospital and Asad Siddiqui, MD, from the Hospital for Sick Children, Toronto, Canada. The principal investigators provided the following description of their proposed work.

Alexander Nagrebetsky, MD, MSc

Assistant Professor, Massachusetts General Hospital

Dr. Nagrebetsky's project is entitled *"The Million Anesthesia Cases Study (MACS)—a multicenter registry-based study assessing the incidence, severity, and clinical effects of prolonged preoperative fasting."*

Background: The American Society of Anesthesiologists (ASA) guidelines emphasize that "fasting duration is often substantially longer than recommended and prolonged fasting has well-described adverse consequences."[1] However, there are no large, methodologically robust studies quantifying the incidence and the effects of prolonged preoperative fasting.[2]

Clinicians worldwide are concerned about excessive fasting for clear liquids due to the loss of both water and calories with potential adverse effects on metabolism and patient well-being.[2,3] Despite the low grade of evidence on the incidence and harm of prolonged fasting for clear liquids, considerations of such harm led to the emerging practice of unrestricted clear liquids until surgery.[4] Some high-profile publications call for "the removal of fasting requirements prior to…procedures that require conscious sedation."[5] The heightened interdisciplinary focus on the potential adverse effects of preoperative fasting creates an opportunity for anesthesiologists to lead patient safety efforts by addressing the substantial evidence gap in this area. A large, high-quality study on the clinical effects of preoperative fasting is required to guide policymaking, patient care, and definitive trial design.

Aims: The Million Anesthesia Cases Study aims to estimate the incidence and severity of prolonged preoperative fasting for clear liquids in a large and diverse sample of clinical settings, procedures, and patients. We will use these data to quantify adherence to the national guidelines[1] We will also test for an association between the duration of preoperative clear liquid fasting and (a) perioperative volume- and glycemia-related events and (b) the risk of perioperative pulmonary aspiration.

Implications: The study will set the foundation for improving fasting guideline adherence by quantifying nonadherence and its impact. Furthermore, our results will expand the evidence base for fasting recommendations by assessing the objective outcomes of intraoperative hypotension, kidney injury, myocardial injury, and dysglycemia that have not been sufficiently studied in this context. Our epidemiological data will contribute to clinician, patient, and societal knowledge of the prevalence and impact of unnecessarily prolonged preoperative clear liquid fasting. Such improved understanding will address the current lack of awareness of the negative effects of prolonged clear liquid fasting—a major driver of nonadherence to guidelines that encourage clear liquid intake until two hours before surgery.

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Funding: $199,469 (January 1, 2026-December 31, 2027). The grant was designated as the APSF/American Society of Anesthesiologists (ASA) President's Research Award, and was also designated as the APSF Ellison C. Pierce, Jr., MD, Merit Award with $10,000 unrestricted research support.

Asad Siddiqui, MD

Assistant Professor of Anesthesiology, The Hospital for Sick Children, Toronto, Canada

Dr. Siddiqui's project is entitled *"High-Frequency Physiologic Data for Predictive Modeling of Hypotension in Pediatric Patients in the Operating Room."*

Background: Intraoperative hypotension (IOH) is a significant concern in anesthesia and perioperative medicine and is associated with major adverse outcomes including acute

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kidney injury, major cardiac or cerebrovascular events, and increased mortality.[1] IOH also contributes to longer hospital stays, higher readmission rates, and greater health care costs. One analysis estimated that improved IOH management in a 10,000-case surgical population could save $1.2–4.6 million annually by preventing hypotension-related complications.[2] Thus, IOH is both a patient safety priority and an important driver of health care resource utilization.

In pediatrics, however, the definition, thresholds, and consequences of IOH are less clearly understood. Data from the GAS study demonstrated that hypotension during anesthesia in infants and young children is common: 87% experienced a mean arterial pressure (MAP) <45 mmHg, and 49% had MAP <35 mmHg while under sevoflurane anesthesia.[3] Prior work suggests these MAP values are associated with reduced cerebral blood flow and oxygenation in infants.[4] Yet, few studies link IOH in children to postoperative organ injury, and existing findings are mixed. Although age and sex-specific blood pressure reference ranges exist, these do not define thresholds or durations of hypotension that lead to clinically significant hypoperfusion. Consequently, meaningful definitions of IOH in children remain uncertain and likely differ from adult thresholds.

In adults, IOH is strongly linked to organ injury, and machine learning based prediction tools have been developed to proactively identify and prevent hypotension.[5] One randomized trial demonstrated that an AI-driven alert system significantly reduced time spent in hypotension compared with standard care.[5] However, no comparable predictive models exist for pediatric surgical patients. Our proposal will utilize a large local physiologic waveform repository to leverage high-frequency data to define IOH patterns and develop predictive models tailored to children.

Aims: The primary objective of this study is to develop an AI-based prediction tool for IOH in pediatric surgical patients using high-frequency physiologic waveform data. **Aim 1:** Determine the prevalence and characteristics of IOH in pediatric surgical patients using established pediatric BP reference ranges, and assess clinician intervention patterns in response to hypotension. **Aim 2:** Develop and validate an AI model that predicts imminent IOH based on high-frequency physiologic waveform data.

Implications: This project will further elucidate the prevalence and clinical response patterns associated with IOH in children, while demonstrating that physiologic waveform data can be used to predict hypotension. An effective prediction tool will provide clinicians with early warning, enabling more timely interventions and reducing the risk of hypoperfusion-related injury. Ultimately, this project has the potential to substantially improve perioperative patient safety for all pediatric surgical patients, with opportunities for broader translation to other clinical environments, including critical care and general hospital wards.

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Yan Xiao, PhD, is a professor at the University of Texas at Arlington College of Nursing and Health Innovation, and the chair of the APSF's Scientific Evaluation Committee through 2025.

Yan Xiao is the chair of the APSF Scientific Evaluation Committee through 2025.

Wellness Bias, Maternal Physiology, and the Hidden Drivers of Maternal Mortality: An Obstetric Perspective for Anesthesia Professionals

by Courtney Martin, DO, MHA, FACOG

INTRODUCTION

The United States continues to face rising maternal mortality and severe maternal morbidity (SMM). Sepsis alone now accounts for nearly 13% of maternal deaths, which is on par with hemorrhage and hypertensive disorders.[1] What is striking across reviews of maternal deaths is how often these cases are deemed preventable by multidisciplinary review committees. The themes are consistent: delayed recognition, delayed escalation, and interventions initiated only after a patient is already critically ill.

Moving toward forecasting decompensation and earlier intervention requires acknowledgement of two hidden contributors to maternal morbidity and mortality: wellness bias and physiologic masking in pregnancy. These cognitive traps are particularly relevant to anesthesia professionals, who are frequently involved in patient care only once decompensation has already occurred, and who face the daunting task of resuscitating patients who have already lost the reserve that pregnancy physiology once provided.

"WELLNESS BIAS" AND THE "NORMALIZATION OF DEVIANCE" IN PREGNANCY CARE

"Wellness bias" is the subconscious tendency among clinicians to assume that young, healthy-appearing pregnant patients are well, even when symptoms suggest otherwise.[2] This can extend to medically complex pregnant patients with pre-existing conditions, for whom wellness bias can result in minimization of the real medical conditions that actually make the pregnancy extremely high risk. This is particularly worrisome in a progressively older and obese obstetric population, where the risks of SMM and mortality compound and potentially magnify complications outside of what would be recognized as a normal healthy pregnant person.

Wellness bias inherently lowers clinical suspicion for serious conditions. For example, in obstetric patients with infection or sepsis, wellness bias can lead to minimization of concerns voiced by the patients, or dismissal of abnormal vital signs and laboratory values. It is this pregnancy-related optimism that explains why tachycardia is often dismissed as "normal pregnancy," why shortness of breath may simply be attributed to the gravid uterus, or why postpartum fatigue is accepted at face value rather than evaluated as possible sepsis or cardiomyopathy.

RED FLAGS in PREGNANCY

NORMAL PREGNANCY ADJUSTMENTS	RED FLAGS THAT MAY BE MISSED
HR up to 100–105 bpm	HR > 110 bpm = possible early shock
BP may trend slightly lower	SBP < 105 mmHg = not benign
$PaCO_2$ 28–32 mmHg	$PaCO_2$ ≥40 mmHg = hypoventilation, CO_2 retention
Creatinine 0.4–0.6 mg/dL	Creatinine ≥ 1.0 mg/dL = abnormal
RR elevated slightly, but not above 24	**Low-grade fever (≥100.4°F) = possible sepsis**
	New O2 requirement or unexplained dyspnea = possible PE, pneumonia, or sepsis

"Normalization of deviance" is a related phenomenon through which safety standards gradually erode over time after repeated encounters without negative outcomes.[3] Both wellness bias and normalization of deviance are commonly observed in obstetric and pediatric medicine, where abnormal outcomes are relatively infrequent and most patients appear healthy. Normalization of deviance can include disregarding alarms, bypassing protocols, or skipping checklists; over time, unintentional denial, dismissal, and ultimately delays can lead to morbidity and even mortality. Furthermore, systemwide and individualized wellness biases can be compounded by unconscious biases toward marginalized populations, further widening disparities in diagnosis and treatment. Left unaddressed, these cognitive traps delay recognition and escalation of care, placing both maternal and fetal outcomes at risk. For anesthesia professionals, delayed recognition of serious medical conditions may mean that involvement of the anesthesia team only occurs once the patient is *in extremis*, when intubation, hemodynamic support, or transfusion carry higher risks and lower margins for safety.

MATERNAL PHYSIOLOGY THAT MASKS DETERIORATION

The physiology of pregnancy can create a dangerous situation where patients may appear stable until they suddenly are not, particularly when systems rely on nonpregnant thresholds for alerts and when the health care team is not trained and actively aware of early signs of decompensation in a pregnant patient. Clinical understanding of maternal vital signs and physiology is critical to early recognition. For example, while expanded plasma volume and reduced systemic vascular resistance in pregnancy may result in a mildly increased maternal heart rate and lower blood pressure, frank tachycardia and

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Misinterpretation of Maternal Physiology Can Lead to Delays in Care

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hypotension may be erroneously interpreted as "normal." Similarly, a blunted febrile response in pregnancy means infection may present without fever, with 20% of maternal sepsis cases presenting without a fever.[2]

Equally concerning is the lack of awareness of, and system safety alerts regarding, laboratory value differences in pregnancy. There are scoring processes created specifically for obstetric patients, like "MEWS" or "MEWT" that predict deterioration and alert teams of vital sign abnormalities in pregnancy.[4-5] These scores adopt vital sign parameters that are more specific to pregnancy than adult scoring tools. Misinterpretations of maternal physiology can also lead to delays. One example is a common presumption that tachypnea is physiologic to pregnancy. This is incorrect, and while there is a compensatory rise in respiratory rate, it should not be over 24. In addition to the differences in vital sign parameters, there are differences in laboratory values that need to be adjusted for pregnancy. For instance, a baseline creatinine in pregnant patients of 0.4–0.8 mg/dL means that a "normal" value of 1.0 mg/dL reflects developing acute kidney injury. During pregnancy, a normal $PaCO_2$ is ~32–35 mmHg, so a "normal" $PaCO_2$ of 40 mmHg is in fact abnormal during pregnancy, signaling hypoventilation, CO_2 retention, and possible impending respiratory collapse. Expanded intravascular volume and the resultant dilutional anemia of pregnancy can obscure bleeding. The hypercoagulable state of pregnancy makes disseminated intravascular coagulopathy (DIC) harder to recognize until well-advanced. In the third trimester, a normal maternal fibrinogen should be greater than 400 mg/dl, even though a normal nonpregnant adult value is 200 mg/dl.[6-9] Unfortunately, most lab values are not adjusted for pregnancy, nor are critical alerts built into health care systems to alert to these pregnancy-specific lab value aberrations. There also remains a paucity of maternal safety infrastructure and alerts like those that exist for nonpregnant adults, forcing obstetric care teams to rely on individuals to remember these differences. Investing in electronic health record (EHR) systems with maternal-specific alerts for both vitals and lab results is essential for any health system providing care to obstetric patients, and should be extended to emergency departments, operating rooms, and intensive care units (ICUs) where these patients may receive care.[10]

BIAS IN WITHHOLDING MATERNAL DIAGNOSTICS AND THERAPY

Wellness bias can also extend to overemphasizing theoretical fetal risk at the expense of maternal safety. Too often, diagnostic tools and therapeutic interventions are delayed or withheld in pregnancy because of perceived teratogenicity, radiation risk, or concerns regarding drug transfer to breastmilk, despite evidence that timely maternal intervention is the best protection for both mother and baby. Examples include not obtaining a chest x-ray, pulmonary angiography CT, or other indicated imaging; delaying indicated surgery or cardiovascular treatments; and hesitating to give antibiotics, vasopressors, or other indicated medications. These delays in treatment only compound the delay in recognition of serious medical conditions and contribute to increased morbidity and mortality. In fact, *the failure to treat maternal disease aggressively is arguably itself a form of bias*. In every major mortality review, maternal stabilization is cited as the most important determinant of fetal survival and barring a few exceptions to known fetal risk (such as the administration of medications known to be teratogenic, when suitable alternatives exist), pregnant individuals should receive the standard-of-care evaluation and treatment.[11-15]

SYSTEM-LEVEL CONTRIBUTORS AND EQUITY CONSIDERATIONS

In addition to wellness bias and physiologic masking, demographic and social determinants compound risk as maternal mortality is not distributed evenly throughout the population. Pregnant patients 40 and older have nearly a sevenfold increase in mortality compared to those under 25, as age-related comorbidities and reduced physiologic reserve amplify risk during pregnancy.[16-18] Pregnancy-related mortality also increases with higher body mass index (BMI), with women with a BMI ≥ 40 kg/m^2 facing a 5–6 fold higher risk compared with those with a lower BMI. For anesthesia professionals, this translates into greater potential for a difficult/failed airway, altered pharmacokinetics, and increased hemodynamic instability under stress. Race and ethnicity also influence maternal risk: Black women have a pregnancy-related mortality rate three to four times higher than White women, with the highest risk observed in Black women over age 40.[16-18] American Indian and Alaska Native women also face a more than twofold increase. These inequities persist even when controlling for socioeconomic status and comorbidities, reflecting systemic bias and barriers to care. Patients who are uninsured, underinsured, or rely on state-funded health programs face a two- to four-fold higher risk of pregnancy-related mortality compared with those with private insurance. Limited access to preven-

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Anesthesia Teams Should Be Involved Early

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tive care, delayed escalation of care, and systemic barriers compound the danger.[16-18]

IMPLICATIONS FOR ANESTHESIA TEAMS

For anesthesia teams, these biases and physiologic challenges converge at the worst possible moment: the crashing patient with minimal reserve. Intubation is more dangerous, resuscitation more difficult, and transfusion more urgent when recognition is delayed.

ANESTHESIA PROFESSIONALS SHOULD KEEP THE FOLLOWING RECOMMENDATIONS IN MIND:

- **Do not accept "normal" at face value**. Remember maternal-adjusted vitals and lab values.
- **Advocate for early escalation.** Push for sepsis bundle activation, massive transfusion protocol initiation, and/or timely ICU transfer as appropriate.
- **Encourage early neuraxial anesthesia when appropriate.** Timely epidural placement may be preferable to automatically waiting until active labor, when worsening patient status (e.g., HELLP syndrome or sepsis) may increase the risk of neuraxial anesthesia or even preclude its placement.
- **Support postpartum vigilance.** The postpartum period is where patients can decompensate under decreased monitoring and higher nurse staffing ratios. Discharge education regarding warning signs of serious postpartum complications is essential.
- **Promote timely diagnostics and interventions.** Speak up if maternal diagnostics or therapies are being deferred inappropriately out of fetal concern—the safest fetus is one with a stable mother.

SYSTEM-LEVEL SOLUTIONS

System-level changes are required to fully counteract bias and physiologic masking:

- **Embed pregnancy-adjusted thresholds into EHR early warning systems.** Reliance on nonpregnant normal lab value and vital sign cutoffs is unsafe in obstetrics.
- **Use simulation to expose wellness bias.** Train teams with scenarios where a "well-appearing" patient deteriorates rapidly.
- **Normalize anesthesia involvement in early huddles.** Bring anesthesia in early, not just when the patient is coding.
- **Adopt bundles with explicit anesthesia triggers.** Hemorrhage, hypertension, and sepsis pathways should have delineated roles for anesthesia professionals from the start.
- **Institutionalize maternal-first counseling**. Establish standards that reinforce maternal stabilization as the priority in decision-making regarding diagnostics and treatment.

CONCLUSION

Maternal mortality and SMM will not be reduced without addressing embedded wellness bias and the unique physiology of pregnancy. These silent drivers of delay are within our power to fix—by recalibrating our thresholds, building better systems, and challenging our assumptions.

For anesthesia professionals, the message is urgent: your vigilance, your voice, and your leadership in early recognition can change the trajectory of care. By speaking up when "normal" isn't normal, by advocating for appropriate diagnostics and therapies, and by partnering with obstetrics to counteract bias, we can better forecast and prevent decompensation, prioritize early intervention, preserve maternal safety, and close the gap on preventable harm.

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The author reports no conflicts of interest.

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SPOTLIGHT on Legacy Society Members

Dr. Ephraim S. (Rick) and Eileen Siker

Rick's interest in anesthesia began as a third-year medical student at NYU when he had a brief opportunity to cross paths with Emery Rovenstine, the first of many future encounters. What an honor it was when Rick was invited to give the Rovenstine Lecture in 1981. Rick's circle of friends and influencers include too many to list, but a few names stand out: Drs. Frances Foldes, John Bonica, Pepper Jenkins, Richard Kitz, David Little, Bill Hamilton, Art Keats, Al Betcher, Don Benson, and, most importantly, Eileen B. Siker, his wife of more than 60 years. Rick was dedicated to patient safety and it's noteworthy that in 1996 he was invited to present the Lewis Wright Lecture. Rick's talk was titled; "Anesthetic Safety: an Evolution." This would turn out to be his final opportunity to address an ASA audience.

Rick's tenure with the APSF began in 1985 when he became the founding secretary. He was then appointed as the first executive director of the APSF, a role in which he served from 1992 to 1997.

Rick and Eileen Siker truly are an APSF legacy.

Paul Pomerantz

Anesthesiology is all about patient safety, innovation, stakeholder engagement, and health care leadership. As CEO of ASA from 2013 to 2023, I had the pleasure of working closely with APSF's president, board, volunteers, and staff and saw firsthand how the foundation embodied these values. When ASA launched APSF in the mid 1980s, it represented one of the earliest such initiatives in patient safety and has been an integral part of the specialty's significant progress in this area. Its approach to research, best practices, global outreach, and implementation science has inspired similar efforts across the health care system.

Through APSF, I have learned that the work of improving patient safety is never complete and APSF continues to identify new directions requiring its attention. I hope that by being part of the Legacy Society, I can make a small contribution to APSF's important work and its enduring future.

Della Lin and Lee Guertier

An abiding belief in safeguarding the future of anesthesiology.

Established in 2019, the ***APSF Legacy Society*** honors those who make a gift to the foundation through their estates, wills, or trusts, thus ensuring that patient safety research and education will continue on behalf of the profession about which we are so deeply passionate.

APSF recognizes and thanks these inaugural members who have generously supported APSF through an estate or legacy gift.

For more information about planned giving, please contact Jill Maksimovich, APSF Director of Development at maksimovich@apsf.org.

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