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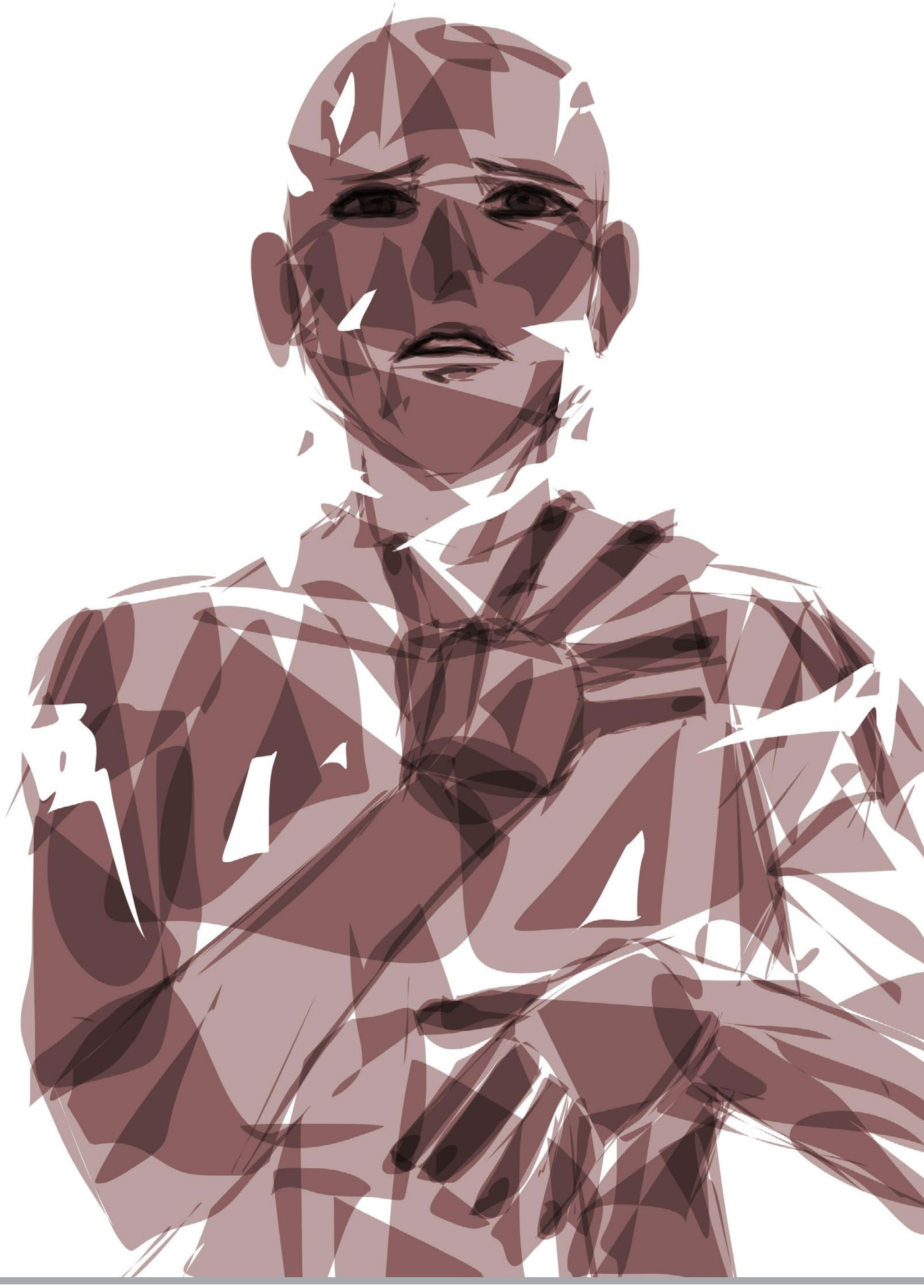
# CLINICS IN MEDICAL EDUCATION

*Docendo Discimus*

[ By Teaching We Learn ]



**Awarded First Prize at the ASRA 2025 Fall Meeting *Pain Illuminated* art show.**

*"This piece illustrates the fragility patients experience when they have pain.*

*-Ruby Feng, MD*

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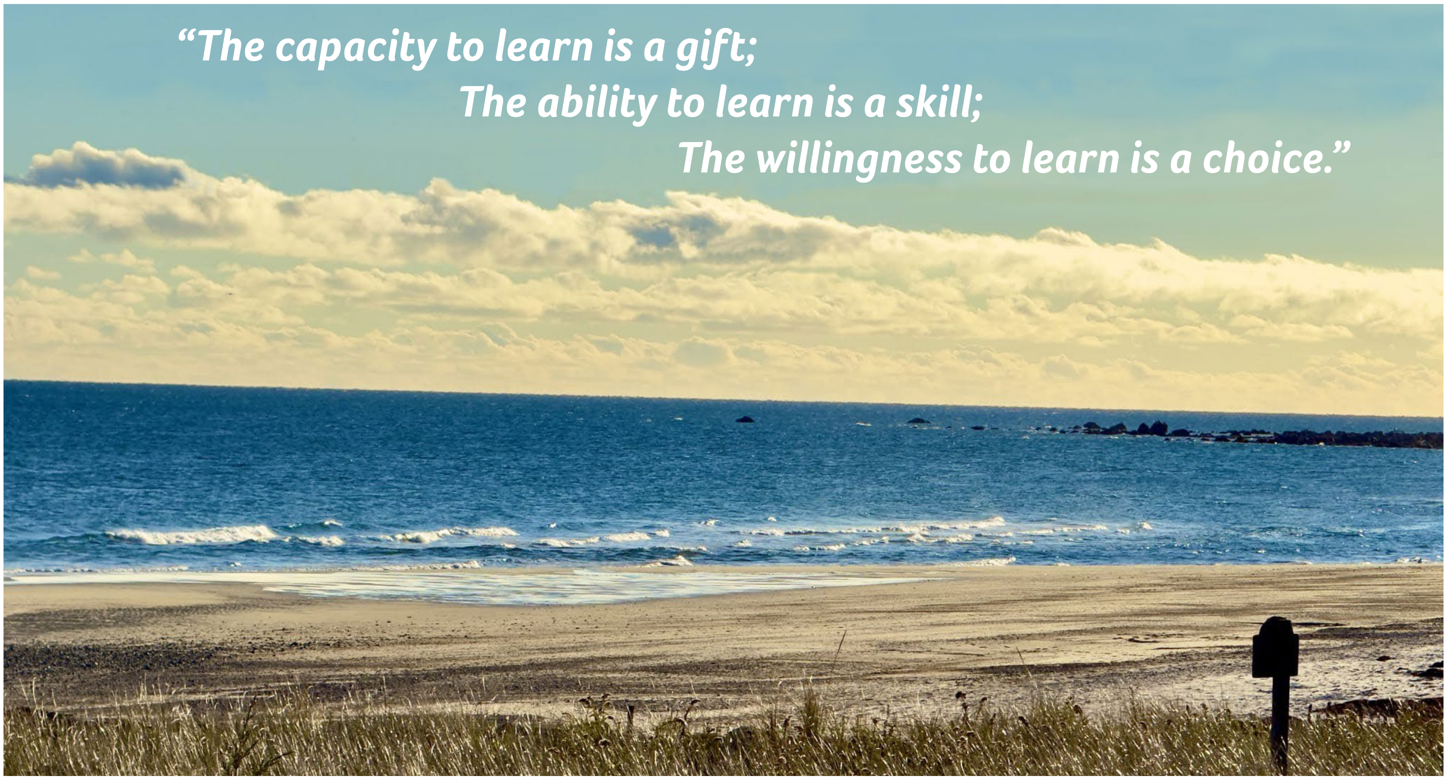


***White Horse Beach, Plymouth, Massachussetts***
Quote: ***Brian Herbert*** *on learning, education, leadership, and the power of ideas.*

Nyansapo "Wisdom Knot": A symbol of wisdom, ingenuity, intelligence, and patience. The proverb associated with this Adinkra is "Nyansapo wosane no badwenma," to wit, "A wisdom knot is untied (only) by the wise."
https://www.adinkrasymbols.org/symbols/nyansapo/

**New Website**

Check us out online! medicaleducationclinic.com offers the latest updates in research, academia, and pedagogy from the Department of Anesthesia, Critical Care and Pain Medicine at BIDMC. The site features extra content, interactive courses, quizzes, and a wide array of engaging resources. Click here to explore and enhance your learning experience!

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*Usman Ahmed*

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Beth Israel Deaconess Medical Center

*Anesthesia, Critical Care and Pain Medicine*

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## EDITOR'S WELCOME

As we enter 2026, we are excited to share the first issue of volume 2 of *Clinics in Medical Education*! This started as a table talk concept and has now taken the form of an interactive publication with increased guest submission and an expansive global health portfolio.

This is an interactive education journal that will deliver a summary of clinical and medical education directly to your mobile devices, ipads and computers. We have recently launched our website (https://medicaleducationclinic.com/) and look forward to hearing your feedback and suggestions for future content. Our aim is to provide unlimited educational resources to our residents and faculty. Every other month, we present complex and unique cases to enhance your expertise featuring embedded live lectures, quizzes and rich visual aids including ultrasound images, CT scans, X-rays and interpretation of invasive and non-invasive monitoring.

We hope you enjoy this issue!

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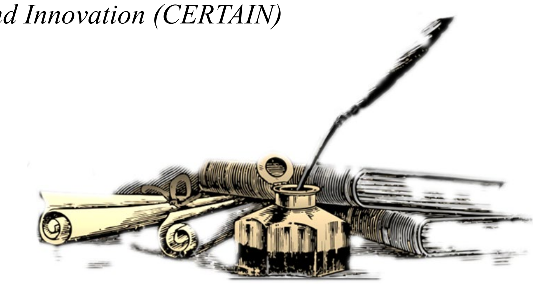
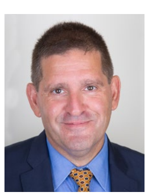


**Feroze Mahmood, MD, FASE**
*Division Director, Cardiac Anesthesia*
*Mark E. Comunale Chair in Anesthesia*
*Beth Israel Deaconess Medical Center*
*Professor of Anesthesia, Harvard Medical School*



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## OUR MISSION

- Empowering scholarly dialogue and advancing knowledge through rigorous research and insightful perspectives.
- Advancing medical education through effective teaching practices and ongoing mentorship.
- Fostering excellence in medical teaching through continuous innovation and professional growth.

PEDAGOGY IN EDUCATION

# Artificial Intelligence in Medical Education: Opportunities, Challenges, and the Emerging Need for Critical Reflection

**Feroze Mahmood, MD**


## Abstract

Artificial intelligence (AI) has rapidly expanded across multiple dimensions of health professions education, from adaptive learning systems to virtual tutors and generative language models. While AI's potential to enhance knowledge acquisition, simulation-based learning, and individualized feedback is substantial, concerns about cognitive offloading, algorithmic transparency, data privacy, and the risk of "solutions without problems" remain underexamined. This article synthesizes historical and contemporary developments in AI, reviews its applications in medical education, and discusses emerging pedagogical, ethical, and regulatory considerations. A balanced and deliberate approach is essential to ensure that AI augments, rather than replaces, human reasoning, professional judgment, and reflective practice.


## Introduction

Artificial intelligence (AI) has re-emerged as a transformative force in healthcare and medical education. From early conceptual work by Alan Turing in the 1950s to the development of advanced large language models (LLMs) and generative tools in the 2020s, AI technologies now influence clinical workflows, decision-making, and approaches to teaching and learning. In medical education, AI promises improved access to information, personalized learning pathways, and enhanced simulation-based training. However, these opportunities are accompanied by risks, including cognitive deskilling, algorithmic bias, opacity in decision systems, and evolving legal and ethical uncertainties. Educators and institutions must therefore assess both the pedagogical value and potential unintended consequences of integrating AI into training environments.

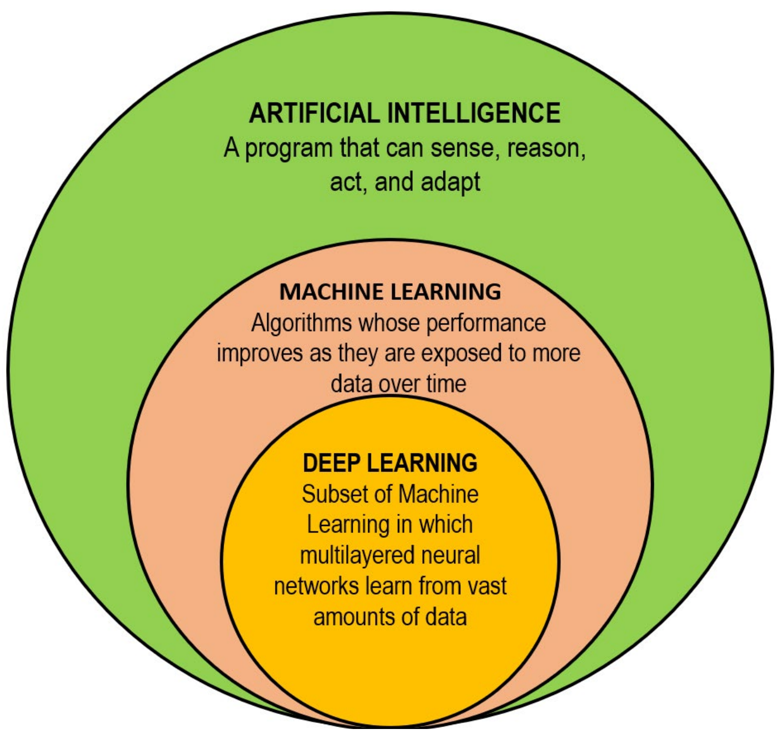


***Figure 1:*** *Relationship between Artificial Intelligence, Machine Learning, and Deep Learning*

## Historical Evolution of Artificial Intelligence

The trajectory of AI reflects decades of interdisciplinary innovation. Foundational contributions—from Turing's question, "Can machines think?" (1950) to the Dartmouth Conference (1956)—established the intellectual framework for machine-based reasoning. Over subsequent decades, milestones such as IBM's Deep Blue defeating world chess champion Garry Kasparov in 1997, and the progressive development of autonomous Mars rover capabilities from Sojourner (1997) through Perseverance (2021), demonstrated advances in computational power and real-time decision-making.

Since approximately 2005, AI development has accelerated dramatically, driven by advances in machine learning algorithms, the availability of large-scale data, and increased computing power. Breakthroughs in deep learning enabled systems to surpass human performance on specific image recognition benchmarks in 2012, while socially interactive robots with limited conversational abilities gained prominence in the mid-2010s. By the late 2010s, natural language processing systems achieved or exceeded human-level performance on several standardized evaluation tasks. The release of large-scale generative models such as GPT-3 (2020) and DALL·E (2021) further showcased the expanding capacity of AI to generate coherent text and images. This rapid evolution has laid the groundwork for modern educational tools that leverage prediction, content generation, and adaptive feedback.

## Types and Classifications of AI Relevant to Education

AI technologies vary in capability and functionality. ***Artificial Narrow Intelligence (ANI)*** systems perform task-specific functions such as speech recognition or autonomous navigation. ***Artificial General Intelligence (AGI)***, though not fully realized, represents hypothetical systems capable of transferring learning across contexts—analogous to human flexible problem-solving. ***Artificial Superintelligence (ASI)*** remains speculative but raises philosophical questions about autonomy, safety, and self-awareness. From a functional perspective, educational applications typically involve:

| Type of AI | Description |
|---|---|
| Reactive AI | Responds to immediate input |
| Limited Memory AI | Integrates past data to improve performance (e.g., adaptive tutoring systems) |
| Generative AI | Creates new content such as text, images, or explanations |
| Predictive AI | Forecasts performance or identifies learning gaps |

| Applications of AI in Medical Education | | | |
|---|---|---|---|
| Large Language Models and Generative Tools | Intelligent Tutoring Systems and Adaptive Learning | Simulation, Gamification, and Virtual Patients | Monitoring and Analytics |

## Large Language Models and Generative Tools

Large language models (LLMs), such as the GPT series, analyze vast amounts of text data to generate human-like language, synthesize complex information, answer questions, and support problem-solving. In medical education, these tools can function as continuous digital tutors by offering explanations tailored to different levels of learner expertise, act as content generators capable of producing clinical cases, assessments, or customized learning materials, and serve as cognitive supports by reducing the burden of information retrieval and allowing learners to focus on higher-order reasoning.

### Intelligent Tutoring Systems and Adaptive Learning

AI-driven tutoring systems adjust difficulty, pacing, and content to match learners' abilities, enabling individualized learning pathways. These systems can identify knowledge gaps, modify instructional strategies, and deliver formative feedback in real time.

### Simulation, Gamification, and Virtual Patients

AI enhances simulation-based learning through dynamic scenario generation, automated debriefing insights, and virtual patient platforms that adapt to learner input. These tools improve clinical decision-making, communication, and diagnostic reasoning in risk-free environments.

### Monitoring and Analytics

Predictive and monitoring algorithms can track learner engagement, performance trends, and competency development. In research settings, advanced tools such as EEG-based cognitive load monitoring reveal how learners interact with AI, providing insight into patterns of engagement and mental workload.

### Cognitive Implications: Offloading, Deskilling, and "Never-Skilling"

AI's ability to automate information retrieval and synthesis raises concerns about cognitive offloading—the transfer of essential thinking processes from learners to digital systems. While this may reduce cognitive load for routine tasks, overreliance risks deskilling, mis-skilling, or even never-skilling, in which learners fail to develop foundational reasoning abilities.

Experimental studies comparing learners using LLMs, search engines, or no external tools have demonstrated distinct neural connectivity patterns. Individuals switching from AI-assisted to independent work showed reduced activation in memory and processing networks, suggesting under-engagement when transitioning away from AI reliance. These findings underscore the need to balance assistance with deliberate practice, ensuring that learners maintain the capacity for independent critical thinking.

### Ethical Considerations:

**Informed Consent and Transparency:** Patients increasingly encounter AI-driven systems in diagnosis, triage, and clinical decision-making. Whether patients should be informed that AI, not human reasoning, contributes to their care remains debated. When used in education, transparency is equally important; learners must understand when AI is generating or influencing content, assessments, or feedback.

**Algorithmic Bias and Fairness:** AI can unintentionally reproduce or amplify biases present in training datasets. While AI is often promoted as a democratizing force, inequitable data representation can lead to inaccurate predictions, biased recommendations, or harmful clinical assumptions. Educators must recognize these risks and teach learners to critically interrogate algorithmic outputs.

**Data Privacy and Ownership:** AI tools depend on large datasets, often containing sensitive health or educational information. Issues of data ownership, monetization, security, and the right to withdraw data remain unresolved. Although de-identified data is often considered safe, triangulation techniques can re-identify individuals, threatening confidentiality protections.

**Regulatory and Legal Challenges:** Regulation has struggled to keep pace with technological advancement. The U.S. Food and Drug Administration (FDA) increasingly reviews AI-driven medical devices, particularly in imaging diagnostics and autonomous screening. However, many software tools fall into exemptions such as those defined by the 21st Century Cures Act, complicating oversight. Liability remains a central concern: when an AI-assisted decision causes harm, responsibility may rest with clinicians, institutions, or product developers. Current malpractice frameworks are ill-equipped to address the hybrid nature of human–machine clinical decision-making.

## Do We Have a Solution Without a Problem?

As AI expands into health professions education, an essential question emerges: Are we solving genuine educational challenges or creating new ones? In some instances, AI is applied not because a pedagogical deficit exists, but because technological enthusiasm drives its adoption. Implementing "solutions without problems" may generate unintended consequences such as overreliance on automation or compromised critical thinking while diverting attention from longstanding structural issues in education.

## Conclusion

AI has the potential to meaningfully enhance medical education through personalization, improved accessibility, and enriched simulation-based learning. Yet its integration must be cautious, ethical, and intentional. Educators should emphasize adaptive expertise, critical reflection, and humanistic judgment, skills that cannot be automated. A responsible, learner-centered approach will ensure that AI becomes an augmentation tool rather than a replacement for the intellectual, moral, and clinical capacities essential to medical practice.

### Key Take Away Points

1. AI can enhance medical education, but must augment—not replace—human reasoning. When used intentionally, AI supports personalized learning, simulation, and feedback; unchecked use risks cognitive offloading, deskilling, and erosion of independent clinical judgment.
2. Ethical, legal, and equity concerns are central to AI integration in education. Issues of algorithmic bias, data privacy, transparency, informed consent, and unclear liability frameworks require explicit attention and must be incorporated into curricula.
3. Critical reflection is essential to avoid "solutions without problems." AI adoption should be driven by genuine educational needs rather than technological enthusiasm, with educators maintaining focus on adaptive expertise, reflective practice, and humanistic care.

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*Click here to watch Dr. Feroze Mahmood talk about the role of Artificial Intelligence in medical education!*

*Click here to read more about the role of Artificial Intelligence in Anesthesiology Board–Style Examination Questions*

## Human Factors Applications in Anesthesia Practice: Part II

### Situational Awareness During Anesthesia Care

Jacqueline Hannan, PhD

Situational awareness is a cognitive skill that plays a central role in safe anesthesia care because it supports real-time decision making in a complex and dynamic clinical environment. This article is part two of an ongoing discussion of human factors in anesthesia practice, building on a previous introduction to core human factors principles and their relevance to patient care and the clinical space. Situational awareness has become central to understanding how clinicians interact with patients, technology, and teams during anesthesia care.

The framework for situational awareness is defined as a three-level construct consisting of perception of relevant elements in the environment, comprehension of their meaning, and projection of their status into the near future. (1) This framework has been widely applied in high-risk industries. In the context of healthcare, the model is used to explain how clinicians maintain vigilance and anticipate problems before they cause harm. (2)

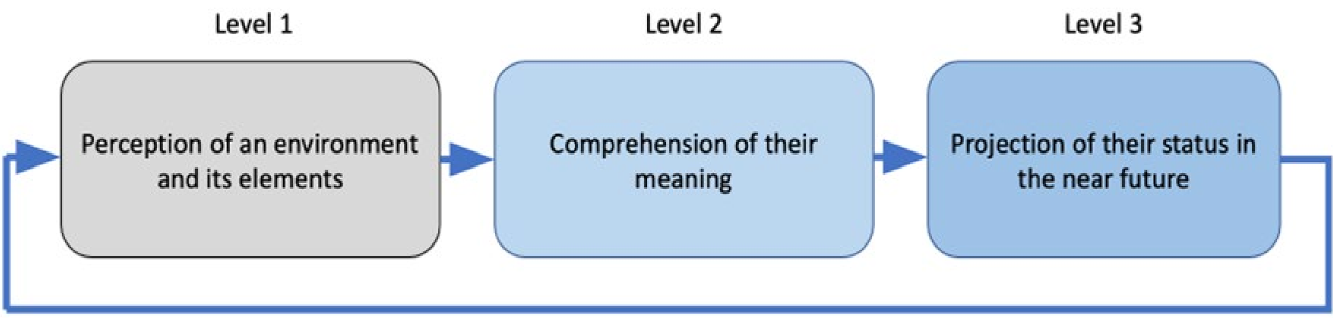


***Figure 1.*** *Model of situational awareness, adapted from (1)*

In anesthesia practice, situational awareness spans the entire continuum of care, from preoperative evaluation through emergence and handoff. At the level of perception, anesthesia professionals continuously gather information from multiple sources, such as the patient history, physical examination, physiologic monitors, the surgical field, and verbal communication with the care team. There are numerous inputs, and the information conveyed is constantly changing. Comprehension occurs when these data are integrated into an understanding of the patient's current physiologic state and the goals of the surgical procedure. For example, recognizing that mild hypotension in a patient with limited cardiac reserve during a specific phase of surgery carries different implications than the same blood pressure in a healthy patient. Projection represents the ability to anticipate what is likely to happen next, such as predicting airway obstruction during emergence or anticipating hemodynamic instability during surgical stimulation, and to intervene proactively rather than reactively.

The relevance of situational awareness to anesthesia safety is supported by a growing body of evidence. Analyses of anesthesia-related adverse events and malpractice claims demonstrate that failures in situational awareness contribute substantially to severe patient harm, or potential fatality. (3) These failures may occur at any of the three levels, such as failing to notice a deteriorating oxygen saturation, misinterpreting its cause, or not anticipating the downstream consequences of delayed intervention. Similar findings have been reported in studies of critical incident reporting systems, which consistently identify situational awareness breakdowns as a common contributor to adverse events in anesthesia and critical care. (4) Beyond anesthesia, situational awareness has been studied in nursing, emergency medicine, and intensive care, where it has been linked to recognition of patient deterioration and timely escalation of care. (5,6)

Despite its importance, situational awareness is vulnerable to multiple threats in the perioperative environment. High cognitive workload, time pressure, fatigue, and interruptions can impair a clinician's ability to perceive and integrate critical information. Increasing reliance on complex technology may also contribute to automation bias, in which clinicians overtrust monitors or devices and fail to actively verify that the patient's condition aligns with expectations. Communication failures within the care team further degrade shared understanding of the clinical situation, increasing the risk that important cues are missed or misinterpreted. (2,7)

Recognizing these vulnerabilities has led to the development of strategies to support and strengthen situational awareness in anesthesia practice. Structured preoperative assessments, briefings, and checklists help ensure that key information is perceived and shared among team members. Deliberate scanning of the patient, monitors, and environment supports ongoing perception and helps counteract attentional narrowing. Training approaches that emphasize nontechnical skills, particularly simulation-based education, allow clinicians to practice maintaining situational awareness under stress and during rare critical events. (8) Effective communication and the development of shared mental models within the perioperative team further enhance collective situational awareness and improve coordination of care.

## Conclusion

Situational awareness provides a powerful framework for understanding how anesthesia professionals perceive, interpret, and anticipate events in the high-risk clinical environment. Evidence from anesthesia and broader healthcare literature demonstrates that breakdowns in situational awareness are strongly associated with patient harm, while strategies that support situational awareness contribute to safer care. As a continuation of broader discussions on human factors, situational awareness should be viewed as a core professional skill that deserves explicit attention in anesthesia training and daily practice.

### Key Take Away Points

1. Situational awareness is a core safety skill in anesthesia, encompassing perception, comprehension, and projection across the perioperative continuum; failures at any level are strongly associated with adverse events and patient harm.
2. Situational awareness is fragile but trainable—cognitive load, fatigue, automation bias, and communication failures threaten it, while structured workflows, deliberate scanning, effective teamwork, and simulation-based training can strengthen it and improve patient safety.

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## Resilience in Medical Training: A Core Professional Competency

Daniel P. Walsh, MD

### What is resilience?

Resilience refers to the ability to bounce back from stress, adapt to adversity, and continue functioning at or above one's usual level despite challenging circumstances. (1,2) Within medical training and practice, resilience supports clinicians as they navigate uncertainty, emotional strain, and time-sensitive decision making. It is important to distinguish resilience from the capacity to tolerate unhealthy work environments or unsafe workloads. Rather than endurance for its own sake, resilience reflects an adaptive psychological process that enables sustained learning, growth, and professional performance. (3)

### Why is this necessary for the practice of medicine?

The practice of medicine is inherently stressful, requiring clinicians to provide high-quality care to seriously ill patients, often during nights, weekends, or periods of limited staffing. Many specialties, including anesthesiology, face shortages that require clinicians to shoulder demanding schedules. The emotional weight of caring for vulnerable patients, combined with the need for rapid decision making under pressure, makes resilience essential for maintaining performance and well-being. Increasing evidence demonstrates that resilience not only influences clinician well-being but also meaningfully affects patient outcomes across diverse clinical settings. (4)

In a multicenter analysis of 1360 older adults undergoing hip fracture surgery, higher preoperative psychological resilience, measured by the Brief Resilience Scale, was associated with significantly lower odds of death or new inability to walk independently at 60 days, as well as reduced odds of death or new nursing home residence. (5) Resilience also appears to shape recovery after elective procedures. In a study of 1180 patients undergoing foot and ankle surgery, individuals in the high and average resilience groups reported significantly better patient-reported outcomes at 24 months, including improved pain interference, global physical health, and Single Assessment Numeric Evaluation scores, compared with those with low resilience, despite all groups experiencing clinically meaningful improvement. (6) Resilience plays a critical role in critical illness as well. In a multicenter study of ICU survivors recovering from mechanical ventilation and shock, patients with normal or high resilience scores demonstrated significantly lower rates of moderate to severe post-traumatic stress symptoms and reported higher quality-of-life scores several months after discharge. (7) Stronger social support and less threatening perceptions of illness were independently associated with greater resilience in these survivors. Together, these studies highlight that resilience is clinically meaningful, influencing postoperative recovery, long-term functional outcomes, psychological health, and overall well-being. Among physicians, higher resilience has similarly been associated with lower burnout, underscoring its importance in sustaining a healthy and effective workforce. (8)

### Does resilience have a capacity to improve?

Resilience is influenced by personality traits such as optimism and emotional regulation, but it is not fixed. Studies have shown that medical students develop higher resilience by their final year of training compared to earlier years, even without explicit resilience-focused instruction. (9) Many clinicians describe feeling more resilient with accumulated experience as gaining confidence and perspective. At the same time, resilience is highly complex and multifactorial, shaped not only by innate personality traits but also by contextual and organizational factors. A systematic review has emphasized that while personality characteristics may present opportunities for individualized guidance or counseling, resilience extends far beyond personal attributes and is influenced by modifiable external factors such as workload, work environment, social support, and opportunities for leisure. (4) These findings suggest that improving resilience relies not only on personal growth but also on addressing structural and environmental contributors within training and practice. Many interventions intended to enhance resilience, including mindfulness-based programs, do not consistently increase measured resilience scores, prompting questions about whether their benefits may instead lie in improving professional quality of life, coping skills, or perceived well-being. Altogether, the evidence suggests that resilience can improve over time, but its development depends on a combination of individual characteristics, experiential learning, and supportive environments.

| The Brief Resilience Scale (BRS) | | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|---|
| BRS 1 | I tend to bounce back quickly after hard times: | 1 | 2 | 3 | 4 | 5 |
| BRS 2 | I have a hard time making it through stressful events: | 5 | 4 | 3 | 2 | 1 |
| BRS 3 | It does not take me long to recover from a stressful event: | 1 | 2 | 3 | 4 | 5 |
| BRS 4 | It is hard for me to snap back when something bad happens: | 5 | 4 | 3 | 2 | 1 |
| BRS 5 | I usually come through difficult times with little trouble: | 1 | 2 | 3 | 4 | 5 |
| BRS 6 | I tend to take a long time to get over setbacks in my life: | 5 | 4 | 3 | 2 | 1 |

***Table 1:*** *The Brief Resilience Scale*

## What do we know about how to improve resiliency?

Efforts to deliberately increase resilience among trainees have produced mixed results. Many existing interventions are short term and often focus on mindfulness, reflective exercises, or stress management techniques. (10) While measurable improvements in resilience scores are inconsistent, participants frequently report subjective benefits, including enhanced coping and emotional regulation. Several factors appear consistently helpful. Mentorship and social support from senior colleagues who model healthy coping strategies play a central role in shaping trainees' adaptive responses. Traits such as optimism, cooperativeness, and self-directedness support resilience but are not prerequisites for improvement. Meaning making also contributes significantly. Drawing on Viktor Frankl's work, helping trainees explore how purpose and perspective influence their responses to stress can strengthen their sense of agency. (11,12)

In practice, educators can foster resilience by first identifying whether challenges stem from gaps in knowledge, technical skills, or decision making, as well as addressing personal stressors that may affect performance. Creating supportive learning environments, normalizing struggle through open discussion, sharing personal narratives of navigating adversity, and modeling emotionally regulated behavior can help build adaptive capacity. Incorporating brief mindfulness or meaning centered activities may further support trainees in maintaining perspective and managing stress effectively.

**Key Take Away Points**

1. Resilience is a core competency in medicine, enabling clinicians to adapt, recover, and perform effectively under sustained stress, distinct from enduring unsafe or unhealthy systems.
2. Clinical and educational impact is well established, with higher resilience linked to improved patient outcomes, recovery, quality of life, and reduced clinician burnout
3. Resilience is dynamic and developable, shaped by experience, perspective, and progression through training rather than fixed personality traits alone.
4. Individual interventions have mixed effects, while mentorship, social support, meaning-making, and healthy role modeling consistently strengthen adaptive capacity.

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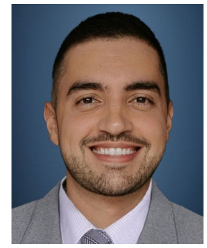
# A Framework for Simulation Instructor Development in Anesthesiology Training

Dario Winterton, MD

Federico Puerta Martinez, MD



## Introduction

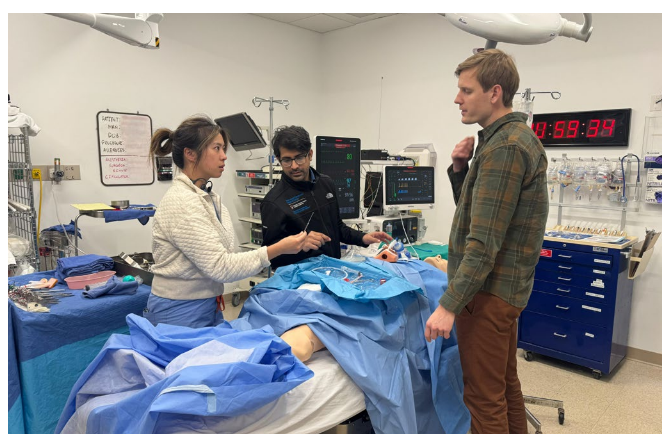
Simulation-based education has become a central component of modern anesthesiology training and is well established as an effective method for improving patient safety, crisis resource management, clinical performance, and interprofessional teamwork. ***Although anesthesiology has long been a leader in healthcare simulation, many fellows and early-career faculty enter academic practice without formal preparation in advanced teaching and leadership roles.*** Contemporary simulation extends far beyond technical skills to include cognitive and behavioral training, reflective practice, diagnostic reasoning, teamwork development, hazard detection, system probing, and educational scholarship. This expanded scope has created a growing need for structured simulation educator development within anesthesia fellowship training.

## Institutional Need for Simulation Educator Training

At Beth Israel Deaconess Medical Center (BIDMC), simulation plays a central role in departmental education. The program incorporates in-situ simulations, interprofessional scenarios, community hospital sessions, and procedural training across the operating rooms, PACU, ICU, and ambulatory sites. Sustaining and expanding these initiatives requires educators who can design scenarios with clear learning objectives, deliver psychologically safe and theory-informed debriefings, incorporate principles of fidelity and cognitive load, and use simulation for translational functions such as system probing and latent safety threat detection. Despite these needs, most anesthesiology fellowship programs do not provide a structured pathway for developing simulation teaching competencies.

## Course Purpose and Learning Objectives

To address this competency gap, BIDMC partnered with the Center for Medical Simulation (CMS) to establish the Foundations of Healthcare Simulation: Skills, Strategies, and Applications course. The overall goal of the course is to prepare anesthesia fellows to serve as competent simulation educators capable of designing, implementing, debriefing, and evaluating simulation-based educational interventions. By the end of the course, fellows are able to describe the evolution and modalities of healthcare simulation, apply core educational theories to simulation design, integrate teamwork frameworks into teaching, construct structured simulation scenarios, facilitate debriefings using approaches such as Debriefing With Good Judgment and Rapid Cycle Deliberate Practice (RCDP), and implement simulations across task trainer, full scenario, in-situ, and RCDP modalities.



## Curriculum Overview

The three-day CMS curriculum employs a progressive design grounded in adult learning principles and experiential learning theory.

| | Focus | Key Concepts | Activities | Learning Approach |
|---|---|---|---|---|
| **Day 1** | Foundations of Simulation and Scenario Design | Adult learning theory, history of simulation, debriefing | Simulation exercises, structured debriefings, scenario design workshop | Experiential, linked to clinical experiences |
| **Day 2** | Teamwork, RCDP, Advanced Facilitation | Sequential simulation, team cognition, communication, leadership, interprofessional collaboration, RCDP, deliberate practice | RCDP-based training, high-frequency feedback, rapid skill cycles, meta-debriefing | Reflective practice, skill acquisition |
| **Day 3** | In-Situ Simulation and Scenario Implementation | In-situ simulation, system evaluation, latent safety threat identification | Run developed scenarios, lead debriefings, receive faculty feedback | Application, integration of technical and nontechnical skills |

## Impact and Skill Application

The curriculum equips fellows with skills that directly translate to the BIDMC clinical environment. Graduates of the program are prepared to lead in-situ simulations across perioperative and critical care settings, design structured scenarios aligned with educational goals, and facilitate psychologically safe debriefings that promote reflective learning. Their enhanced capabilities strengthen departmental quality improvement, crisis resource management efforts, and interprofessional team training.

## Program Evaluation and Future Directions

Program evaluation includes post-course surveys assessing participant satisfaction, perceived competency growth, and readiness to implement simulation-based education. Ongoing faculty observation throughout the academic year provides additional assessment of fellows' simulation facilitation skills. These evaluations guide iterative improvements to the curriculum and support long-term faculty development goals within BIDMC's Education Division.

The Foundations of Healthcare Simulation: Skills, Strategies, and Applications course provides a rigorous, evidence-based framework for preparing anesthesia fellows to serve as effective simulation educators. By integrating foundational theory, experiential practice, teamwork training, RCDP, and in-situ implementation, the course addresses both institutional needs and learner development. This structured approach supports the advancement of simulation-based education and contributes to improved patient safety, team performance, and educational excellence within anesthesiology.

## Course Evaluation

The Course received excellent evaluations from 10 anesthesia and critical care fellows. Overall satisfaction was unanimously 5/5, with participants consistently highlighting the course's clear structure, high interactivity, and strong relevance to their educational responsibilities. Hands-on components, such as scenario design, running simulations, and practicing debriefing, were identified as the most valuable elements, reinforcing the course's practical focus and applicability to clinical teaching.

## Understanding of Concepts and Confidence Applying Them

Learners demonstrated strong understanding across all core domains of simulation-based education covered in the course (Figure 1). Participants also reported increased confidence in applying these concepts during clinical care and teaching, particularly in leading debriefings, incorporating NTS principles, and providing structured, psychologically safe feedback.

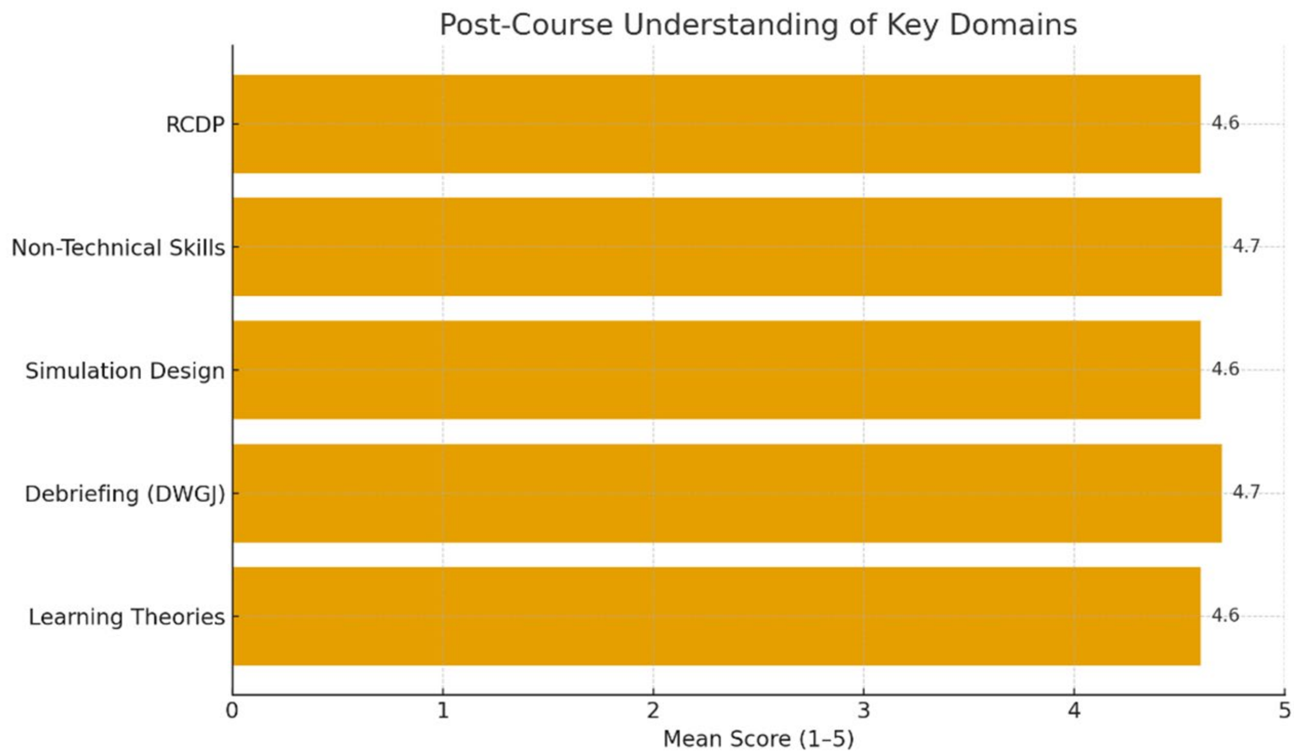



***Figure 1:*** *Post course evaluation of Simulation Course for BIDMC Anesthesia Fellows*

| **Feedback Quotes** |
|---|
| "The hands-on sessions and practicing debriefings were incredibly useful." |
| "The instructors' depth of knowledge made everything feel clear and applicable." |
| "Learning new frameworks for debriefing will immediately improve my teaching." |
| "The structure of the course made it easy to understand how to design and run scenarios." |
| "The hands-on sessions, especially learning how to debrief, were excellent." |
| "One of the most practical and engaging courses I've taken." |
| "The simulation design workshop transformed how I teach." |
| "RCDP was a game-changer—simple, powerful, and immediately usable." |

## Application

Fellows indicated they plan to apply the course content directly within their clinical and educational roles. Intended uses include leading debriefings with residents, integrating brief feedback conversations and micro-debriefings into routine clinical work, designing and facilitating simulation sessions for trainees, and applying non-technical skills frameworks during real clinical events. Many also expressed interest in contributing to departmental OR and ICU simulation programs, underscoring the course's impact on future educational engagement.

# Introduction to Medical Education Research for Clinician Educators

Jacqueline Hannan, PhD

## Introduction

Medical education research plays a critical role in improving how physicians are trained and how educational innovations are evaluated. Clinician educators, both in anesthesia and across other specialties, routinely engage in teaching activities that generate important questions about learning methods and performance assessment. Transforming these questions into rigorous scholarship requires familiarity with foundational concepts in education research as well as practical approaches to study design. This article introduces key principles of medical education research for clinician educators, with emphasis on research question development, outcome selection, use of frameworks, and methodological alignment.

## Defining Medical Education Research

Medical education research is the systematic study of teaching, learning, assessment, and educational systems within the health professions. Its purpose is to generate knowledge that extends beyond a single institution and contributes to the broader educational literature. This distinguishes education research from local program evaluation or quality improvement activities, which primarily serve internal decision making rather than broader dissemination.

Education research is most successful with a clarity of purpose, transparency of methods, and alignment between research questions, study design, outcomes, and interpretation. Rigor in medical education research is defined less by methodological complexity and more by coherence and justification of choices made throughout the research process. (1)

## From Educational Problem to Research Question

Most medical education research begins with an observed teaching or learning challenge. Some examples of common sources of research questions include recurring learner difficulties, uncertainty regarding the effectiveness of an educational intervention, or variability in assessment practices. Review of existing literature is essential to identify what is already known and to define meaningful gaps that warrant further investigation.

A well-constructed research question is focused, feasible, relevant, and grounded in prior scholarship. Several frameworks can assist clinician educators in refining research questions. The PICO framework, which considers population, intervention, comparison, and outcome, is particularly useful for intervention-based studies. In addition, the use of conceptual or theoretical frameworks strengthens research design by articulating assumptions about how learning occurs and how the intervention is expected to influence outcomes. Commonly used frameworks in medical education include self-determination theory, cognitive load theory, and experiential learning theory. (1)

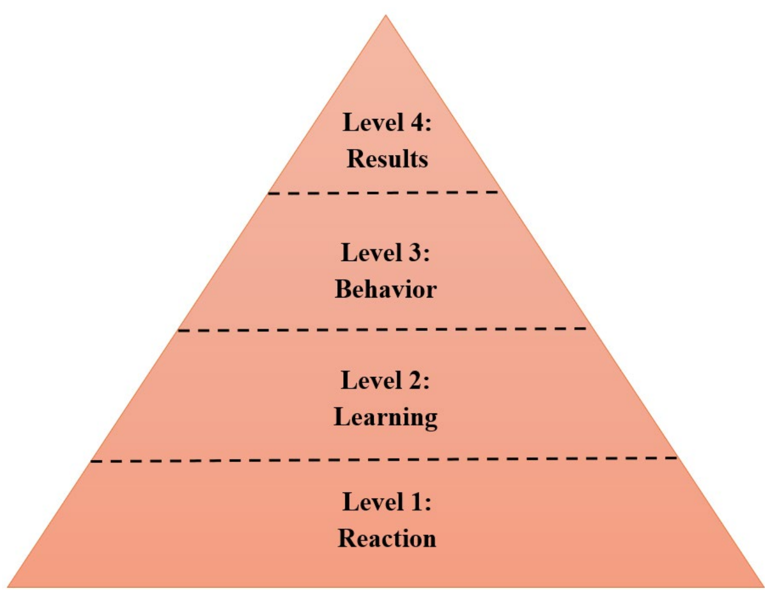



***Figure 1:*** *Kirkpatrick Model of Evaluation*

## Study Designs, Frameworks, and Educational Outcomes

The research question determines the appropriate study design and outcome measures. Quantitative designs are commonly used to measure change, compare groups, or examine relationships between variables. Qualitative designs are well suited to exploring experiences, perceptions, and processes of participants in the learning process. Mixed methods designs intentionally combine quantitative and qualitative approaches to address complex educational questions and to provide complementary perspectives.

Educational outcomes are frequently categorized using the Kirkpatrick model. (2) Level one outcomes reflect learner reactions, such as satisfaction or perceived value. Level two outcomes assess learning from the intervention by measuring changes in knowledge or skills. Level three outcomes examine whether learners experience a behavior change and apply new skills in clinical practice. Level four outcomes evaluate broader effects such as patient outcomes or system level changes. While outcomes at higher levels are more challenging to measure, they often provide stronger evidence of educational impact and are particularly relevant to clinical disciplines such as anesthesiology. Frameworks such as the Kirkpatrick model serve not only as outcome classification tools but also as guides for selecting appropriate data collection instruments and aligning outcomes with study goals.

## Common Methods in Medical Education Research

There are multiple data collection tools and approaches for conducting medical education research. Quantitative data collection instruments include surveys, knowledge examinations, structured performance assessments such as objective structured clinical examinations, and institutional metrics. Selection of quantitative instruments should be guided by the outcome of interest and supported by evidence of reliability and validity whenever possible. (4) Qualitative data collection instruments include interviews, focus groups, direct observation, and analysis of written documents such as reflective narratives or evaluation comments. These methods allow investigators to explore how learners and faculty experience educational interventions and to examine contextual and social factors that influence learning. Standards for rigor and transparency in qualitative research have been well described in the medical education literature and should guide study design and reporting. (5)

## Conclusion

Medical education research provides clinician educators with a structured approach to examining and improving teaching and learning in anesthesiology. Effective studies begin with clearly articulated research questions, are grounded in conceptual and theoretical frameworks, and align methods and outcomes with educational goals. Quantitative, qualitative, and mixed methods each offer unique strengths and can be used individually or in combination. By starting with feasible projects, seeking mentorship, and emphasizing methodological alignment, clinician educators can meaningfully contribute to the growing body of medical education scholarship.

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**Building Teamwork and Communication through a Sustainable In Situ Simulation Program**

Noor Dirini, MD

Dario Winterton, MD

## Introduction

Healthcare teams in anesthesiology and perioperative care often form on the spot, with members who may have never worked together before. These ad hoc teams must rapidly establish roles, expectations, and coordinated action, sometimes within seconds. In anesthesiology and perioperative environments, this occurs continuously. Importantly, introducing even one unfamiliar team member effectively renders a team ad hoc and could shift dynamics, requiring rapid creation of shared mental models and reliable communication structures.

A robust body of literature shows that non-technical skill (NTS) failures contribute to the majority of preventable adverse events in healthcare. The Joint Commission consistently identifies communication breakdowns as a root cause in 70–80% of serious medical errors. (1-3) Research in anesthesia, critical care, and emergency medicine further demonstrates that lapses in teamwork, situational awareness, and coordination frequently precede adverse events or near misses. (4-6)

Conversely, team training grounded in Crisis Resource Management (CRM) principles has been shown to improve communication, reduce errors, and strengthen crisis performance. (7-9) These principles underpin our training program.

## Key CRM Concepts Embedded in the Program

| Term | Description |
|---|---|
| Call-outs | Clearly verbalizing critical information to promote shared situational awareness. |
| Closed-loop communication | Ensuring messages are directed, acknowledged, and confirmed through action. |
| Name–Claim–Aim (Center for Medical Simulation) | A practical mnemonic for recognizing a problem, assuming leadership when necessary, and directing team actions. (10) |
| Situational awareness | Understanding what is happening, what it means, and anticipating what comes next. |
| Cross-monitoring | Team members checking one another's actions to prevent or mitigate errors. |

## A Sustainable In Situ Program for Team Training

Our goal was to create a sustainable, embedded in situ simulation program that trains real clinical teams in their real clinical environments with minimal disruption to clinical operations. Training in situ has been shown to increase realism, strengthen interprofessional engagement, and uncover latent safety threats that would otherwise go unrecognized in a simulation center. (11-13) By practicing in their actual workspaces, teams engage with familiar equipment, workflows, and cognitive loads, making the development of CRM behaviors more authentic and more transferable to clinical practice.

We launched two parallel tracks:

**1. Teamwork on Tuesday (TWT) for Residents:** Conducted weekly during existing resident education time (TED). Scenarios focus on teamwork behaviors in perioperative crisis situations, with repeated practice of CRM behaviors in evolving contexts.

**2. Interprofessional Sessions for Faculty, CRNAs, Nursing Staff:** Delivered during established education blocks for practicing clinicians, focusing on leadership, role clarity, and interprofessional coordination during perioperative crises.

To date, eight sessions have been completed, four for residents and four for faculty, with strong engagement across all disciplines. In total, approximately 110 participants have taken part, including around 70 faculty, CRNAs, and OR nurses, along with 40 residents. The next phase will extend the program to include surgical colleagues, further strengthening coordination and shared situational awareness across the entire perioperative team.

To support rapid acquisition of communication skills within these sessions, we use Rapid Cycle Deliberate Practice (RCDP) as our debriefing modality. Rather than waiting until the end of a scenario, RCDP allows facilitators to pause events at key moments, provide targeted behavioral feedback, and immediately "rewind" so learners can try again. This structure reinforces correct behaviors through high-frequency repetition and allows communication strategies such as call-outs, closed-loop exchanges, role clarification, and leadership statements to be corrected and strengthened in real time. RCDP has been shown to improve the uptake and retention of teamwork behaviors in fast-paced clinical environments. (14)

## Conclusion

This sustainable in situ simulation program provides recurring, high-impact training for both residents and interprofessional perioperative teams. By integrating CRM principles, practicing in the real clinical environment, and using RCDP to strengthen communication behaviors, the program addresses well-established contributors to medical error and supports the development of reliable, high-functioning ad hoc teams. Preliminary data suggest that the initiative is well received and improves participants' confidence in teamwork and communication. As the program grows, next steps include incorporating surgical teams and developing measures to evaluate CRM skill transfer to clinical practice.

## Key Take Away Points

1. Failures in teamwork and communication are major contributors to preventable perioperative harm, particularly in ad hoc anesthesia teams, making deliberate training in CRM-based nontechnical skills essential.
2. A sustainable in situ simulation program using CRM principles and Rapid Cycle Deliberate Practice strengthens real-world communication, leadership, and team coordination, improving confidence and performance across interprofessional perioperative teams.

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## Translaryngeal Ultrasound (TLUS) Usage in the Assessment of Vocal Fold Abnormality

**Peva Gbagornah, MD**

**Akiva Leibowitz, MD**

Vocal fold abnormalities encompass a broad spectrum of functional, structural, and neurologic conditions that commonly present with hoarseness, dysphonia, dyspnea, or stridor and frequently require direct assessment of vocal fold structure and mobility. While dysphonia is often transient and related to self-limited etiologies such as viral laryngitis or reflux, persistent or progressive symptoms raise concern for disorders including muscle tension dysphonia, medication-associated mucosal changes, benign phonotraumatic lesions (nodules, polyps, and cysts), vocal fold paralysis, and malignant disease. These conditions may alter vocal fold thickness, symmetry, mucosal vibration, or abduction–adduction dynamics; features that are increasingly amenable to evaluation using noninvasive imaging. Translaryngeal ultrasound (TLUS) offers a radiation-free, bedside modality capable of assessing vocal fold movement, approximation, and gross structural abnormalities, making it particularly relevant in patients with suspected vocal fold paralysis, mass lesions, functional disorders, or in those for whom endoscopic visualization is limited or contraindicated. As the clinical spectrum of vocal fold pathology ranges from benign and reversible conditions to life-threatening airway compromise and malignancy, there is growing interest in TLUS as a complementary tool for the initial assessment, screening, and longitudinal monitoring of vocal fold abnormalities.

Multimodal ultrasound has been recognized as a potentially useful, noninvasive tool for evaluation of the airways and vocal folds. Its availability to bedside clinicians has increased steadily since the 1980s. (1-3) B-mode ultrasound enables visualization of glottic anatomy and dynamic vocal fold movement, whereas spectral Doppler can further characterize motion and vibration patterns. Some vocal movement disorders, such as bilateral vocal fold paralysis, paradoxical vocal fold motion abnormalities, arytenoid dislocation, and laryngeal edema, may underlie respiratory distress and stridor. Laryngeal nerve injury has been reported during surgical procedures involving the thyroid, anterior cervical spine, esophagus, and mediastinum in the surgical patient population. The reported incidence is 2.3% among patients following cardiac and great vessel surgery (4), 3.9% following initial thyroid surgery (5), and 45.3% after radical esophagectomy. (6) Paradoxical vocal motion abnormalities occur when the vocal folds close (adduct) rather than open (abduct) during inspiration and may present with inspiratory stridor and respiratory distress. (7) Therefore, early identification of these abnormalities may help manage patients with respiratory distress or those developing post-extubation respiratory failure in the ICU. The primary methods for diagnosing vocal fold motion abnormalities are clinical examination and indirect flexible laryngoscopy (IFL) (8), which may sometimes be replaced by less invasive Translaryngeal Ultrasonography (TLUS). Ultrasound allows identification of key laryngeal landmarks, including the thyroid cartilage, cricothyroid membrane, vocal folds, arytenoid cartilage, and adjacent vascular structures, while simultaneously assessing vocal fold motion and detecting palsies. The unique characteristics of the larynx, particularly the presence of air in the laryngotracheal space surrounded by cartilaginous structures, pose specific challenges for ultrasound airway evaluation and require a dedicated, technique-specific approach.

### What is currently being used?

Indirect flexible laryngoscopy is a commonly used gold standard diagnostic tool for evaluating vocal fold abnormalities. The procedure involves passing a flexible endoscope through the nasal cavity to visualize the larynx, often with the aid of topical anesthesia. It provides high-quality visualization of vocal fold structure and movement. However, it is invasive and may cause patient discomfort, which can limit tolerance in some individuals, and may lead to respiratory distress.

## Ultrasound Anatomy of the Vocal Folds

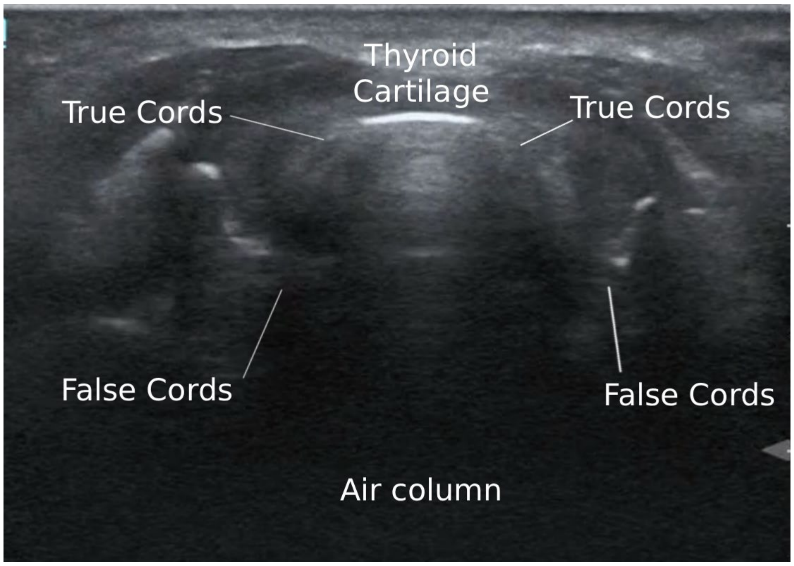


***Figure 1:*** *Labelled ultrasound image of the vocal cords*

Using a Mindray ultrasound machine, a high-frequency linear probe (6-13 MHz) is typically preferred to visualize the laryngeal structures due to its superior spatial resolution. A low-frequency curvilinear probe (2-5 MHz) may also be used in patients with a deeper neck or challenging anatomy, though resolution is reduced at lower frequencies.

The vocal folds consist of mucosal folds that attach anteriorly to the inner surface of the thyroid cartilage and extend posteriorly to the arytenoid cartilages. On ultrasound, the true vocal folds appear as paired, hypoechoic bands corresponding to the thyroarytenoid muscles, bordered by the vocal ligament. The false vocal folds, which contain more fatty tissue, are relatively hyperechoic and lie superior and lateral to the true folds.

Dynamic ultrasound imaging during respiration and phonation allows visualization of vocal fold abduction and adduction. Color or spectral Doppler may be used to identify adjacent vascular structures, such as the superior laryngeal artery, or to assist with orientation. Understanding the relative echogenicity of the true and false vocal folds is essential for accurate interpretation, particularly in patients with edema, anatomical distortion, or limited acoustic windows.

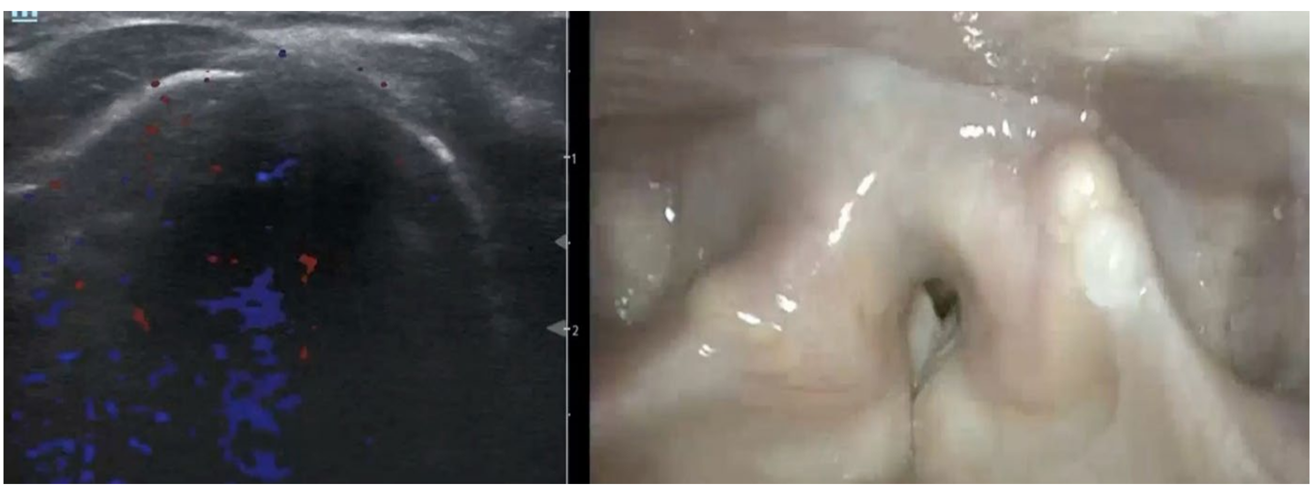

***Figure 2:*** *Translaryngeal ultrasound demonstrating vocal fold anatomy corresponding to the laryngoscopic view*

## Translaryngeal Ultrasound (TLUS) Scanning Technique

### Patient Positioning and Probe Selection:

The patient is placed in the supine position with the neck slightly extended or in a sitting position with an extended neck. A small towel roll beneath the shoulders may optimize exposure of anterior neck structures. During dynamic assessment, the patient may be asked to perform quiet breathing, phonation ("ee"), or sniffing maneuvers to evaluate abduction and adduction.

A high-frequency linear probe (6-13 MHz) is preferred for superficial laryngeal structures due to superior resolution. A low-frequency curvilinear probe (2-5 MHz) may be used in patients with thicker necks or calcified cartilage, though with reduced detail.

### Scanning Planes:

**Transverse (axial) plane:** The transducer is placed horizontally across the thyroid cartilage. This plane shows the true and false vocal folds, the anterior commissure, and the arytenoids.

**Longitudinal (sagittal) plane:** Provides assessment of the cricothyroid membrane, vocal ligament, and anterior laryngeal landmarks.

**Oblique plane:** Helpful in capturing arytenoid movement and the penetration of the superior laryngeal artery using color Doppler.

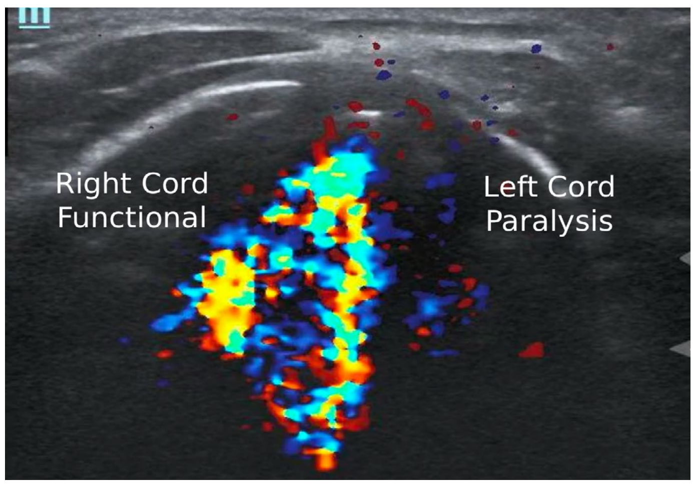


***Figure 3:*** *Translaryngeal ultrasound image with transverse view*

### Step-by-Step Imaging Protocol:

1. Identify the thyroid cartilage: Appears as a hyperechoic linear structure.
2. Slide inferiorly to visualize the true vocal folds, seen as paired hypoechoic bands that move symmetrically during respiration.
3. Locate the false folds, which are more hyperechoic and positioned superiorly.
4. Assess dynamic motion by asking the patient to: Quietly breathe, phonate ("ee" or "he"), or perform a short sniff
5. Apply color Doppler to identify the superior laryngeal artery and assess vibratory patterns. False vocal folds appear hyperechoic due to fatty content.

During quiet breathing, true folds abduct; during phonation, they adduct. Sniff maneuver produces rapid abduction.

Color Doppler may show symmetrical vibration patterns or flow signals near the arytenoids.

## Abnormal Findings:

Unilateral vocal fold paralysis is characterized by immobility of one vocal fold while the contralateral fold crosses the midline during adduction to compensate. In bilateral vocal fold paralysis, there is minimal or absent movement of both folds, resulting in a persistently narrowed glottic gap. Paradoxical vocal fold motion is identified by inappropriate adduction of the vocal folds during inspiration, often producing inspiratory stridor. Arytenoid dislocation presents with asymmetric arytenoid movement or an abnormal contour of the posterior glottis. Laryngeal edema is suggested by thickened soft tissues, reduced vocal fold mobility, and, in some cases, poor visualization of laryngeal structures.

## TLUS vs Indirect Flexible Laryngoscopy (IFL)

| Feature | TLUS | IFL (Gold Standard) |
|---|---|---|
| **Invasiveness** | Noninvasive | Invasive (nasal insertion) |
| **Patient comfort** | High | Low to moderate; may cause gagging/tearing |
| **Respiratory distress risk** | None | Possible worsening of stridor |
| **Imaging quality** | Good for folds and landmarks | Excellent visualization |
| **Real-time dynamic assessment** | Yes | Yes |
| **Visualization limits** | Obesity, thick necks, air interference | Minimal |
| **ICU / sedated patients** | Very feasible | Difficult or unsafe |
| **Training requirement** | Easier for residents | Higher skill requirement |

Translaryngeal ultrasound (TLUS) is particularly valuable in a range of clinical scenarios where noninvasive airway assessment is advantageous. It can be used to evaluate patients with post-extubation stridor, helping to identify underlying vocal fold dysfunction or airway compromise. TLUS is also useful in cases of suspected vocal fold palsy following thyroid, esophageal, or cardiac surgery. In the intensive care unit, it offers a practical alternative for patients who are unable to tolerate indirect fiberoptic laryngoscopy (IFL). Additionally, TLUS plays an important role in pediatric airway evaluations, where cooperation may be limited, and can support preoperative airway assessment in patients with anticipated or challenging airways.

## Discussion:

TLUS is a valuable adjunctive tool for airway evaluation. While IFL remains the gold standard for direct visualization of the larynx, its invasive nature, associated patient discomfort, and potential to exacerbate respiratory distress limit its utility in certain critical care settings. TLUS offers a noninvasive, radiation-free, bedside alternative that is particularly advantageous for anesthesiologists and ICU clinicians.

With appropriate training, clinicians can reliably acquire TLUS images and identify key laryngeal structures. Capturing standardized views in a defined sequence improves the reproducibility and consistency of TLUS assessments. Accordingly, the integration of ultrasound-based airway evaluation into simulation training and perioperative education may enhance clinician proficiency and diagnostic confidence.

However, TLUS has important limitations. Visualization may be impaired in patients with increased neck adiposity, calcified thyroid cartilage, or significant subcutaneous emphysema. In addition, air-tissue interfaces can introduce artifacts that obscure deeper structures. Despite these challenges, TLUS demonstrates strong potential for detecting gross laryngeal motion abnormalities, particularly unilateral or bilateral vocal fold paralysis and paradoxical vocal fold motion disorders.

**Clinical Points**

1. Vocal fold abnormalities are common and clinically significant, ranging from benign, reversible dysphonia to life-threatening airway compromise; persistent or progressive symptoms warrant direct assessment of vocal fold structure and mobility.
2. Translaryngeal ultrasound (TLUS) provides a noninvasive, bedside method to assess vocal fold motion and gross structural abnormalities, making it especially useful in patients with suspected paralysis, post-extubation stridor, ICU patients, pediatrics, or when indirect flexible laryngoscopy is poorly tolerated or contraindicated.
3. TLUS complements but does not replace laryngoscopy; while indirect flexible laryngoscopy remains the gold standard, TLUS enables rapid screening, dynamic assessment, and longitudinal monitoring, particularly for motion disorders such as unilateral or bilateral vocal fold paralysis and paradoxical vocal fold motion.

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**INNOVATION IN EDUCATION**

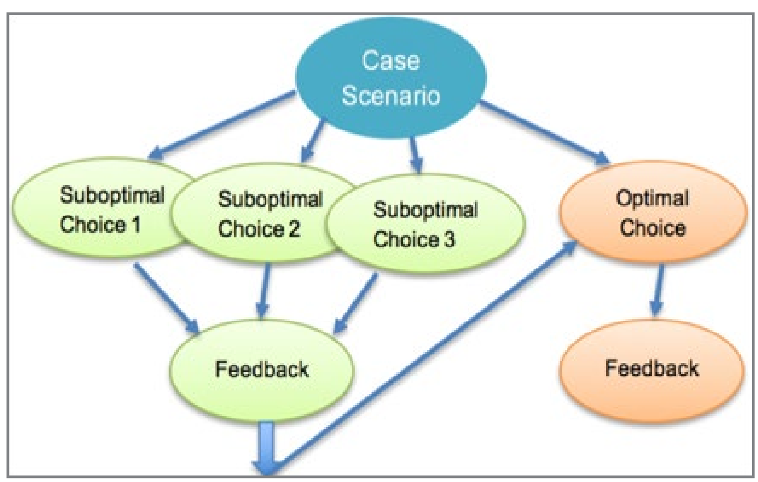
# Development of Advanced Proficiency in Decision Making Using Branched Chain Learning Modules

**Shirin Saeed, MD**

**Daniel Walsh, MD**

The field of anesthesiology has been on the forefront in establishing a strong culture of patient safety by introduction of innovative methods of training, technical advances, and continuous systematic improvements.1 Anesthesiologists work in a highly dynamic and inherently uncertain clinical environment that requires continuous assessment, adept interpretation and informed decision making. Evolving clinical situations require integrative decision-making skills to avoid catastrophic events. Failures in cognitive skills like (1) lapse in clinical judgement, (2) error in decision making, (3) absent shared mental models, and (4) lack of situational awareness have been linked to adverse intraoperative outcomes. Intraoperative decision making is a multifaceted process that incorporates critical thinking, relevant factual knowledge and prior clinical experience. Current model of pedagogy is based on binary and categorical information to manage life threatening situations (black and white) but lacks structured training for evolving clinical emergencies (gray zone). Novice trainees need deliberate repetitive practice in order to develop decision making skills to manage grey areas of anesthesia practice. In current training model, residents develop technical and decisional competency largely through engaging in real clinical setting. However, reduced training hours and sporadic nature of clinical practice limits exposure of residents to various clinical situations. (3) Additionally, the contextual subjectivity and specificity of decision-making skills make it challenging to teach and reliably assess them.

Our proposed method offers targeted teaching for clinical reasoning and decision making in order to further improve training methodology. Branched Chain Learning Modules (BCLM) offer a platform to address these barriers and develop advanced proficiency in decision making in addition to the OR setting. Currently residents are taught decision making skills using problem-based learning discussions and in situ simulation-based learning. We propose that BCLMs offer same level of training with more convenience. BCLMs have a significant advantage over other learning styles in that once module is developed it can be accessed and revisited at any time by the learners. PBLDs and simulation sessions need to be scheduled which limit their accessibility. This flexibility and adaptability make BCLMs an invaluable tool for a wide range of topics. Branched scenarios are interactive storylines designed to simulate real-life clinical situations. In these modules, residents are presented with a series of decision points in which they must make critical choices related to patient management. (4) Learners gain insights and develop expertise for handling challenging and ambiguous clinical situations as they navigate through various decision points in the branching scenario, which promotes active engagement, deep learning, and increased knowledge retention. For instance, a resident is presented with multiple interventional options in a branched scenario on management of a difficult airway. Based on their decisions, the scenario branches out to different pathways (Figure 1). If the resident chooses the most optimal decision, they are directed to a positive outcome for their decision. On making



a suboptimal choice, the scenario leads them to a pathway illustrating the consequences of their decisions. They receive feedback and in-depth explanations regarding the effectiveness of their choice, reinforcing their understanding of their decision and its implications. This iterative process forces residents to learn from their mistakes and they are encouraged to reassess their clinical reasoning and identify their knowledge deficit.

**Problem Based Learning Discussion:** Problem-based learning focuses on addressing a declared specific problem and delves into foundational knowledge and problem-solving skills for only a specific concept.

**In-situ Simulation Learning:** While in-situ simulations expose residents to these types of decision-making situations, they involve multiple logistical and scheduling challenges, and focuses on binary decision making. Additionally, in situ simulation session are offered infrequently in majority of the training programs.

**Expected Findings and their Significance:** Through this pilot study, we hope to show that learners gain better insights and develop expertise for handling challenging and ambiguous clinical situations more easily by navigating through various decision points, which enhances clinical reasoning and the ability to make appropriate and timely decisions, rather than through traditional, linear information presentations.

**Key Take Away Points**

1. Intraoperative decision making is a critical but under-trained competency in anesthesiology, particularly for managing "gray zone" clinical scenarios where evolving physiology and uncertainty demand nuanced judgment beyond binary algorithms
2. BCLMs provide structured, deliberate practice in clinical reasoning, allowing trainees to experience consequences of decisions, receive immediate feedback, and iteratively refine judgment in a safe, reproducible environment.

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GUEST SUBMISSIONS

# Spinal Anterior Column Pain: The Great Mimicker

**Keanne Jabbarzadeh, BS**

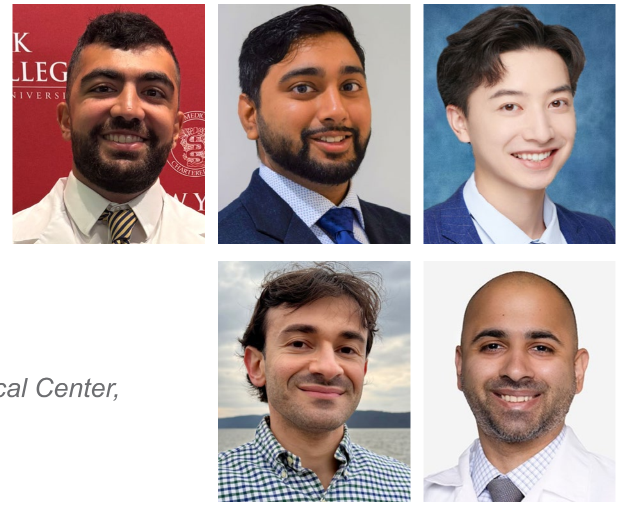
**George John, DO**

**Zhihao Wang, MD**

**Aron Sulovari, MD**

**Ammar Siddiqui, MD**

***Affiliation:*** *Department of Anesthesiology, Westchester Medical Center, New York Medical College, Valhalla NY*



## Introduction

Low back pain accounts for approximately 5.3% of all emergency department visits and costs the U.S. healthcare system an estimated $9.6 billion annually. (1,2) Successful treatment depends on accurately identifying the primary pain generator, which may originate from the posterior (facet or sacroiliac joints) or anterior spinal column (vertebral bodies, endplates, or discs).

Anterior column pain is traditionally associated with axial loading activities (sitting, flexion, or rising from seated positions), but recent evidence suggests that vertebrogenic pain can also present with extension or walking pain. (3) Pathologies involving this region include disc degeneration, acute compression fractures, and vertebral tumors. Kyphoplasty has been associated with improved survival and dramatic reduction in pain in acute compression fractures and may be effective for tumor-related pain when combined with radiofrequency ablation (RFA). (4,5) Meanwhile, basivertebral nerve ablation (BVNA) has emerged as a minimally invasive option for chronic vertebrogenic pain from Modic changes.

We report a case of a patient with multiple anterior column pain generators, including vertebral hemangiomas and Modic changes, who achieved complete resolution of pain after sequential kyphoplasty and BVNA. The case reviews the different pain generators that can cause axial back pain as well as interventions targeted towards diagnosing and treating each of them. Consent was approved from the patient, and the NYMC IRB waived need for IRB approval.

## Case Presentation:

The patient is a 72-year-old male with no significant past medical history who was referred to a chronic pain clinic for axial low back pain. The pain was in the lower back, bilateral, most painful with lumbar extension and facet loading, but also painful with lumbar flexion. Both sitting for prolonged periods and ambulating aggravated the pain.

MRI Lumbar Spine was notable for bilateral facet arthropathy at L5/S1, a small hemangioma near the superior endplate of L3, and a 2-cm hemangioma on the right side of L5, as well as significant Modic 1 and 2 changes in L3, 4, 5 and S1. Given the imaging and exam findings, bilateral medial branch blocks were performed at the levels of L4/L5 and L5/S1 (1 cc local anesthetic per site), producing transient relief during the anesthetic phase. However, subsequent RFA two weeks later (17-gauge needle, Coolief, 2 min 30 sec) failed to provide sustained benefit.

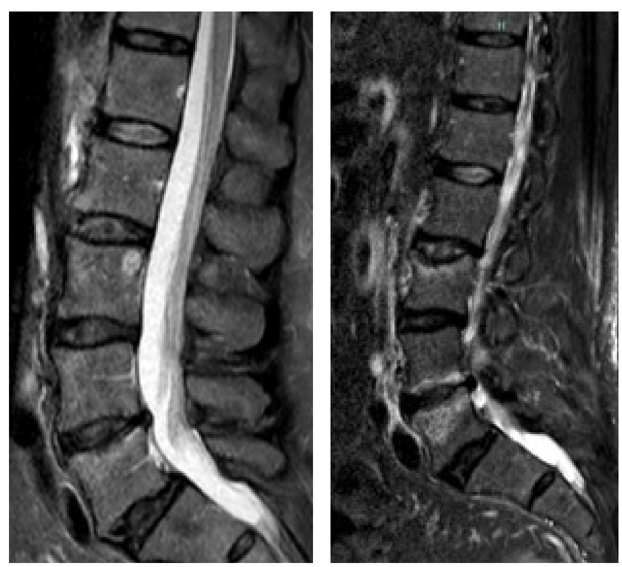


***Figure 1: Left:** Pre-fracture image showing L3 hemangioma. **Right:** STIR sequence showing compression fracture at L3 superior endplate as well as Modic changes at L4 and 5.*

Two weeks later, the patient developed abrupt worsening of low back pain while assisting his wife to stand. The pain was constant, severe, and prevented ambulation. CT imaging revealed a new superior endplate compression fracture at L3, corresponding to the prior hemangioma site. MRI confirmed an acute fracture with STIR hyperintensity in the L3 vertebral body (Figure 1).

The patient underwent a unipedicular L3 balloon kyphoplasty with resolution of his acute pain mid-back within 24 hours of his procedure (Figure 2). His chronic low back pain persisted, however, prompting further evaluation.

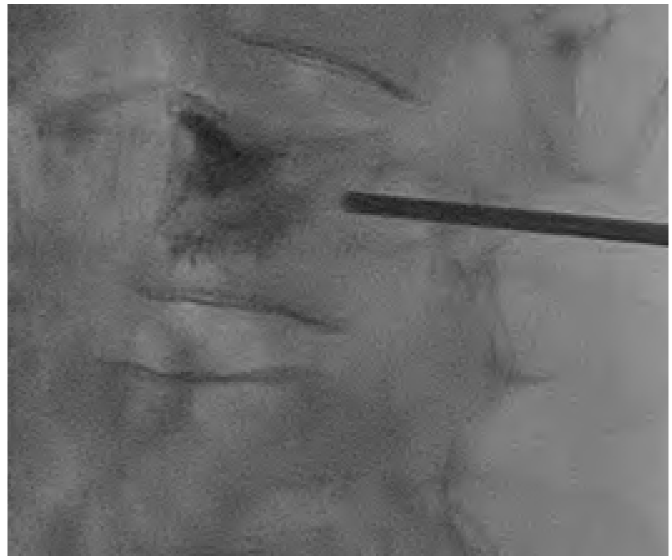


***Figure 2:*** *Unipedicular L3 kyphoplasty*

One week later, he underwent BVNA at L4, L5, and S1 using an 8-gauge transpedicular approach (Figure 3). Procedural trajectories were planned carefully to avoid traversing hemangiomas in the L5 vertebral body and S1 pedicle. No bleeding or complications occurred. The following day, the patient reported complete pain relief (Numeric Rating Scale of 0), which has been sustained for six months. The patient has stopped taking analgesics. In addition, patient reported improved sleep, and improved mobility following the procedures.

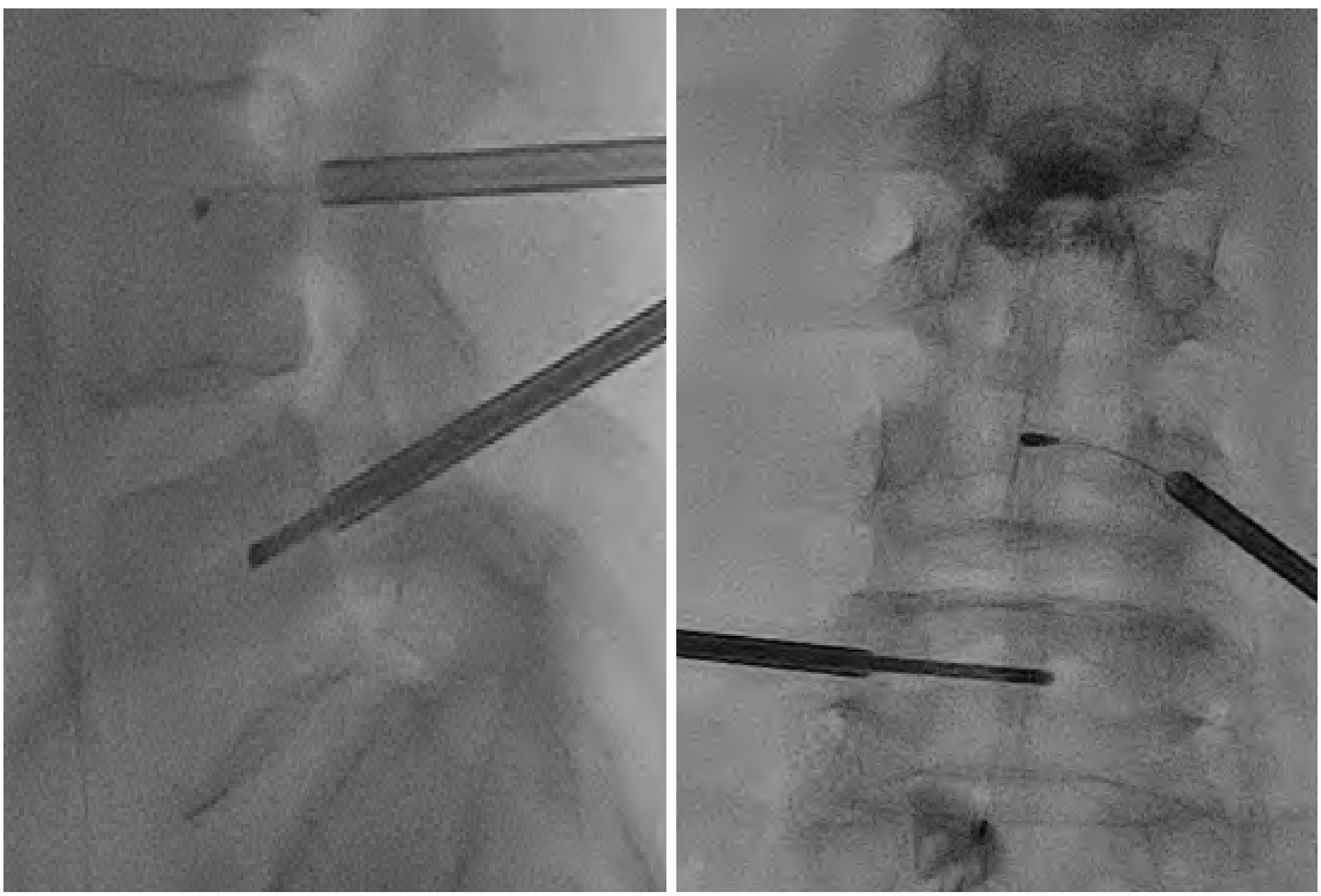


***Figure 3:*** *Basivertebral nerve ablation probe at L4. J Stylet being advanced at L5 to create cavity for probe. S1 was also ablated (not pictured).* ***Left:*** *Lateral image.* ***Right:*** *Anterior-Posterior image.*

## Discussion:

This case illustrates a rare combination of pain generators culminating in a hemangioma-related vertebral fracture. Vertebral hemangiomas are common, benign vascular lesions found in up to 12% of adults. (6,7) They are usually asymptomatic, but aggressive or large lesions can weaken vertebral architecture, predisposing them to fracture. (8)

The initial presentation suggested facetogenic pain based on exam findings and transient relief with medial branch blocks. However, the lack of response to RFA raised suspicion for an alternative pain source. It is plausible that diagnostic block spread temporarily anesthetized the sinovertebral or basivertebral nerve, yielding a false-positive result.

Following the fracture event, kyphoplasty effectively resolved the acute pain from structural collapse. Persistent chronic pain was attributed to vertebrogenic mechanisms given the presence of Modic changes and absence of classic discogenic features. Recent studies indicate that vertebrogenic pain may manifest with extension or walking pain rather than flexion pain, and that Modic changes are the strongest predictors of BVNA success. (9)

This patient had large vertebral body hemangiomas. While hemangiomas in themselves may become painful (the first approved indication for vertebral augmentation was not compression fractures, but painful hemangiomas), this patient was asymptomatic until the weakened structural integrity caused by the hemangioma led to an endplate fracture. The acute compression fracture at L3 was treated with unipedicular balloon kyphoplasty, resulting in immediate improvement of the patient's acute lower-back pain . However, the patient's chronic low-back pain persisted.

There were additional large hemangiomas in the right S1 pedicle and right L5 vertebral body which necessitated careful planning of the procedural trajectory. BVNA utilized 8-gauge cannulas, so there is a risk of further weakening structural integrity and causing fractures should the cannula go through a hemangioma. Additionally, if an ablation probe is deployed within a hemangioma, ablation may be unsuccessful due to poor heat conduction and high impedance.

Another consideration was the risk of compression fractures following BVNA. Fogel's study (10) suggested a high incidence of post procedural compression fractures in patients with untreated osteoporosis, though more recent and larger studies have not. (11) The cause of the patient's fracture was not osteoporosis but a hemangioma. Even though the patient recently had a compression fracture, it was felt that so long as other hemangiomas were not violated by the procedure, the risk of a new fracture was minimal.

BVNA was deferred at the recently augmented L3 level because the thermal effect of kyphoplasty cement may have already ablated basivertebral nerve tributaries, rendering additional ablation unnecessary. (12) Subsequent BVNA at L4, L5, and S1 resulted in complete and durable resolution of axial back pain.

## Conclusion:

This case underscores the need for continual reassessment of pain sources in complex axial low back pain. In patients with multifactorial etiologies, including facet arthropathy, vertebrogenic pain, and vertebral body lesions, targeted sequential interventions can achieve comprehensive and sustained pain relief. Combined kyphoplasty and BVNA represent a rational, complementary approach in selected patients with both structural and vertebrogenic pain components.

## Clinical Points

1. Axial low back pain is often multifactorial; failure of an expected treatment should prompt reassessment of alternative pain generators.
2. Vertebrogenic pain may present with extension or walking pain, mimicking facetogenic patterns and leading to misleading diagnostic block responses.
3. Vertebral hemangiomas are usually incidental, but large or strategically located l esions can weaken vertebral structure and precipitate acute compression fractures.
4. Kyphoplasty rapidly relieves acute fracture-related pain, but does not address coexisting chronic vertebrogenic pain.
5. Sequential, mechanism-based interventions can provide complete and durable relief in patients with complex axial low back pain.

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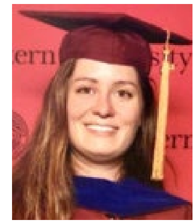
GLOBAL HEALTH

## Severe Anaphylaxis in an Austere Recovery Room: Etiology and Discussion

**Kelly Gallant, PhD, CRNA**
*Northeastern University, Boston*



The patient is a 76-year-old, 59-kilogram G3P2012 female with a history of hypertension and asthma, however, she does not take any daily medications. Despite this, her functional status is excellent as she can easily manage walking long distances in the rugged hillside terrain of Kigali, Rwanda with assistance of a cane. She presented with Stage 4c uterovaginal prolapse with a plan for a Lefort colpocleisis, perineorrhaphy, and a cystoscopy.

A spinal anesthetic was chosen due to equipment limitations and a local shortage of volatile agents (halothane and isoflurane). The patient's hemoglobin was 14.0 g/dl, hematocrit was 44.1%, and platelets 248 $10^3/\mu$. Other lab values were within normal limits. Pre-operative blood pressure was 151/82 millimeters of mercury (mmHg), heart rate of 91 beats per minute (bpm), oxygen saturation of 94% on room air with clear lung sounds.

At 13:20, spinal anesthesia was initiated utilizing bupivacaine 15mg (in 8.25% dextrose), dexmedetomidine 5mcg, fentanyl 15mcg, and epinephrine 200mcg using a 25-gauge Whitacre needle. Clear cerebrospinal fluid flow was obtained easily with one attempt. This created a T3 level block to pin prick within ten minutes.

Surgery began at 13:42. All the following medications mentioned were given intravenously (IV). The patient received midazolam 0.5mg, dexmedetomidine 4mcg, 450mcg of phenylephrine total in 50mcg aliquots. She also received 750mg of intravenous acetaminophen at 14:30. Surgery concluded at 14:48 without complications. Estimated blood loss (EBL) was 50 milliliters (mL). A 14Fr foley was inserted by the surgical team at the end of the case.

Upon arrival to the post anesthesia recovery room at 14:55, her blood pressure was 87/47mmHg, heart rate was 60bpm, and oxygen saturation was 94% on 4 liters oxygen. Ephedrine 10mg was given, with improvement of blood pressure to 144/75, heart rate 53bpm, oxygen saturation 98%. Within five minutes, she began to complain of pruritus and rapidly developed angioedema. The patient soon exhibited decompensated anaphylactic shock, with her heart rate climbing to the 140s, and blood pressure in the 80s/50s mmHg. She was rapidly treated with dilute epinephrine, in aliquots of 10mcg; increasing to 100mcg. This would provide stabilization for about twenty minutes, and then the patient would begin to deteriorate again. In addition to epinephrine, she was given 100mg hydrocortisone, 50mg diphenhydramine, and 20mg famotidine.

In total, 1mg of epinephrine had been given in attempt to stabilize the patient, but her blood pressure kept decreasing as she became increasingly tachycardic. With only one vial of epinephrine remaining, the team decided to chart review again to see if any potential allergens were overlooked. Unfortunately, every exogenous medication that had been given by the anesthesia team had been given over two hours prior at this point. The team reached out to providers in the United States via deidentified text message in attempt to crowdsource a potential allergen. An experienced anesthetist suggested a surgical source.

Upon inspection under the mylar thermal blanket, the Foley catheter was found to be made of latex. The surgical team immediately replaced it with a silicone Foley, resulting in rapid improvement—angioedema resolved, pruritus decreased, and hemodynamics stabilized. The patient's heart rate normalized to 78bpm, blood pressure to 132/51mmHg, respiratory rate to 14 breaths per minute, and oxygen saturation to 99% on room air.

An additional dose of 50mg hydrocortisone was given overnight, and the patient was assessed the next morning in much better condition, with stable vital signs and no pruritus. The patient reported mild pain from the surgical area but otherwise had no complaints. She was discharged to lower levels of monitoring the following day.

Latex anaphylaxis is a function of type one hypersensitivity to IgE-mediated reactions to the proteins in rubber products, with a clear rise of prevalence in the 1980s and 1990s coinciding with the human immunodeficiency virus (HIV) and the advent of standard precautions. (1,2) Prevalence of latex sensitivity ranges from <1% to 7.6% in population studies, with healthcare workers disproportionally reporting allergy, ranging from 3% to 64%. (1)

Allergic asthma strongly correlates with this occupational exposure reaction. Further risk factors include exposure to latex on a frequent basis, as well as those with spina bifida, urogenital abnormalities, preterm infants, cerebral palsy, and history of allergic reactions in the past to name a few. There also is cross reactivity shown between kiwi, bananas, avocado, and chestnuts. (1)

Management requires immediate removal of the causative agent. Therapeutic treatment includes 100% $FiO_2$ supplemental oxygen, IV fluids, and pharmacological treatment:

- Epinephrine: 100-500mcg IV for severe reactions or 0.3-0.5mg of 1mg/ml [1:1000] epinephrine IM
- H-1 blocking antihistamines: diphenhydramine 25-50mg IV
- Bronchodilators: albuterol and ipratropium bromide
- H-2 blockers: famotidine 20mg IV
- Steroids: hydrocortisone 100mg IV or methylprednisolone 125mg IV (2,3)

The patient should have telemetry, frequent blood pressure readings, oxygen saturation, and large-bore intravenous access should be obtained. The patient should be monitored for at least 12-24 hours for refractory anaphylaxis. In the event of refectory anaphylaxis, the patient can be started on an epinephrine infusion anywhere from 1-4mcg/min, titrated to blood pressure. Norepinephrine can be given if there is persistent shock. Further, glucagon 1-5mg IV bolus can also be given if the patient is on a pre-existing beta blocker to reverse its effects. Upon discharge, patients should receive two epinephrine auto-injectors, education on latex avoidance, and referral to an allergist. (3)

**Key Take Away Points**

1. Team-based situational awareness and re-evaluation of every potential exposure can identify hidden causes of anaphylaxis.
2. Even a small, overlooked item, such as a latex Foley catheter, can cause life-threatening decompensation.
3. Latex allergy is now uncommon but still possible—always confirm that all materials used are latex-free, including IV hubs and tubing.

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## Establishing a Paediatric Surgical Outreach Program in Rural Botswana

Catriona Stewart, MD

Botswana has a predominantly young population, with approximately 30% of its citizens under the age of 18. Healthcare services are provided free of charge to all Batswana through the public health system. Services not available within the public sector are typically referred to private facilities and funded by the Ministry of Health; however, due to the current public health crisis, all non-emergency referrals have been temporarily suspended.

For paediatric patients residing in rural areas, transportation to the capital city is funded by the government and includes travel for both the child and a caregiver. Despite this support, long travel distances and prolonged hospital stays impose substantial economic and social burdens on families, as well as significant financial strain on the healthcare system. Extended hospitalizations frequently result from systemic barriers rather than patient-related factors, including limited operating theatre availability, staffing shortages, and inadequate access to specialized equipment, all of which delay timely surgical care.

At present, the national waiting list for paediatric surgical procedures exceeds 500 patients. Over the past two years, the appointment of two paediatric surgeons at Princess Marina Hospital has created an opportunity to expand access through a paediatric surgical outreach model. With facilitation from Dr. Matshaba, Head of the Botswana–Baylor Partnership, Dr. Elnour, a paediatric surgeon within the partnership, and the Botswana–Harvard Health Partnership, a paediatric surgical outreach initiative was developed. This program was made possible through close collaboration with the Botswana Ministry of Health, Airborne Lifeline, and Choppies Supermarket, which together provided access to private aircraft to transport specialist teams to remote regions.

Currently, airborne outreach services are operational in two rural locations, with plans to expand to two additional sites. Ghanzi was selected as an initial outreach site due to its relatively high paediatric population and the availability of suitable infrastructure at the primary hospital, including a dedicated paediatric ward and a single operating theatre with recovery facilities. Surgical capacity at Ghanzi is limited, with an average of approximately five operations performed per week, predominantly caesarean sections, occasional appendectomies, and infrequent emergency laparotomies. The nearest referral hospital is approximately two hours away by road, and all other surgical cases are typically referred to Maun or Princess Marina Hospital in Gaborone.

Prior to implementation, strict patient selection criteria were established to ensure safety in this remote setting. Eligible patients were required to be over two years of age, classified as American Society of Anesthesiologists (ASA) physical status I or II, and scheduled for day-case procedures. A deliberately low threshold for cancellation was adopted should any concerns arise related to patient condition, staffing, or equipment availability. Each outreach team consisted of a specialist anesthetist and either a resident, medical officer, or anaesthetic nurse, ensuring that a dedicated provider was always available to manage postoperative recovery or respond to emergencies on the ward. To reduce same-day cancellations, preoperative telephone assessments were conducted by a medical officer in Ghanzi prior to each outreach visit.

Given the absence of paediatric anaesthesia equipment at the outreach site, all necessary equipment was assembled in advance and transported from Gaborone for each visit. A standardized equipment checklist and proforma were developed to ensure completeness and minimize the risk of omissions.

A typical outreach visit involved departure from Gaborone at approximately 07:00, shortly after sunrise, with arrival at the hospital by 09:00 to conduct preoperative assessments. Surgical lists generally commenced at 10:00, contingent upon the absence of an emergency caesarean section. Return travel was dictated by completion of all specialist activities, with a strict operational cut-off at sunset due to aviation safety constraints. On occasion, this limitation prevented completion of the planned surgical list, raising important system-level, ethical, and moral considerations, including appropriate case overbooking, responsibility for postoperative follow-up, and management of patients cancelled for medical reasons. To address continuity of care, a paediatrician accompanied each outreach visit, allowing same-day evaluation of any child requiring specialist medical assessment.

To date, four outreach visits have been successfully completed. Patients treated ranged in age from two to nine years, with inguinal hernia repair being the most commonly performed procedure, followed by orchidopexy for undescended testes. Although the outreach program is currently paused due to limited availability of paediatric anaesthesia equipment, efforts are underway to address these constraints, with plans to resume services in the near future.

**Key Take Away Points**

**Problems:**

1. Paediatric surgical care in Botswana is highly centralized, resulting in long waiting lists, delayed care, and substantial travel and socioeconomic burdens for rural families.
2. System constraints, including limited theatre capacity, staffing shortages, and lack of paediatric anaesthesia equipment, mpede timely and safe surgical care in rural hospitals.

**Solutions:**

1. A paediatric surgical outreach program was implemented to decentralize care by delivering specialist surgical and anaesthesia services directly to rural sites.
2. Strategic partnerships enabled airborne transport of multidisciplinary teams, while strict patient selection, standardized equipment preparation, and preoperative screening ensured safety and continuity of care.

## VASCULAR CORNER

# Perioperative Management of Patients with Cardiac Implantable Electronic Devices

**Sumeeta Kapoor, MD**

**Xiaohan Xu, MD**

## Introduction

Cardiac implantable electronic devices (CIEDs) are being implanted at increasing rates, reflecting both an aging population and expanding indications for pacing and defibrillation therapies. The introduction of novel technologies including leadless pacemakers, S-ICDs, and EV-ICDs has added further complexity to perioperative management. The newer generation of pacemakers and their distinctive characteristics pose risk of device malfunction inappropriate tachytherapies due to electromagnetic interference from surgical equipment These innovations require clinicians to remain current with device functionalities, manufacturer-specific behaviors, and the implications of EMI from contemporary surgical practices.

In parallel, the perioperative population now includes a growing number of medically complex patients, many of whom undergo vascular, thoracic, and high-risk noncardiac procedures. The perioperative period poses risk for device malfunction, inappropriate tachytherapies, or hemodynamic compromise related to pacing-dependent physiology. Clear, multidisciplinary planning is essential to optimize safety and outcomes.

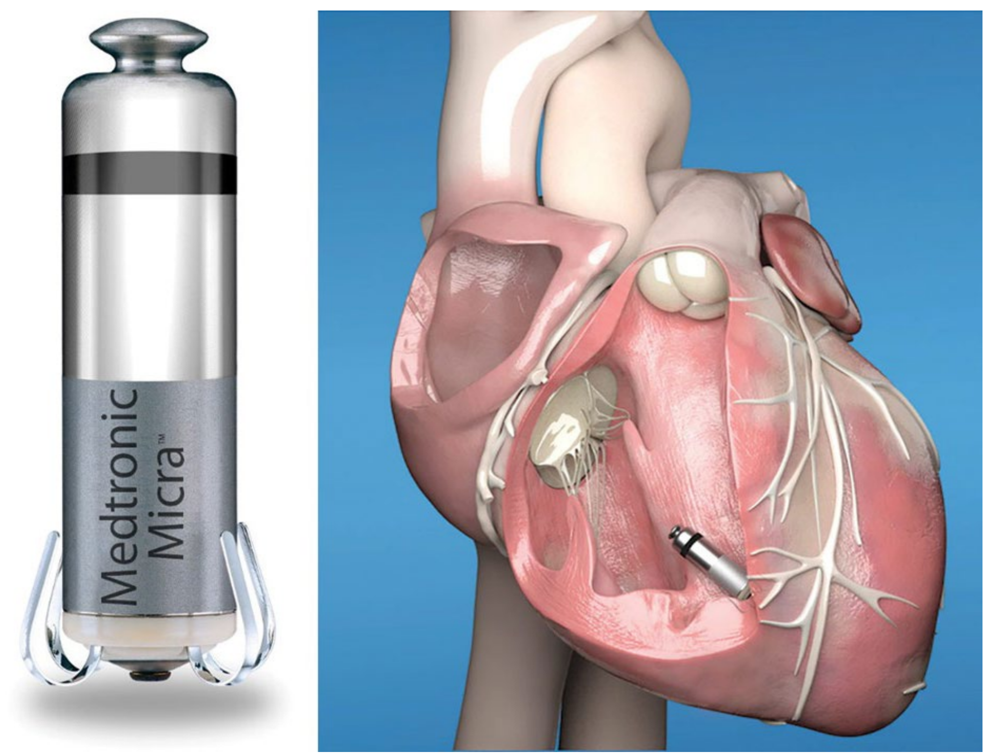


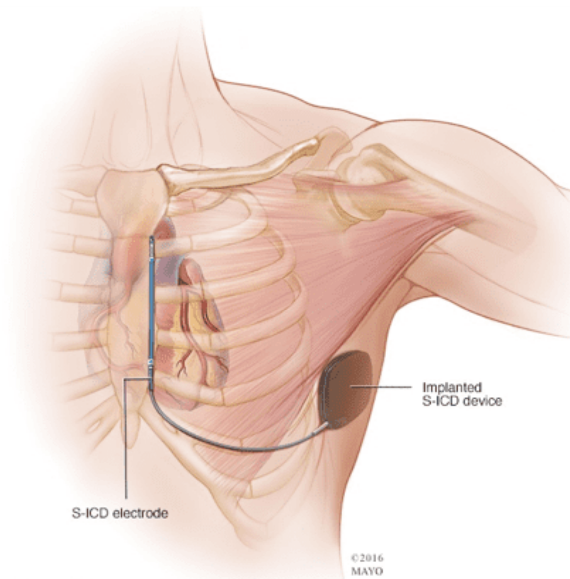

***Figure 1:** An illustration of Cardiac Resynchronisation Therapy Device*

## Epidemiology and Growing Clinical Burden

More than 400,000 new CIEDs including pacemakers, ICDs, CRT devices, leadless pacemakers, and implantable loop recorders are implanted annually in the United States, with most recipients older than 65. Over three million individuals now live with a permanent pacemaker or ICD, with dual-chamber systems comprising the majority of new implants.

## Indications for CIED Placement and Device Selection

Current guideline-based device selection relies on the underlying rhythm disorder, the anticipated pacing burden and dependency, ventricular function, and individual patient characteristics. Dual-chamber pacing remains the preferred approach for patients with sinus node dysfunction or atrioventricular block, while cardiac resynchronization therapy is indicated for individuals with heart failure and conduction delay. Leadless pacemakers are increasingly utilized for single-chamber pacing indications or among patients at heightened risk for device-related infections, providing a less invasive alternative to transvenous systems. Implantable loop recorders continue to play a central role in evaluating unexplained syncope, intermittent arrhythmias, and cryptogenic stroke.




## Electromagnetic Interference (EMI): Mechanisms and Clinical Impact

Electromagnetic interference remains the most common perioperative hazard affecting patients with CIEDs, with monopolar electrocautery above the umbilicus presenting the highest risk. EMI may result in oversensing and subsequent pacing inhibition, inappropriate tachyarrhythmia detection leading to unwarranted ICD shocks, asynchronous pacing or a noise-reversion mode, unintended electrical reset of the device, or, in rare cases, direct generator or lead damage. Understanding these potential outcomes is essential for anticipating and mitigating intraoperative complications.

**Pacemaker syndrome** arises from the loss of atrioventricular synchrony, most commonly in ventricular-only pacing modes such as VVI or VOO. Clinically, it may present with hypotension, dizziness, syncope, palpitations, or exacerbation of heart failure symptoms. Perioperatively, asynchronous pacing should be used only when clearly indicated, as patients with intact AV nodal conduction are susceptible to hemodynamic instability if maintained in asynchronous mode for prolonged periods. Following surgery, it is essential to restore each device to its preoperative settings to minimize these risks and support physiological AV coordination.

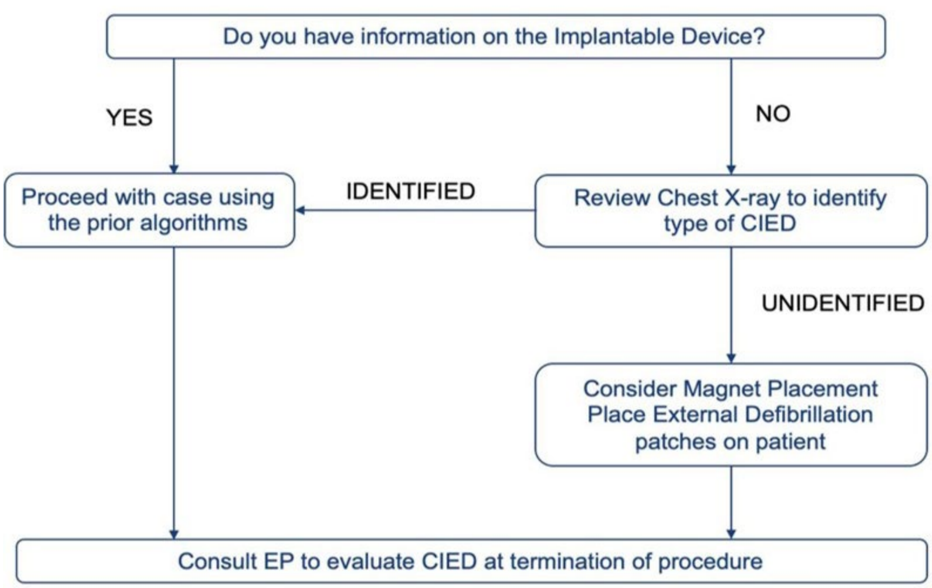



***Figure 2:*** *Decision algorithm for emergency cases*

## Anesthetic Management of Pacemaker

**Preoperative Assessment and Device Evaluation:**

The first step is accurately identifying the device type and manufacturer, distinguishing between transvenous and leadless pacemakers, transvenous ICDs, subcutaneous ICDs, extravascular ICDs, biventricular CRT devices, and implantable loop recorders, while also reviewing the indication for implantation and confirming the precise device location and accessibility. Recent device interrogation, ideally within the prior three months, should be reviewed to determine the patient's underlying rhythm and pacing dependency, along with battery longevity, lead integrity, sensing thresholds, arrhythmia episodes, MRI compatibility, and the device's magnet response. Patient-specific comorbidities such as chronic kidney or liver disease, pulmonary pathology, neurologic impairment, limited vascular access, and the risk of active or recurrent infection must also be factored into perioperative planning. Finally, it is critical to identify potential sources of electromagnetic interference, including monopolar and bipolar electrocautery, radiofrequency ablation, radiation therapy, and a range of procedural tools such as endoscopic devices, TENS units, LVADs, and cardiac contractility modulation systems.

**Intraoperative Management**

Electrosurgical dispersive pads should be placed at least six to twelve inches away from the device and leads, and clinicians should minimize the energy and duration of electrocautery whenever feasible. Bipolar cautery or ultrasonic surgical tools are preferred alternatives when appropriate. Throughout the procedure, external pacing and defibrillation devices must be readily available in the operating room to ensure immediate intervention if device malfunction or arrhythmia occurs.

**Postoperative Considerations**

Before discharge, every patient with a CIED should undergo a postoperative device interrogation to ensure that the original programming has been restored, sensing and capture thresholds are appropriate, and no unexpected arrhythmias or device therapies occurred during the procedure. Battery status should be reassessed, particularly after procedures involving cardioversion, extensive cautery, or radiation exposure. Thorough documentation and communication with electrophysiology teams support continuity of care and help prevent delayed recognition of device-related complications.

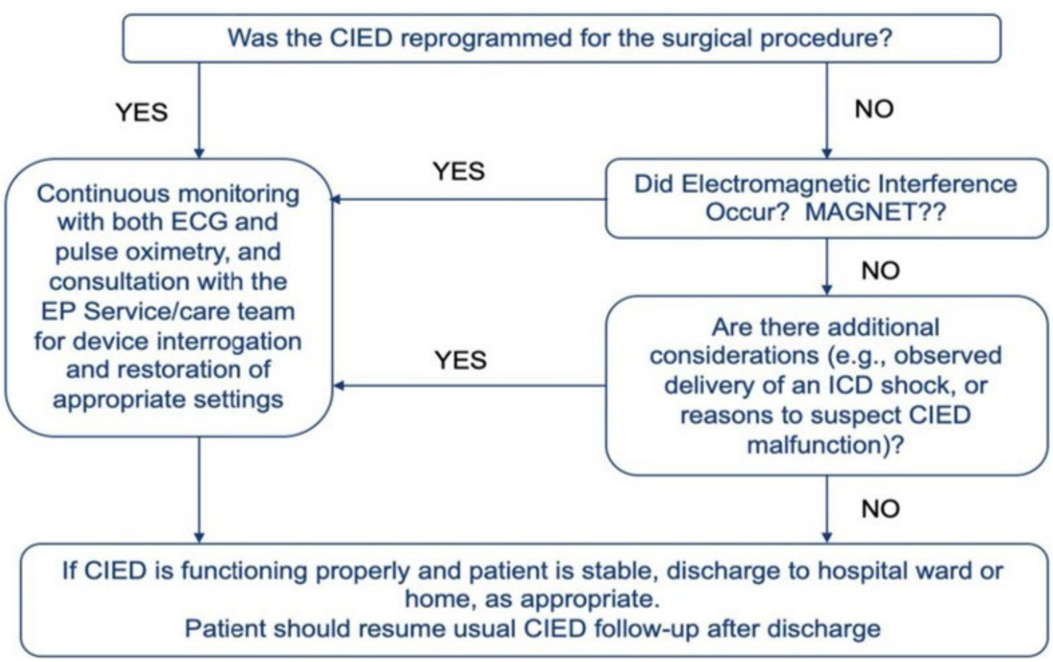



***Figure 3:** Decision algorithm for postoperative management*

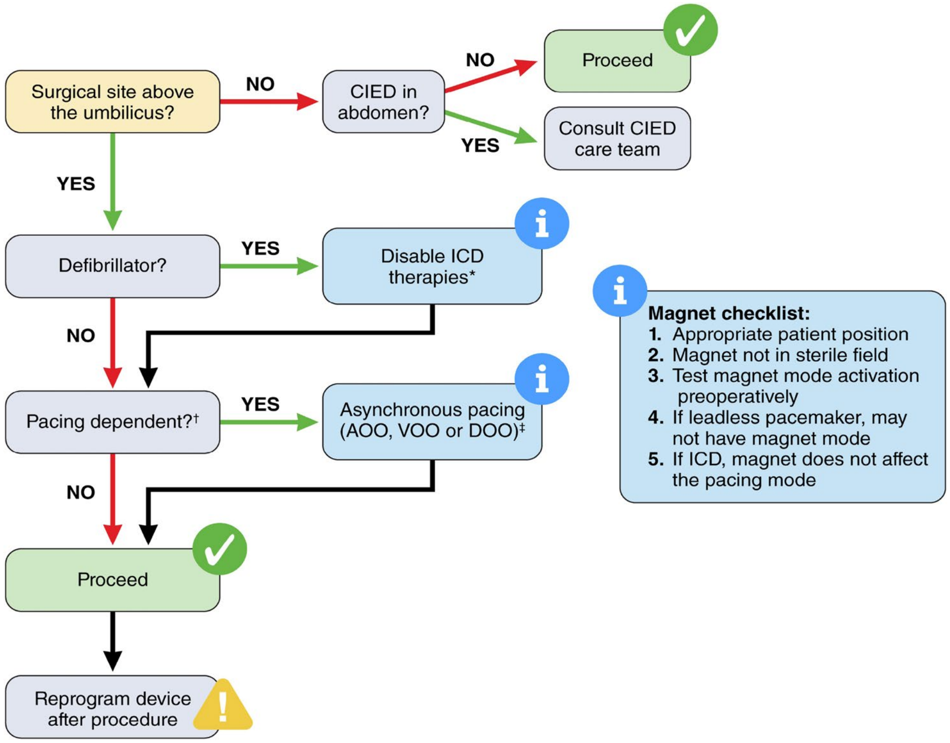



***Figure 4:*** *Perioperative decision-making algorithm for the management of patients with cardiac implantable electronic devices (CIEDs)*

This flowchart (figure 4) outlines a stepwise approach to perioperative CIED management based on surgical site location, device type (pacemaker vs implantable cardioverter-defibrillator), and pacing dependence. For procedures above the umbilicus, defibrillator therapies should be disabled in patients with ICDs, and pacing-dependent patients should be placed in an asynchronous pacing mode (AOO, VOO, or DOO) as appropriate. For surgeries below the umbilicus, most patients may proceed without device reprogramming unless the CIED is located in the abdomen, in which case consultation with the CIED care team is recommended. A magnet checklist highlights key considerations for safe magnet use. All devices should be reassessed and reprogrammed to baseline settings after the procedure.

## 2024 AHA Guidelines: Management of Pacemakers and ICDs

For pacing-dependent patients undergoing surgery above the umbilicus where EMI is anticipated, the 2024 AHA guidelines recommend either magnet application or reprogramming to an asynchronous pacing mode. Reprogramming is generally preferred when magnet stability cannot be ensured, such as during procedures involving leadless systems or those with limited external access. For patients with ICDs, magnet application reliably suspends tachytherapies but does not alter pacing mode; therefore, pacing considerations must be independently assessed. Regardless of device type, postoperative interrogation is essential prior to discharge to confirm that therapies have been restored and device parameters remain intact.

## Leadless Pacemaker

Leadless pacemakers introduce unique perioperative challenges because they are not externally visible or palpable. Micra systems do not respond to external magnets, necessitating preprocedural reprogramming when asynchronous pacing is required, whereas Aveir systems may allow magnet-mediated mode changes depending on configuration. Subcutaneous ICDs are particularly sensitive to EMI due to their superficial lead configuration; their tachytherapies can be suspended with magnet placement, which produces a confirmatory audible tone, though reprogramming is preferred when magnet positioning is unreliable. Extravascular ICDs also permit magnet-mediated suspension of tachytherapies, but their pause-prevention pacing remains unaffected, underscoring the need for direct confirmation of the magnet's effect.

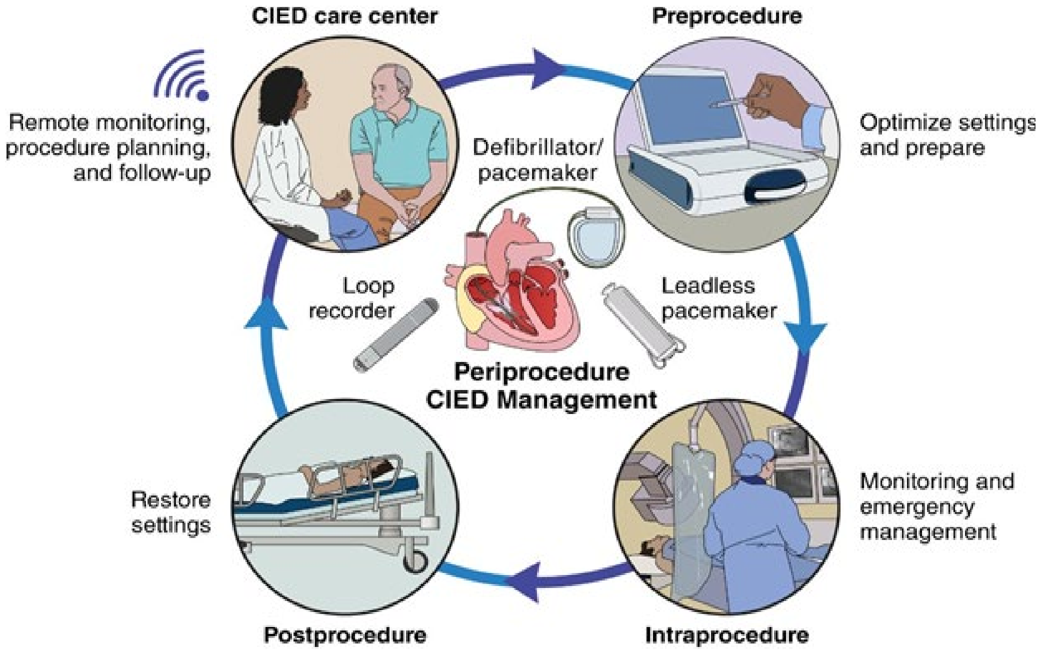



***Figure 5:****Perioperative CIED Management*

**Key Take Away Points**

1. CIEDs are increasingly encountered perioperatively, reflecting expanding use of newer device technologies.
2. Electromagnetic interference is the primary perioperative risk, with potential for pacing inhibition, inappropriate ICD therapies, and hemodynamic instability.
3. Perioperative management must be individualized, based on device type, pacing dependence, and surgical location.
4. Safety relies on coordinated perioperative planning, including device interrogation, EMI mitigation, and readiness for external pacing or defibrillation.
5. Postoperative interrogation is critical, to restore baseline settings and confirm device integrity before discharge.

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## Hyperkalemia Following Peripheral Vascular Surgery

**Sadique Ali, MD**

**Dario Winterton, MD**


Severe hyperkalemia is a time-critical perioperative complication that can rapidly progress to ventricular arrhythmias and cardiac arrest. Patients undergoing lower-limb revascularization for critical limb ischemia and gangrene are at increased risk due to chronic limb ischemia, severe tissue necrosis, metabolic acidosis, and the biochemical consequences of ischemia–reperfusion injury.

Reperfusion following vascular repair and unclamping can abruptly shift potassium and acid load into the circulation, with little warning on standard monitoring. Continuous arterial access permits targeted intraoperative monitoring and serial arterial blood gas analysis at predefined critical time points, particularly before clamp removal, which may facilitate early detection of electrolyte disturbances. Nevertheless, clinically significant hyperkalemia in patients with chronic ischemic peripheral arterial disease can develop rapidly despite close monitoring and may extend into the immediate postoperative period.

### Case:

A 68-year-old female presented for right iliofemoral endarterectomy in the setting of chronic ischemic peripheral arterial disease and a non-healing right heel wound. She had extensive past medical history of chronic obstructive pulmonary disease (COPD) requiring home oxygen, asthma, heart failure with preserved ejection fraction (HFpEF; left ventricular ejection fraction [LVEF] 50–55% on transthoracic echocardiogram [TTE]), coronary artery disease status post percutaneous coronary intervention with stent placement. At the time of presentation, the patient was being treated for an active urinary tract infection with intravenous cefepime and had a recent positive blood culture. After multidisciplinary discussion between the anesthesia, surgical, and infectious diseases teams, the decision was made to proceed with surgery, given clinical improvement and the perceived balance of risks and benefits.

Preoperative TTE was limited by poor image quality. LVEF was globally low-normal (50–55%), with regional wall motion abnormalities not ruled out. The right ventricle was mildly dilated but had normal systolic function. Mild tricuspid regurgitation was present, and pulmonary artery pressures were normal. Preoperative EKG (figure 1) showed a sinus rhythm with marked sinus arrhythmia, left axis deviation, and nonspecific T wave abnormalities. Preoperative labs were largely unremarkable, patient's WBC trend was decreasing from 17k to 13k to 10k on the day of procedure in the setting of an active UTI.


***Figure 1:*** *Preoperative ECG*

Shortly after intubation, the patient was noted to have wide QRS complexes, although hemodynamically stable, but in the setting of new EKG changes, an arterial line was placed in the OR, and arterial blood gas was obtained, which was unremarkable (with potassium of 4.8). Cardiology was consulted, and a 12-lead EKG (figure 2) was obtained, which showed a right bundle branch block with left anterior fascicular block.

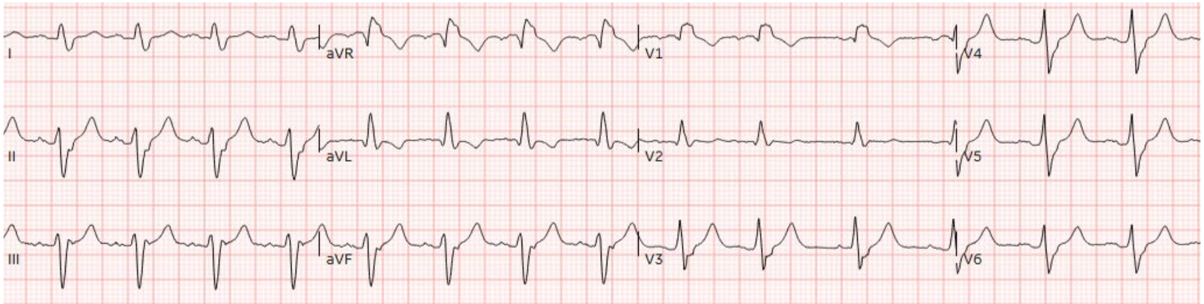


***Figure 2:*** *Intraoperative ECG*

The patient underwent a right iliofemoral endarterectomy with greater saphenous vein patch angioplasty, antegrade angiography of the right lower extremity, and angioplasty of the right superficial femoral and popliteal arteries. The intraoperative course was uneventful after initial EKG changes. The procedure lasted for a total of 4 hours, with 2 hours of clamp time. She was extubated uneventfully after complete reversal of neuromuscular blockade.

After arrival in the post-anesthesia care unit (PACU), the patient developed a wide-complex QRS rhythm accompanied by progressive hypotension, increased work of breathing, use of accessory muscles, and signs of upper airway obstruction. Decision was made to proceed with emergent reintubation. Arterial blood gas analysis and laboratory studies were obtained, and a 12-lead ECG (figure 3) was performed.Tthe patient developed recurrent episodes of bradycardia with prolonged asystolic pauses lasting 3–5 seconds, and a code blue was activated. She developed pulseless electrical activity (PEA) and underwent multiple rounds of cardiopulmonary resuscitation. Transcutaneous pacing was initiated. The lab report showed a K of 8.2 from a prior 4.8, lactic acidosis with lactate of 4.5, which peaked to 9.0, and a pH of 7.14. The patient was treated for hyperkalemia and was transferred to the medical intensive care unit after return of spontaneous circulation (ROSC) was achieved and continuous renal replacement therapy (CRRT) was initiated due to resistant hyperkalemia and lactic acidosis. Post-temporizing labs showed improved K level of 5.6. Potassium continued to improve, though the patient removed on 3 vasopressors (epinephrine, norepinephrine, vasopressors) with rising lactate to 8.3. The post operative course was further complicated by type 1 NSTEMI, persistent encephalopathy, shock liver and renal failure secondary to shock continued need for mechanical ventilation and CRRT requirement.

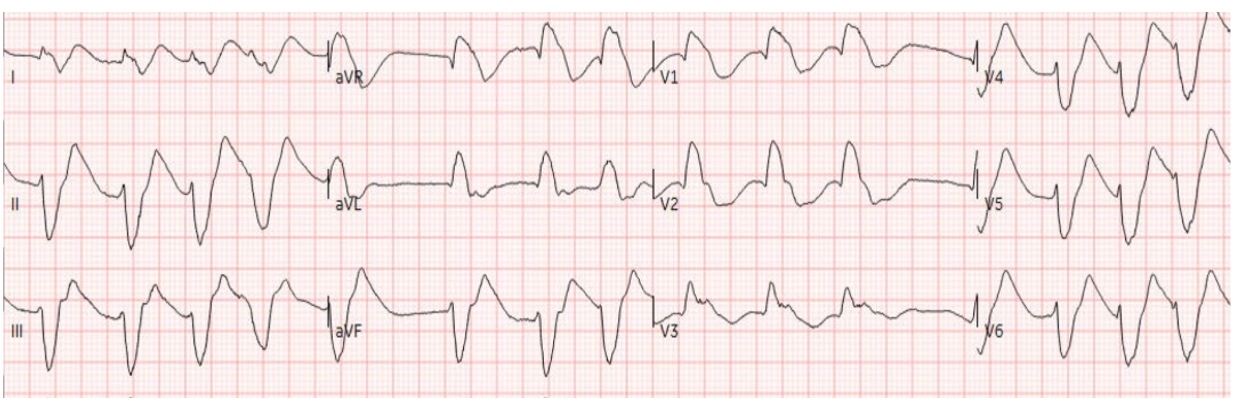


***Figure 3:*** *Postoperative ECG in PACU*

## Discussion:

In the context of chronic limb-threatening ischemia with a non-healing gangrenous heel wound, several peri-operative mechanisms could account for hyperkalemia. These include ongoing cellular breakdown within necrotic tissue and an ischemia–reperfusion injury after revascularization. (1) Restoration of limb perfusion can produce a sudden systemic load of potassium, hydrogen ions, and lactate, particularly on clamp release. Concomitant acidemia can further increase extracellular potassium via transcellular shifts and reduce myocardial contractility. (2) Classic electrocardiographic manifestations of hyperkalemia may be absent or attenuated under anesthesia, making biochemical monitoring critical rather than reliance on ECG changes alone (3). This case also highlights the importance of treating other contributing factors that may potentiate hyperkalemia-related cardiovascular collapse. Hypoxemia and hypercapnia related to sedation or peri-procedural ventilatory compromise can precipitate PEA directly and worsen acidosis, while hypovolemia from vasodilation, third spacing, or blood loss may reduce preload and coronary perfusion, tipping the patient into PEA. These factors should be managed along with management of hyperkalemia (delay clamp removal, intravenous calcium for membrane stabilization, insulin–dextrose ± beta-agonist for intracellular shift, correction of significant acidemia, and definitive potassium removal via CRRT). (4) Vigilant perioperative monitoring, including appropriate point of care testing like (serial ABGs) and maintaining a high index of suspicion for reperfusion injury at critical time points (including clamp release) is essential for earlier recognition and timely management of these high-risk patients.

**Key Take Away Points**

1. Patients with chronic limb-threatening ischemia undergoing lower-limb revascularization are at high risk for sudden, severe hyperkalemia due to ischemia–reperfusion injury, which may precipitate malignant arrhythmias and cardiac arrest.
2. Electrocardiographic changes may be absent or misleading under anesthesia; therefore, high-risk cases require proactive biochemical surveillance with serial arterial blood gases and electrolytes, particularly around clamp release and into the immediate postoperative period.
3. Perioperative cardiovascular collapse in hyperkalemia is often multifactorial, with acidosis, hypoxemia, hypercapnia, and hypovolemia amplifying potassium toxicity; successful management requires simultaneous treatment of hyperkalemia and correction of contributing physiologic derangements, with early consideration of definitive potassium removal (e.g., CRRT).

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## Diastolic Dysfunction and its Importance in Anesthesia

Huma Syed Hussain, MD
Robina Matyal, MD

### Case Vignette:

A 72-year-old female with hypertension, type 2 diabetes mellitus, and a prior cerebrovascular accident was scheduled for right carotid endarterectomy for high-grade symptomatic carotid stenosis. Preoperative vital signs were stable. A transthoracic echocardiography (TTE) performed one year earlier showed preserved systolic function (EF 66%), moderate concentric LVH, grade II diastolic dysfunction, normal valvular structure, and normal pulmonary pressures.

Anesthesia was induced smoothly with propofol, fentanyl, and rocuronium, and maintained with a volatile agent and remifentanil infusion. The surgical procedure was uneventful, with a carotid clamp time of 30 minutes. The patient remained hemodynamically stable throughout, emerged neurologically intact, and was extubated in the operating room before transfer to the PACU.

Shortly after arrival, the patient developed acute shortness of breath. Her vital signs showed tachycardia (108 bpm), a transient hypertensive episode (165/88 mmHg) followed by hypotension (96/54 mmHg), increased respiratory rate (24/min), and reduced oxygen saturation despite supplemental oxygen. Auscultation revealed bibasilar crackles, and ECG showed sinus tachycardia without ischemic changes. Bedside TTE in the PACU demonstrated preserved systolic function (EF ~60%), progression to grade II diastolic dysfunction, moderate concentric LVH, mild left atrial enlargement, and diffuse bilateral B-lines consistent with pulmonary congestion.

This scenario highlights the hemodynamic vulnerability of patients with diastolic dysfunction undergoing carotid surgery, and the importance of tailored postoperative monitoring strategies, particularly in patients with evolving or underestimated diastolic dysfunction.

### Introduction

Left ventricular (LV) diastolic dysfunction (DD) describes abnormalities in myocardial relaxation and ventricular filling during diastole. These abnormalities arise from impaired active relaxation, increased ventricular stiffness, or a combination of both, resulting in elevated LV filling pressures. Although the terms are often used interchangeably, DD refers specifically to echocardiographic evidence of abnormal diastolic filling, whereas diastolic heart failure, or heart failure with preserved ejection fraction (HFpEF), is diagnosed when these abnormalities are accompanied by clinical symptoms such as dyspnea and exercise intolerance. With the progressive aging of the surgical population, DD has become increasingly prevalent and is now commonly encountered in both cardiac and noncardiac surgical settings.

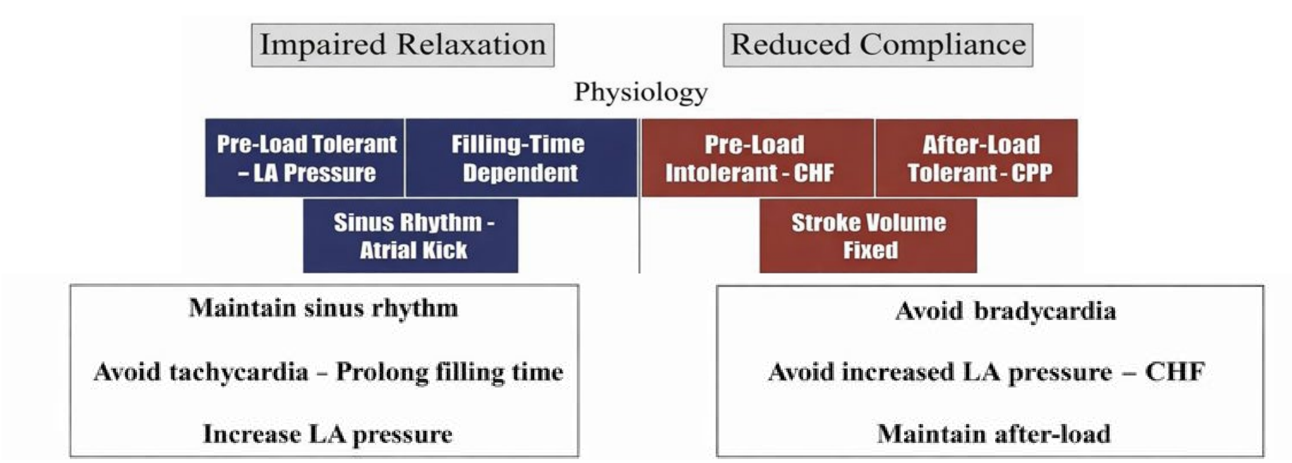


***Figure 1:*** *Physiological differences between impaired relaxation and decreased compliance (1)*

## Pathophysiology of Diastolic Dysfunction

The pathophysiology of DD reflects a complex interaction between the passive elastic properties of the myocardium and the energy-dependent process of active relaxation. At the cellular level, increased myocardial stiffness may result from alterations in the extracellular collagen matrix or shifts in titin isoform expression, which modulate myocardial elasticity. In addition, ventricular–vascular coupling is frequently impaired, leading to an "afterload mismatch," wherein increased arterial load delays myocardial relaxation. In patients with HFpEF, these abnormalities are often dynamic; for instance, exercise may paradoxically slow relaxation due to myocardial energetic deficiency, thereby limiting stroke volume at times of increased physiological demand.

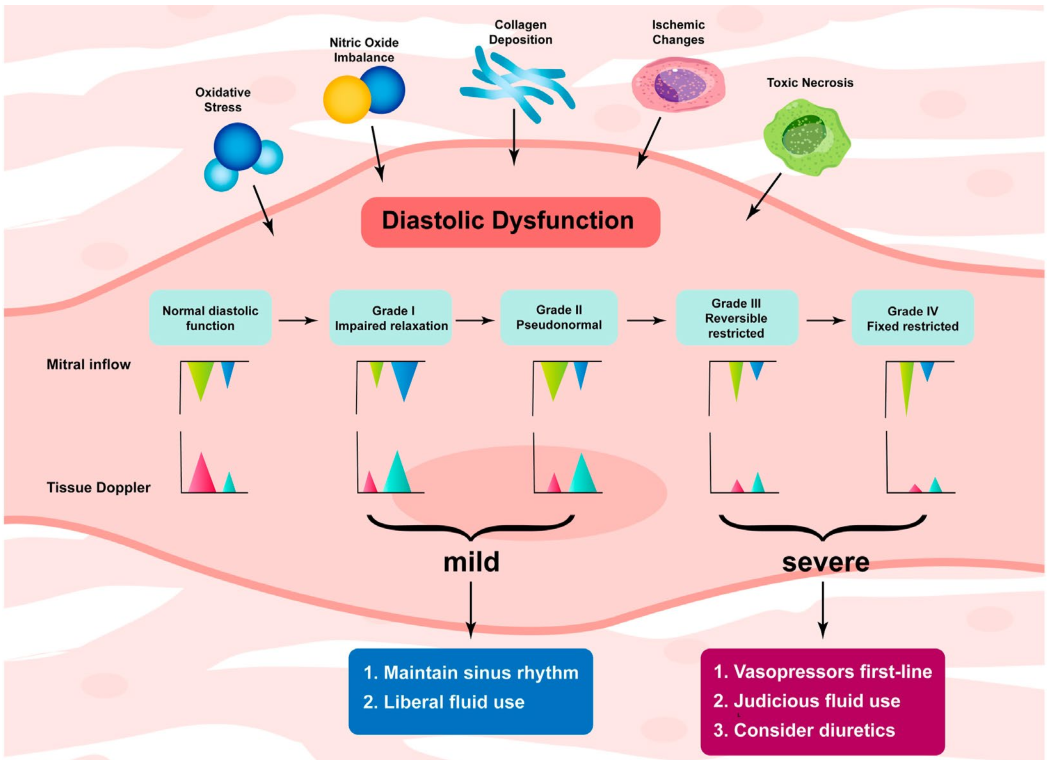


***Figure 2:*** *Underlying causes of diastolic dysfunction (2)*

## Challenges in the Perioperative Setting

Anesthesiologists face challenges in the assessment of DD because current American Society of Echocardiography (ASE) guidelines were developed for ambulatory patients and are not intended for intraoperative use. General anesthesia, altered intravascular volume status, and positive pressure ventilation significantly modify cardiac loading conditions, rendering traditional Doppler-derived indices highly variable and frequently inconclusive. Furthermore, while guideline-based assessments rely primarily on TTE, intraoperative evaluation is almost exclusively performed using transesophageal echocardiography (TEE), necessitating a physiology-based approach rather than strict adherence to complex outpatient algorithms.

## Clinical Importance and Risk Stratification

Identification of DD is clinically important, as it is a strong prognostic marker for adverse perioperative outcomes in cardiac, vascular, and critical care populations. Numerous studies have demonstrated that echocardiographic indices of DD are independently associated with progression to overt heart failure and increased mortality. Even in asymptomatic patients, elevated LV end-diastolic pressures confer vulnerability to abrupt rises in atrial pressure when exposed to surgical stress, tachycardia, or increased afterload. For anesthesiologists, early recognition of DD enables improved perioperative risk stratification, particularly in elderly patients and those with multiple comorbidities who are at heightened risk of developing HFpEF under operative stress.

## Key Echocardiographic Markers

Intraoperative assessment of DD relies on echocardiographic markers that are relatively less load-dependent. Mitral annular early diastolic velocity (e′) is a key indicator of myocardial relaxation, with septal e′ ≤ 6 cm/s or lateral e′ ≤ 7 cm/s generally reflecting impaired relaxation independent of age. The E/e′ ratio is commonly used to estimate left atrial pressure, with values greater than 14 demonstrating high specificity for elevated filling pressures. Additional indices include the left atrial volume index (LAVi), which serves as a marker of chronic pressure elevation when exceeding 34 mL/m², and flow propagation velocity (Vp), which reflects global LV filling dynamics. Emerging parameters such as left atrial strain (LARS) have shown promise in identifying patients at increased risk of heart failure–related hospitalization.

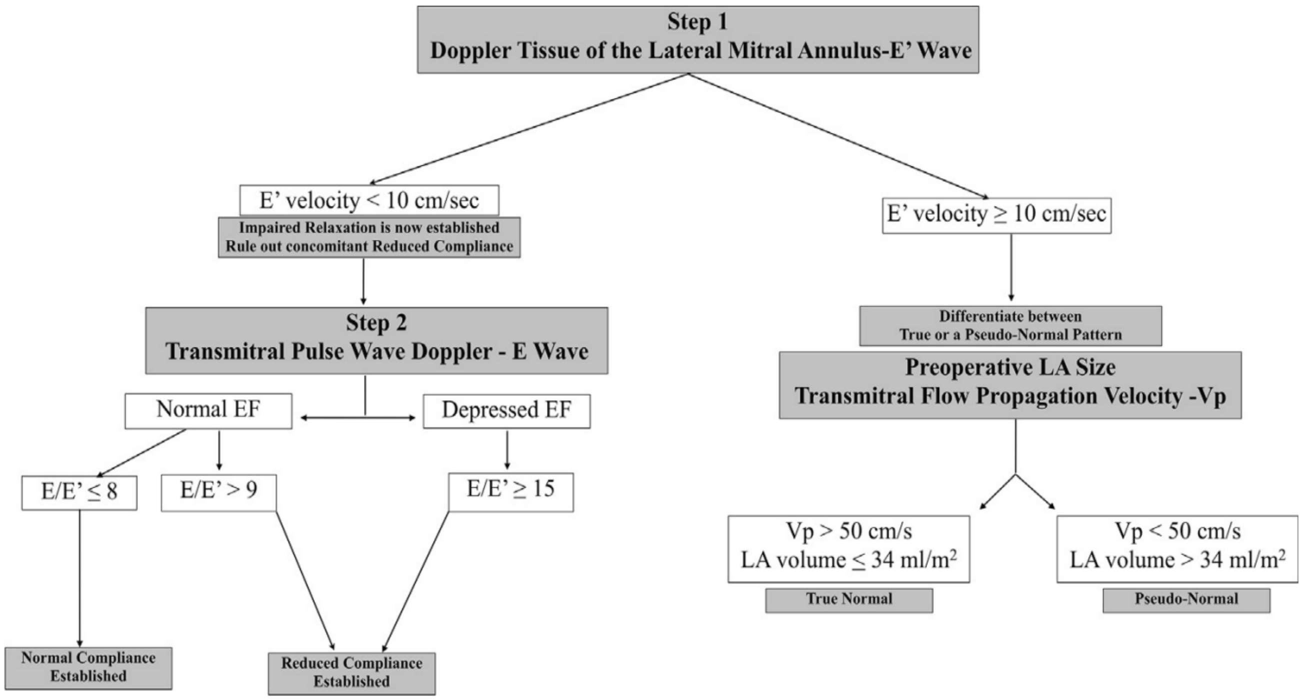


***Figure 3:*** *Diastolic dysfunction algorithm based on the ASE guidelines (3)*

## Conclusion

Although no single therapy exists to reverse diastolic dysfunction, accurate characterization of its severity is essential for optimizing perioperative management. Patients with early-stage impaired relaxation benefit from strategies that enhance diastolic filling, including avoidance of tachycardia and maintenance of adequate preload to preserve atrial contribution to ventricular filling. In contrast, patients with advanced DD and reduced ventricular compliance are often intolerant of volume loading and require cautious fluid administration with judicious use of diuretics to prevent pulmonary congestion. Ultimately, the anesthesiologist's ability to identify and stage DD facilitates individualized, physiology-guided management strategies that can significantly improve perioperative and postoperative outcomes.

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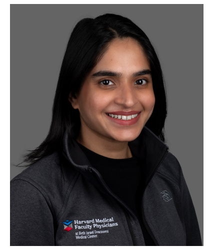
## REGIONAL CORNER

# Local Anesthetic Systemic Toxicity (LAST)

Huma Hussain, MD
Robina Matyal, MD



### Case Vignette:

A 65-year-old female undergoing preparation for elective right upper extremity surgery received an ultra-sound-guided infraclavicular peripheral nerve block in the preoperative holding area. Standard monitoring was in place, intravenous access was confirmed, and the patient remained awake without sedation. The block was performed using incremental injections of local anesthetic with frequent negative aspiration under continuous ultrasound visualization.

Near completion of the block, the patient reported perioral paresthesia, lightheadedness, anxiety followed rapidly by loss of consciousness. Given the close tempo-ral relationship to local anesthetic administration and the combination of neurologic and cardiovascular manifestations, local anesthetic systemic toxicity was immediately suspected. An anesthesia emergency response was activated, and resuscitative measures were initiated.

Management included prompt airway support, seizure control, and early administration of intravenous lip-id emulsion therapy in accordance with established recommendations. The patient experienced transient hypoxemia requiring assisted ventilation and developed cardiac rhythm disturbances during resuscitation, which were managed medically. She subsequently regained consciousness with intact neurologic function and was transferred to the intensive care unit for continued monitoring and supportive care.

The patient made a full recovery and was discharged without residual neurologic or cardiopulmonary deficits.

This case highlights the potential for sudden, life-threatening LAST despite adherence to recommended regional anesthesia techniques and underscores the importance of early recognition, team-based response, and guideline-driven management, including timely lipid emulsion therapy, in optimizing patient outcomes.

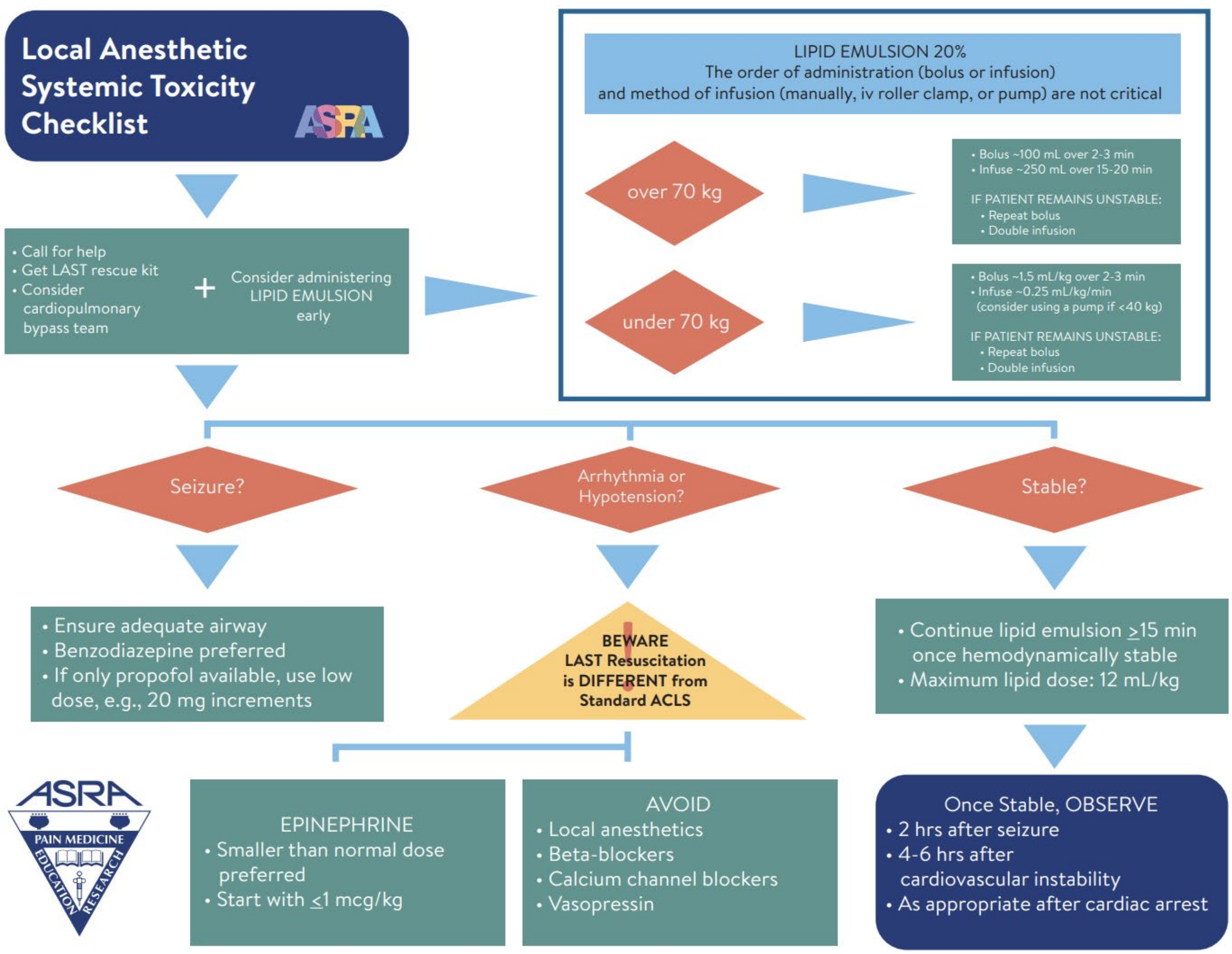
### Management and Discussion

Local anesthetic systemic toxicity (LAST) is a rare but potentially fatal complication that requires rapid recognition and an organized, protocol-driven response. Early neurologic symptoms such as tinnitus, me-tallic taste, and altered mental status may rapidly progress to seizures, hemodynamic instability, malignant arrhythmias, and cardiovascular collapse.

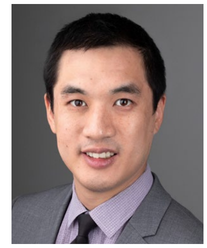
Immediate activation of an institutional emergency response, including an “Anesthesia STAT” call and access to a code cart, is essential. Early designation of a crisis manager facilitates clear leadership and effective team communication. Administration of local anesthetic should be stopped immediately, volatile anesthetics reduced or discontinued, and 100% oxygen delivered to mitigate hypoxia and acidosis

Prompt intravenous lipid emulsion (ILE) therapy is the cornerstone of treatment and should not be delayed. Rec-ommended dosing includes a 1.5 mL/kg bolus of 20% lipid emulsion followed by an infusion of 0.25 mL/kg/min, with escalation to 0.5 mL/kg/min if instability persists and continuation for at least 10 minutes af-ter hemodynamic recovery. Seizures should be treated with benzodiazepines, and large doses of propofol avoided in the setting of cardiovascular compromise.

Management of cardiovascular instability differs from standard resuscitation algorithms. If required, epi-nephrine should be administered in reduced doses (<1 mcg/kg). Agents such as vasopressin, calcium chan-nel blockers, beta-blockers, and additional local anesthetics should be avoided. Prolonged resuscitation may be necessary, and early consideration of cardiopulmonary bypass or extracorporeal support is recom-mended in refractory cases. Following stabilization, patients should be monitored in an intensive care set-ting due to the risk of delayed or recurrent toxicity. Chest radiography may demonstrate pulmonary ede-ma, atelectasis, or aspiration-related changes following seizures or hypoventilation. This case highlights the importance of preparedness, cognitive aids, and team-based training to ensure timely, guideline-driven management of LAST, even when regional anesthesia is performed using recommended techniques.



## MICHAEL LI CORNER



# Gastric Ultrasound

Michael Li, MD

### Background and Clinical Significance

Pulmonary aspiration of gastric contents is a major anesthesia-related complication associated with significant morbidity and mortality. The risk is particularly pronounced in high-risk populations and clinical scenarios such as parturients, emergency surgery, and patients with conditions that impair gastric emptying. The severity of aspiration-related injury is influenced by the volume of gastric contents, their physical nature (clear fluid versus particulate or solid matter), and acidity. Current preventive strategies rely largely on standardized preoperative fasting (nil per os, NPO) guidelines. However, appropriate fasting does not reliably ensure an empty stomach, especially in patients with diabetes, neuromuscular disorders, renal or hepatic dysfunction, trauma, pain, opioid use, or active labor. These limitations underscore the need for individualized, real-time assessment of aspiration risk.

### Role of Gastric Point-of-Care Ultrasound

Point-of-care gastric ultrasound (POCUS) has emerged as a noninvasive, bedside modality that allows qualitative and quantitative assessment of gastric contents immediately before anesthesia, sedation, or airway management. Its primary objective is to aid clinical decision-making when fasting status is unknown, unreliable, or uncertain. Initially adopted in anesthetic practice, gastric POCUS is increasingly utilized by emergency physicians and intensivists who manage airways in time-sensitive and high-risk environments. The technique is focused and goal-directed, with easily recognizable findings and a short learning curve, making it well suited for point-of-care use.

### Conceptual Framework and Clinical Integration

Gastric POCUS follows the I-AIM framework, encompassing Indications, Acquisition, Interpretation, and Medical decision-making. Image acquisition requires appropriate probe selection, patient positioning, image optimization, and adherence to a standardized scanning protocol. Interpretation involves understanding gastric anatomy, physiology, and ultrasound artifacts, while medical decision-making integrates ultrasound findings with clinical assessment and other diagnostic data. While gastric ultrasound can often rule in or rule out clinically significant gastric contents, indeterminate results may occur, in which case serial examinations are recommended.

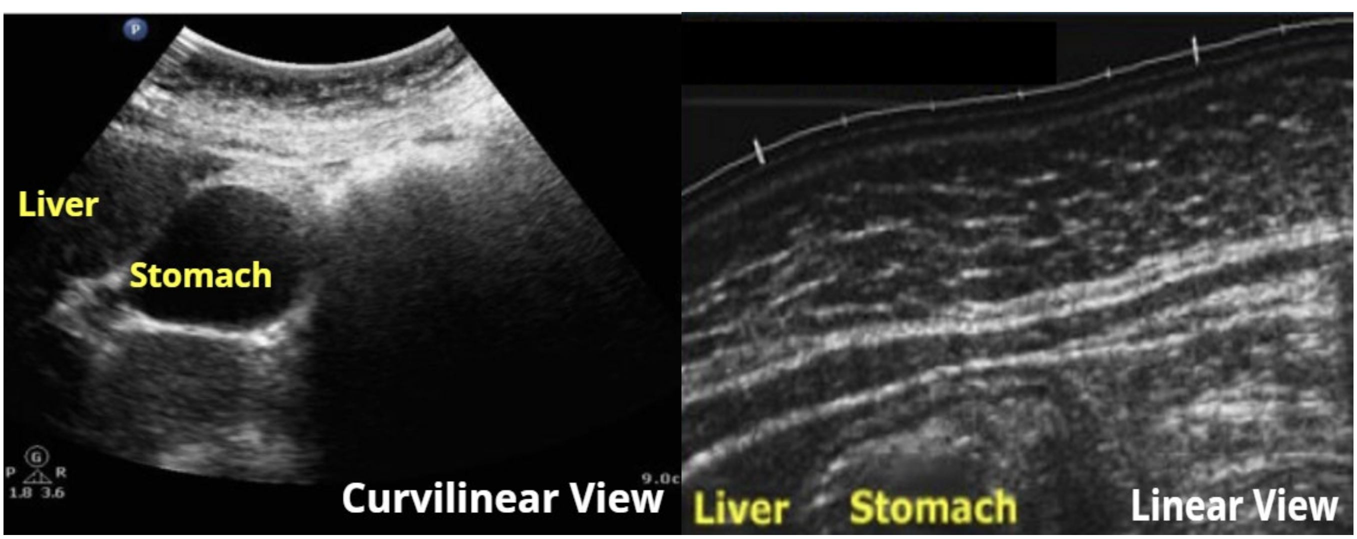



***Figure 1: (Left)** Gastric ultrasound view with curvilinear probe. **(Right)** Gastric ultrasound view with linear probe*

## Sonoanatomy and Imaging Approach

The stomach consists of the fundus, body, and antrum, with the antrum being the preferred target for ultrasound assessment due to its consistent anatomical location and favorable acoustic window. The antrum is located in the epigastrium, inferior to the left lobe of the liver and anterior to the pancreas, aorta, and inferior vena cava. It contains less air than the proximal stomach, facilitating reliable visualization. The gastric wall comprises five distinct layers that can be identified on ultrasound, particularly with high-frequency probes. Accurate assessment requires scanning in both the supine and right lateral decubitus positions, as gastric contents preferentially gravitate to the antrum in the latter position. Ongoing research continues to validate the diagnostic accuracy and clinical utility of gastric POCUS in both elective and emergency settings, supporting its growing role in aspiration risk assessment and perioperative safety.

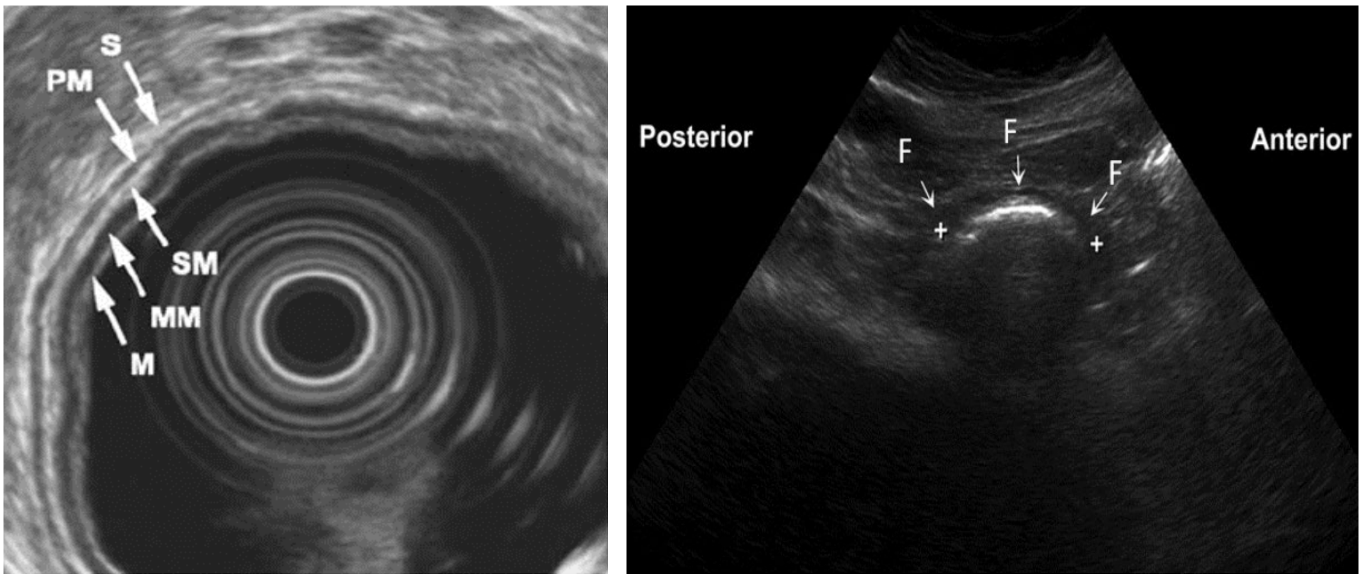



***Figure 2: (Left)*** *Ultrasound image of gatsric wall.* ***(Right)*** *Ultrasound image of gatsric fundus (F).*

Click here to view
a quick gastric ultrasound image!

Click here to *learn how to evaluate*
*aspiration risk with gastric ultrasound!*

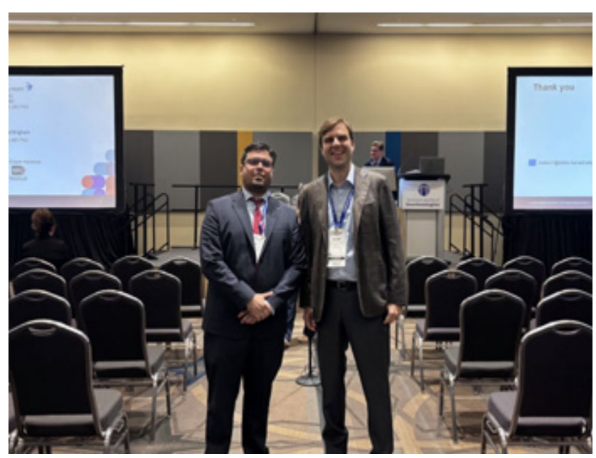
Click here to *learn how to*
*do ultrasound guided gastric volume assessment!*

## NEWS CORNER

The Education team is pleased to present the following abstracts at the upcoming Society for Education in Anesthesia (SEA) 2026 Annual Meeting, on April 24–26, 2026, in St. Louis, Missouri. Aligned with the theme "Beyond the Anesthesia Machine: Finding Your Professional Purpose," these presentations highlight innovative approaches to anesthesia education that support professional identity, growth, and meaningful practice.

| Category | Title |
|---|---|
| Idea Lab Lunchtime Breakout Panel Session | Using Wearable Sensors for Automaticity Training in Ultrasound-Guided Needle-Based Procedures |
| Idea Lab Lunchtime Breakout Panel Session | AI-Driven Debriefing to Enhance Communication in Anesthesiology Simulation |
| Workshop | Strategic Play: Using Board Games to Teach Protocols and Purpose |
| Abstract - Innovative Curriculum | Development, Implementation, and Outcomes of a Virtual Point-of-Care Ultrasound (POCUS) Training Program for Anesthesia Faculty in India |
| Abstract - Designed Study | Virtual Reality Masterclass for Neuraxial Procedure Training: A Multi-Center Pilot Interventional Study |
| Abstract - Designed Study | Assessment of Knowledge, Utilization, and Barriers to the Use of Point-of-Care Ultrasound (POCUS) Among Anesthesiologists in India |
| Abstract - Designed Study | Virtual Reality (VR) Training for Anesthesiologists in Invasive Procedures (VR TAIP) - a Single Center Randomized Controlled Trial |


The Department of Anesthesia at BIDMC was strongly represented at the American Society of Anesthesiologists (ASA) Annual Meeting in San Antonio, Texas, showcasing a range of scholarly and educational contributions. Juan Valencia, MD delivered an oral presentation titled "Development of Biventricular Dysfunction in a Mouse Model of Hyperoxic Lung Injury." Shirin Saeed, MD presented work on the use of chatbots in education, highlighting innovative approaches to anesthesia teaching and learning. In addition, Claudia Friedrich, MD, PhD, was awarded an ASA Annual Meeting Scholarship, supporting her participation in the conference and recognizing her potential as an emerging leader in anesthesiology.



## NEWS CORNER

In November 2025, Clinical Fellows in Department of Anesthesia, Critical Care and Pain Medicine at Beth Israel Deaconess Medical Center (BIDMC) participated in a comprehensive simulation-based training course. Thirteen fellows from the cardiac, vascular, and ICU programs attended the course, which was conducted at the Center for Medical Simulation (CMS) in Charlestown, Massachusetts. The BIDMC Simulation Team, comprising Nadav Levy, Dario Winterton, Federico Puerta Martinez, and Noor Dirini, partnered with CMS to deliver an immersive curriculum focused on enhancing critical clinical skills and decision-making in high-acuity scenarios.

The Simulation team also included Rapid Cycle Deliberate Practice (RCDP) sessions for non technical skills with faculty and CRNAs on December 17, 2025. Overall, the efforts of the BIDMC Simulation Team provided a robust, hands-on educational experience, further strengthening the skills of the teams in critical care and perioperative medicine.

Also in November 2025, the BIDMC Simulation Team comprising of Nadav Levy, Dario Winterton, Federico Puerta Martinez, Noor Dirini, and Isaac Brezinski partnered with Mindray to conduct a comprehensive simulation training course at CMS in Charlestown. The four-day program was tailored for visiting physicians from all over the world and focused on equipping them with the tools and strategies needed to implement simulation-based training in their own institutions using available resources.

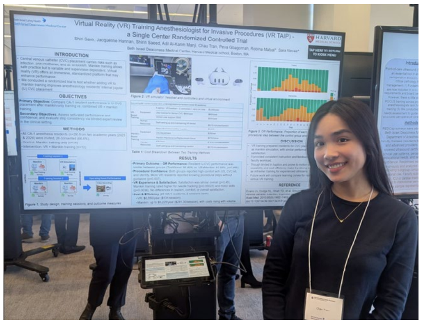


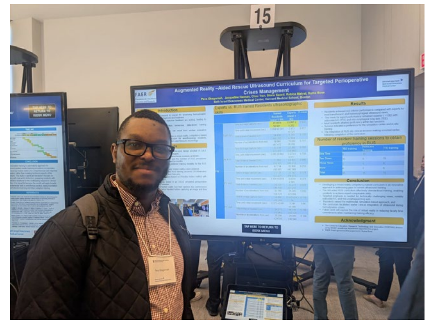
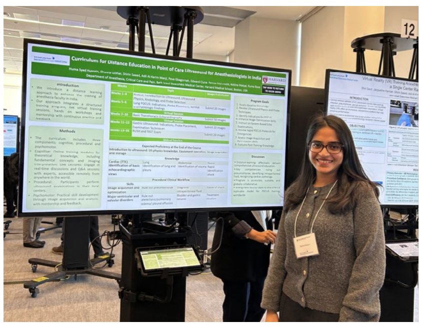


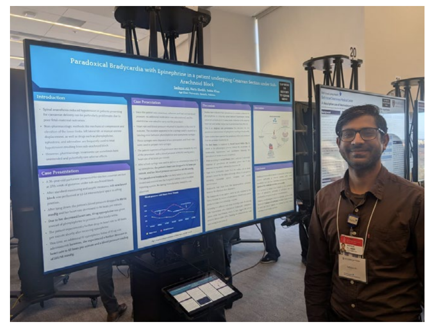

On November 19, 2025, the education team in the Department of Anesthesia, Critical Care and Pain Medicine hosted a Grand Rounds on Cardiac and Lung POCUS featuring practical, hands-on stations with designated faculty leads. Cardiac models were led by Drs. Mark Robitaille and Camila Machado de Souza, while lung ultrasound instruction was led by Dr. Sumeeta Kapoor. Participants performed focused examinations using 2D and M-mode imaging, including standard views such as PLAX, PSAX, A4C, SC4C, SCIVC for cardiac and four-quadrant scans with diaphragmatic views for lung. Case-based discussions were led by Drs. Mona Hedayat,  Shweta Yemul Golhar, and Aidan Sharkey, reinforcing clinical reasoning and application of POCUS findings. Exams were recorded and submitted to QPath, Dr. Michael Li as quality assurance reviewer.

The Education Team presented extensively at the annual BIDMC Anesthesia Research Retreat on November 15, 2025, demonstrating the breadth of scholarly, translational, and educational work within the department.

Chau Tran, MD, was selected as one of the four Top Research Poster Award winners!





| Category | Presentation Title | Presenter(s) |
|---|---|---|
| **Translational/ Basic Science Research** | Impaired PGC-1α–pAMPK Signaling in Postmenopausal Women Undergoing Cardiac Surgery and the Role of Nicotinamide in Its Reversal: Insights from a Murine Model | Ahmed U, Manji A, Valencia J, Bu Y, et al. |
| | MicroRNA Dysregulation May Predict Acute Atrial Fibrillation After CABG: Insights from a Pilot Study | Manji A, Ahmed U, Bu Y, Robitaille M, et al. |
| | Impaired Liver–Heart Crosstalk in Metabolic Syndrome Leading to Cardiac Dysfunction: Role of FGF-21 | Valencia J, Ahmed U, Manji A, Matyal R and Robitaille M, et al. |
| | Development of Echocardiographic Abnormalities in Mice with Hyperoxic Lung Injury | Valencia J, Schroeter J, Robitaille M, Matyal R, et al. |
| **Virtual & Augmented Reality Education** | Virtual Reality Masterclass for Neuraxial Procedure Training: A Multi-Center Pilot Interventional Study | Savir S, Manji A, Matyal R, Jotwani R. |
| | Virtual Reality Training Anesthesiologists for Invasive Procedures (VR-TAIP): A Single-Center Randomized Controlled Trial | Savir S, Hannan J, Saeed S, Manji A, et al. |
| | Augmented Reality–Aided Rescue Ultrasound Curriculum for Targeted Perioperative Crisis Management | Gbagornah P, Hannan J, Tran C, Saeed S, et al. |

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| **Ultrasound Education** | Developing a Perioperative Ultrasound Curriculum: A Multimodal Needs Assessment | Manji A, Saeed S, Bose R, Matyal R, Li M. |
| | Assessment of Knowledge, Utilization, and Barriers to the Use of POCUS Among Anesthesiologists in India | Hussain HS, Yemul -Golhar S, Saeed S, et al. |
| | Curriculum for Distance Education in POCUS for Anesthesiologists in India | Hussain HS, Yemul-Golhar S, Saeed S, et al. |
| | Implementation and Outcomes of a Virtual POCUS Training Program for Anesthesia Faculty in India | Hussain HS, Yemul-Golhar S, Saeed S, et al. |
| | Integration of QPath in Resident Training and Credentialing: A Mentorship-Based Approach | Saeed S, Li M, Manji A, Ahmed U, et al. |
| | Enhancing Resident Competency in Cardiac Ultrasound Through a Structured QA and Feedback System | Saeed S, Li M, Manji A, Ahmed U, et al. |
| | From Fundamentals to Advanced Skills: A Hands-On Refresher Workshop Series | Saeed S, Manji A, Ahmed U, et al. |
| **Health Systems/ Outcomes Research** | Impact of Dexamethasone Vial Size on Dosing Practices and Administration Patterns | Puerta-Martinez F, Winterton D, Levy N, et al. |
| **Simulation & Educational Assessment** | Design and Implementation of a High-Fidelity EEG Simulation Curriculum for Perioperative Training | Brzezinski Sinai I, Puerta Martinez F, Manji A, et al. |
| | High-Frequency In-Situ Simulation in Anesthesia Residency: Impact on Resident Confidence and Communication Skills | Hannan J, Hussain H, Winterton D, et al. |
| | Objective Evaluation of Automaticity in Ultrasound-Guided Procedures: From Simulation to Clinical Translation | Hannan J, Jackson C, Mahmood F, Matyal R. |
| | Resident Confidence with Rescue Ultrasound for Hemodynamic Instability: A Cross-Sectional Survey | Hannan J, Gbagornah P, Tran C, Saeed S, et al. |

## Quiz Yourself

**Audio & Visual Lesson**

Check out case nine here.

*We have compiled cases for quick review of **ECG and rhythm interpretations** for efficient learning and skill enhancement.*

ECG and Rhythms Interpretation