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CLINICS IN MEDICAL EDUCATION

Docendo Discimus
[By Teaching We Learn]

Beth Israel Lahey Health
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HARVARD MEDICAL SCHOOL

Leonardo da Vinci (self-portrait), c. 1478/79. (Courtesy of Peter Ackermann)

"Learning is the only thing
the mind never exhausts,
never fears,
and never regrets."
– Leonardo da Vinci

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."

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EDITOR'S WELCOME

As we enter 2026, we are excited to share the second 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 interactive education journal delivers 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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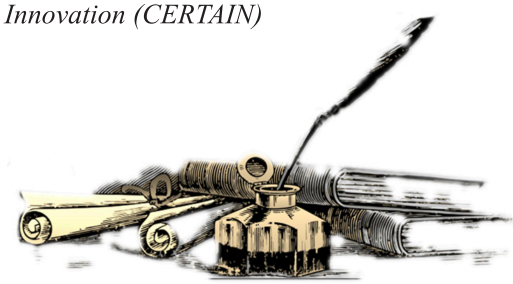

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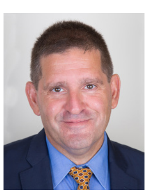

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- Fostering excellence in medical teaching through continuous innovation and professional growth.

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PEDAGOGY IN EDUCATION

Simulation in Healthcare Education: Advancing Clinical Competence, Teamwork, and Patient Safety

Aidan Sharkey, MD

Introduction

Simulation-based education has become an essential component of healthcare training. Increasing clinical complexity, patient safety considerations, and limited opportunities for novice trainees to perform procedures on patients have accelerated the adoption of simulation as a complementary educational strategy. Simulation recreates clinical environments and patient scenarios in a controlled setting, allowing learners to develop technical, cognitive, and behavioral skills without placing patients at risk. Over the past two decades, simulation has evolved from simple procedural task trainers to sophisticated, curriculum-based educational programs that incorporate crisis management, interprofessional collaboration, and performance assessment. The growing body of literature supporting simulation-based training has demonstrated improvements in learner performance, team dynamics, and patient safety outcomes. As a result, many healthcare institutions have integrated simulation into undergraduate, graduate, and continuing medical education programs.

Simulation as a Training Modality

Several features make simulation particularly valuable in healthcare education. First, it provides a risk-free environment for learning. Second, it enables deliberate practice, allowing learners to repeat tasks and refine skills until competency is achieved. Third, it allows standardized exposure to clinical scenarios, ensuring that all trainees encounter key learning experiences regardless of variability in clinical case availability. Simulation is also uniquely suited to teaching complex clinical situations that occur infrequently but require rapid recognition and coordinated management. These high-risk, low-frequency events, such as perioperative crises, hemorrhagic shock, or airway emergencies, are difficult to teach effectively through traditional clinical exposure alone.

***Figure 1:** Forms of simulation in medical education*

Evidence Supporting Simulation-Based Education

Simulation improves procedural skills, enhances team communication, and increases learner confidence and preparedness. In many instances, simulation-based education has also been associated with improvements in clinical performance and patient outcomes. Simulation provides an opportunity for learners to practice procedural and cognitive skills repeatedly, which can shorten the learning curve for complex tasks. Additionally, structured feedback and debriefing allow participants to reflect on their performance and identify areas for improvement. These elements contribute to the development of clinical competence in a controlled educational setting. Importantly, simulation also facilitates the teaching of non-technical skills, including leadership, situational awareness, communication, and teamwork. These competencies are increasingly recognized as critical determinants of patient safety in complex healthcare systems.

Simulation for Procedural Skill Development

One of the earliest applications of simulation in healthcare education involved the use of part-task trainers to teach procedural skills. Training novices in invasive procedures presents several challenges. Clinical care must take precedence over training, and patients expect competent care rather than serving as opportunities for procedural practice by inexperienced trainees. Simulation addresses this challenge by allowing learners to develop procedural proficiency before performing procedures on patients. Prior to performing a clinical procedure, trainees should possess several competencies, including familiarity with equipment, knowledge of relevant anatomy and physiology, understanding of procedural indications, and the motor skills necessary to perform the task. However, evidence suggests that simulators are most effective when used within a structured educational curriculum rather than as isolated training tools. Integrating simulation into a curriculum allows educators to combine technical skill development with cognitive learning and clinical decision-making. For example, point-of-care ultrasound (POCUS) training programs often incorporate simulation to teach image acquisition and interpretation while simultaneously reinforcing clinical reasoning. Facilitated instruction and deliberate practice can improve operator performance and accelerate the development of clinical proficiency. Advances in performance measurement technologies, such as motion metric analysis, further enhance simulation training by providing objective and quantifiable assessments of technical skill. These tools allow educators to track efficiency, movement, and procedural competence over time.

Figure 2: *Task-Trainer Manikins*

Simulation and Crisis Resource Management

Beyond technical skill acquisition, simulation plays a crucial role in teaching Crisis Resource Management (CRM) principles. CRM focuses on the non-technical skills required to manage complex and rapidly evolving clinical crises, including leadership, communication, role allocation, and situational awareness. Simulation scenarios designed around clinical emergencies provide learners with opportunities to practice coordinated responses to critical events. These scenarios often involve interdisciplinary teams, including physicians, nurses, and other healthcare professionals, reflecting the collaborative nature of real clinical environments. Designing effective simulation scenarios requires clearly defined learning objectives, an understanding of the target audience, and a structured narrative that allows the clinical situation to evolve dynamically. Equally important is the pre-briefing process, which establishes psychological safety, clarifies expectations, and ensures that participants understand the goals and logistics of the simulation. Following the scenario, structured debriefing sessions are essential for maximizing educational value. Debriefing frameworks such as Promoting Excellence and Reflective Learning in Simulation (PEARLS) guide reflective discussion and facilitate deeper learning by encouraging participants to analyze their actions and decision-making processes.

Rapid Cycle Deliberate Practice

An innovative approach to simulation-based learning is Rapid Cycle Deliberate Practice (RCDP). Unlike traditional simulation models that allow scenarios to run to completion before debriefing, RCDP interrupts the scenario when a critical skill or behavior is performed incorrectly. Immediate feedback is provided, and the learner is given the opportunity to repeat the task correctly. This cycle of performance, feedback, and repetition continues until the desired level of mastery is achieved. RCDP is particularly effective for teaching time-sensitive skills and reinforcing correct behavioral responses in emergency situations.

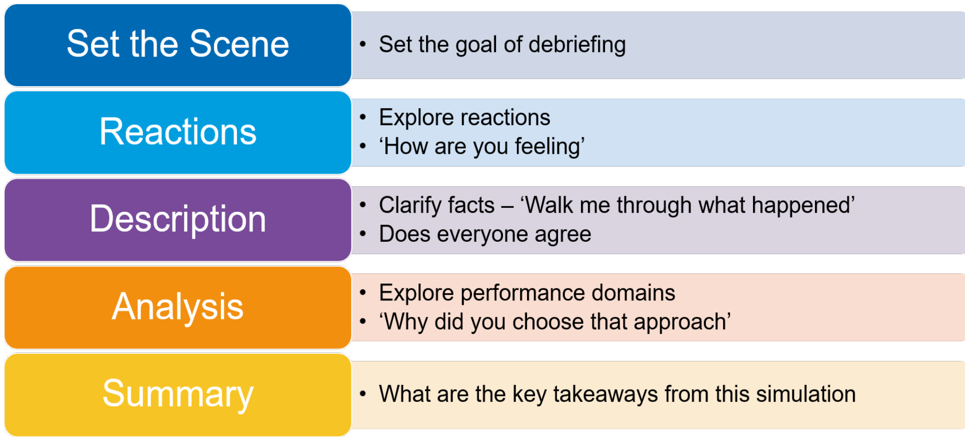

Figure 3: *PEARLS (Promoting Excellence and Reflective Learning in Simulation)*

In-Situ Simulation

In recent years, in-situ simulation has emerged as a valuable extension of simulation-based education. In contrast to simulation conducted in dedicated training centers, in-situ simulation occurs within the clinical environment itself, such as operating rooms, emergency departments, or intensive care units. This approach enhances realism and allows healthcare teams to practice crisis management in their actual work settings. In-situ simulation also provides an opportunity to identify system-level challenges, such as workflow inefficiencies, communication barriers, or equipment limitations. Because these sessions are typically brief and conducted during regular working hours, they can be implemented with minimal disruption to clinical operations. These sessions often place a trainee in the primary decision-making role while other team members participate in their usual clinical roles, allowing learners to experience realistic leadership and crisis management scenarios.

Conclusion

Simulation-based education has become a cornerstone of healthcare training, offering a powerful platform for developing both technical and non-technical clinical skills. By providing a safe environment for deliberate practice, simulation enhances learner competence, improves teamwork, and supports patient safety initiatives. Such programs have the potential to improve not only individual performance but also the overall quality and safety of patient care.

Key Take Away Points

1. Simulation provides a safe and structured environment for clinical learning, allowing trainees to practice technical procedures, decision-making, and crisis management without risking patient safety.

2. When integrated into a structured curriculum, simulation enhances both technical and non-technical skills, including procedural competence, communication, leadership, and teamwork: key components of effective patient care.

Check out Dr. Sharkey's presentation!

Teaching Patient-Centered Communication in Anesthesia: Educational Strategies to Improve Perioperative Patient Satisfaction

Mitra Khany, MD

Abstract

Patient satisfaction is increasingly recognized as an important indicator of healthcare quality and patient-centered care. In perioperative medicine, patients often encounter anesthesiologists shortly before surgery during a period of heightened vulnerability and anxiety. Evidence suggests that patient satisfaction with anesthesia is influenced primarily by communication, empathy, and management of perioperative anxiety rather than technical aspects of anesthetic care alone. This educational review examines determinants of patient satisfaction in anesthesia and discusses practical strategies for incorporating patient-centered communication training into anesthesia residency education.

Introduction

Patient satisfaction has emerged as an important component of healthcare quality assessment. In perioperative medicine, patients frequently meet anesthesiologists shortly before surgery, often during a time when they may feel vulnerable, anxious, and uncertain about the upcoming procedure. Unlike many other specialties, anesthesiologists must establish trust with patients within a limited time frame before the induction of anesthesia. Research examining patient satisfaction in anesthesia consistently demonstrates that emotional and interpersonal factors are among the most important determinants of patient experience. These factors include the clarity of information provided to patients, the quality of communication between clinicians and patients, and the ability of the anesthesiologist to address anxiety and expectations prior to surgery. Preoperative anxiety is particularly common among surgical patients. Many patients express fears related to not waking from anesthesia, experiencing awareness during surgery, postoperative pain, and loss of control during the procedure. Addressing these fears through effective communication and reassurance is therefore essential to improving the perioperative patient experience.

Determinants of Patient Satisfaction in Anesthesia

Communication between clinicians and patients plays a central role in determining patient satisfaction. Patients frequently report that understanding the anesthesia plan and knowing what to expect during and after surgery helps reduce anxiety and improves confidence in their care. Studies have shown that patients who receive clear explanations regarding anesthesia procedures report higher satisfaction scores. Providing information regarding the anesthetic plan, monitoring during surgery, and postoperative recovery can improve patient understanding and reduce fear of the unknown. Empathy is another key determinant of patient experience. Patients often evaluate healthcare encounters based on how respected, heard, and reassured they feel during interactions with clinicians. Simple behaviors such as clearly introducing oneself, maintaining eye contact, and listening carefully to patient concerns can significantly influence patient perceptions of safety and comfort. Clinical outcomes also contribute to patient satisfaction. Poorly controlled postoperative pain, nausea, and vomiting are commonly cited sources of dissatisfaction when not adequately managed. However, studies demonstrate that patients often evaluate their overall experience based on how they were treated emotionally rather than solely on physical symptoms.

Educational Strategies for Teaching Communication

Residency programs can enhance patient-centered communication by incorporating structured teaching methods. One effective approach involves providing residents with structured communication frameworks that encourage acknowledging patient concerns, explaining procedures clearly, addressing fears, reassuring safety, and setting realistic expectations for recovery. Faculty role modeling during bedside encounters is another important educational strategy. Observing experienced clinicians interacting with patients allows residents to learn effective communication techniques in real clinical contexts. Direct observation followed by feedback can further reinforce these skills. Simulation-based education also provides valuable opportunities for residents to practice communication skills. Simulation scenarios involving anxious patients, language barriers, or unexpected concerns allow residents to develop strategies for addressing emotional and informational needs in a safe learning environment. Finally, postoperative follow-up visits by anesthesiologists provide opportunities to reinforce patient trust and continuity of care. Teaching residents to conduct these visits emphasizes the importance of ongoing communication throughout the perioperative process.

Limitations of Current Patient Satisfaction Measures

In the United States, patient experience in hospitals is commonly measured using the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey. Although HCAHPS provides valuable information regarding hospital-wide patient experience, it does not specifically evaluate anesthesia care. Important aspects of anesthesia practice, including preoperative communication, management of perioperative anxiety, and explanations of anesthetic procedures, are not directly assessed in these surveys. Several anesthesia-specific instruments have been developed to evaluate patient satisfaction with anesthesia care, including the Iowa Satisfaction with Anesthesia Scale and other perioperative questionnaires. Despite the availability of these tools, they are not widely incorporated into hospital quality measurement systems. As a result, the contribution of anesthesiology to patient experience may not be fully captured.

Conclusion

Patient satisfaction in anesthesia care is strongly influenced by communication quality, empathy, and management of perioperative anxiety. The brief but critical interaction between the anesthesiologist and the patient before surgery represents an important opportunity to establish trust and address patient concerns. Teaching patient-centered communication should therefore be considered an essential component of anesthesia residency education. Educational strategies such as structured communication frameworks, bedside teaching, simulation training, and postoperative follow-up visits may help residents develop the skills necessary to improve the perioperative patient experience. By integrating communication training into anesthesia education, residency programs can promote both high-quality clinical care and improved patient-centered outcomes.

Key Take Away Points

1. Communication and empathy are central to patient satisfaction in anesthesia, often influencing patient experience more strongly than technical aspects of anesthetic care.
2. Training anesthesia residents in patient-centered communication strategies, through structured teaching, role modeling, and simulation, can improve perioperative patient experience and trust.

References:

1. *Capuzzo M, et al. Emotional and interpersonal factors are most important for patient satisfaction with anaesthesia. Acta Anaesthesiol Scand. 2005.*
2. *Capuzzo M, et al. Factors predictive of patient satisfaction with anesthesia. Anesth Analg. 2007.*
3. *Caljouw MA, et al. Patient satisfaction with perioperative care. Br J Anaesth. 2008.*
4. *Bello C, et al. Patient-reported perioperative anxiety and satisfaction. Scientific Reports. 2023.*
5. *Soltner C, et al. Empathy and continuous anesthesiologist care. Br J Anaesth. 2011.*
6. *Myles PS, et al. Patient satisfaction after anesthesia and surgery. Br J Anaesth. 1999.*

Teaching Anesthetic Management of Pheochromocytoma: A Structured Educational Framework for Trainees

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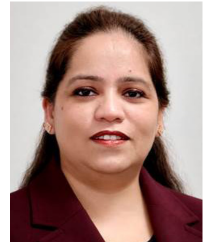


Abstract

Pheochromocytoma is a catecholamine-secreting tumor associated with significant perioperative hemodynamic instability. Anesthetic management requires careful preoperative preparation, vigilant intraoperative monitoring, and rapid responses to dramatic physiological changes during tumor manipulation and resection. Because of the rarity of the condition and the complexity of its management, trainees often have limited clinical exposure to these cases. Structured educational approaches can therefore play a critical role in preparing anesthesia learners for safe perioperative management. This article presents a teaching framework for the anesthetic management of pheochromocytoma, integrating pathophysiology, perioperative planning, and crisis management algorithms. The framework is designed to facilitate trainee understanding through a stepwise approach covering preoperative evaluation, intraoperative anesthetic strategies, and postoperative care. Emphasis is placed on recognizing key physiologic transitions, particularly hypertensive crises during tumor manipulation and profound hypotension following adrenal vein ligation. This structured approach provides educators with a practical model for teaching complex endocrine surgical anesthesia while reinforcing principles of crisis resource management and hemodynamic stabilization.

Introduction

Pheochromocytoma is a rare catecholamine-producing tumor arising most commonly from the adrenal medulla. Excess secretion of catecholamines such as norepinephrine, epinephrine, and dopamine results in significant cardiovascular instability that can complicate surgical management. Patients classically present with episodic headaches, diaphoresis, and palpitations, although clinical manifestations may vary depending on the predominant catecholamine secreted.

From an anesthetic perspective, surgical resection of pheochromocytoma presents unique challenges. Manipulation of the tumor can trigger sudden surges of catecholamines, producing severe hypertension, tachyarrhythmias, and end-organ stress. Conversely, ligation of the adrenal vein leads to an abrupt decrease in circulating catecholamines and may result in profound hypotension. Due to the rarity of these tumors, many trainees encounter few cases during their training. Consequently, educational strategies that integrate physiology, pharmacology, and crisis management are essential. A structured educational framework can help learners conceptualize the dynamic phases of perioperative management and prepare them to respond effectively to rapid hemodynamic changes.

This article presents an educational approach to teaching anesthetic management of pheochromocytoma that emphasizes three key phases: preoperative optimization, intraoperative management, and postoperative care.

Pathophysiology Relevant to Anesthetic Management

Pheochromocytomas secrete catecholamines that act on adrenergic receptors to produce widespread physiologic effects. Norepinephrine predominantly stimulates α-adrenergic receptors, resulting in intense vasoconstriction and severe hypertension. Epinephrine produces both α- and β-adrenergic effects and may cause tachyarrhythmias and episodic hypertensive crises. Dopamine-secreting tumors may be clinically silent and occasionally present without sustained hypertension.

Chronic catecholamine excess leads to several physiologic adaptations relevant to anesthetic management. Persistent vasoconstriction results in contraction of the intravascular volume. Additionally, prolonged adrenergic stimulation can cause receptor downregulation and catecholamine-induced cardiomyopathy. These changes create a paradoxical physiological state in which patients appear hypertensive yet remain volume depleted. Understanding these mechanisms helps learners anticipate the hemodynamic responses that occur throughout the perioperative period.

Preoperative Assessment and Optimization

Diagnostic Evaluation: Diagnosis is typically confirmed through biochemical testing demonstrating elevated plasma or urinary metanephrines. Imaging modalities such as computed tomography, magnetic resonance imaging, or metaiodobenzylguanidine (MIBG) scans are used to localize the tumor. Approximately 30% of pheochromocytomas are associated with hereditary syndromes, including multiple endocrine neoplasia type 2 (MEN2), von Hippel–Lindau disease, and neurofibromatosis type 1. Genetic counseling and testing may therefore be recommended. Cardiac evaluation is essential. Electrocardiography may reveal left ventricular hypertrophy or arrhythmias, while echocardiography is used to assess ventricular function and evaluate for catecholamine-induced cardiomyopathy.

Alpha-Adrenergic Blockade: Alpha-blockade is the cornerstone of preoperative preparation and is typically initiated 7–14 days before surgery. Common agents include phenoxybenzamine, a nonselective irreversible α-blocker, or doxazosin, a selective α1 antagonist. Adequate blockade helps prevent intraoperative hypertensive crises and allows restoration of intravascular volume.

Beta-Adrenergic Blockade: Beta-blockers are introduced only after effective alpha-blockade has been established. Initiating beta-blockade prematurely can lead to unopposed α-adrenergic vasoconstriction and severe hypertension.

Volume Expansion: Patients are encouraged to follow a high-salt diet with increased fluid intake to correct chronic volume depletion. This strategy reduces the severity of post-tumor resection hypotension.

Intraoperative Management

Operating Room Preparation

Preparation of the operating room is critical for safe management of these cases. Standard monitoring is supplemented with invasive arterial blood pressure monitoring prior to induction of anesthesia. Large-bore intravenous access is required to facilitate rapid fluid administration. Advanced hemodynamic monitoring, such as central venous catheters, pulmonary artery catheters, or transesophageal echocardiography, may be considered in patients with cardiac dysfunction or significant comorbidities. Anesthetic teams must also ensure immediate availability of vasoactive medications, including vasodilators for hypertensive crises and vasopressors for post-resection hypotension.

Induction of Anesthesia

The primary goal during induction is to avoid sympathetic stimulation that could trigger catecholamine release. Adequate anxiolysis and a smooth induction are essential. Common induction agents include propofol or etomidate combined with opioids such as fentanyl or remifentanil. Non-depolarizing neuromuscular blocking agents such as rocuronium, vecuronium, or cisatracurium are preferred. Drugs that stimulate the sympathetic nervous system or release histamine should be avoided. For example, ketamine may provoke sympathetic activation, while agents such as morphine or atracurium can cause histamine release and hemodynamic instability. Deep anesthesia must be achieved prior to airway manipulation to prevent hypertensive responses during laryngoscopy and intubation.

Maintenance of Anesthesia

Volatile anesthetics such as sevoflurane or isoflurane are commonly used for maintenance. Short-acting vasoactive agents should be readily available to treat rapid fluctuations in blood pressure and heart rate. Several surgical events can provoke catecholamine release and hemodynamic instability. These include patient positioning, skin incision, pneumoperitoneum during laparoscopic procedures, and particularly tumor manipulation.

Management of Intraoperative Hypertensive Crisis

Severe hypertension during tumor manipulation is a hallmark of pheochromocytoma surgery. Management follows a stepwise approach. The first step is optimization of anesthetic depth to eliminate reversible causes such as inadequate anesthesia, hypercarbia, or surgical stimulation. If hypertension persists, rapid-acting vasodilators are administered. Common pharmacologic options include phentolamine, nicardipine or clevidipine, and sodium nitroprusside. Magnesium sulfate may also be used because it provides calcium channel blockade and may inhibit catecholamine release. Tachycardia can be treated with short-acting beta-blockers such as esmolol. This algorithmic approach helps trainees respond systematically during periods of severe hemodynamic instability.

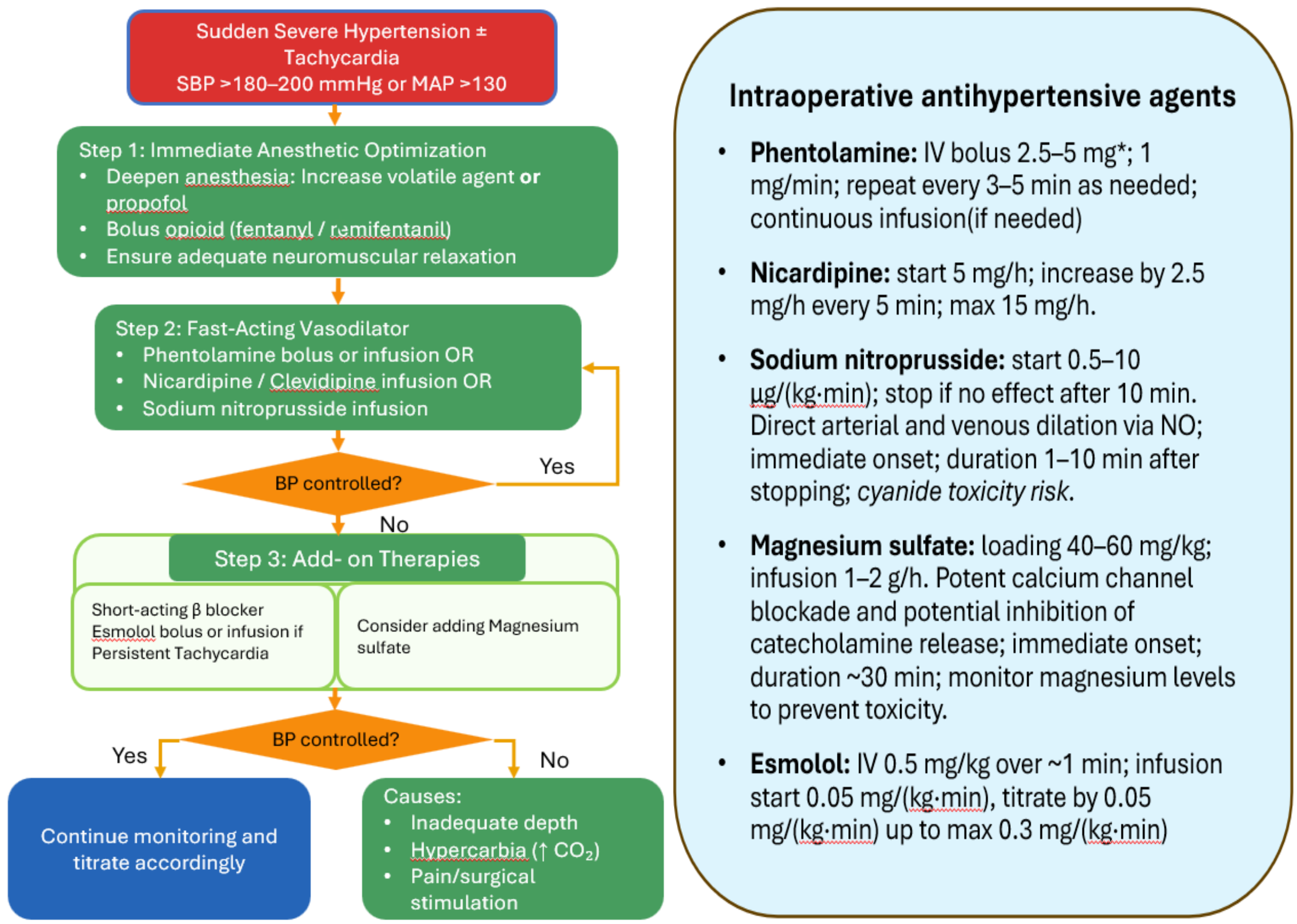

Figure 1: *Intraoperative hypertensive crisis algorithm*

CT-Guided Ablation

CT-guided ablation of adrenal masses is a minimally invasive technique used to treat functional or metastatic adrenal tumors when surgery is not feasible. Several ablation modalities may be employed. Radiofrequency ablation (RFA) uses alternating electrical current to generate thermal injury, typically producing temperatures of 60–100 °C, while microwave ablation uses electromagnetic waves to generate heat and may achieve faster and more uniform ablation zones. In contrast, cryoablation destroys tissue through cycles of rapid freezing and thawing, and chemical ablation involves direct injection of ethanol or acetic acid into the tumor. The choice of anesthesia varies according to the ablation modality, patient condition, and institutional practice, with either general anesthesia or moderate sedation commonly used. Heat-based techniques such as RFA and microwave ablation often require deeper sedation because they may be more painful than cryoablation. Continuous hemodynamic monitoring with a radial arterial catheter is recommended because adrenal manipulation can precipitate significant catecholamine release. Severe hypertensive crises may occur, with systolic blood pressure occasionally exceeding 240 mmHg and associated arrhythmias such as ventricular tachycardia or atrial fibrillation. These episodes most commonly occur during the active thaw phase of cryoablation or during radiofrequency or microwave energy delivery, with mean systolic blood pressure increases of approximately 100 mmHg reported. Immediate treatment is required when systolic blood pressure exceeds 200 mmHg (or ≥180/120 mmHg). Phentolamine, a short-acting α-adrenergic antagonist with rapid onset (1–2 minutes) and short duration (10–30 minutes), provides the most targeted treatment. When phentolamine is unavailable, nicardipine is an effective alternative, typically started at 5 mg/h and titrated by 2.5 mg/h every 5–15 minutes to a maximum of 15 mg/h. Tachyarrhythmias can be managed with IV esmolol due to its rapid onset and short half-life. Agents such as labetalol and hydralazine should generally be avoided, as labetalol provides relatively inadequate α-blockade and hydralazine may produce cardiostimulatory effects that exacerbate the hemodynamic instability.

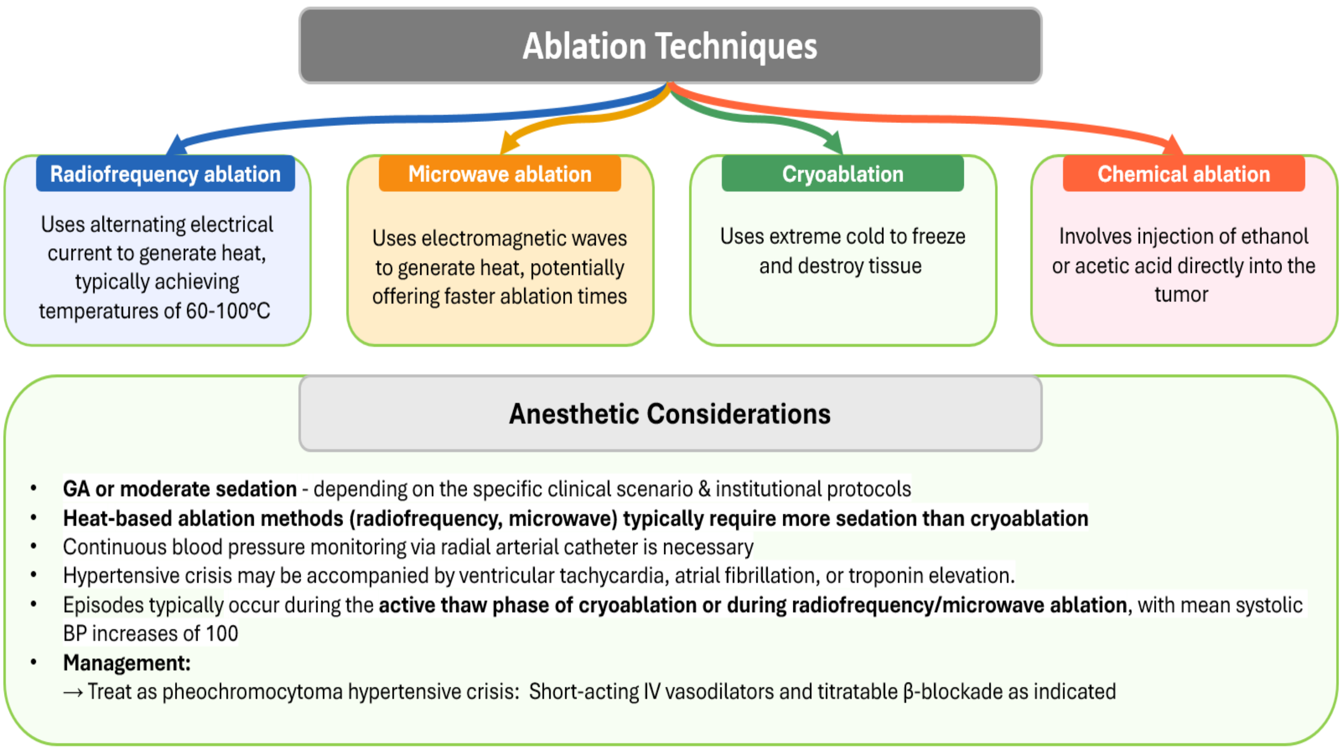

Figure 2: *CT-guided ablation of adrenal masses*

The Post-Ligation Hemodynamic Transition

One of the most critical moments during pheochromocytoma surgery occurs when the adrenal vein is ligated. At this point, circulating catecholamine levels fall abruptly. Combined with chronic volume depletion and anesthetic-induced vasodilation, this sudden change often produces severe hypotension.

Management focuses on aggressive fluid resuscitation and discontinuation of vasodilator infusions. Vasopressor support may be required using agents such as norepinephrine, phenylephrine, vasopressin, or epinephrine. Anticipating this "vaso-switch" and preparing for rapid physiologic changes are key teaching points for trainees.

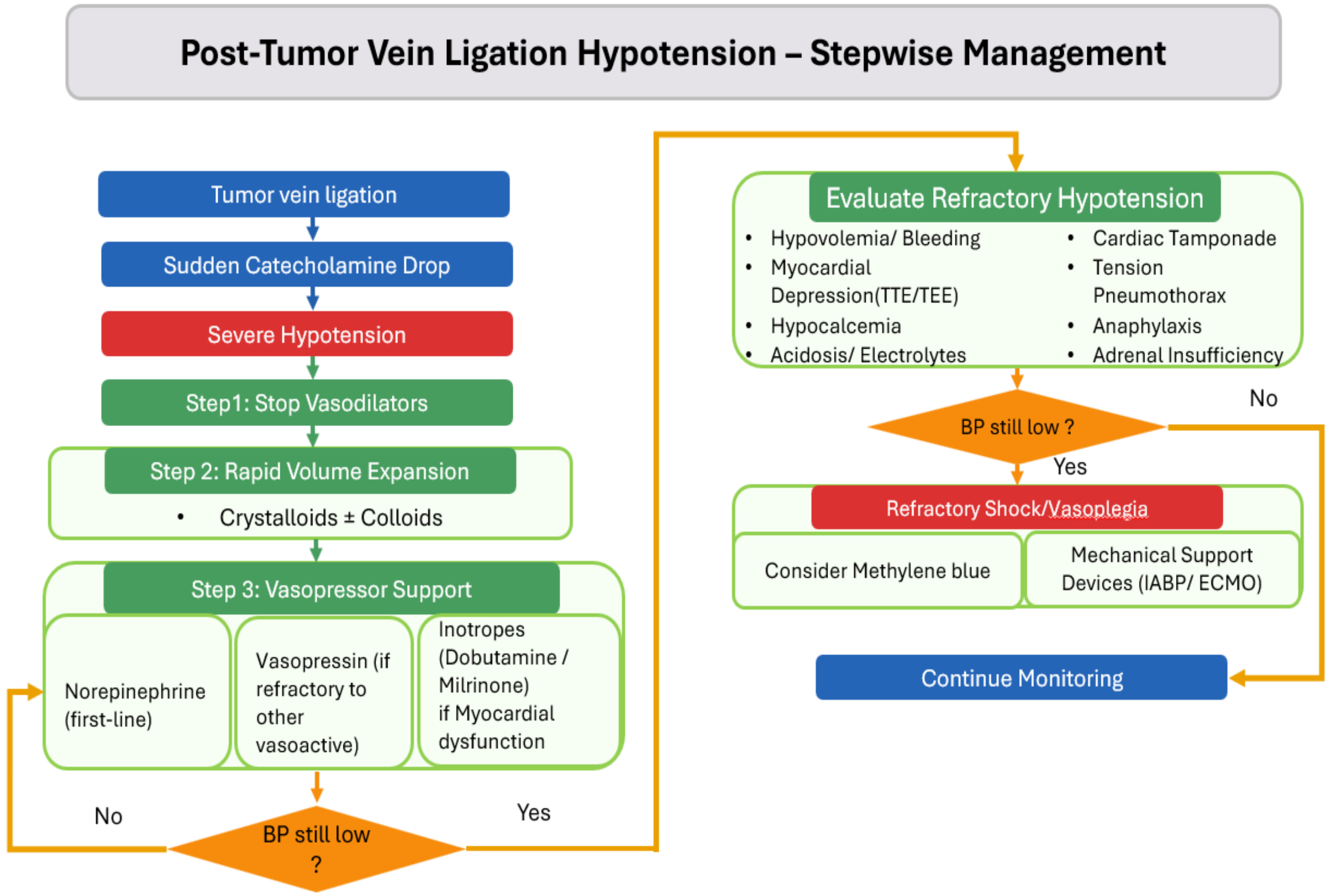

Figure 3: Stepwise management of post-tumor vein ligation hypotension

Postoperative Care

Patients are typically monitored in a post-anesthesia care unit or intensive care unit for at least 24 hours after surgery. Persistent hypotension may occur due to ongoing vasodilation or residual effects of antihypertensive medications. Hypoglycemia is also common because catecholamines normally inhibit insulin release; removal of the tumor may therefore lead to increased insulin activity. Pain management should emphasize multimodal analgesia to minimize sympathetic stimulation. In patients undergoing bilateral adrenalectomy, corticosteroid replacement therapy is required to prevent adrenal insufficiency. Delayed emergence or neurologic deficits should prompt evaluation for potential cerebrovascular complications.

Educational Implications for Training Programs

Teaching anesthetic management of pheochromocytoma provides an opportunity to reinforce several core principles of perioperative medicine and crisis resource management.

First, the condition illustrates the importance of understanding pathophysiology in guiding anesthetic decision-making. Second, it highlights the need for multidisciplinary coordination among anesthesiology, surgery, and endocrinology teams. Finally, the dramatic physiologic transitions encountered during tumor manipulation and vein ligation provide valuable opportunities to teach structured crisis management algorithms. Educational strategies may include didactic lectures, simulation scenarios, and algorithm-based teaching materials. Presenting the management in a structured, phase-based framework helps learners organize complex information and apply it during real clinical situations.

Click here for self assessment questions!

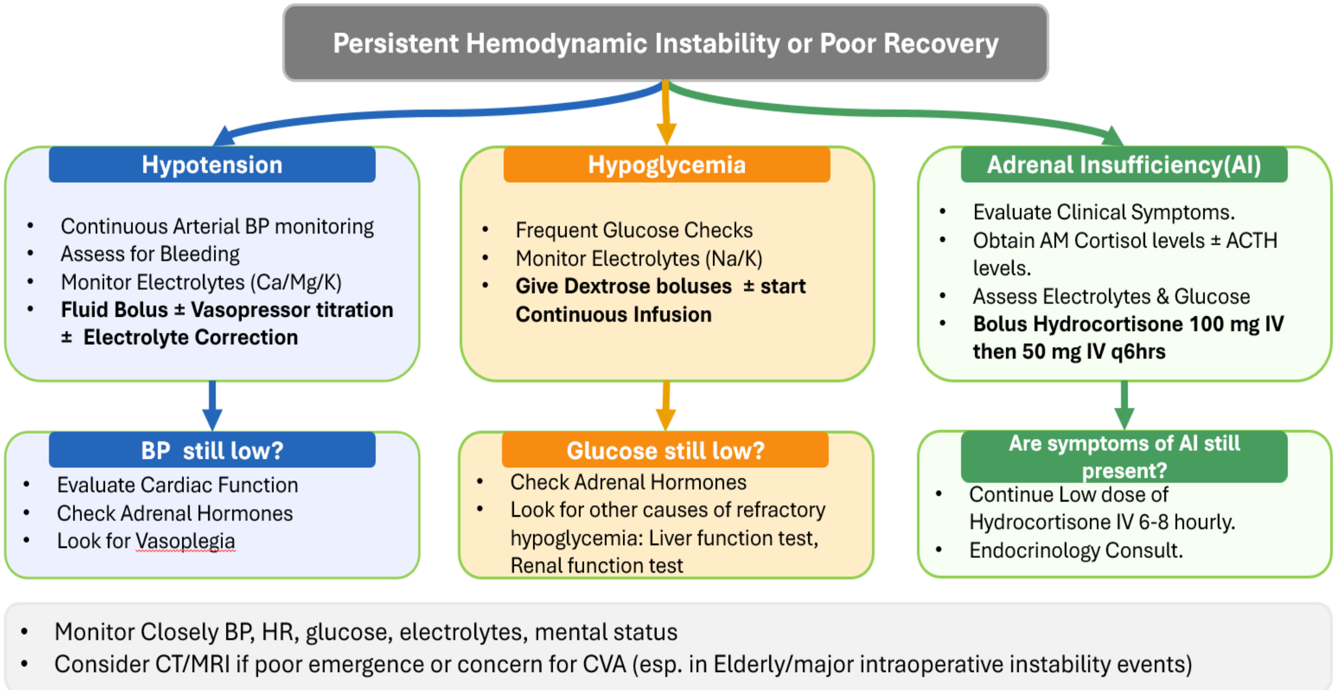

Figure 4: *Postoperative complications and management*

Conclusion

Pheochromocytoma surgery presents significant anesthetic challenges due to extreme hemodynamic variability. Effective management requires careful preoperative preparation, vigilant intraoperative monitoring, and rapid responses to hypertensive and hypotensive crises. A structured educational framework that integrates physiology, pharmacology, and crisis management can help trainees develop the knowledge and confidence needed to manage these complex cases. By emphasizing key physiologic transitions and algorithm-based decision-making, educators can prepare learners to deliver safe and effective perioperative care for patients with pheochromocytoma.

Key Take Away Points

1. A phase-based teaching framework (preoperative optimization, intraoperative management, and postoperative care) helps learners organize complex physiologic and pharmacologic concepts and apply them in clinical decision-making.

2. Algorithm-based crisis management and simulation-based learning can enhance trainee readiness to manage hypertensive crises, arrhythmias, and post-resection hypotension in high-risk endocrine surgical cases.

References:

1. *Gombert AJ, Nerantzinis AM, Li J, et al. The perioperative biochemical and clinical considerations of pheochromocytoma management. International Journal of Molecular Sciences. 2025;26(13):6080.*
2. *Kamath AS, Singh K. Perioperative management of pheochromocytoma. In: StatPearls [Internet]. Treasure Island, FL: StatPearls Publishing; 2025.*
3. *Fagundes GFC, Almeida MQ. Perioperative management of pheochromocytomas and sympathetic paragangliomas. Journal of the Endocrine Society. 2022;6(2):bvac004.*
4. *Fang F, Ding L, He Q, Liu M. Preoperative management of pheochromocytoma and paraganglioma. Frontiers in Endocrinology. 2020;11:586795.*
5. *Barash PG, Cullen BF, Stoelting RK, Cahalan MK, Stock MC. Miller's Anesthesia. 9th ed. Philadelphia, PA: Elsevier; 2020.*

Addressing the Gap in Leadership Training for Early-Career Anesthesiology Faculty

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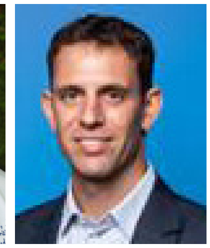
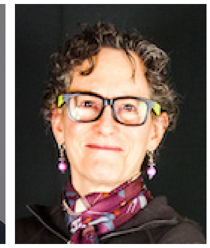


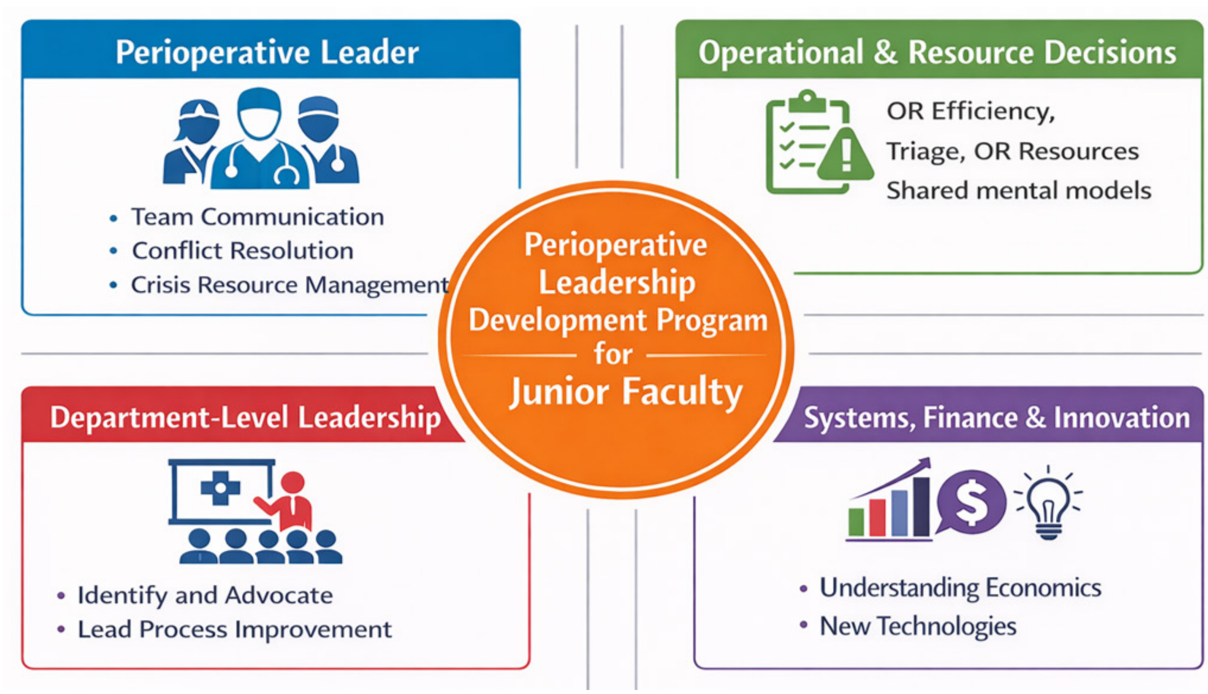


Introduction

Leadership is embedded in the daily practice of anesthesiology. In the operating room, anesthesiologists coordinate multidisciplinary teams, monitor rapidly evolving clinical conditions, and make decisions that influence both patient outcomes and operational efficiency. These responsibilities require competencies that extend beyond clinical expertise, including communication, situational awareness, conflict management, and the ability to lead under conditions of uncertainty and time pressure. Unlike many other specialties, anesthesiology places physicians at the center of complex perioperative systems where coordination across surgeons, nurses, technicians, and administrators is essential. In this environment, anesthesiologists frequently function as frontline leaders responsible for maintaining shared situational awareness and aligning clinical and operational priorities. Despite this central role, formal leadership training is rarely integrated into clinical education or early faculty development.

Leadership Preparation in Early-Career Faculty

Across medical education, structured preparation for leadership responsibilities remains limited. Early-career faculty are often expected to assume roles that require skills in financial management, strategic planning, and systems-based decision-making, yet these competencies are inconsistently addressed during training. While evidence-based practice and clinical reasoning are emphasized, organizational and operational skills receive far less attention. As a result, many physicians enter faculty positions well prepared clinically but less equipped to navigate the administrative and leadership dimensions of their roles.



Navigating Communication and Hierarchy

Effective leadership in healthcare depends heavily on communication across professional and hierarchical boundaries. However, early-career physicians often describe difficulty engaging within traditionally hierarchical systems, particularly when questioning decisions or addressing safety concerns. Without explicit training in structured communication and conflict navigation, these interactions can be challenging. This is especially relevant in perioperative care, where safe outcomes rely on coordinated team performance and the ability to speak up across roles and levels of authority.

Leadership Under Pressure: Teamwork and Decision-Making

High-acuity clinical environments demand rapid decision-making, prioritization, and the ability to manage stress while maintaining team coordination. Although clinical knowledge is well taught, the behavioral and cognitive skills required to lead in these situations are less consistently developed. In anesthesiology, clinicians must continuously interpret evolving data, anticipate complications, and direct team responses in real time. The absence of structured preparation in these domains can lead to variability in leadership performance and increased cognitive and emotional burden during critical events.

Experiential Learning and Its Limitations

In the absence of formal curricula, leadership skills are typically acquired through experience, informal mentorship, or ad hoc professional development. While experiential learning is valuable, it often lacks consistency and may not provide the conceptual frameworks needed to support deliberate growth. Existing leadership programs in medicine frequently target senior faculty or focus on administrative roles, leaving early-career clinicians—who already carry significant leadership responsibility in daily practice—without tailored support.

Expanding Scope of Perioperative Leadership

The demands placed on anesthesiologists extend beyond intraoperative care to include operational and systems-level responsibilities. Operating rooms are among the most resource-intensive and economically significant areas within hospitals, requiring coordination of staffing, case flow, and resource allocation. Anesthesiologists are increasingly involved in decisions related to scheduling, efficiency metrics such as turnover time and first-case starts, and broader quality and safety initiatives. These responsibilities require familiarity with healthcare systems, financial drivers, and organizational priorities—areas that are rarely addressed in traditional training but are essential for effective leadership in modern practice.

Conceptual Framework for Leadership Development

A structured approach to leadership development can be organized around three interconnected domains: self-leadership, team leadership, and systems leadership. Self-leadership emphasizes self-awareness, emotional regulation, and the development of a clear leadership identity. Team leadership focuses on communication, supervision, conflict management, and fostering psychological safety within multidisciplinary teams. Systems leadership broadens this perspective to include operational understanding, institutional structures, and the ability to influence change within complex healthcare environments. Integrating these domains allows clinicians to develop leadership capabilities that are directly applicable to both clinical and organizational contexts.

A Perioperative Leadership Development Program

To operationalize this framework, we propose a three-month, cohort-based leadership development program designed specifically for early-career anesthesiology faculty. The program is intentionally small, experiential, and closely aligned with the realities of perioperative practice. Through interactive sessions, simulation-based learning, and reflective exercises, participants engage with leadership as a daily clinical activity rather than an abstract or future role.

The curriculum progresses through three phases. The first focuses on leadership identity, helping participants develop self-awareness, emotional intelligence, and presence under pressure. The second emphasizes team leadership, including communication, conflict management, supervision of trainees, and crisis leadership through case-based discussions and simulation. The final phase introduces systems-level thinking, where participants explore operational leadership, quality improvement, and organizational dynamics within perioperative care.

A central component of the program is a mentored capstone project. Participants identify a real-world leadership challenge within their clinical or departmental environment and develop a structured strategy to address it. This process emphasizes stakeholder engagement, practical decision-making, and leadership behaviors such as influence without authority, negotiation, and strategic communication. Mentorship from faculty leaders further supports individualized growth and contextual understanding.

Anticipated Impact

Developing leadership capacity at the early faculty stage has implications for both individual growth and organizational performance. Participants may gain greater confidence in leading teams, managing conflict, and contributing to departmental initiatives. Early engagement with leadership frameworks can also foster involvement in education, quality improvement, and operational innovation. At the systems level, strengthening leadership among frontline clinicians can enhance communication, promote psychological safety, and improve team performance in high-stakes environments. Such programs may contribute to a sustainable pipeline of physician leaders equipped to guide change within perioperative medicine.

Conclusion

As healthcare systems grow more complex, the ability to lead teams, manage operations, and engage with organizational systems is increasingly essential. A targeted, practice-oriented leadership development program offers an opportunity to bridge this gap by reframing leadership as a core clinical competency. By equipping early-career anesthesiologists with the skills, frameworks, and support needed to lead effectively, such initiatives can strengthen both individual practice and the broader healthcare system.

Key Take Away Points

1. Leadership is integral to anesthesiology practice, yet most anesthesiologists receive little formal preparation in leadership, communication, and systems-based management during training.

2. Early-career faculty frequently assume supervisory and operational responsibilities without structured leadership education, particularly in areas such as conflict management, hierarchical communication, financial management, and strategic decision-making.

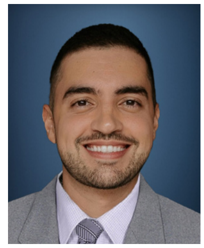
3. Targeted leadership development programs for early-career anesthesiologists can bridge the gap between clinical expertise and leadership competence, strengthening team performance, communication, and engagement within increasingly complex perioperative systems.

References:

1. *Rotenstein LS, Huckman RS, Cassel CK. Making doctors effective managers and leaders: a matter of health and well-being. Acad Med. 2021.*
2. *Warren OJ, Carnall R. Medical leadership: why it's important, what is required, and how we develop it. Postgrad Med J. 2010.*
3. *Ross SJ, Sen Gupta T, Johnson P. Leadership curricula and assessment in Australian and New Zealand medical schools. BMC Med Educ. 2021.*
4. *Barnes T, Yu TW, Webster CS. Preparedness of medical students and junior doctors for their role as clinical leaders: a systematic review. Med Teach. 2019.*
5. *Tan YX, Jalal AHB, Ngai V, Manobharath N, Soh TCF. What are the non-technical skills required by junior doctors in the NHS to manage medical emergencies? A scoping review. Postgrad Med J. 2021.*
6. *Myers CG, Pronovost PJ. Making management skills a core component of medical education. Acad Med. 2017.*
7. *Blumenthal DM, Bernard K, Bohnen J, Bohmer R. Addressing the leadership gap in medicine: residents' need for systematic leadership development training. Acad Med. 2012.*
8. *Fitzgerald AS, Fang M, Lee RS, Gann J, Burnet DL. The ACLGIM LEAD program: a leadership program for junior-mid-career faculty. J Gen Intern Med. 2021.*

Teaching Situational Awareness in Anesthesia Care

Federico Puerta Martinez, MD
Dario Winterton, MD
Jacqueline Hannan, PhD



In a previous article in this series, situational awareness (SA) was introduced as a foundational cognitive skill for safe anesthesia practice [1]. Drawing on Endsley's three-level framework, that discussion described how anesthesia professionals perceive elements of the clinical environment (Level 1), integrate those elements into an understanding of the patient's current state (Level 2), and project what is likely to happen next (Level 3) [2]. Evidence was presented linking SA failures to adverse events and patient harm across all three levels [3,4]. This second installment shifts focus from understanding SA to teaching it – examining instructional strategies that support SA development, with particular attention to how virtual simulation can serve as an accessible and effective training platform.

Why Situational Awareness Must Be Explicitly Taught

Although SA develops through clinical experience over time, relying solely on experiential learning is insufficient for this critical patient safety skill. Research on anesthesiologists' understanding of SA reveals that, despite recognizing its importance, many clinicians lack formal definitions of the concept and do not explicitly address it in teaching [5]. SA is often learned informally through role modeling, reflection on errors, and increasing clinical independence. However, the perioperative environment introduces multiple threats to SA, including high cognitive workload, fatigue, interruptions, and communication failures [1,6]. Without deliberate instruction, clinicians may not develop the mental models and scanning strategies needed to maintain awareness during high-stress events. This gap underscores the need for structured educational approaches that make SA visible, trainable, and measurable.

Approaches to Teaching Situational Awareness

Several instructional strategies have been proposed for developing SA across its three levels. Endsley and Robertson described SA training principles including attention management, pattern recognition exercises, and part-task training that expose learners to a wide range of scenarios in compressed timeframes [7]. In anesthesia, these principles have been translated into practical approaches such as structured scanning of monitors and the surgical field, verbalization of clinical reasoning, use of preoperative checklists and briefings, and facilitated debriefing after critical events [1,5]. Table 1 summarizes how common teaching strategies map to the three levels of SA.

Table 1. *Teaching Strategies Mapped to Situational Awareness Levels*

SA Level	Teaching Strategy	Example in Anesthesia Practice
Level 1: Perception	Structured scanning; checklists; deliberate environmental monitoring	Systematic review of monitors, IV lines, airway, and surgical field at regular intervals
Level 2: Comprehension	Verbalization of clinical reasoning; pattern recognition training; case-based discussion	Explaining aloud why vital sign changes may indicate hemorrhage versus anesthetic depth change
Level 3: Projection	Simulation-based crisis scenarios; anticipatory planning exercises; debriefing with projection prompts	Predicting hemodynamic instability following observed blood loss and planning for vasopressor and transfusion needs

Simulation-based training has become one of the most widely adopted methods for developing SA in anesthesia. Originating from crew resource management (CRM) programs adapted from aviation, simulation allows clinicians to practice managing rare but high-stakes events in a psychologically safe environment [8,9]. Crisis resource management training, pioneered at Stanford in 1990, demonstrated that realistic simulation followed by structured debriefing can improve teamwork, communication, and situation-level decision making [10]. More recently, research has shown that experience influences how clinicians allocate visual attention and recognize abnormal patterns during simulated emergencies, reinforcing the importance of repeated exposure to dynamic scenarios [11,12].

Virtual Simulation: An Emerging Platform for SA Training

While manikin-based high-fidelity simulation remains a cornerstone of anesthesia education, virtual simulation platforms have emerged as a complementary approach. Virtual simulations offer several logistical advantages: they are portable, can be completed individually on a standard computer, and provide standardized scenario delivery and efficient data capture across large numbers of participants [13,14]. Recent evidence suggests that virtual simulations produce comparable learning outcomes to manikin-based training in knowledge acquisition and clinical reasoning, while also reducing mental demand during crisis scenarios [14,15].

To explore the feasibility of virtual simulation for SA assessment, a pilot study was conducted within a departmental Human Factors Workshop at our institution. Twenty-four anesthesia professionals, including attending physicians, residents, fellows, and certified registered nurse anesthetists (CRNAs), completed a virtual anesthesia scenario on individual laptop computers. The simulation, developed in Articulate 360 and delivered through a learning management system, depicted a patient handoff during a multilevel spine surgery followed by rapid intraoperative blood loss.

The scenario unfolded across three phases: handoff, patient deterioration, and recovery. During the handoff, participants listened to an audio report delivered over operating room background noise, describing the patient's clinical status including cardiac comorbidities, vital signs, access, and medications. The deterioration phase presented dynamic vital sign changes, auditory alarms, and verbal cues from the surgical team, with cognitive load intentionally increased through amplified noise and alarm frequency. In the recovery phase, physiologic parameters stabilized. After each phase, participants responded to open-ended written prompts designed to capture what they noticed, how they interpreted the situation, and what actions they would take—corresponding to Levels 1, 2, and 3 of SA, respectively.

A panel of clinicians identified 23 situational cues embedded in the scenario, rating each as high, moderate, or low importance for clinical management. Results from 22 participants demonstrated that cues rated as high importance were identified significantly more frequently than those rated as moderate or low importance ($\chi^2F(2) = 20.67$, $p < .0001$). Twenty of 22 participants correctly identified hemorrhage as the cause of patient decompensation, and the most commonly reported next steps were initiating vasopressors ($n = 14$), administering blood products ($n = 13$), and opening intravenous fluids ($n = 11$). No significant differences in cue identification were observed by gender, years of experience, or clinical role, indicating consistent performance across the pilot sample.

These findings support the feasibility of virtual simulation as a method for delivering standardized SA-focused training scenarios with built-in assessment. The significant effect of cue importance level suggests that the scenario effectively conveyed information across graded levels of clinical relevance, with participants appropriately prioritizing the most critical cues. The consistent performance across participant groups may reflect the salience of the cues presented in this initial scenario; future iterations with more subtle or ambiguous cues may reveal differences related to experience or expertise.

Conclusion

Situational awareness is not only a cognitive skill to be understood but also a professional competency to be trained. While informal learning through clinical experience remains valuable, structured approaches, including simulation-based training, deliberate scanning practice, and facilitated debriefing, offer more reliable pathways for developing SA across all three levels. Virtual simulation represents a promising addition to the training toolkit, combining accessibility and standardization with the ability to capture meaningful performance data. Our pilot experience at this institution demonstrates that virtual scenarios can engage anesthesia professionals across roles and experience levels, effectively convey clinically relevant cues, and generate data suitable for evaluating SA performance. As virtual simulation platforms continue to evolve, they hold significant potential for both individual skill development and programmatic assessment of SA in anesthesia education. Lessons from this pilot will inform the design of a larger-scale study aimed at refining scenario complexity and measurement sensitivity.

Key Take Away Points

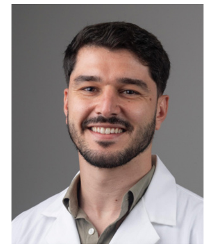
1. Situational awareness (SA) must be deliberately taught; relying on experience alone is insufficient; structured instruction is needed to develop perception, comprehension, and projection skills.

2. Targeted teaching strategies improve SA; approaches such as structured scanning, verbalizing clinical reasoning, simulation, and debriefing help make SA visible and trainable.

References:

1. *Hannan J. Situational awareness during anesthesia care. BIDMC Clinics in Medical Education. December 2025.*
2. *Endsley MR. Toward a theory of situation awareness in dynamic systems. Human Factors. 1995;37(1):32–64.*
3. *Schulz CM, Burden A, Posner KL, et al. The frequency and type of situational awareness errors contributing to death and brain damage. Anesthesiology. 2017;127(2):326–337.*
4. *Wahr JA, Prager RL, Abernathy JH, et al. Patient safety in the cardiac operating room: human factors and teamwork. Circulation. 2013;128(10):1139–1169.*
5. *Siu J, Maran N, Paterson-Brown S. Observation of behavioural markers of non-technical skills in the operating room and the effect of inter-observer training. Exploring anesthesiologists' understanding of situational awareness: a qualitative study. Canadian Journal of Anesthesia. 2016;63:1084–1094.*
6. *Endsley MR, Jones DG. Designing for Situation Awareness: An Approach to User-Centered Design. 2nd ed. CRC Press; 2011.*
7. *Endsley MR, Robertson MM. Training for situation awareness. In: Endsley MR, Garland DJ, eds. Situation Awareness Analysis and Measurement. Lawrence Erlbaum Associates; 2000:349–365.*
8. *Gaba DM, Howard SK, Fish KJ, Yang GS, Sarnquist FH. Anesthesia crisis resource management training: teaching anesthesiologists to handle critical incidents. Aviation, Space, and Environmental Medicine. 1992;63(9):763–770.*
9. *Rosen MA, DiazGranados D, Dietz AS, et al. Teamwork in healthcare: key discoveries enabling safer, high-quality care. BMJ Quality & Safety. 2018;27(5):433–445.*
10. *Howard SK, Gaba DM, Smith BE, et al. Simulation study of rested versus sleep-deprived anesthesiologists. Anesthesiology. 2003;98(6):1345–1355.*
11. *Ljubenovic A, Said S, Braun J, et al. Visual attention of anesthesia providers in simulated anesthesia emergencies. JMIR Serious Games. 2022;10(1):e35642.*
12. *Grundgeiger T, Klöffel C, Mohme S, Wurmb T, Happel O. An investigation into the effects of real vs. simulated cases and level of experience on the distribution of visual attention during induction of general anaesthesia. Anaesthesia. 2017;72(5):624–632.*
13. *Sałacińska I, Trojnar P, Gebriné KÉ, Törő V, Sárváry A, Więch P. A comparative study of traditional high-fidelity (manikin-based) simulation and virtual high-fidelity simulations concerning their effectiveness and perception. Frontiers in Medicine. 2025;12:1523768.*
14. *Babus LW, Gurnaney H, Doshi AK, et al. The utility of virtual reality and manikin crisis scenario simulations for anaesthesia trainee education: a randomised crossover pilot study. Anaesthesia Reports. 2024;12(2):e12316.*
15. *Fleet A, Kaustov L, Belfiore EBR, et al. Current clinical and educational uses of immersive reality in anesthesia: narrative review. Journal of Medical Internet Research. 2025;27:e62785.*

Lessons in Decision-Making from a Bushfire Survival Exercise



Noor Dirini, MD

Imagine you are stranded near an advancing bushfire in Topanga Canyon in the Santa Monica Mountains. The power is out. Smoke is visible on the horizon. You have a limited set of items at your disposal: wool blankets, a garden hose, leather boots, a cell phone, a map. Which do you prioritize for survival? And how might that ranking change once you discuss it with your team?

That was the premise of a survival scenario we facilitated during a recent departmental grand rounds as part of a faculty development workshop. What followed was one of the most interesting educational sessions I have been part of, not because of the scenario itself, but because of what it revealed about how teams actually function when pressure, uncertainty, and different opinions are all in play.

Part of what made the exercise so effective was the nature of the problem. A bushfire scenario is not the kind of problem with one clear answer. Everything depends on context: wind direction, available resources, timing, and what you decide to do first. People got into it right away. The discussions were lively, thoughtful, and genuinely fun to watch. What was especially striking was how differently groups approached the exact same problem, even though everyone had the same information and the same resources. Some teams focused on mobility and escape, while others prioritized shelter, protection, or conserving key supplies. That alone was a useful reminder that under uncertainty, reasonable people can look at the same situation and come to very different conclusions.

But the most revealing finding was a little uncomfortable. In several groups, participants actually scored better individually than as part of their team. In other words, discussion did not always improve the final decision. In some cases, it made it worse.

That was one of the most valuable lessons of the workshop. The issue was not lack of effort or lack of engagement. Quite the opposite. Most people were very involved. What seemed to happen, though, was that many participants were willing to go with the flow rather than strongly voice their own reasoning, even when their individual judgment may have been stronger than the group's final choice. The result was consensus without fully trusting either the process nor the decision.

For me, that was the strongest reminder that teamwork does not automatically produce better outcomes. Teams do well when people do more than simply cooperate. They need to share different perspectives, question assumptions, and create space for people to speak honestly, especially when their view differs from where the group seems to be heading. Without that, a team can actually underperform its own members.

The workshop also offered a useful way to think about leadership. In medicine, leadership can sometimes be imagined as the person with the answer or the strongest voice in the room. But what became visible in this exercise was something more shared and, honestly, more realistic. No single person directed the discussion, and yet leadership was clearly present. Some participants helped define the problem. Others challenged assumptions, introduced alternatives, or kept the group organized and moving. Leadership showed up not as a title, but as something people stepped into when the team needed it.

The parallels to perioperative care were hard to miss. The OR is also a place shaped by time pressure, incomplete information, changing conditions, and the need for coordinated action. During a difficult airway, sudden hemodynamic instability, major hemorrhage, or an unexpected change in the surgical course, several team members may each notice something important. A resident may pick up on a pattern early. A nurse may notice a workflow or equipment issue. An anesthesia provider may recognize a subtle physiological change. But that information only helps the patient if it is said out loud.

One of the clearest takeaways from the workshop is that teams can make worse decisions when people defer too quickly, stay quiet, or mistake agreement for good judgment. In the OR, that is not merely a communication issue. It is a patient safety issue. The exercise reinforced the importance of speaking up, inviting different views before settling on a plan, and making room for quieter voices before consensus forms too early.

What I appreciated most about the session was that it made these dynamics visible in a way that was practical, memorable, and engaging. It showed that even highly capable groups can lose decision quality if different perspectives stay unspoken. More importantly, it reminded us that effective teamwork is not just about getting along or moving efficiently. It is about how well we think together when the stakes are high.

In the end, the workshop was a reminder that good teams are not defined soley by expertise, but by whether people feel able to bring that expertise into the conversation when it matters most.

Key Take Away Points

1. Team discussion does not guarantee better decisions; groups can underperform when consensus overrides stronger individual judgment.

2. Psychological safety is essential; team members must feel comfortable speaking up, especially when their views differ.

3. Effective teamwork requires active, shared thinking; questioning assumptions and voicing diverse perspectives improves decision quality in high-stakes settings.

High-Yield Perioperative Research Summaries

Huma Syed Hussain, MD

1. Preoperative Hemoglobin A1C, Glycemic Status, and Postoperative Outcomes in General Surgery by Schaschinger T, Niederegger T, Brandt J, et al.

JAMA Surgery, January 2026

Research Question: This study asked whether elevated preoperative hemoglobin A1c (HbA1c) of 6.4%, including undiagnosed dysglycemia, is associated with increased 30-day postoperative complications, readmissions, and mortality in general surgery patients.

Finding: In a large cohort of 282,131 patients, higher HbA1c levels were independently associated with an increased risk of postoperative complications, readmissions, and mortality. Risk increased progressively with worsening glycemic control, even among patients with "near-normal" <6.0% HbA1c. Notably, 6.4% of patients had undiagnosed diabetes, which was also linked to higher complication rates and mortality.

Takeaway: These findings highlight that both diagnosed and undiagnosed dysglycemia are important, independent predictors of poor surgical outcomes. Routine preoperative HbA1c screening could improve risk stratification and enable targeted glycemic optimization, ultimately reducing perioperative complications and improving patient outcomes in general surgery.

Click here to read the full article!

2. Buprenorphine Versus Full Agonist Opioids for Acute Postoperative Pain Management: A Systematic Review and Meta-Analysis of Randomized Controlled Trials by Hickey TR, Costa GPA, Oliveira D, et al.

Regional Anesthesia & Pain Medicine (RAPM), January 2026

Research Question: This systematic review and meta-analysis examined whether buprenorphine is more effective and safer than full agonist opioids (FAOs) for managing acute postoperative pain in surgical patients.

Finding: Across 58 studies, buprenorphine was associated with significantly lower postoperative pain scores and reduced need for rescue analgesia compared with FAOs. It also demonstrated a longer duration of analgesia (~8.5 hours). There were no significant differences in adverse effects such as respiratory depression, nausea, or sedation.

Takeaway: These findings suggest that buprenorphine is an effective and safe alternative to traditional opioids for postoperative pain management. Its favorable safety profile, including lower abuse potential and reduced risk of respiratory depression, makes it a compelling first-line option. Broader use of buprenorphine could help mitigate opioid-related harms, though variability across studies indicates the need for further research and individualized clinical application.

Click here to read the full article!

3. Effects of Intraoperative Higher Versus Lower Positive End-Expiratory Pressure During One-Lung Ventilation for Thoracic Surgery on Postoperative Pulmonary Complications (PROTHOR): A Multicentre, International, Randomised, Controlled, Phase 3 Trial by Writing Committee; Steering Committee; PROTHOR Collaborative Group; PROtective VEntilation Network (PROVE Network) for the Clinical Trial Network of the European Society of Anaesthesiology and Intensive Care.

The Lancet, January 2026

Research Question: This multicenter randomized trial (PROTHOR) investigated whether an intraoperative lung expansion strategy using higher positive end-expiratory pressure (PEEP) of 10 cm H_2O with recruitment maneuvers reduces postoperative pulmonary complications (PPCs) compared with lower PEEP without recruitment in patients undergoing thoracic surgery with one-lung ventilation.

Finding: Among 2,200 patients, higher PEEP did not significantly reduce PPCs compared with lower PEEP (53.6% vs 56.4%). However, the high PEEP strategy was associated with significantly increased intraoperative complications, including hypotension and arrhythmias, while hypoxemia rescue interventions were more frequent in the low PEEP group. Mortality and other major outcomes were similar between groups.

Takeaway: Routine use of high PEEP with recruitment maneuvers during one-lung ventilation does not improve postoperative pulmonary outcomes and may increase hemodynamic instability. These findings support an individualized approach to intraoperative ventilation, balancing oxygenation needs against hemodynamic risk rather than applying a uniform lung expansion strategy.

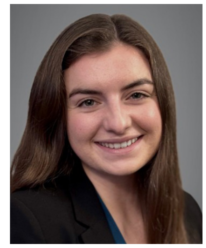
Click here to read the full article!

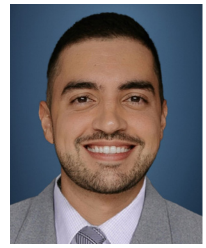
MICHAEL LI CORNER

Lung pulse on point-of-care ultrasound refers to subtle, rhythmic pleural line movement synchronized with cardiac activity, best appreciated when ventilation is absent or minimal. Its presence helps confirm pleural apposition and effectively rules out pneumothorax at the scanned location, making it a valuable sign in acute respiratory and peri-arrest assessments.

Click here to view the clips!

Human Factors in Anesthesia: A Workshop to Promote Safety Awareness and Systems Thinking






Jacqueline Hannan, PhD
Liana Zucco, MD
Federico Puerta Martinez, MD
Dario Winterton, MD

Human factors principles have become increasingly influential in healthcare safety and medical education. These principles focus on understanding how clinicians interact with complex systems, including technology, environments, and teams, and how those interactions influence performance and patient safety. Within anesthesiology and other high-acuity specialties, adverse events are frequently multifactorial and associated with both technical failures and breakdowns in non-technical domains, including communication, situational awareness, teamwork, and system design. As clinical environments become increasingly technologically complex and cognitively demanding, integration of human factors principles into clinician education represents a critical component of safety-focused training.

Despite growing recognition of its importance, formal instruction in human factors remains limited across medical training programs. Existing exposure often occurs within crisis resource management curricula or simulations of rare critical events. However, human factors vulnerabilities commonly arise during routine clinical processes, including patient handoffs, equipment preparation, and information processing in busy clinical environments. Educational interventions that promote structured observation and reflection on everyday system interactions may therefore enhance clinician awareness of latent safety threats and reinforce safer practice behaviors.

To address this educational gap, we developed a Human Factors in Anesthesia Workshop composed of interactive learning stations focusing on key human factors concepts that each individual can incorporate into their routine anesthetic care. The workshop consisted of four stations, each targeting a distinct human factors domain. Participants rotated through stations in small groups, engaging in structured activities intended to stimulate discussion, reflection, and identification of system vulnerabilities, as well as potential mitigation strategies.

Distractions and Situational Awareness

The first station examined situational awareness and the effects of environmental distractions on cognitive performance. Participants observed a virtual simulation depicting a patient handoff during management of massive hemorrhage. Background auditory and visual stimuli typical of the operating room environment were intentionally incorporated to replicate real-world attentional demands.

At predefined freeze points, participants were asked to recall critical patient information and ongoing clinical developments. The exercise demonstrated the degradation of situational awareness when competing sensory inputs increase cognitive load. Facilitated discussion focused on common sources of distraction within perioperative environments and practical strategies for protecting attentional resources during safety-critical tasks, including handoffs and periods of clinical instability.

Ergonomic Setup of Equipment

The second station explored ergonomic principles and workspace configuration for procedural performance. Using a central venous line placement scenario, participants compared two contrasting setups: an optimized workspace with organized equipment and appropriate monitor positioning, and a deliberately suboptimal environment characterized by disorganization and poor visual alignment.

Participants interacted with both configurations and reflected on the effects of equipment layout, visibility, and body positioning affected workflow efficiency and task execution. Facilitators guided discussion on how deliberate workspace design reduces cognitive burden, improves procedural flow, and mitigates risks such as procedural error or breaches in sterile technique. The station emphasized ergonomics as a patient safety intervention rather than a matter of operator preference.

Leadership and Teamwork in Daily Practice

The third station addressed leadership behaviors and team dynamics in routine clinical settings. Participants completed a structured group decision-making exercise commonly used in leadership training, in which individuals ranked survival items in a hypothetical emergency scenario. Rankings were first completed independently and subsequently developed through group consensus.

The activity enabled observation of communication patterns, leadership emergence, and collaborative decision-making processes. Following completion, participants compared their rankings with expert consensus and reflected on how team interactions influenced outcomes. Facilitators highlighted core teamwork principles, including inclusive communication, psychological safety, shared mental models, and effective utilization of distributed expertise during decision-making under uncertainty.

Near-Miss Identification and Reporting

The final station focused on recognition and classification of near-misses and latent safety hazards. Participants first discussed operational definitions of near-miss events and related safety terminology. Small groups were then provided with clinical event descriptions and tasked with categorizing each as a near-miss, no-harm event, or event associated with patient harm.

Participants organized cases collaboratively and discussed areas of disagreement. Facilitators reviewed classifications, addressed common misconceptions, and demonstrated how definitional ambiguity can influence safety reporting practices. Discussion emphasized the role of near-miss reporting in identifying system vulnerabilities prior to patient harm. The station concluded with brief reflection questions on application within participants' own clinical environments.

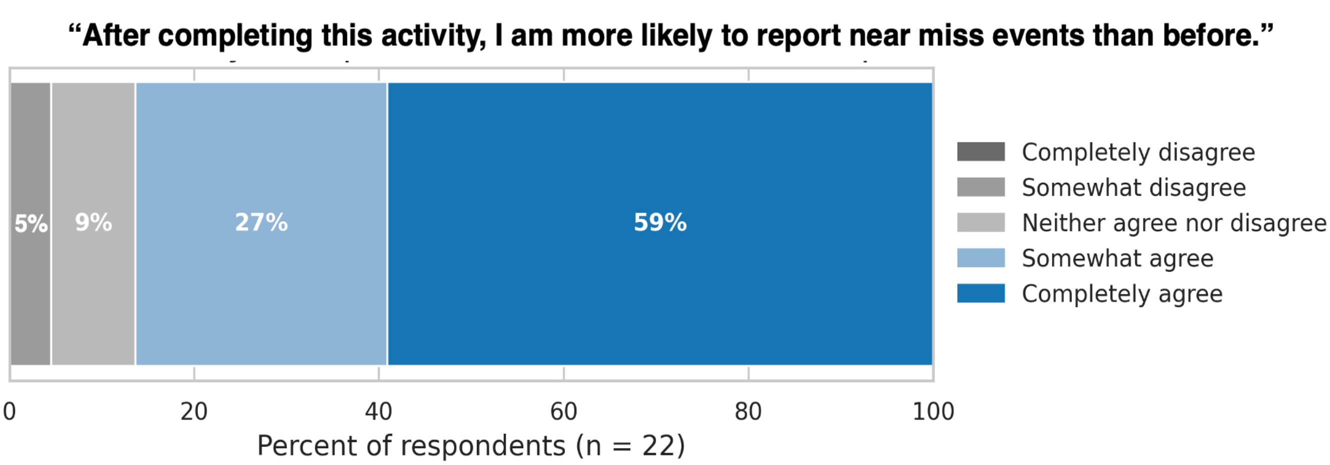


Figure 1: *Impact of workshop on likelihood of reporting near-misses*

Educational Impact

Each station concluded with a focused operational takeaway aimed at translating human factors principles into routine clinical practice. Key strategies included protecting attention during high-risk tasks, optimizing procedural workspaces to reduce cognitive load, promoting effective team communication, and improving recognition and reporting of near-miss events. Anchoring these principles within familiar contexts enhanced relevance and facilitated practical application to everyday anesthesia care.

Human factors provide a structured framework for understanding clinician performance within complex sociotechnical systems and their relationship to patient safety outcomes. Experiential educational approaches may enhance clinicians' ability to identify latent system vulnerabilities and adopt safer work practices. Workshops represent a practical model for integrating human factors education into anesthesia training and for bridging the gap between safety theory and routine clinical practice.

Key Take Away Points

1. Human factors are central to patient safety: Errors in anesthesia often arise from system interactions, communication, situational awareness, and environment, not just technical skill.

2. Everyday practice, not just crises, matters: Human factors vulnerabilities commonly occur during routine tasks (handoffs, setup, workflow), highlighting the need for continuous awareness beyond simulation of rare events.

3. Experiential learning improves awareness: Interactive, station-based workshops help clinicians recognize distractions, optimize ergonomics, strengthen teamwork, and identify near misses in real-world contexts.

4. Focus on systems thinking and prevention: Training emphasizes identifying latent safety threats and implementing practical strategies (attention management, workspace design, communication, reporting) to prevent harm before it occurs.

References

1. *Fermin, L., Lobaugh, L., Parr, K. G., & Currie, M. (2024). The role of human factors engineering in patient safety. Current Opinion in Anaesthesiology, 37(6), 683–688.*

2. *Flin, R., & Maran, N. (2015). Basic concepts for crew resource management and non-technical skills. Best Practice & Research Clinical Anaesthesiology, 29(1), 27–39.*

3. *Grigg, E. (2025). Improving anesthesia safety: A human factors approach to feedback and system constraints. Current Opinion in Anesthesiology, 38(6), 769–775.*

4. *Riem, N., Boet, S., Bould, M. D., Tavares, W., & Naik, V. N. (2012). Do technical skills correlate with non-technical skills in crisis resource management? A simulation study. British Journal of Anaesthesia, 109(5), 723–728.*

5. *Weinger, M. B., & Slagle, J. (2002). Human factors research in anesthesia patient safety. Journal of the American Medical Informatics Association, 9(Suppl 6), S58–S63.*

6. *Yee, B., Naik, V. N., Joo, H. S., Savoldelli, G. L., Chung, D. Y., Houston, P. L., Karatzoglou, B. J., & Hamstra, S. J. (2005). Nontechnical skills in anesthesia crisis management with repeated exposure to simulation-based education. Anesthesiology, 103(2), 241–248.*

INNOVATION IN EDUCATION

Proficiency Index: An Objective Framework for Resident Assessment

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Graduate medical education is increasingly shifting from a traditional time-based apprenticeship model toward a competency-based framework in which progression depends on demonstrated achievement of predefined milestones. In this model, advancement should reflect measurable competence rather than exposure and duration of training alone. Traditional assessment methods in residency training incompletely capture clinical competence. Cognitive knowledge can be measured through written examinations, but procedural ability, workflow execution, communication, and situational awareness are often inferred only after clinical exposure. These judgments are frequently subjective and based on endpoint outcomes such as procedural success, errors, or need for intervention from supervising faculty. Such measures may fail to identify important deficiencies in critical thinking, equipment handling, teamwork, or task prioritization. A resident may score highly on knowledge-based tests yet still struggle to apply that knowledge effectively in a real clinical environment. For this reason, resident assessment should move beyond knowledge testing and clinical exposure as the principal indicators of readiness. A more objective approach requires direct, structured evaluation across the domains that together define competent performance.

Concept of the Proficiency Index

The Proficiency Index (PI) is a composite, criteria-based assessment framework designed to quantify resident readiness for clinical performance. It defines proficiency as the integration of cognitive knowledge, clinical reasoning, workflow execution, technical skill, communication, and adaptive improvement required for the safe and effective completion of a clinical task. Rather than equating competence with time in training or number of cases performed, the PI evaluates whether a trainee can consistently meet predetermined standards across multiple performance domains. The central principle of the PI is that resident competence should be assessed on multi-modular domains. Safe clinical performance depends not only on factual knowledge but also on the ability to think critically, take timely appropriate actions, use equipment appropriately, communicate effectively, interpret findings accurately, and respond to dynamic clinical conditions. Therefore, the PI operationalizes resident assessment through structured evaluation of these domains using standardized tools.

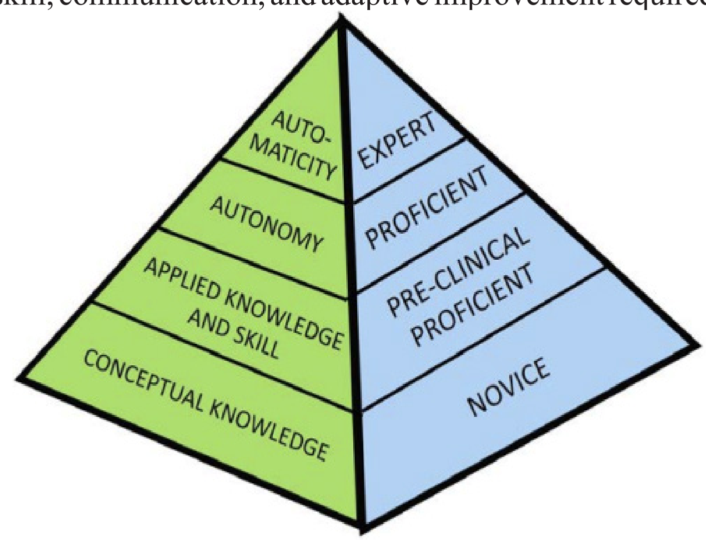


Figure 1: *Modified Miller's pyramid of clinical performance*

Rationale for an Objective Multidomain Framework

The value of the PI lies in its ability to capture the full spectrum of trainee readiness. Competent performance in medicine is not a single attribute; it is the coordinated expression of knowledge, judgment, psychomotor ability, and professional behaviors within a specific clinical context. Cognitive knowledge reflects foundational understanding, including anatomy, indications, contraindications, interpretation of findings, and safety principles. Workflow understanding evaluates whether the trainee can execute the correct sequence of tasks, including preparation, equipment setup, patient positioning, and adherence to institutional protocols. Clinical reasoning measures interpretation and decision-making during a scenario, such as selecting the appropriate study or intervention, integrating findings, recognizing abnormal results, and escalating concerns appropriately. Psychomotor and technical skills assess the physical execution of the procedure, including instrument handling, ergonomics, image acquisition or technical precision, and maintenance of sterile or safe technique. Communication and professionalism capture behaviors essential to safe supervised practice, including patient explanation, consent language, teamwork, respect, and documentation. Feedback responsiveness and deliberate practice assess whether the trainee can incorporate coaching, correct errors, and demonstrate improvement through repeated attempts. Taken together, these components provide a more valid representation of clinical readiness than any written test or subjective global impression alone.

Structure of the Proficiency Index

The PI can be constructed as a weighted composite score across six domains. A proposed model is shown below. This model produces a total score of 100%, allowing proficiency to be expressed quantitatively while still reflecting the multidimensional nature of performance.

Domain	Purpose	Example Indicators	Assessment Method	Weight
Cognitive Knowledge	Measures foundational understanding before clinical application	Anatomy, indications, contraindications, image interpretation, clinical decision rules, safety principles	Multiple-choice examination, short-answer test, image-based quiz	20%
Workflow Understanding	Assesses whether the resident follows the correct sequence of tasks in a standardized encounter	Preparation, equipment setup, patient positioning, stepwise execution, landmark recognition, appropriate next steps	OSCE station with checklist	20%
Clinical Reasoning	Evaluates interpretation and judgment during a simulated scenario	Selecting the correct study or procedure, integrating findings, recognizing abnormal results, escalating concerns appropriately	Case-based OSCE, oral viva, structured simulation debrief	20%
Psychomotor / Technical Skills	Measures hands-on procedural execution	Probe or instrument handling, ergonomics, dexterity, image acquisition, sterile technique, technical precision	Direct observation in simulation, skills checklist, global rating scale	20%
Communication and Professionalism	Captures behaviors required for safe supervised practice	Consent language, patient explanation, closed-loop communication, teamwork, respect, documentation	Standardized patient station, faculty observation rubric	10%
Feedback Responsiveness / Deliberate Practice	Assesses improvement across repeated attempts rather than one-time performance only	Incorporates feedback, corrects prior errors, shows consistency across attempts	Longitudinal faculty rubric, repeated simulation sessions	10%

How the Proficiency Index Supports Objective Assessment:

A major strength of the PI is that it transforms resident assessment from a largely subjective process into a structured and reproducible one. Clinical evaluations often rely on global impressions formed after patient encounters. Although such judgments remain important, they are prone to inconsistency across evaluators, variable case complexity, and retrospective bias. In contrast, the PI uses predefined domains, explicit scoring criteria, weighted components, and standardized testing environments. This allows faculty to assess residents using a common framework rather than relying solely on personal impressions of performance. The PI does not simply generate a score, but identifies the specific domain in which a trainee is underperforming. A resident with strong knowledge but weak workflow execution will require a different educational intervention than a resident with appropriate technical ability but poor communication or inconsistent clinical reasoning. Thus, the PI provides actionable diagnostic information for targeted remediation.

Key Take Away Points

1. Competence should be multidimensional: The Proficiency Index (PI) evaluates knowledge, reasoning, workflow, technical skills, communication, and adaptability—rather than relying on single metrics.

2. Shifts assessment from subjective to objective: Standardized domains, scoring, and tools improve consistency and reduce evaluator bias.

3. Enables targeted remediation: By identifying specific weak domains, the PI supports focused, individualized learning interventions.

4. Emphasizes performance over time-based progression: Advancement is based on demonstrated proficiency and improvement, not just training duration or case numbers.

References:

1. *Fatima H, Mahmood F, Mufarrih SH, Mitchell JD, Wong V, Amir R, Hai T, Montealegre M, Jones SB, Knio ZO, Matyal R. Preclinical Proficiency-Based Model of Ultrasound Training. Anesth Analg. 2022 Jan 1;134(1):178-187.*
2. *Matyal R, Mahmood F, Knio ZO, et al. Evaluation of the quality of transesophageal echocardiography images and verification of proficiency. Echo Res Pract. 2018;5:89–95.*
3. *Sanfey H, Ketchum J, Bartlett J, Markwell S, Meier AH, Williams R, Dunnington G. Verification of proficiency in basic skills for postgraduate year 1 residents. Surgery. 2010 Oct;148(4):759-66; discussion 766-7.*

GLOBAL HEALTH CORNER

Global Health Journal Club

Shweta Golhar, MD
Edward Clune, MD

A global health journal club session organized by Dr. Shweta Golhar convened anesthesia residents for a focused discussion on disparities in perioperative outcomes across health systems. Attendees included Ruma Bose, George Bekheet, Laura Santa Cruz, Rheanna Maitland, Luca Wachtendorf, and Diana Park. Virtual attendees were Edward Clune, Sarah Lu and Bidisha Bhattacharya. The session emphasized critical appraisal of global surgical data and its implications for anesthesia practice.

The first article, the "African Surgical Outcomes Study," highlighted a striking paradox: despite younger, lower-risk patients and relatively modest complication rates, postoperative mortality in African settings was disproportionately high. Limited workforce density, high rates of urgent surgery, and delayed recognition of postoperative deterioration were key contributing factors. The discussion underscored that improving access to surgery alone is insufficient without parallel investment in perioperative monitoring, early warning systems, and critical care infrastructure.

The second paper, the "Failure to Rescue After Appendectomy Study," reinforced this theme through a comparative lens. Although patients in Colombia experienced fewer complications than those in the United States, they had significantly higher mortality. This discrepancy was attributed to markedly higher "failure to rescue" rates, reflecting systemic challenges in recognizing and managing complications once they occur. Differences in surgical approach, resource availability, and postoperative care capacity were explored as contributing factors.

Together, these studies prompted rich discussion on the concept of "failure to rescue" as a key driver of global surgical inequities. Residents reflected on the role of anesthesia teams not only in intraoperative care but also in postoperative vigilance, escalation, and systems-based safety practices. The session highlighted that advancing global surgical equity requires strengthening perioperative systems, improving team-based responses to complications, and fostering context-specific solutions in low-resource settings.

ECHO CORNER

Is This Cardiac Tamponade? A Case-Based Review of Hemodynamic and Echocardiographic Assessment

Mona Hedayat, MD

Case: A 76-year-old male with paroxysmal atrial fibrillation (on anticoagulation), pulmonary hypertension, COPD with prior episodes of hypoxemic and hypercapnic respiratory failure, chronic kidney disease stage 3a, and obesity was found to have a large chronic circumferential pericardial effusion following perioperative hemodynamic instability during left total hip arthroplasty. Serial transthoracic echocardiography demonstrated a stable effusion with organized features, preserved biventricular systolic function, and no echocardiographic evidence of tamponade, with findings consistent with right ventricular pressure and volume overload. Clinically, the patient experienced progressive dyspnea on exertion and recurrent volume overload requiring ongoing diuresis. In the absence of an identified etiology for the effusion, he was referred for pericardial window via left thoracotomy intervention.

Cardiac Tamponade: Cardiac tamponade is a life-threatening clinical syndrome caused by the accumulation of fluid, blood, pus, or air within the pericardial space, resulting in increased intrapericardial pressure, impaired diastolic filling, and reduced cardiac output. The hemodynamic impact depends not only on the volume of pericardial fluid but also on the rate of accumulation and pericardial compliance, giving rise to the classic “last-drop” phenomenon, whereby small incremental increases in pericardial volume precipitate abrupt circulatory collapse.

Clinically, acute cardiac tamponade is characterized by hemodynamic instability and obstructive shock, classically described by Beck’s triad of hypotension, elevated jugular venous pressure, and muffled heart sounds. However, these findings lack sensitivity, and early manifestations such as dyspnea, tachycardia, reduced exercise tolerance, and oliguria are often more prominent. Jugular venous distention may demonstrate a failure of inspiratory collapse (Kussmaul sign), particularly in cases with concomitant pericardial constraint or effusive–constrictive physiology, further reflecting impaired right-sided filling (Video 1). Pulsus paradoxus, defined as an inspiratory decrease in systolic blood pressure of greater than 10 mmHg, is a highly specific but variably present sign reflecting exaggerated ventricular interdependence under conditions of fixed intrapericardial volume (Fig. 1A). Notably, pulmonary rales are typically absent despite elevated filling pressures, distinguishing tamponade physiology from cardiogenic pulmonary edema.

Chest radiography may show cardiomegaly with a characteristic “water bottle”-shaped cardiac silhouette in patients with large effusions, typically in the absence of pulmonary congestion, reflecting reduced pulmonary blood volume rather than pulmonary edema (Fig. 1B). Electrocardiography may demonstrate sinus tachycardia, low QRS voltage, and electrical alternans (beat-to-beat variation in QRS amplitude and/or axis caused by the pendular motion of the heart within a large pericardial effusion), findings that are highly suggestive, though not pathognomonic, of tamponade (Fig. 1C).

Transthoracic echocardiography is the diagnostic modality of choice, with hallmark findings including a circumferential pericardial effusion, right atrial systolic collapse, right ventricular diastolic collapse, a plethoric inferior vena cava, and exaggerated respiratory variation in transvalvular Doppler inflow velocities reflecting ventricular interdependence. Although acute tamponade represents a medical emergency requiring prompt drainage, slowly progressive or chronic effusions may present with more subtle hemodynamic compromise, posing diagnostic and management challenges, particularly in patients with comorbid pulmonary hypertension or right ventricular dysfunction, in whom elevated baseline right-sided pressures may mask chamber collapse and blunt traditional tamponade physiology, despite clinically significant circulatory limitation.

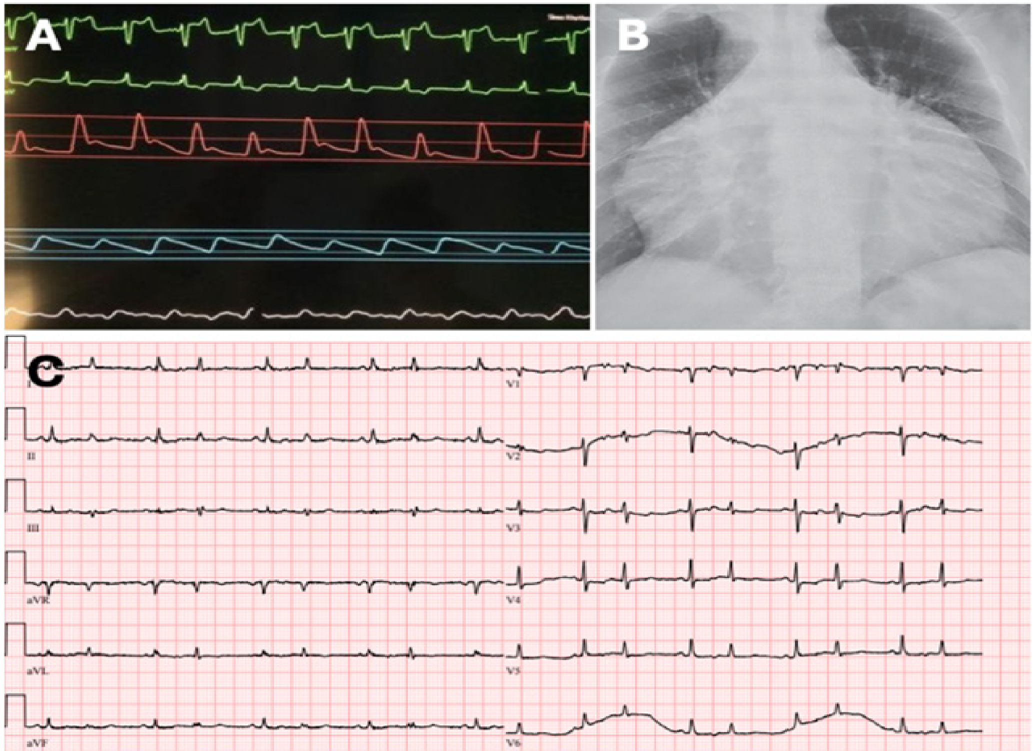
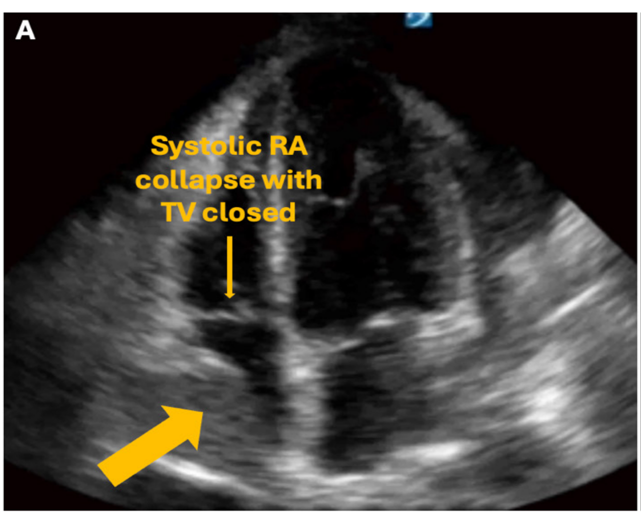


Figure 1: Diagnostic techniques in cardiac tamponade. Pulsus paradoxus: inspiratory reduction of >10 mmHg in systolic blood pressure (A). Chest radiograph showing cardiomegaly and a "water bottle"-shaped cardiac silhouette (B). Electrocardiogram showing low QRS voltage and electrical alternans (C).

On echocardiography, chamber collapse reflects periods during the cardiac cycle when intracavitary pressures fall below intrapericardial pressure. Right atrial systolic collapse occurs during ventricular systole, when right atrial pressure is at its nadir, and is therefore often the earliest echocardiographic sign of cardiac tamponade. In contrast, right ventricular diastolic collapse occurs during early diastole, when right ventricular pressure is lowest, and is considered more specific for hemodynamically significant tamponade, as it reflects impaired ventricular filling (Fig. 2).

A plethoric inferior vena cava with reduced respiratory collapse reflects persistently elevated right atrial pressure and impaired venous return, supporting the presence of hemodynamically significant pericardial constraint. In the setting of pericardial effusion, this finding suggests limited right-sided filling and contributes supportive evidence of tamponade physiology, even when overt chamber collapse is absent.



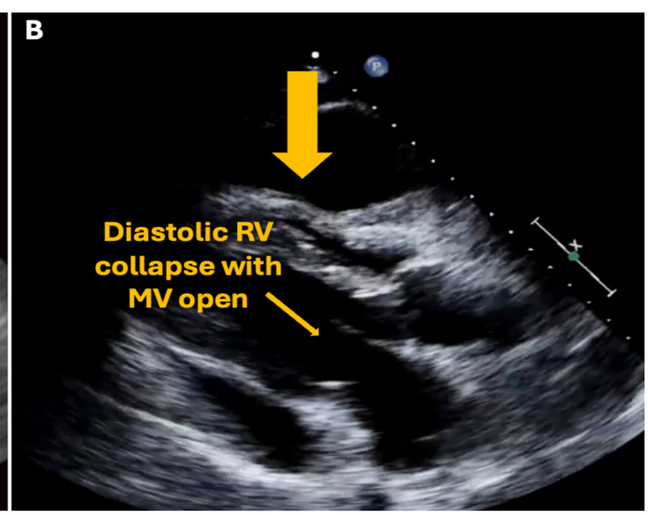


Figure 2: Echocardiographic evidence of right atrial collapse during systole, when the atrioventricular valves are closed, which is an early and sensitive but nonspecific sign of cardiac tamponade (A), and right ventricular diastolic collapse, which is more specific for tamponade physiology (B).

Under normal physiologic conditions, respiratory variation in transvalvular Doppler inflow velocities is modest and reflects changes in intrathoracic pressure with respiration. During spontaneous ventilation, inspiration is associated with a mild increase in tricuspid inflow and a slight decrease in mitral inflow, whereas during positive-pressure ventilation the direction of this variation is reversed; however, the magnitude of change typically remains limited (generally <15% for mitral and <25% for tricuspid inflow). Respiratory variation is assessed using pulsed-wave Doppler from the apical four-chamber view, with the sample volume positioned at the leaflet tips of the mitral and tricuspid valves and the sweep speed reduced (≈25 mm/s) to capture multiple respiratory cycles during quiet spontaneous breathing. Peak E-wave velocities are measured during inspiration and expiration. In the setting of cardiac tamponade or significant pericardial constraint, respiratory variation becomes exaggerated, with an inspiratory decrease ≥25% in mitral inflow velocity and a reciprocal inspiratory increase ≥40% in tricuspid inflow, reflecting enhanced ventricular interdependence within a fixed intrapericardial volume (Fig. 3).

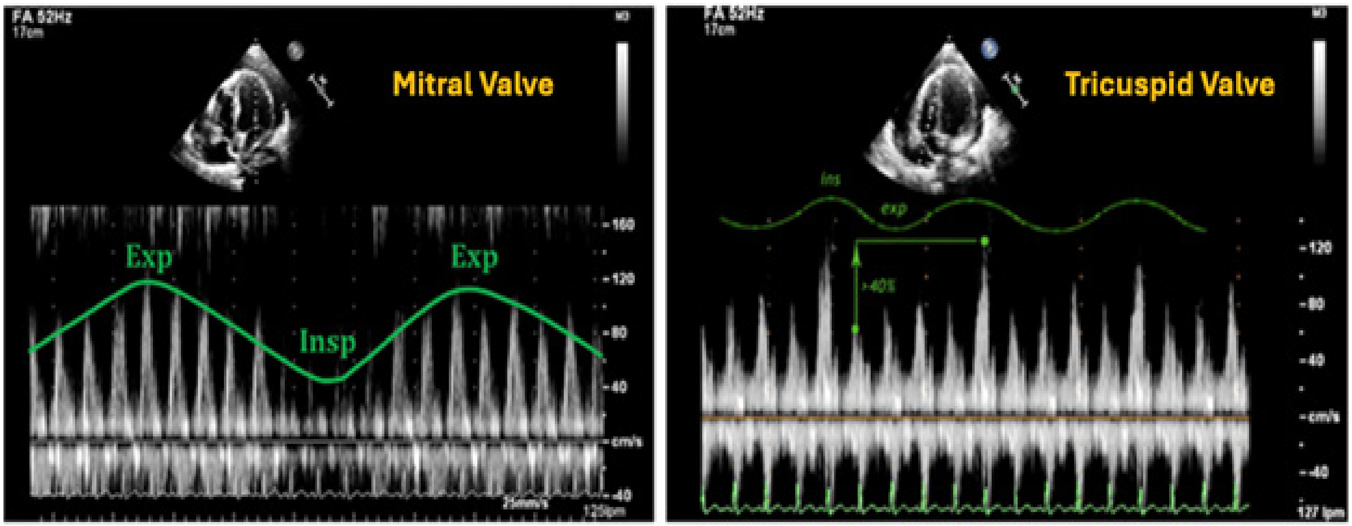


Figure 3: *Doppler evaluations of respiratory variations (Adapted from Reference 3). In the presence of cardiac tamponade, the peak filling velocities of the mitral and tricuspid valves demonstrate respiratory variation due to the shifting balance of intrathoracic and intracardiac pressures.*

Definitive management of cardiac tamponade requires prompt drainage of the pericardial space. In most cases, echocardiography-guided percutaneous pericardiocentesis is the preferred initial approach, allowing real-time identification of the largest and safest fluid pocket while minimizing procedural complications. The subxiphoid approach is most commonly employed due to its broad safety margin and ability to access circumferential effusions, whereas apical or parasternal (intercostal) approaches may be selected when the effusion is loculated or more readily accessible from those windows. Adjunctive imaging modalities, including fluoroscopy or computed tomography, may be useful in selected cases such as post-cardiac surgery tamponade, loculated effusions, neoplastic pericardial disease, or effusive-constrictive pericarditis, where anatomic distortion or limited echocardiographic windows complicate percutaneous access. Continuous hemodynamic monitoring during drainage is recommended, as the greatest physiologic improvement often occurs with removal of the initial volume of fluid, consistent with the "last-drop" phenomenon.

Surgical drainage is indicated when percutaneous pericardiocentesis is contraindicated, unsuccessful, or unlikely to provide durable relief. Indications include traumatic hemopericardium, aortic dissection, purulent pericarditis, ongoing intrapericardial bleeding, and recurrent or loculated effusions not amenable to catheter-based drainage. Surgical options include subxiphoid pericardiotomy, which allows both drainage and tissue sampling, and thoracotomy or thoracoscopic pericardial window, which may be preferred for recurrent effusions or when long-term decompression is required.

Special consideration is warranted in patients with pulmonary hypertension or pre-existing right ventricular dysfunction, in whom rapid pericardial decompression may precipitate acute right ventricular failure. Sudden removal of pericardial constraint can result in abrupt increases in venous return and right ventricular preload in the setting of fixed elevated pulmonary vascular resistance, leading to acute RV dilation, interventricular septal shift, impaired left ventricular filling, and hemodynamic collapse, a phenomenon described as pericardial decompression syndrome. In such patients, gradual, controlled drainage with close hemodynamic monitoring is recommended to mitigate the risk of acute RV failure.

Case Summary: Electrocardiography demonstrated low QRS voltage in selected leads without evidence of sinus tachycardia or electrical alternans (Fig. 4A). Chest radiography revealed moderate cardiomegaly with a characteristic "water bottle" cardiac silhouette, accompanied by small bilateral pleural effusions and no radiographic evidence of pulmonary edema (Fig. 4B).

Point-of-care ultrasound (POCUS) demonstrated a very large circumferential pericardial effusion (Fig. 5A-B). There was no systolic right atrial or diastolic right ventricular collapse (Fig. 5A), and no exaggerated respiratory variation in transvalvular Doppler inflow velocities (Fig. 5C-D). Notably, the right ventricle was dilated (Fig. 5A) with septal flattening in both systole and diastole (Fig. 5E-F), consistent with right ventricular volume and pressure overload.

The patient underwent induction of general anesthesia without significant vasopressor requirement or hemodynamic instability, further supporting the chronic nature of the effusion and absence of tamponade physiology. A left thoracotomy pericardial window was performed, and approximately 2.5 liters of pericardial fluid were drained. Given the presence of right ventricular pressure and volume overload, fluid evacuation was performed gradually to mitigate the risk of acute hemodynamic shifts. No significant hemodynamic changes occurred during drainage. The patient was subsequently extubated and recovered uneventfully in the post-anesthesia care unit.

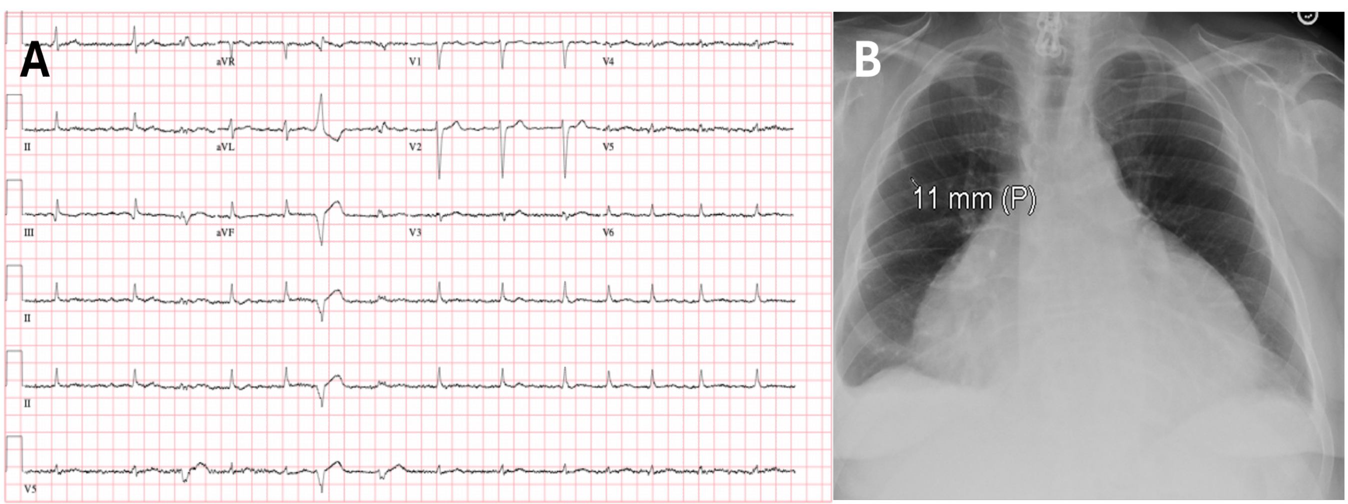


__Figure 4:__ ECG on day of surgery showing atrial fibrillation with premature ventricular or aberrantly conducted complexes; unusual R wave regression from V2 into V3-V5 with improvement into V6, suggesting electrode misplacement (A). CXR a week prior to the surgery showing moderate cardiomegaly with normal hilar and mediastinal contours, without focal pulmonary consolidation (B).

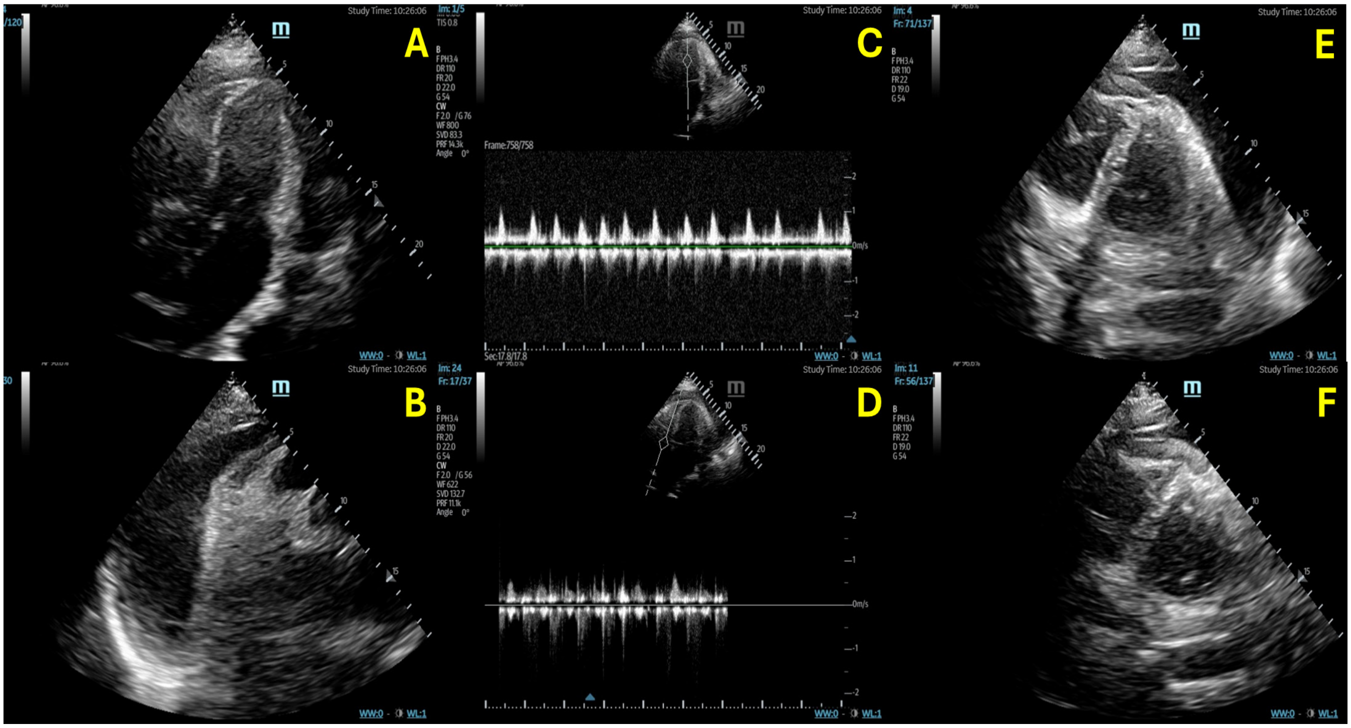


Figure 5: *POCUS findings. Apical 4 chamber showing large circumferential pericardial effusion with evidence of RV dilation (A) and absence of right atrial or right ventricular collapse. Modified parasternal long-axis showing large pericardial effusion (B). Transvalvular Doppler inflow patterns demonstrating absence of exaggerated respiratory variation across the mitral (C) and tricuspid (D) valves. Parasternal short axis showing flattening of septum during both diastole (E) and systole (F).*

Key Take Away Points

1. Cardiac Tamponade is a clinical diagnosis. A large pericardial effusion alone does not equal tamponade; hemodynamic compromise must be present.

2. Echocardiography guides diagnosis but must be interpreted in context. Right atrial and ventricular collapse, IVC plethora, and Doppler variation are key, but may be absent in pulmonary hypertension.

3. Chronic effusions can be large yet stable. Rate of accumulation determines physiology more than absolute volume.

4. Management depends on physiology, not size. Tamponade requires urgent drainage, while stable effusions allow controlled, often gradual intervention, especially in patients with RV dysfunction.

References:

1. Spodick DH. Acute cardiac tamponade. N Engl J Med. 2003 Aug 14;349(7):684-690.

2. Adler Y, Ristić AD, Imazio M, Brucato A, Pankuweit S, Burazor I, et al. Cardiac tamponade. Nat Rev Dis Primers. 2023 Jul 20;9(1):36.

3. Pérez-Casares A, Cesar S, Brunet-Garcia L, Sanchez-de-Toledo J. Echocardiographic evaluation of pericardial effusion and cardiac tamponade. Front Pediatr. 2017 Apr 24;5:79.

Click here to view an interactive module on Cardiac Tamponade!

VASCULAR CORNER

Argatroban and Bivalirudin Use in Vascular Surgery

Sumeeta Kapoor, MD

Abstract

Heparin-induced thrombocytopenia (HIT) is an immune-mediated adverse reaction to heparin characterized by thrombocytopenia and a paradoxical risk of thrombosis. Because unfractionated heparin remains the standard anticoagulant in vascular surgery, managing patients with HIT presents a significant clinical challenge. Argatroban, a direct thrombin inhibitor that does not cross-react with HIT antibodies, has emerged as a practical alternative. This review outlines its mechanism of action, pharmacokinetics, dosing strategies including bolus versus infusion, and perioperative monitoring using serial activated clotting time (ACT). It also compares argatroban with bivalirudin, another direct thrombin inhibitor. Although current evidence is limited, both agents appear to provide effective anticoagulation, with selection guided by patient-specific factors and institutional practice.

Introduction

Unfractionated heparin is widely used in vascular surgery due to its rapid onset and reliable reversal with protamine sulfate. However, HIT represents a contraindication to further heparin exposure. HIT is an immune-mediated syndrome caused by antibodies against platelet factor 4 (PF4)–heparin complexes, resulting in platelet activation and a prothrombotic state. In patients requiring vascular procedures, this creates a therapeutic dilemma, as systemic anticoagulation is essential during arterial clamping and revascularization. Argatroban has emerged as an alternative anticoagulant in this setting, though standardized protocols remain limited.

Pathophysiology and Clinical Implications of HIT

HIT occurs when IgG antibodies form against PF4-heparin complexes, triggering platelet activation, thrombin generation, and a hypercoagulable state. Despite thrombocytopenia, the clinical consequence is an increased risk of venous and arterial thrombosis, including deep vein thrombosis, pulmonary embolism, and acute limb ischemia. In vascular surgery, this is particularly concerning because thrombosis can compromise graft patency and limb viability. Immediate discontinuation of heparin and initiation of alternative anticoagulation are therefore essential.

Pharmacology of Argatroban

Argatroban is a synthetic direct thrombin inhibitor derived from L-arginine that reversibly binds the catalytic site of thrombin, inhibiting fibrin formation, platelet activation, and thrombus propagation without requiring cofactors. It has a rapid onset of action and a short half-life of approximately 45–52 minutes, allowing for predictable anticoagulant effects. Its duration is brief, with activity declining within 2–4 hours after discontinuation, although this may be prolonged in hepatic dysfunction. Argatroban undergoes hepatic metabolism, making it suitable in renal impairment but requiring dose reduction in liver disease. Elevated bilirubin levels, reflecting biliverdin metabolism, are associated with reduced clearance and prolonged anticoagulant effect. Unlike heparin, argatroban has no specific reversal agent, an important limitation in surgical settings.

Perioperative Anticoagulation Strategy Using Argatroban

Argatroban is administered as a continuous intravenous infusion, with or without an initial bolus depending on clinical urgency. Standard dosing begins at 2 µg/kg/min, with reduced dosing (e.g., 0.5–1 µg/kg/min) in hepatic dysfunction or critically ill patients. In select cases, a bolus of 100–200 µg/kg may be used to rapidly achieve anticoagulation. Monitoring is performed using serial ACT measurements intraoperatively, targeting values of approximately 300–450 seconds depending on the procedure. ACT should be measured at baseline, after initiation or dose adjustments, and at regular intervals to guide titration. While aPTT (target 1.5–3 times baseline) is useful outside the operating room, ACT is more practical intraoperatively. Due to its short half-life, anticoagulant effects diminish relatively quickly after discontinuation, facilitating postoperative hemostasis, though this may be delayed in hepatic dysfunction.

Clinical Evidence in Vascular Surgery

Evidence supporting argatroban in vascular surgery remains limited but suggests effective anticoagulation. Prospective studies in HIT populations have demonstrated rapid achievement of therapeutic anticoagulation within 4–5 hours and reduced composite outcomes of thrombosis, amputation, and death compared with historical controls. In vascular surgery specifically, case reports and small series describe successful use in procedures such as carotid endarterectomy and limb revascularization, with anticoagulation guided by serial ACT monitoring and acceptable bleeding and thrombotic outcomes.

Comparison With Bivalirudin

Bivalirudin is another direct thrombin inhibitor that serves as an alternative anticoagulant in patients with HIT. It has a shorter half-life of approximately 20–25 minutes and is cleared via proteolytic metabolism with partial renal elimination, in contrast to the hepatic metabolism of argatroban. As a result, bivalirudin may be preferred in patients with hepatic dysfunction, whereas argatroban is often favored in renal impairment. Dosing strategies for bivalirudin in HIT are less well standardized, with infusion rates typically ranging from 0.02 to 0.1 mg/kg/hour and titrated to aPTT targets of 1.5–2.5 times baseline.

Comparative studies suggest that argatroban and bivalirudin provide similar efficacy and safety. A retrospective analysis demonstrated comparable time to therapeutic anticoagulation (approximately 5–6 hours), similar proportions of time within therapeutic aPTT range, and no significant differences in thromboembolic or bleeding complications between the two agents. Argatroban was associated with a higher frequency of supratherapeutic aPTT values, whereas overall anticoagulation control was similar. Other studies report conflicting findings regarding speed of anticoagulation and bleeding risk, and a meta-analysis found no significant differences in major clinical outcomes. However, most available data are derived from cardiac surgery and critically ill populations, limiting direct applicability to non-cardiac vascular surgery.

In practice, the choice between argatroban and bivalirudin is guided by patient-specific factors, including hepatic and renal function, as well as institutional familiarity and monitoring protocols. Given the lack of clear superiority, both agents remain appropriate options for anticoagulation in patients with HIT undergoing vascular procedures.

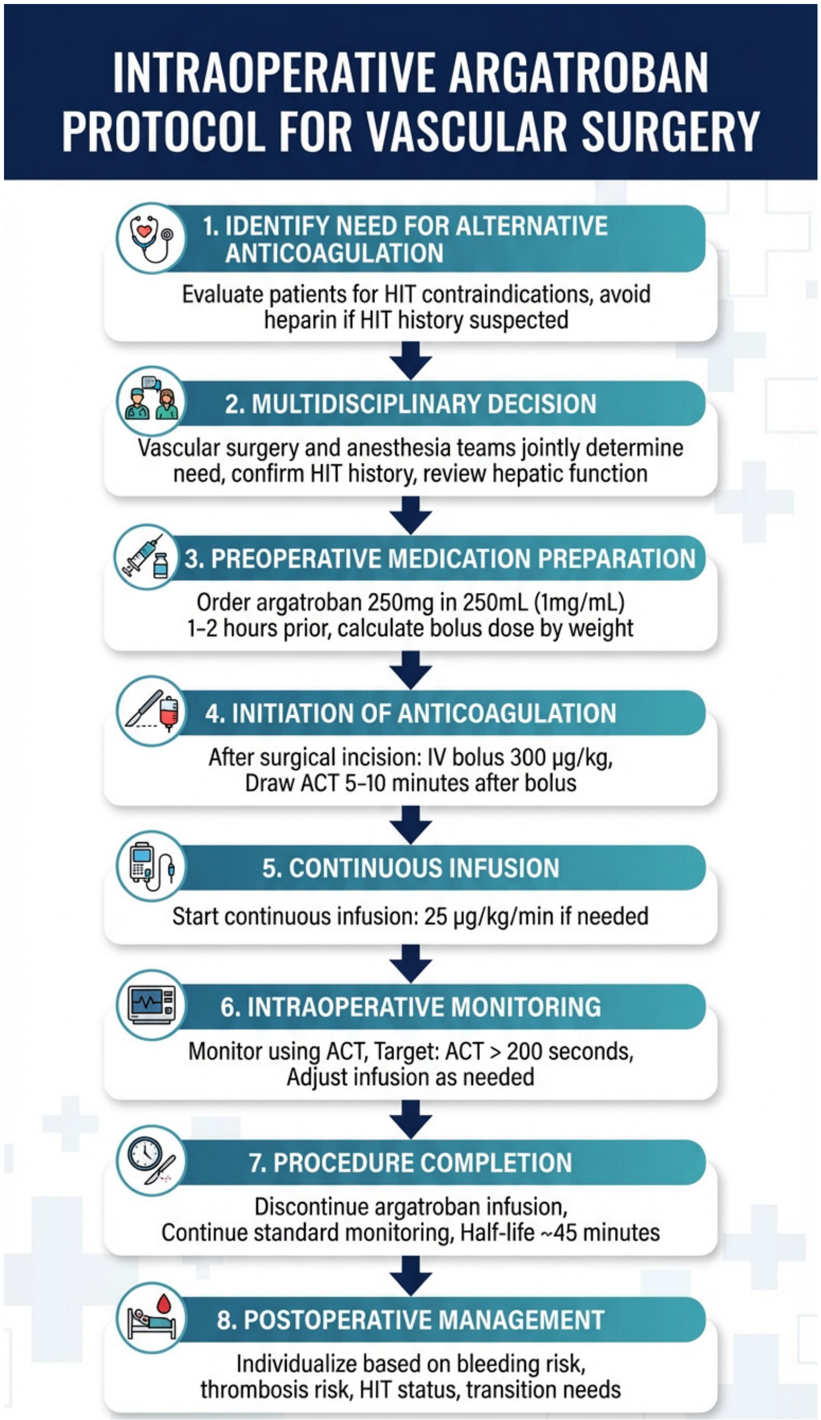
Advantages and Limitations of Argatroban in Vascular Surgery

Argatroban provides predictable anticoagulation, does not cross-react with HIT antibodies, and is safe in renal dysfunction. Its short half-life allows for relatively rapid cessation of anticoagulant effect. However, it lacks a reversal agent, requires dose adjustment in hepatic dysfunction, and may have prolonged effects in the setting of elevated bilirubin. Additionally, variability in dosing strategies reflects the limited availability of high-quality evidence.

Conclusion

Argatroban is an effective alternative anticoagulant for patients with HIT undergoing vascular surgery, offering rapid onset, short duration, and predictable pharmacokinetics when guided by serial ACT monitoring. Bivalirudin provides a comparable alternative, with differences in metabolism influencing drug selection based on patient comorbidities. Although current evidence suggests similar clinical outcomes between agents, data specific to non-cardiac vascular surgery remain limited. Future studies are needed to define optimal anticoagulation strategies in this population.

Feature	Argatroban	Bivalirudin
Drug Class	Direct thrombin inhibitor (small molecule)	Direct thrombin inhibitor (synthetic hirudin analog)
Mechanism of Action	Reversibly binds thrombin catalytic site	Binds both catalytic site and anion-binding site of thrombin
Onset of Action	Rapid (within minutes)	Rapid (within minutes)
Half-life	~45–52 minutes	~25 minutes
Metabolism	Hepatic metabolism	Proteolytic cleavage + partial renal clearance
Elimination	Liver	Kidney + enzymatic degradation
Use in Hepatic Impairment	Requires dose reduction	Preferred over argatroban
Use in Renal Impairment	Preferred (no adjustment usually needed)	Dose adjustment required
Monitoring	aPTT (target ~1.5–3× baseline)	ACT (intraoperative), aPTT (ICU setting)
Bolus Dose	Not routinely used (infusion-based: typically 2 μg/kg/min, lower in critical illness)	Not routinely used (infusion-based: typically 2 μg/kg/min, lower in critical illness)
Intraoperative Use (Vascular Surgery)	Less commonly used due to longer half-life and titration challenges	Preferred due to predictable kinetics and shorter half-life
Reversal	No specific antidote	No specific antidote (but shorter duration helps)
Bleeding Risk	Moderate (prolonged effect if accumulation)	Lower intraoperative bleeding risk due to rapid offset
Transition to Oral Anticoagulants	Complicates INR interpretation (false elevation)	Easier transition to warfarin/DOACs
Evidence in Non-Cardiac/ Vascular Surgery	Limited but widely used historically	Increasing use; favored in procedural settings



References:

1. *King MA, Walker M, Hussaini T, Misskey J, Faulds J. Review of the use of parenteral direct thrombin inhibitors in carotid endarterectomy in patients with a history of heparin-induced thrombocytopenia. JVS Vasc Insights. 2024;2:100102.*

2. *Tokuda Y, Matsumoto M, Sugita T, et al. Vascular surgery using argatroban in a patient with a history of heparin-induced thrombocytopenia. Circ J. 2003;67(10):889-890.*

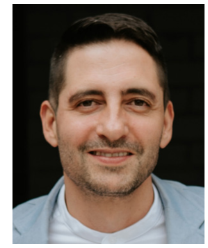
3. *Nogueira S, Queijo J, Teles AR. Recent Myocardial Infarction and Acute Heparin-Induced Thrombocytopenia: A Case Report on Perioperative Management of a Patient for Acute Limb Vascular Surgery. Cureus. 2022;14(10):e30763. Published 2022 Oct 27.*

4. *Duewell BE, Briski MJ, Feih JT, Rinka JRG, Tawil JN. Argatroban Versus Bivalirudin in the Treatment of Suspected or Confirmed Heparin-Induced Thrombocytopenia. J Pharm Pract. 2021;34(4):529-534.*

REGIONAL CORNER

A Structured Approach for Teaching Ultrasound-Guided Central Neuraxial Blocks

Sadique Ali, MD
Juan Puerta Martinez, MD



Introduction

Central neuraxial blocks are widely used for surgical anesthesia, obstetric analgesia, and chronic pain management. Traditionally, these procedures rely on surface anatomical landmarks and tactile cues such as loss of resistance or visualization of cerebrospinal fluid. However, these methods can be unreliable, particularly in patients with obesity, edema, spinal deformities, or prior spinal surgery. Even under optimal conditions, accurate identification of the intended intervertebral level is inconsistent, which may increase the risk of complications. Ultrasound provides an opportunity to overcome these limitations by allowing direct visualization of spinal anatomy, thereby improving accuracy and confidence in performing these procedures.

Anatomical Considerations for Ultrasound Imaging

A comprehensive understanding of spinal anatomy is fundamental to effective ultrasound use. The vertebral column consists of cervical, thoracic, lumbar, sacral, and coccygeal segments, each contributing to the overall curvature of the spine. These curvatures influence probe positioning and image acquisition. On ultrasound, key anatomical structures such as the spinous processes, interlaminar spaces, ligamentum flavum–dura complex, and anterior spinal elements must be recognized. Developing the ability to identify these structures enables trainees to orient themselves spatially and select appropriate needle insertion points with greater accuracy.

Role and Advantages of Ultrasound Guidance

Ultrasound guidance enhances neuraxial procedures by providing real-time or pre-procedural visualization of relevant anatomy. It allows clinicians to accurately identify the midline and intervertebral spaces while also estimating the depth to the epidural space. This reduces the number of needle passes required and minimizes the risk of complications such as accidental dural puncture. Although ultrasound does not replace clinical skill, it serves as a powerful adjunct that improves both procedural success and patient safety when integrated into routine practice.

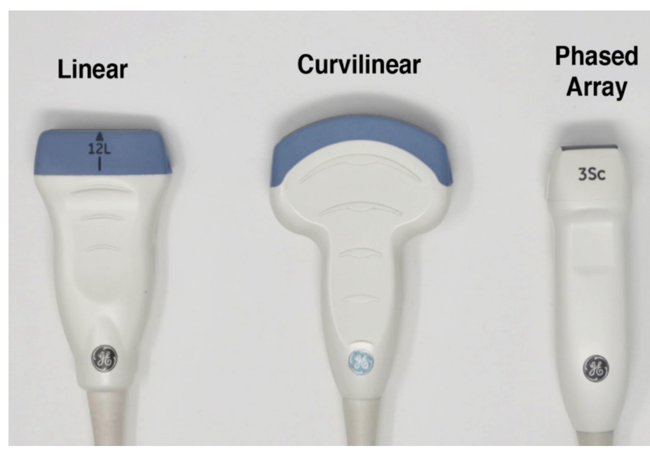


Figure 1: *Types of probe*

Ultrasound Equipment and Optimization

Appropriate equipment selection and image optimization are critical for successful neuraxial ultrasound imaging. Low-frequency curved array transducers are generally preferred because they provide adequate penetration to visualize deeper spinal structures, typically located several centimeters beneath the skin. While high-frequency probes offer superior resolution, their limited penetration restricts their usefulness in this context. Image quality can be further improved by adjusting gain and depth settings to achieve optimal visualization, as well as maintaining consistent probe orientation. Proper patient positioning, such as flexion of the spine in the sitting or lateral decubitus position, also plays an important role in enhancing image acquisition.

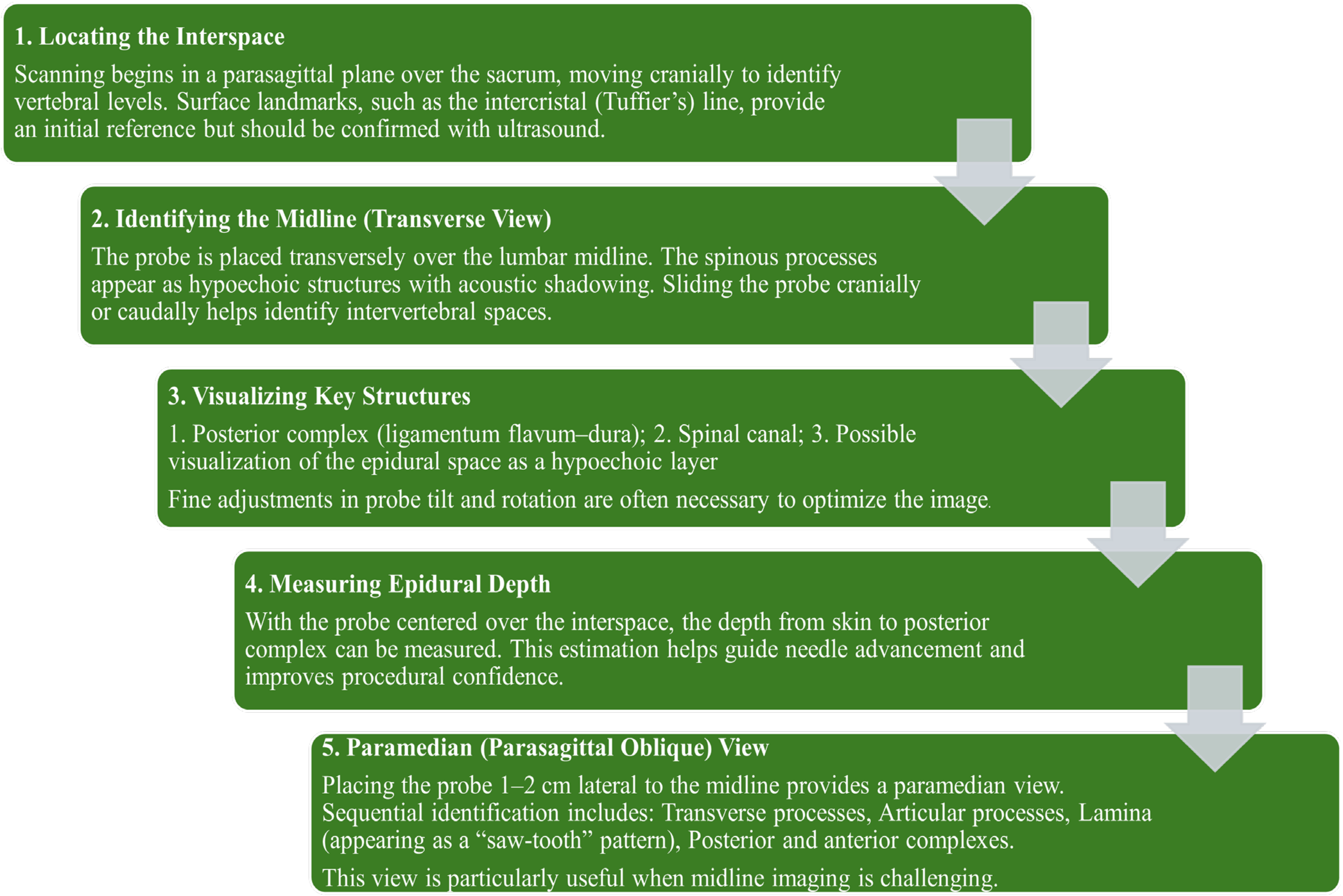


Figure 2: *Scanning Techniques and Stepwise Approach*

Educational Strategies for Teaching Ultrasound-Guided CNBs

Effective teaching of ultrasound-guided neuraxial techniques requires a structured and progressive approach. Training should begin with foundational knowledge, including spinal anatomy and ultrasound physics, followed by guided practice in image acquisition and interpretation. Simulation-based learning provides a safe environment for skill development before transitioning to clinical practice. Emphasis should be placed on deliberate practice, repetition, and feedback, allowing trainees to build both technical proficiency and clinical decision-making skills over time. Integrating ultrasound into routine teaching can help bridge the gap between theoretical knowledge and practical application.

Figure 3: *Transverse Plane at Midline (Spinous Process)*

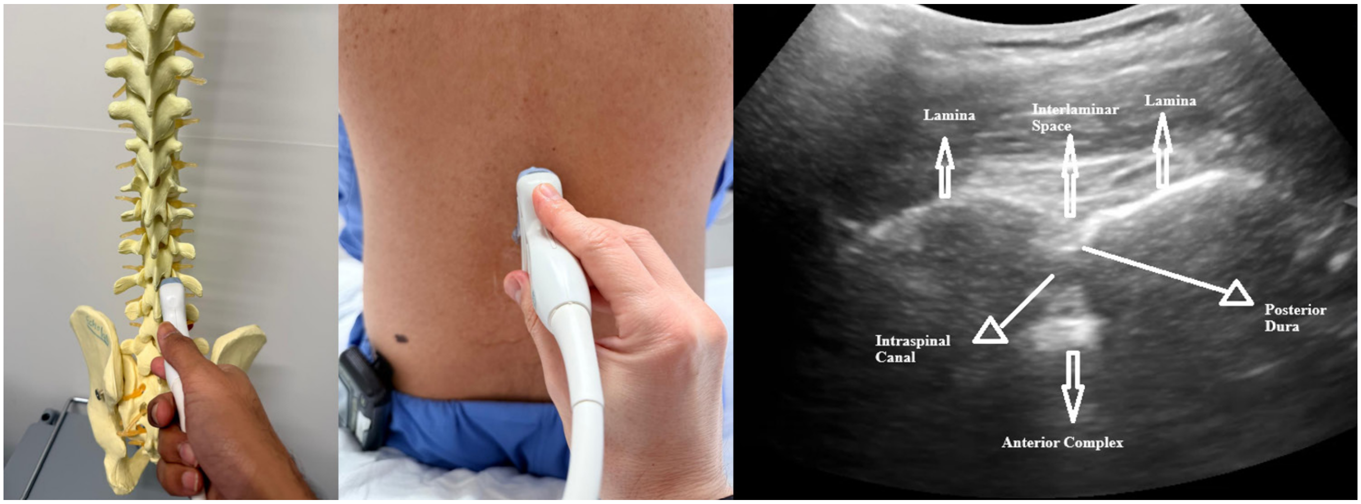


Figure 4: Paramedian Sagittal View

Figure 5: Thoracic Paramedian Parasagittal View

Limitations and Challenges

Despite its advantages, ultrasound-guided neuraxial anesthesia presents several challenges. The technique is operator-dependent and requires a learning curve, particularly for image acquisition and interpretation. Real-time needle guidance can be technically demanding, often requiring coordination of both hands. Time constraints in busy clinical settings and variability in equipment availability may also limit its routine use. Additionally, image quality can be affected by patient factors, and evidence supporting improvements in certain long-term outcomes remains limited.

Future Directions

Advances in technology are likely to expand the role of ultrasound in neuraxial anesthesia. Emerging developments include real-time ultrasound-guided needle insertion, artificial intelligence-assisted image interpretation, and three-dimensional spinal imaging. Needle tracking systems and standardized training programs may further enhance both education and clinical practice. These innovations have the potential to improve accuracy, efficiency, and accessibility of ultrasound-guided techniques.

Conclusion

Ultrasound-guided central neuraxial blocks represent a significant advancement in anesthetic practice and education. By adopting a structured teaching approach that integrates anatomical knowledge, ultrasound skills, and systematic scanning techniques, educators can enhance trainee competence and patient safety. While challenges remain, ongoing innovation and emphasis on education are likely to solidify the role of ultrasound as an essential tool in neuraxial anesthesia.

Click here to view the interactive module on neuraxial ultrasound!

Key Take Away Points

1. Ultrasound improves accuracy and safety of central neuraxial blocks. It allows visualization of spinal anatomy, identification of midline and intervertebral spaces, and estimation of epidural depth, reducing needle passes and complications.

2. Structured, stepwise teaching is essential. Training should progress from anatomy and ultrasound physics to image acquisition, interpretation, simulation-based practice, and supervised clinical application.

3. Operator skill and patient factors affect success. Ultrasound guidance is operator-dependent, and challenges include obesity, spinal deformities, or prior surgery; deliberate practice and feedback are crucial.

4. Future innovations may enhance training and clinical practice. AI-assisted imaging, real-time needle guidance, and 3D spinal imaging could further improve accuracy, efficiency, and accessibility.

Cutting-Edge Cardiac Insights to Be Showcased at SCA 2026

The following abstracts will be presented as posters and oral presentations at SCA 2026 Annual Meeting & Workshops, which will take place April 23-26, in Nashville, Tennessee.

1. Correlation between Intraoperative Invasive Hemodynamic and Color Flow Doppler Assessment After Percutaneous Edge-to-Edge Mitral Valve Repair
2. Urgent Transcatheter Edge-to-Edge Mitral Valve Repair Versus Surgery in Cardiogenic Shock: A Single-Center Comparative Analysis
3. Echocardiographic Correlates of Pressure-Volume-Derived Indices: Advancing Intraoperative Assessment of Right Ventricular Function

Session: Best of Meeting Oral Abstracts and Early Career Investigator Awards

4. Tricuspid Annular Dynamism and Tenting Geometry as Surrogates of Right Ventricular-Pulmonary Arterial Coupling in Cardiac Surgery

Session: Best of Meeting Oral Abstracts and Early Career Investigator Awards

Arthur E. Weyman Award Honors Dr. Feroze Mahmood's Contributions to Echocardiography

Dr. Feroze Mahmood was awarded the prestigious **Arthur E. Weyman Award** by the Society of Cardiovascular Anesthesiologists in 2026, recognizing outstanding contributions to the field of cardiovascular anesthesiology and perioperative echocardiography.

As part of this honor, Dr. Mahmood delivered a featured lecture titled "TEE – A Journey in Time: From Echocardiography to Echocardiology"during the Annual SCA Echo Week in Atlanta. The lecture highlighted the evolution of transesophageal echocardiography and its expanding role in advancing perioperative cardiac care.

Serious Games in Action: From Blueprint to Bedside Learning

On March 18, 2026, Beth Israel Deaconess Medical Center hosted a Grand Rounds session with Carolyn Weiniger, Visiting Professor, BIDMC, using a Serious Games format to enhance clinical learning. Moving beyond traditional didactics, the session incorporated interactive, team-based activities centered on four stations: Crisis Resource Management (CRM), point-of-care ultrasound (POCUS), a general versus neuraxial anesthesia case-based discussion, and thromboelastography (TEG).

Each station used structured exercises followed by facilitated debriefings to reinforce key clinical principles in communication, decision-making, and application of knowledge. The format encouraged active participation across experience levels and created a dynamic learning environment focused on practical, bedside-relevant skills.

Feedback from attendees highlighted strong engagement and improved retention of key concepts, underscoring the value of Serious Games as an effective and scalable approach to clinical education.

Quiz Yourself

Audio & Visual Lesson

[Check out case ten here.]

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

ECG and Rhythms Interpretation

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