



CLINICS IN MEDICAL EDUCATION

Docendo Discimus

[By Teaching We Learn]



Beth Israel Deaconess Medical Center



HARVARD MEDICAL SCHOOL
TEACHING HOSPITAL

Department of Anesthesia,
Critical Care and Pain Medicine

Center for Education Research,
Technology and Innovation

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*“You cannot discover new oceans
unless you lose sight of the shore.”*



Heraclitus: A Greek philosopher of Ephesus

Progress in medical education and research requires moving beyond established practices and comfort zones. Just as one must leave the shore to find new oceans, educators, trainees, and researchers must take intellectual risks exploring new ideas, methods, and perspectives to achieve meaningful innovation and breakthroughs.

<https://en.wikipedia.org/wiki/Heraclitus>



Nyansapo “Wisdom Knot”: A symbol of wisdom, ingenuity, intelligence, and patience. The proverb associated with this Adinkra is “Nyansapo wosane no badwenma,” to wit, “A wisdom knot is untied (only) by the wise.”

<https://www.adinkrasymbols.org/symbols/nyansapo/>



New Website

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

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EDITOR'S WELCOME

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

We hope you enjoy this issue!

Robina Matyal

Robina Matyal, MD

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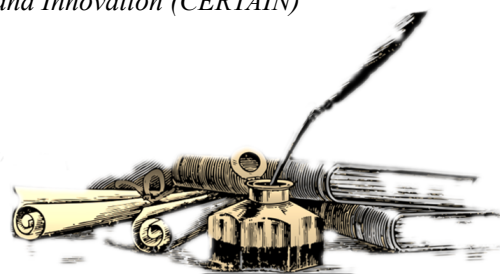
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OUR MISSION

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

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Human Factors Applications in Anesthesia Practice: Part 1

Jacqueline Hannan, PhD

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Human Factors Applications in the Perioperative Setting: Part 1

Human factors engineering (HFE) is defined as: the scientific discipline concerned with understanding (1) interactions among humans and other elements of a system, and (2) the profession that applies theory, principles, data, and methods of design to optimize human well-being and overall system performance. The origins of HFE have roots in psychology, physiology, and industrial design, as these fields became increasingly interested in the fit between humans and tools.

HFE methodologies can be leveraged to provide understanding about complex, high-risk domains, identify opportunities for procedural improvement, and support overall system safety. This multipart series will explore the applications of HFE in healthcare, with specific focus on the ways that HFE practices improve the safety and quality of perioperative care.

History of Human Factors

The true catalyst in forming the field of HFE was the rapid technological advancement that took place during World War II, with specific focus in the aviation and military domains. Psychologists began recognizing how poor control panel design within airplane cockpits influenced operational errors [1]. The lack of salience and uniformity of gauges, levers, and buttons significantly contributed to misinterpretation of the system state and improper actions taken (Figure 1). Additionally, a growing concern about the effects of circadian rhythm on pilot performance led to the consideration of designing systems and processes to best fit natural human tendencies and ultimately began the human factors discipline. This period marked the formalization of human factors: psychologists, engineers, and physiologists collaborated to redesign controls, displays, and systems to align with human capabilities and limitations.



Figure 1. Cockpit of an airplane flown in World War II

Following the war, HFE began expanding into other domains and evolving to support the growth of technology. In the aerospace industry, NASA integrated human factors in cockpit design, space shuttle controls, and astronaut life-support systems [2]. In factories during the industrial revolution, industrial engineering began to focus not just on efficiency, but also on comfort, safety, and long-term health [3]. Implementation of physical ergonomics provided work layout improvements to reduce the number of work-related musculoskeletal injuries (WMSDs) that result from repetitive and forceful jobs. Additionally, HFE has become a prominent aspect of the automotive industry, with user experience considerations informing dashboard readability and safety mechanisms [4]. As automation advances in vehicle design, human-machine interaction considerations are essential to ensure safety for the passengers and other pedestrians on the road and in other vehicles.



By the 1970s and 1980s, HFE matured into a multidisciplinary science drawing from psychology, engineering, biomechanics, and cognitive science [5]. With the rise of computing, human factors evolved to address human-computer interaction [6]. This expanded HFE into the digital space, emphasizing usability, error reduction, and user experience [7]. Modern HFE now focuses on systems-level thinking: understanding how teams, environments, and organizations interact as whole systems.

Implementation of HF into Healthcare

Healthcare is complex, high-stakes, and highly variable. Like aviation in WWII, healthcare systems rely on humans interacting with technology under pressure, often in environments where errors can be catastrophic. Yet, for decades, healthcare lagged behind other industries in adopting formal HFE approaches [8]. The shift began in the 1990s, when research showed that many medical errors were preventable and often traced to system design issues rather than individual negligence. The Institute of Medicine's landmark 1999 report *To Err Is Human* highlighted that up to 98,000 patients die each year in U.S. hospitals due to preventable errors, giving an urgent call for human factors integration [9].

HFE is now integrated into healthcare in multiple ways. One of the most prominent areas is in medical device design, where regulatory bodies such as the FDA require usability testing to ensure that devices and technologies are safe and intuitive to use [10]. Beyond medical devices, HFE also informs workflow and systems design, helping hospitals reconfigure processes such as patient handoffs, team communication, and medication administration to reduce error and improve coordination. The principles of human factors are also embedded in patient safety initiatives, including the widespread use of checklists and standardized protocols that reduce reliance on memory and minimize variability. In training, healthcare has drawn inspiration from the use of simulation in the aviation domain, employing simulation-based education to prepare teams for emergencies and high-stakes scenarios. As healthcare continues to integrate into digital spaces, human-computer interaction research has guided improvements in electronic health records, aiming to decrease clinician burden and reduce documentation errors.

Example Applications of HF in Perioperative Care

Perioperative care is one of the most human factors-intensive domains of healthcare, encompassing preoperative preparation, intraoperative management, and postoperative recovery. Each stage involves rapid decision-making, close interaction with technology, and coordination among multidisciplinary teams in a high-stakes environment. HFE applications can be seen across multiple aspects of perioperative practice.

One critical area of concern is technology and information usability. Across the perioperative continuum, clinicians interact with electronic health records, monitoring systems, infusion pumps, and scheduling platforms. These tools must be intuitive and reliable to use under time pressure. Standardized and clear design features can reduce errors during high-stress situations. Alarm and alert management are particularly important in the perioperative environment, where providers often face an overwhelming number of notifications. HFE research supports strategies to minimize alarm and alert fatigue by ensuring that signals are both meaningful and actionable.

Teamwork and communication also benefit from HFE integration. Perioperative care requires coordination among anesthesiologists, surgeons, nurses, and support staff, with frequent handoffs between teams and transitions across phases of care. Structured tools, such as surgical safety checklists, preoperative briefings, and standardized handoff protocols, ensure that critical information is shared consistently and clearly.

Finally, training and simulation practice represent a powerful application of human factors in perioperative care. Simulation-based education allows providers to practice crisis management, teamwork, rare complications, and handoff processes in a controlled environment. These exercises enhance individual and team performance while exposing latent system weaknesses, enabling improvements before patient safety is at risk.



Together, these examples demonstrate how HFE is integrated into every layer of perioperative care, from the design of digital and physical tools to the organization of workflows and training programs. The result is a more resilient system that supports clinicians in delivering safe, reliable patient care.

Conclusion and Future Topics

This article is the first entry in our series about the applications of human factors in the perioperative environment. Throughout this series, we will focus on a variety of human factors topics in the healthcare setting. The following topic areas will be discussed in this series, to be published in future issues of our journal.

Topic	Description
Situational Awareness	Monitoring multiple streams of information (patient vitals, surgical progress, equipment alarms) while avoiding fixation errors.
Communication and Teamwork	Clear, closed-loop communication with surgeons, nurses, perfusionists, and other anesthesia team members. Feeling comfortable speaking up and conducting safe handoffs.
Design of Equipment and Ergonomics	Designing workstations, anesthesia machines, and monitors that are intuitive and minimize error, and the use of wearable sensors to measure motion.
Decision-Making and Cognitive Bias	Focus on bias, tunnel vision, and overreliance on technology.
Stress, Fatigue, and Burnout	Long hours, night calls, and high cognitive demand can impair performance.
Learning from Errors and Near Misses	Non-punitive incident reporting and debriefing create opportunities for learning.
Education and Simulation	Simulation-based training allows practice of non-technical skills (communication, teamwork, decision-making) alongside technical skills.
Systems Thinking and Safety	Integration of checklists, cognitive aids, and learning from adverse events in the process of making system-level changes.

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ACGME Clinician Educator Milestones: A Competency Based Education Roadmap for Faculty Development

Federico Puerta Martinez, MD

Noor Dirini, MD



In the previous installments of our medical education series, we focused on curriculum development and the steps to design effective programs. We now turn to another crucial facet of academic medicine: the competencies of the educators themselves. The ability of faculty to teach, mentor, and lead effectively is just as important as a well-crafted curriculum. This article outlines Competency-Based Medical Education (CBME) principles and introduces the ACGME Clinician Educator Milestones (CEMs), a framework to guide faculty growth as teachers and leaders, with practical strategies for lifelong educator development.

CBME in a Nutshell: From Time-Served to Competency Demonstrated

Competency-Based Medical Education has reshaped physician training by emphasizing outcomes: what learners can actually do, rather than how long they spend in training. Traditional models were time-based; CBME is “fundamentally oriented to graduate outcome abilities,” ensuring trainees demonstrate required competencies even if they progress at different paces. This approach offers greater accountability and flexibility by focusing on real clinical or educational performance. Key principles include defining end outcomes and tailoring training to each learner’s progress. Frameworks like the ACGME’s milestone system assess residents and fellows on a developmental scale. The same philosophy now informs faculty development: clinician-educators can track and self-assess their growth as teachers. This is the context in which the Clinician Educator Milestones (CEMs) emerged—a competency-based, outcomes-focused approach to faculty development.

Origins of the Clinician Educator Milestones

The CEMs arose from a national effort to address the lack of a formal system for defining and tracking faculty teaching skills in the CBME era. In 2020, the Accreditation Council for Graduate Medical Education (ACGME), Accreditation Council for Continuing Medical Education (ACCME), Association of American Medical Colleges (AAMC), and American Association of Colleges of Osteopathic Medicine (AACOM) convened a workgroup to develop educator competencies. Over two years, the group identified key domains, created milestones, sought nationwide feedback, and refined the framework. Released in 2022, the CEMs are the first standardized developmental model for clinician-educator skills.

What exactly are the CEMs?

In brief, they are a set of ~20 subcompetencies (specific skill areas) organized under five overarching competency domains (explained below). For each subcompetency, the CEMs define a developmental progression with five milestone levels. This provides a common language to describe an educator’s growth from novice to expert in each skill area. The milestones were designed to support faculty self-improvement and to guide faculty development efforts, not to serve as an external evaluative instrument. Laura Edgar, EdD (ACGME’s senior VP for milestones) notes that the CEMs give educators “a scaffold for improvement” – a roadmap to assess one’s own teaching abilities and identify areas for growth.

A Developmental, Voluntary Framework – Not an Evaluation Tool

A critical point for faculty to understand is that the Clinician Educator Milestones are entirely voluntary and meant for formative development, not for high-stakes evaluation or promotion decisions. The ACGME has made it clear that these milestones “are not an ACGME accreditation requirement and are not intended to become one.” In other words, no residency or faculty member will be “graded” on them by accreditors. Likewise, institutions should not mandate them as part of faculty annual reviews or tie them to tenure. Unfortunately, early misconceptions have arisen about their purpose, so let’s dispel those clearly:



- **Not for Compliance or Promotion:** The CEMs are not tied to any program accreditation standards or faculty promotion criteria. Using them is optional, and they do not become part of one's official record.
- **Not a High-Stakes Exam:** The milestones are formative, intended for self-reflection or coaching, not summative assessments. Faculty can use them candidly to gauge their skills without fear of judgment.
- **Not One-Size-Fits-All:** There is no expectation that everyone reaches Level 5 (the expert level) in every domain. An educator's target level may depend on their role, experience, and goals. For example, a program director might strive for higher levels in administrative competencies, whereas a new junior faculty member might focus on achieving competency (Level 3) in core teaching skills first.
- **Not a Checklist of Requirements:** The example behaviors listed under each milestone level are illustrative, not prescriptive. They provide a picture of what performance at a given level might look like, but they are not a mandatory to-do list.

By understanding these points, faculty can use the CEMs as intended: a personal roadmap for growth and reflection. They promote a growth mindset, support self-assessment, guide professional development, inform mentoring conversations, and help tailor faculty development programs.

What does a milestone look like?

Each milestone is a descriptive rubric for a sub competency, outlining observable behaviors across five levels from beginner to expert. A Level 1 descriptor typically reflects a Novice understanding – basic awareness or knowledge of the skill. Level 3 often corresponds to being Competent, meaning the faculty member can perform the skill independently in routine situations. By Level 5, the individual is an Expert in that area, a role model who can innovate and influence others or systems with that skill. The intermediate levels (Level 2 “advanced beginner” and Level 4 “proficient”) capture the gradations in between, as one gains experience and ability to handle more complexity. These milestone levels are descriptive, not evaluative labels. (Image 1)

Image 1. Competency (red circle), Sub-competency (blue circle), and Milestones example (green circle).

Educational Theory and Practice 1: Teaching and Facilitating Learning				
Level 1	Level 2	Level 3	Level 4	Level 5
Identifies various techniques for teaching	Delivers instruction in unidirectional manner resulting in passive learning	Teaches in a way that invites active learning and encourages critical appraisal	Uses scholarly teaching methods for varied levels of learners across settings	Serves as a coach to other educators on effective teaching practices
Discusses lessons implicitly learned (e.g., hidden curriculum)	Identifies that own behavior (role modeling) is part of the hidden curriculum	Intentionally role models desired practice behaviors to aid learners	Intentionally role models desired behaviors to aid learners across multiple settings	Works collaboratively to develop educators' ability to demonstrate evidence-based teaching behaviors
☐	☐	☐	☐	☐
Comments:				
Not Yet Completed Level 1 ☐				

Selecting a response box in the middle of a level implies that milestones in that level and in lower levels have been substantially demonstrated.

Selecting a response box on the line in between levels indicates that milestones in lower levels have been substantially demonstrated as well as **some** milestones in the higher level(s).



The Five Competency Domains for Educators

Universal Pillars	Foundational qualities such as reflective practice, professionalism, bias mitigation, and personal well-being that support growth across all other domains.
Educational Theory & Practice	Core teaching and learning skills, including instructional strategies, learner assessment, feedback, curriculum design, and educational scholarship.
Well-Being	Skills for maintaining personal resilience and fostering healthy learning environments for colleagues and learners.
Administration	Leadership and management abilities in educational settings, such as program oversight, change management, and systems thinking.

Using the Clinician Educator Milestones in Practice

How can faculty put the CEMs to work for their own professional development? The process is meant to be practical and self-directed, optionally with input from mentors or peers. Here's a step-by-step approach to using the milestones for growth:

- 1. Select a Subcompetency:** Begin by choosing one specific area (subcompetency) you want to develop. This could be something you're curious about or an area where you feel less confident. Focusing on one or two subcompetencies at a time keeps the process manageable.
- 2. Self-Assess Your Level:** For the chosen subcompetency, read through the milestone level descriptors (Levels 1–5) and honestly identify which level best matches your current behavior. This self-assessment may be informed by prior feedback from learners or colleagues. It's okay if you find you're at a Level 1 or 2 – that simply establishes your starting point. Also, define a desired level you'd like to reach after a period of development.
- 3. Set a Development Goal:** Based on the above, articulate a concrete goal. Setting a clear goal anchors your efforts and aligns with the idea of a professional development plan.
- 4. Identify Actions and Resources:** Now, brainstorm activities to reach that next level. The milestone descriptors can guide you: what do people at the next level do that you're not doing yet?
- 5. Implement and Track Progress:** Put your plan into action and integrate those activities into your routine. This might involve scheduled practice, reflection, or seeking mentorship. Keep notes or a development log – this is part of the reflective practice encouraged by the Universal Pillars domain.
- 6. Reassess and Iterate:** After a set period, revisit the milestone descriptors for that subcompetency. Self-assess again (and you might also ask a trusted peer or mentor to assess you). Have you reached the level you aimed for? Hopefully, yes, if not yet, what obstacles are there, and how might you adjust your plan? This cyclical process of plan, act, reflect, and revise embodies continuous improvement.

Some institutions have even incorporated the CEMs into faculty development programs or individualized faculty development plans, where educators document goals and progress annually (much like an Individual Development Plan, but focused on teaching competencies). Remember that this process is meant to be flexible and self-driven, you can take on as much or as little as is feasible, and you can seek out help.

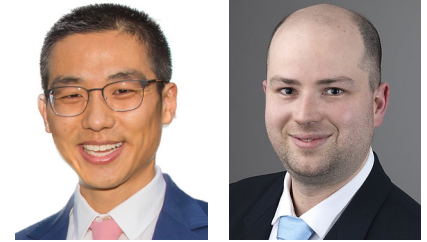
Encouraging Lifelong Growth as Educators

CBME emphasizes clear outcomes and supporting learners to achieve them. The Clinician Educator Milestones extend this to faculty, offering a flexible roadmap for developing teaching skills. Embracing them fosters continual growth, inspiring educators at all career stages and ultimately improving learning, patient care, and the culture of lifelong improvement.



An Interview with Matt Gao, MD Associate Program Director, Anesthesiology Residency

Interview by Dario Winterton, MD



Intraoperative teaching is a critical yet sometimes overlooked opportunity to develop residents' knowledge, decision-making, and professional skills in real time. Unlike classroom or simulation-based teaching, the OR provides a rich, high-stakes environment where learning can be immediately relevant and applied to patient care. However, effective teaching in this setting requires careful timing, awareness of the learner's capacity, and the ability to adapt to rapidly changing clinical situations.

To better understand how faculty can incorporate high-yield, practical teaching into busy operative lists, Dario Winterton, MD, a medical education fellow and attending at BIDMC, spoke with Matt Gao, MD Associate Program Director for the Anesthesiology Residency at BIDMC whose experience and philosophy highlight how small, intentional moments can have a lasting educational impact.

DW: Hi and thanks for taking the time to chat with us today. We wanted to discuss some useful tips for intraoperative teaching with you today.

MG: Of course! Thanks for having me. Intraoperative teaching is something we all can and should do for our learners.

DW: Absolutely. Let's get started - what's the best time for intraoperative teaching?

MG: Anytime! It can be in the pre-op holding area while waiting for the room to be ready, intra-operatively while the surgeons are scrubbing, or even in the PACU area after you drop the patient off.

DW: On the flip side, is there any time when you avoid teaching?

MG: Great point – absolutely. In learning theory, there's an entity called "cognitive load". In short, everyone has a certain bandwidth and once you go over that, whatever you teach is not going to "stick". Think of when the learner is performing laryngoscopy or diluting medications – their entire bandwidth is being used on getting a good view or doing dilution calculations in their head. Going over the difficult airway algorithm or talking about alpha/beta receptors isn't going to be a fruitful conversation in the moment.

DW: Or if you have an unstable trauma patient on the table and you're trying to teach – there's a lot happening and dropping knowledge isn't helpful. That being said, how do you get the conversation started when the time is appropriate?

MG: I like to start with "what are your considerations for this patient/surgery?" This open ended question allows for greater flexibility to discuss what you think are pertinent points. Other ways to start include "...tell me more about your decision to use etomidate instead of propofol – could you have used either/or?" or starting a pro/con discussion regarding one anesthetic choice over another.

DW: Those are great conversation starters! I will sometimes play the role of the surgeon and ask questions from a surgical standpoint. What do you think about that?

MG: That's also a great form of teaching that prepares learners for real-life scenarios and interactions with surgeons. It's easy to cancel cases and not worry about it anymore but it's much harder to verbalize what you want to be done for the patient before they get rescheduled for the procedure.

Teaching Pearls

"Match teaching to moments of low cognitive load. High-stakes or high-focus tasks are not the right time for complex teaching."

Even a three-minute conversation can be high-yield teaching.
Matt Gao, MD

"Case-relevant teaching resonates more deeply. Sharing your own mistakes makes lessons memorable and human."

"Teaching doesn't have to be a lecture — short, intentional conversations are just as impactful."



DW: I completely agree with that. Now I want to focus on more of the content. What do you teach? Do you have a depository of high-yield topics that you go over with the learners?

MG: I usually try to stick to topics and/or concerns pertaining to the case since I feel like that's most high-yield for the day. I also like to discuss real-life situations that I've heard about or that I have experienced myself. I find that learners really like when I give them examples that I've encountered since they seem to resonate much better and makes me more "human" in their eyes. Yes, even attendings make and have made mistakes! When I tell them about my mistakes, I tell them how my approach has changed since then so I don't make the same mistake twice.

DW: Care to share any specific examples?

MG: Nothing I care to share at the moment *nervous laughter* I will say for the more senior learners, I turn teaching moments into a mini mock oral exam by making the patient more critically ill and telling them that their interventions didn't work so they have to come up with a plan B or even plan C.

DW: Great ideas! Before we end, many people are concerned about balancing time spent teaching with supervising two rooms and giving breaks. Any tips or suggestions?

MG: Teaching doesn't have to be done in a formal setting – even a three-minute conversation about a focused topic can be considered teaching. My approach is after I have safely induced in both rooms, I plan on a teaching session after the resident comes back from break. This way I can see what the resident has done so far in terms of anesthetic management and discuss things that I've changed while they were away and why I changed them. It also gives me a chance to share more practical tips like moving the ventilator to create more real estate for us or adding a pillow to make the neck more neutral.

DW: Can't teaching start the night before with the pre-op phone call?

MG: Yes! Many people ask residents the night before what they would like to discuss the following day but often times I will assign a high-yield topic that's pertinent to the case. This allows me to do some of my own research and refresh my memory. Another option is discussing a high impact journal article.

DW: Seems like you always teach to the case – is that true?

MG: Not necessarily. Another technique that residents enjoy is discussing a previous case that they did or a previous case that you did that was difficult or interesting. I'll give a summary of the case and ask the resident what they would've done differently...almost like a PBLD or a mini M&M session.

DW: Wonderful. It seems like that's all the time we have for today. Thank you spending your morning with us!

MG: Thanks for giving me the opportunity to discuss this! As always, I'm always happy to help or answer questions people may have.

DW: Thanks again, ciao!

	<i>Teach when cognitive load is low. Timing is everything.</i>
	<i>Use open-ended questions. They stimulate reasoning and discussion.</i>
	<i>Make it case relevant. Learners remember lessons tied to real patients.</i>
	<i>Keep it short and intentional. Even three minutes counts as teaching.</i>
	<i>Extend beyond the OR. Pre-op calls and post-op debriefs are underused opportunities.</i>



Education Workshop – Teaching and Technology

Jacqueline Hannan, PhD



On July 16, 2025 the Center for Education Research, Technology, and Innovation (CERTAIN) within the Department of Anesthesia, Critical Care and Pain Medicine at Beth Israel Deaconess Medical Center hosted a Grand Rounds workshop focused on the integration of technology into medical education practices. The workshop featured a variety of education technology and fostered lively discussions across four stations. The event provided staff members with the opportunity to learn about the education tools available to support teaching and continued learning in anesthesia. The workshop was well attended, and feedback from the participation survey highlighted great interest in additional events aligned with the goal of this program. The following section highlights the individual topics covered at each station during the workshop and concludes with some noteworthy feedback about the session.

Station #1: Virtual Reality (VR) Simulations and Bronchoscopy Simulator

Attendees had the opportunity to try VR simulation software created by Vantari Systems to practice anesthesia procedural skills, such as placing a central venous catheter or a pulmonary artery catheter. The module-based software guides learners through completing each step in the procedure, providing feedback and pointers throughout. The VR environment also provided an interactive anatomy playground, where the operator could explore components of the human body systems. Alongside the VR simulators, this station also featured a bronchoscopy simulator by ORSIM, providing realistic upper airway simulations to practice a variety of potential complications.

Station #2: Leveraging AI Tools for Medical Education

This AI-focused station explored the use of OpenEvidence and ChatGPT as tools to leverage in anesthesia education. OpenEvidence is an advanced AI-powered search engine that allows users to ask medical questions and receive research-informed responses. The platform helps streamline the most important information for providing medical care, enabling doctors to retrieve useful information at the bedside. In addition to supporting clinical decisions, OpenEvidence is also a helpful platform for facilitating education conversations with trainees. If a trainee has a specific medical question, prompting a research-informed answer with this tool helps guide the conversation. Additionally, using ChatGPT for generating educational materials, such as simulated case scenarios, was demonstrated at this station. Participants had the opportunity to try both platforms, using research from questions asked on OpenEvidence to inform simulation cases created by ChatGPT. This station also discussed the importance of ethical use of AI and the need for an expert to review content before trusting the generated responses.

Station #3: Discussion on Intraoperative Teaching

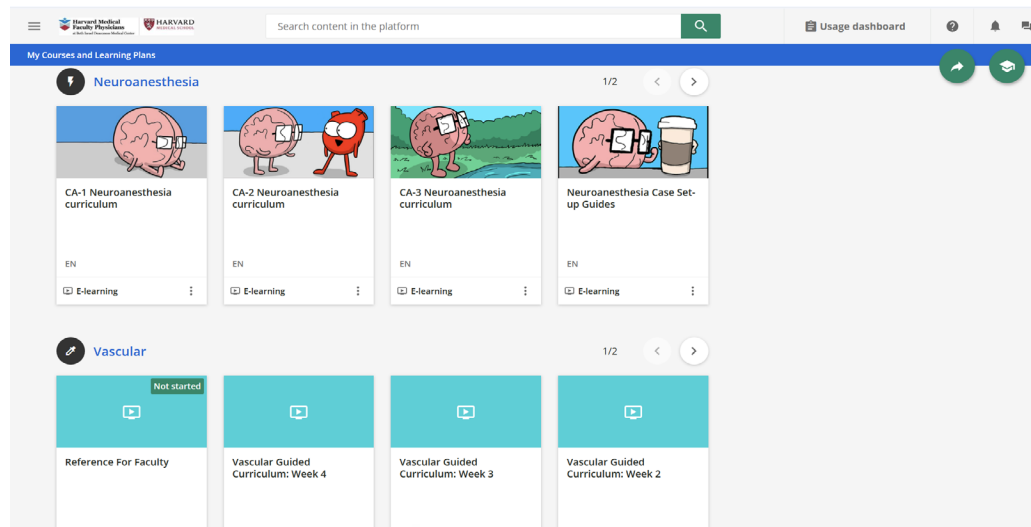
This station provided an opportunity to engage with an ongoing discussion in the medical education space about how to best teach intraoperatively, while still delivering the highest quality patient care. The lively conversations that took place at this station allowed clinicians to exchange ideas about what has worked well for them, and areas that could use improvement. With the right practice and frameworks, medical staff can be equipped to support the next generation of healthcare professionals throughout their skills development.

Station #4: Digital Resources for Anesthesia Education

This station of the workshop featured many subsections to showcase the digital resources available to support anesthesia education in our department. A variety of simulated cases and educational videos created by faculty and staff in our education division are available through a learning management system platform: Docebo. Another platform, C8 Health, was showcased as a tool available in the department. This best-practices management system provides a one-stop location for all resources relating to the department's policies, standard of care, educational material, and administrative information, available on the web and as a smartphone application. Finally, the station showcased the educational resources available on the Clinics in Medical Education website and through this journal, providing information about recent advances in the field and an opportunity to engage with ongoing research.

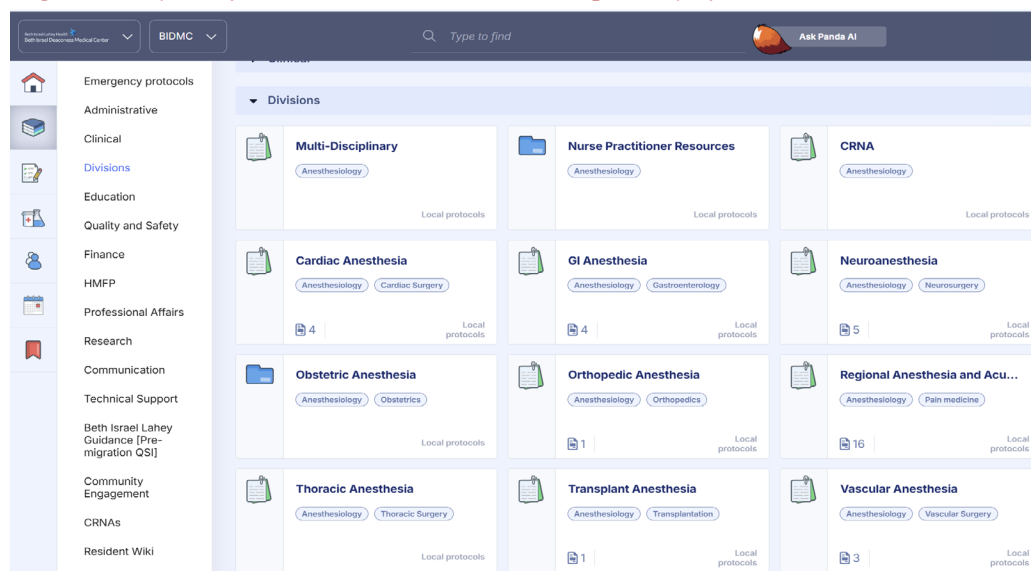


Figure 1. Layout of Docebo - Learning Management System



For BIDMC Anesthesia Staff
[Click here to access Docebo!](#)

Figure 2. Layout of C8 Health - A Centralized Repository of Educational Resources



For BIDMC Anesthesia Staff
[Click here to access C8!](#)

Workshop Feedback:

This event was highly regarded by the attendees, with 21% of participants rating the workshop as “very useful” and 63% of participants rating the workshop as “extremely useful,” on a 5-point Likert scale. In a free response section of the participation survey, we received the following comments regarding the value of the workshop:

“This workshop was amazing and so interactive!”

“Would love to attend more in the future!”

“Great initiative”

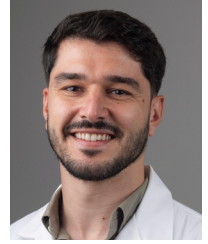
Conclusion:

The workshop successfully showcased a variety of innovative tools and approaches to support anesthesia education, while also fostering meaningful discussion among participants. The overwhelmingly positive feedback highlights strong interest in continued engagement with similar events. Building on this momentum, we look forward to offering future workshops that further advance teaching, learning, and collaboration within our department.



Cricothyrotomy

Noor Dirini, MD



What is a Cricothyrotomy?

A cricothyrotomy is a life-saving emergency surgical airway procedure in which an incision is made through the cricothyroid membrane to establish direct access to the trachea. It is performed when conventional methods of securing the airway have failed or are not feasible, and the patient is at risk of imminent hypoxia or death. It is the fastest and most accessible method to secure a definitive airway in ‘cannot intubate, cannot oxygenate’ (CICO) situations, especially in adults.

Techniques

There are three primary methods for performing a cricothyrotomy. The first is needle cricothyrotomy, which involves percutaneous puncture of the cricothyroid membrane with a large-bore needle to establish temporary oxygenation. The second is the Seldinger technique, in which a guidewire is introduced through the needle and then used to facilitate placement of a catheter or tube. The third is the open surgical approach (scalpel–finger–bougie), where the membrane is incised with a scalpel, the opening is widened with the finger, and a bougie is inserted to guide the placement of an endotracheal tube

Clinical Scenarios That May Require Cricothyrotomy

Cricothyrotomy may be indicated in situations where mouth opening is obstructed or the vocal cords cannot be visualized using standard airway management techniques such as direct laryngoscopy. Examples include maxillofacial trauma (gunshot wounds, motor vehicle accidents, crush injuries, or profuse oral bleeding), upper airway edema (caused by burns, anaphylaxis, or severe swelling), and an obstructed airway due to a foreign body. In addition, cricothyrotomy may be necessary in cases of failed intubation where other rescue techniques are unsuccessful.

Contraindications

There are no absolute contraindications to performing a cricothyrotomy in a life-threatening airway emergency. However, relative contraindications include a history of tracheal surgery, laryngeal fracture, or laryngotracheal disruption, which may complicate the procedure or increase the risk of adverse outcomes.

Complications

Complications of cricothyrotomy can be categorized as early or late. Early complications include bleeding, inadvertent right mainstem bronchus intubation, cartilage damage from misidentified landmarks, posterior tracheal or esophageal injury, false tract formation, and hypoxia. Late complications may include scarring, fistula formation, subglottic stenosis, dysphagia, and voice changes.

	Cricothyrotomy	Tracheostomy
Purpose	Emergency life-saving	Elective/semi-elective
Anatomical Site	Cricothyroid membrane	Tracheal rings (typically 2nd–4th)
Duration	Temporary	Can be definitive
Pediatric Use	Contraindicated in children under 12 years old due to narrow anatomy	Preferred for pediatric populations
Speed of Procedure	Very rapid (<1–2 min in skilled hands)	Slower (5–15+ min)
Equipment Needed	Minimal (scalpel, bougie, ETT or catheter)	Full surgical set with retractors and dilators
Ease of Landmarks	Easier: Superficial and palpable	Harder: Deeper, more dissection required
Long-term Suitability	Not intended for long-term use — convert to tracheostomy	Designed for prolonged airway management
Airway Resistance	Slightly higher (smaller tube)	Lower (larger tube diameter possible)
Speech	Loss of normal phonation until converted	Possible with speaking valves if cuff deflated



Step-by-Step Approach:

Scalpel–Finger–Bougie Technique

- Place patient supine with neck extended.
- Stand on the side of your dominant hand (right-handed stands on the right side of the patient).
- Use the thumb and middle finger of your non-dominant hand on either side of the thyroid cartilage to stabilize the larynx; use your index finger to palpate and mark the cricothyroid membrane for incision.
- Use a scalpel to make a vertical midline skin incision 2–4 cm over the membrane.
- Use your finger for blunt dissection and palpation of the cricothyroid membrane.
- Make a horizontal stab incision through the center of the cricothyroid membrane until you feel a loss of resistance into the airway. You may hear or feel air escape or bubbling of blood in the incision zone.
- Rotate scalpel 90° so the sharp edge is pointing cephalad to keep the airway open.
- Insert bougie with tip facing the anterior wall of the trachea; you may feel tracheal clicks as bougie passes tracheal rings. Keep advancing until you are met with resistance at the carina (usually 10–15 cm in adults).
- Railroad a size 6.0 ETT (lubricated), advance tube until balloon cuff disappears (to avoid mainstem intubation).
- Hold ETT steady and remove bougie, inflate cuff, and confirm placement (bilateral chest wall rise, capnography, auscultation, condensation).

Needle Cricothyroidotomy

Uses a percutaneous approach with a hollow needle or catheter rather than a scalpel/open dissection.

- Stabilize the larynx and create tension over the CTM by using the thumb and middle finger of the nondominant hand to stretch the skin vertically; palpate CTM with index finger.
- Attach a 3–10 mL syringe filled with 50% saline to an angiocatheter.
- Puncture the skin at the inferior margin of the CTM, directing needle caudally at 30°–45°. Apply continuous negative pressure while advancing.
- Air bubbles in the syringe confirm tracheal placement.
- Advance the catheter over the needle until the hub abuts the skin; remove the needle.
- Reattach saline syringe and confirm intratracheal placement by aspirating air.
- Connect catheter to high-pressure tubing or bag-valve mask with 100% O₂. Ventilate at 10–12 breaths/min, I:E ratio ~1:4.
- Hold catheter in place at all times—do not rely on sutures for secure positioning.



Click here to watch the [Needle Cricothyrotomy technique](#)



Click here to watch the [Open Surgical Approach \(Scalpel–Finger–Bougie\)](#)



Click here to watch the [Seldinger technique](#)



Perioperative Guidelines for GLP-1 Receptor Agonists

Huma Syed Hussain, MD



Introduction

Glucagon-like peptide-1 receptor agonists (GLP-1 RAs) are increasingly prescribed for type 2 diabetes, obesity, and metabolic optimization. Their benefits extend beyond glycemic control, supporting weight loss and potential improvement in conditions such as obstructive sleep apnea and osteoarthritis. However, in the perioperative setting, their use poses unique challenges. Concerns about delayed gastric emptying and the risk of pulmonary aspiration during anesthesia have led to evolving guidelines on perioperative management.

Impact on Patients in the Perioperative Period

GLP-1 RAs can improve preoperative metabolic stability and promote weight reduction, which may enhance surgical outcomes. For patients with diabetes, these agents help maintain glycemic control and reduce cardiovascular risk. However, withholding therapy before surgery can worsen hyperglycemia and complicate perioperative management. The balance between metabolic benefits and perioperative risks requires careful consideration. Patients on long-term GLP-1 therapy may experience stable benefits with less pronounced effects on gastric emptying, whereas those recently initiated on treatment or experiencing gastrointestinal symptoms may face a higher aspiration risk. Multidisciplinary planning, engaging anesthesiologists, surgeons, endocrinologists, and gastroenterologists, is crucial to optimize patient safety.

Side Effects Relevant to Surgery

Effect	Description
Nausea and vomiting	Common, especially during early therapy or dose escalation
Delayed gastric emptying	The most clinically significant effect, potentially leading to retained gastric contents and increased aspiration risk under anesthesia or deep sedation
Gastrointestinal bloating	May complicate anesthetic management
Gallbladder disease	Increased risk with long-term use, though not directly perioperative
Cardiovascular effects	Slight increase in heart rate, typically not clinically significant but should be monitored
Hypoglycemia	Rare unless combined with insulin or sulfonylureas

Of these, delayed gastric emptying is the primary concern in the perioperative setting, particularly in patients with new prescriptions, high doses, or persistent gastrointestinal symptoms.

When to Stop GLP-1 RAs Preoperatively:

Current recommendations for perioperative management of GLP-1 receptor agonists (GLP-1 RAs) are largely consensus-based, reflecting limited direct evidence. The American Society of Anesthesiologists (ASA) advises withholding daily-dose GLP-1 RAs on the day of surgery and weekly-dose GLP-1 RAs for at least seven days prior to surgery, regardless of indication, dose, or procedure type. Similarly, the American Diabetes Association (ADA) endorses these guidelines but emphasizes the importance of individualized risk assessment, particularly in patients with diabetes, where interruption of therapy may worsen glycemic control and necessitate bridging strategies such as basal-bolus insulin. The American Gastroenterological Association (AGA) also supports an individualized approach, especially for patients undergoing endoscopic procedures or those experiencing gastrointestinal symptoms. If GLP-1 RAs have not been withheld as recommended and the patient is asymptomatic, the ASA advises proceeding with “full stomach” precautions, including rapid-sequence induction. For urgent or emergent procedures, additional risk mitigation strategies such as gastric ultrasound or prokinetic therapy may be considered.



GLP-1/GIP-GLP-1 Agent	Typical Dosing Interval	When to Stop / Hold	Special Notes
Exenatide (Byetta)	Twice daily (short-acting)	Hold on the day of surgery. If high-risk (e.g., recent dose escalation, active GI symptoms, gastroparesis), consider holding for 24 hours before surgery	Short-acting, generally less likely to impact gastric emptying as much as long-acting agents. Follow standard fasting protocols (e.g., 8 hours before anesthesia).
Tirzepatide (Mounjaro/Zepbound)	Weekly (long-acting)	Hold 1 week prior to surgery. For high-risk patients (e.g., recent dose escalation, active GI symptoms), consider holding 2–3 weeks (up to ~3 half-lives)	Long-acting, similar to semaglutide in terms of gastric emptying delays. Consider holding for 1–2 weeks or more in high-risk cases. Glycemic control should be monitored closely.
Semaglutide (Rybelsus)	Daily (oral)	Hold on the day of surgery. Consider holding for 24 hours in high-risk patients (e.g., gastroparesis, recent dose escalation, or active GI symptoms)	Shorter acting compared to injectable semaglutide, but still can impact gastric emptying. If GI issues are active, consider holding for 24 hours.
Semaglutide (Ozempic/Wegovy)	Weekly (injectable)	Hold 1 week before surgery (unless high-risk). For high-risk patients (e.g., GI symptoms, gastroparesis), consider holding 2–3 weeks (up to ~3 half-lives)	Semaglutide has a long half-life. If held beyond typical dosing interval, consider bridging therapy (e.g., insulin). If GI symptoms are active, consider longer hold period.
Dulaglutide (Trulicity)	Weekly (long-acting)	Hold for 1 week prior to surgery. High-risk patients: Consider holding 1–2 weeks (up to 3 half-lives)	Long-acting agent with potential for delayed gastric emptying. Hold at least 1 week prior to surgery, but longer in high-risk cases.
Lixisenatide (Lyxumia)	Once daily (short-acting)	Hold on the day of surgery. If high-risk, consider holding 24 hours prior to surgery	Short-acting like exenatide. Same considerations for GI symptoms and aspiration risk.

Recent Updates in Guidelines:

Society/Region	Recommendation	Notes
American Gastroenterological Association, American Society for Metabolic & Bariatric Surgery, American Society of Anesthesia, USA, 2024	Most patients can continue GLP-1 agents before elective surgery	Risk-stratified approach, high-risk patients: 24-hour liquid diet, anesthesia planning, gastric ultrasound, airway protection
American Society of Anesthesia, USA, 2023	Withhold GLP-1 medications in days leading up to surgery	Superseded by individualized approach
Canadian Anesthesiologists' Society, Canada, 2023-2024	Stress importance of aspiration risk	Some bulletins: hold GLP-1 for up to 3 half-lives (e.g., 3 weeks for semaglutide), recent commentaries support individualized decision-making
Centre for Perioperative Care, Joint British Diabetes Societies, Europe/UK, 2023	Continue GLP-1 medications as usual	Aspiration precautions recommended (CPOC/JBDS)
Association of Anaesthetists/Anaesthesia, British Journal of Anaesthesia, Europe/UK, 2025	Support continuation of GLP-1	Emphasize risk stratification, adjusted fasting for high-risk cases



Perioperative Protocol for Patients on GLP-1 Receptor Agonists

Risk screening: Patients should first be stratified into high- or low-risk categories. High-risk features include early dose escalation (within the first 4–8 weeks of therapy) or a recent dose increase, active gastrointestinal symptoms such as nausea, vomiting, bloating, or constipation, and known conditions associated with delayed gastric emptying (e.g., diabetic autonomic neuropathy or established gastroparesis). Other high-risk indicators include treatment with higher GLP-1 RA doses or combination therapies such as tirzepatide, a history of retained gastric contents or aspiration during anesthesia, and procedures inherently associated with an increased aspiration risk, such as those performed under deep sedation or with an unprotected airway. Patients without these features are considered low risk.

Low-risk patients: In this group, GLP-1 RAs may be continued as prescribed. Standard preoperative fasting protocols should be followed, and routine anesthesia management is generally appropriate, in line with recent guidance from the USA (2024) and UK (2023).

High-risk patients: Two management strategies have been described. The preferred approach in the USA, UK, and Europe (2024–2025) is to continue GLP-1 therapy with additional perioperative precautions. These include a 24-hour liquid-only diet prior to surgery (particularly for patients on higher doses or with gastrointestinal symptoms), gastric ultrasound assessment where expertise is available, and airway protection strategies such as rapid-sequence induction with intubation. The use of H₂ blockers or non-particulate antacids may also be considered. An alternative approach, which remains in practice in some regions including Canada, involves holding the GLP-1 medication prior to surgery. Daily formulations are typically withheld on the day of surgery, whereas weekly agents are held for at least one week, with some guidance suggesting up to three weeks for semaglutide. If therapy is withheld beyond the usual dosing interval, bridging with alternative glucose-lowering agents (e.g., insulin) may be required to avoid hyperglycemia.

Patients with active gastrointestinal symptoms: On the day of surgery, patients presenting with nausea, vomiting, or other gastrointestinal complaints should be treated as having a full stomach. Elective cases may be deferred until symptoms resolve, whereas urgent procedures should proceed with full stomach precautions, including rapid-sequence induction and/or gastric ultrasound if available (ASA 2023).

Urgent or emergent procedures: Medication washout should not delay life-saving or time-sensitive interventions. These patients should be managed as full stomach cases, with airway protection and appropriate anesthetic precautions (ASA 2023).

Glycemic management when GLP-1 therapy is withheld: If GLP-1 RAs are held beyond their dosing interval, close perioperative glucose monitoring is essential. Temporary adjustments in glucose-lowering therapy, such as basal insulin modification or initiation of bridging regimens, should be considered in collaboration with endocrinology when possible (ASA 2023, 2024).

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Anes360: Leveraging AI to Create a One-Stop Learning and Clinical Support Platform for Anesthesiology Residents

Adnan Ali Khan, MD

Huma Syed Hussain, MD



Starting residency in anesthesiology can be overwhelming, particularly during the first clinical year (CA-1), when new trainees are expected to rapidly integrate foundational knowledge with real-time clinical decision-making. Although numerous educational resources exist, they are often scattered across multiple platforms, making it difficult to access critical information quickly during the demands of a busy workday. Recognizing this gap, a CA-1 resident at BIDMC leveraged large language model (LLM) technology to develop Anes360, a web-based reference guide created by anesthesia residents, for anesthesia residents. Designed to support a smoother transition from intern year to CA-1, Anes360 was conceived as a one-stop resource, to be used as a point-of-care companion that consolidates essential tools and information into a single, user-friendly platform.

The platform offers a comprehensive drug reference, covering all essential agents used for induction, muscle relaxation, opioids, and reversal agents. The weight-based dosage tool can be utilized for accurate and timely calculation of medication, based on actual, ideal, and lean body weight. Its epinephrine dilution calculator simplifies one of the most critical and error-prone tasks in perioperative care, ensuring safety and precision. Local anesthetic toxicity (LAST) is a rare, but sometimes preventable complication from regional anesthesia. The platform features a local anesthetic calculator, allowing users to calculate safe dosages of local anesthetics of different concentrations.

Beyond pharmacology, Anes360 extends into clinical troubleshooting and planning. The website provides step-by-step guidance on managing common anesthesia machines, including the Mindray and Dräger Apollo systems, helping learners quickly identify and resolve technical challenges. Additionally, it offers structured preoperative planning guides for common surgical cases, equipping newer providers with a pre-op template and provide key points in certain cases that may warrant further discussion between attending and anesthesia trainees.

By integrating pharmacology, technology troubleshooting, and case-based preparation, Anes360 offers a simplified, step-wise approach to providers at the start of their anesthesia training bridging the gap between textbook knowledge and real-world practice.

[← Back to Anes360](#) **Local Anesthetic Calculator** [Max Dose Calculator](#)

Calculate maximum safe doses for local anesthetics • Weight-based dosing • Safety warnings

⚠ **Medical Disclaimer:** This calculator is for educational purposes only. Always verify dosages, consider patient factors, and follow institutional protocols. Clinical judgment supersedes calculated values.

Single Drug

Combination

Drug Comparison

Toxicity Management

📋 **Calculation Parameters**

Local Anesthetic

Lidocaine

Patient Weight

70 kg

Concentration (%)

1%

☐ With Epinephrine (1:200,000)

315.0

mg (total)

31.5

mL (max volume)

Patient: 70 kg (70.0 kg)

Drug: Lidocaine 1%

Max dose per kg: 4.5 mg/kg

Epinephrine: No

Onset: Fast (2-5 min)

Duration: 60-120 min

⚠ **Safety Warnings - Lidocaine**

⚠ CNS toxicity: seizures, altered mental status

⚠ Cardiovascular toxicity: arrhythmias, cardiac arrest

⚠ Maximum dose includes all sources (topical, infiltration, nerve blocks)

September 2025

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Anesthesia, Critical Care and Pain Medicine

CLINICS IN MEDICAL EDUCATION

17



Anomalous Connection of the Left Upper Pulmonary Vein to the Vertical Vein Discovered Incidentally by Central Venous Line Cannulation

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Introduction

Partial anomalous pulmonary venous connection (PAPVC) is an uncommon congenital entity with a reported incidence of 0.7% (1). The most common presentation is a right superior pulmonary vein draining into either the right atrium or superior vena cava. Up to 18.2% of PAPVC cases affect the left-sided pulmonary vein (2). The commonest pattern is the left superior pulmonary vein connected to the left brachiocephalic vein via a persistent fetal structure called the vertical vein (3). In this condition, a vertically oriented vessel courses lateral to the aortic arch prior to draining into the left brachiocephalic vein. PAPVC most commonly present with an atrial septal defect. Left sided PAPVC with a left to right shunt predisposes the patient to right-sided volume overload, pulmonary hypertension, right ventricular dysfunction and tricuspid regurgitation (4). However, isolated left sided PAPVC is often clinically silent until adulthood with incidental diagnosis and vague symptoms (5).

We present two cases of isolated left PAPVC. Our first case involves presumed carotid artery cannulation, which in itself is a dreaded complication of central venous line placement that contributes potential significant morbidity and mortality, later proven to be a PAPVC. The second case involves a patient with progressive dyspnea on exertion, hypoxia, syncopal episodes, and SVC syndrome with sparing of the left arm.

Case 1:

A 66-year-old female was admitted for dyspnea secondary to acute-on-chronic heart failure exacerbation. Workup showed severe mitral regurgitation via a flail posterior leaflet. Patient underwent coronary artery bypass and mitral valve repair with insertion of artificial chordae to P2 leaflet and annuloplasty ring. Her postoperative course was complicated by cardiac tamponade with subsequent re-exploration of the chest. After the chest closure, her remaining ICU course was unremarkable. She had an almost one-week old right internal jugular double lumen 9-French introducer. Due to her poor peripheral venous access, a new left internal jugular vein triple-lumen 7-French central venous catheter was placed. The vein was cannulated using the Seldinger technique with ultrasound guidance. The vessel was cannulated uneventfully, and the guidewire was identified with the ultrasound in the venous system. Two post-procedure blood gases revealed PaO₂ of 141 mmHg and 146 mmHg, concerning for left carotid cannulation. Bedside ultrasound failed to show the catheter traversing the LIJ vein into the carotid artery. A chest x-ray was performed and the catheter was suspected to be in the left sided circulation with the tip in the left atrium (Figure 1). The patient was taken to the operating room for angiography, surgical cut down, and primary repair. Intraoperative angiography initially showed contrast filling of left-sided chambers (Figure 2A-B). Pre-operative CT scan was re-evaluated and evidence of a possible vertical vein connecting patient's left-sided venous system to the pulmonary veins was found (Figure 3). Serial angiographic images were obtained and showed that an anomalous vertical vein was bridging the left upper pulmonary vein to the innominate vein with no proximal arterial insertion (Figure 2C). The catheter was removed uneventfully.

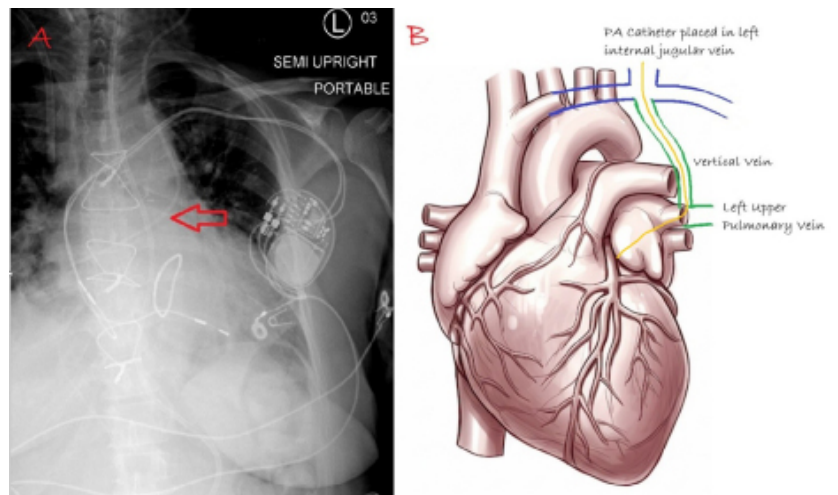


Figure 1. Chest x-ray (A) and illustration (B) showing the catheter suspected to be in the left-sided circulation (Red arrow).

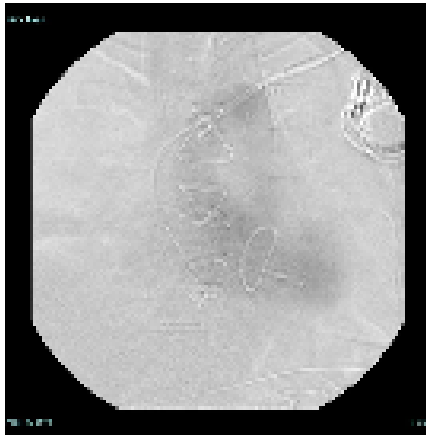


Figure 2. Contrast shot through the catheter is seen filling the left ventricle and subsequently ejected into the aorta (A)



Figure 2. The catheter is subsequently withdrawn, and additional contrast shows the innominate vein draining to the right atrium (B).



Figure 2. The final venogram shows the left internal jugular vein draining into the innominate vein (C).

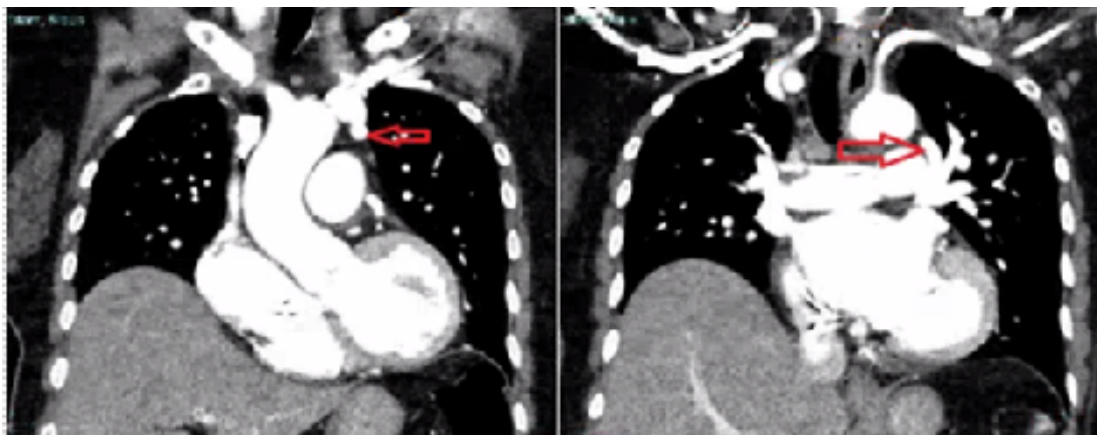


Figure 3. Computed tomography showing the anomalous vertical vein draining into the left superior pulmonary vein (right), and its connection to the innominate vein (left).

Case 2:

A 56-year-old female presented with persistent dyspnea, reduced exercise tolerance, upper body swelling sparing the left arm, and syncopal episodes. Her medical history was significant for ESRD/ESLD combined kidney/liver transplant in 2003 with subsequent kidney graft failure in 2008, a HeRO (Hemodialysis Reliable Outflow) graft placement and use until a second kidney transplant in 2018, COPD, and mild PAH.

On presentation, arterial blood gas showed PaO₂ of 52 mmHg, and TEE showed no PFO. CTA was performed with no evidence of pulmonary embolism, negative for PE. CT venogram showed a HeRO graft, right brachiocephalic vein, but occluded SVC and patent left axillary and left subclavian veins. The left side drained into the left atrium via an anomalous left vertical vein connected to the left upper pulmonary vein (Figure 4). The patient underwent operative ligation of the vertical vein, explantation of the HeRO graft, and endarterectomy of the SVC with patch angioplasty. PaO₂ improved to 90 mmHg post-operative day zero, swelling had resolved, which resulted in marked improvement of her symptoms.

Discussion:

These two case presentations show unique pathological conditions that can be encountered when an undiagnosed anomalous venous connection is present in adult patients. The persistent vertical (levoatriocardinal) vein is an abnormal connection between the pulmonary venous system and the systemic venous system (6,7). The vertical vein is an embryological remnant of the cardinal veins, which are typically obliterated in adults. Existing imaging modalities contribute to the precise and timely diagnosis of this anomaly (8). This condition has the potential for significant clinical consequences. In our first case, our patient was asymptomatic from this anomaly, only to be



discovered incidentally by accidental cannulation, which is not classically taught as a complication of internal jugular vein cannulation. This complication in a setting where X-ray confirmation cannot be timely done can cause devastating complications to the patient. In our second case, a similar anomaly caused a completely different clinical picture by virtue of the patient's baseline pathology. Surgical or percutaneous closure of the persistent vertical vein is controversial (9). There is no current guideline recommendation or expert consensus on the indications for vertical vein closure in adult patients. An individual approach is the best approach for these patients according to the patient's clinical condition, comorbidities, and catheterization findings (10).

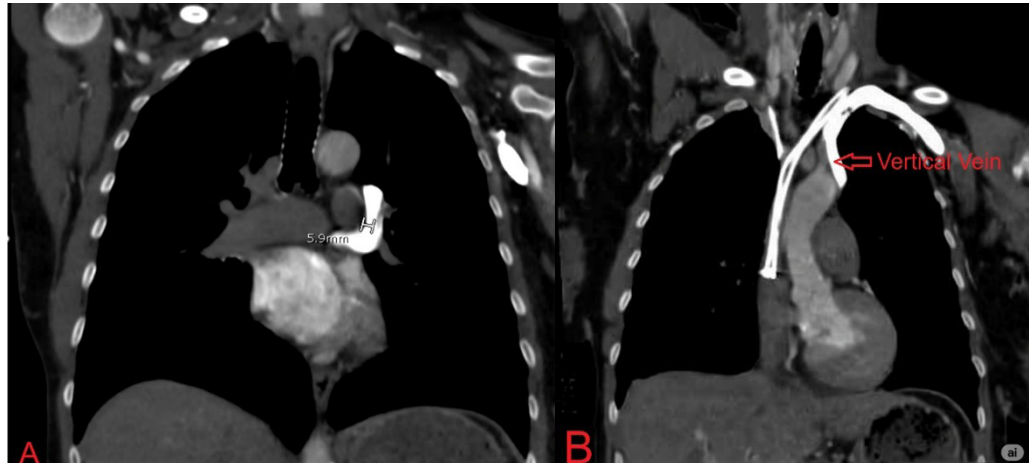


Figure 4. Computed tomography showing anomalous vertical vein draining to left superior pulmonary vein (A), and the vertical veins connection with the left subclavian vein (B).

Conclusion:

These two cases, while both unique, highlight the need for physicians to be cognizant of these rare congenital abnormalities that can create complex clinical scenarios.

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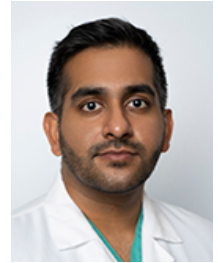
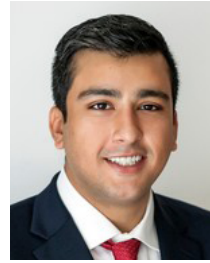
TEE-Guided Vegetectomy for Invasive Aspergillosis with Disseminated CNS Involvement in a Heart Transplant Recipient

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Haidry Syed, MD

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Invasive aspergillosis is an uncommon but highly morbid complication following solid organ transplantation. Invasive aspergillosis remains a leading opportunistic fungal infection among immunocompromised patients, with high mortality after solid organ transplants. Disseminated disease with CNS and cardiac involvement is particularly rare and devastating with mortality typically >80%. Limited data exist on the role of surgical interventions such as vegetectomy under TEE guidance to reduce fungal load.

Case

A 62-year-old man, history of coronary artery disease status post coronary artery bypass graft, ischemic cardiomyopathy with an ejection fraction of ~30%. He underwent a heart transplant which was complicated by Venous-Arterial-Extracorporeal Membrane Oxygenation (VA-ECMO) and intra-aortic balloon pump (IABP). He underwent a deceased donor kidney transplant on 4/2025.

Immunosuppression: tacrolimus monotherapy → Valganciclovir → switched to Letermovir/Acyclovir.

He presented with diarrhea, dehydration, DKA, poor oral intake, and foul-smelling renal wound drainage.

Clinical Findings

Vitals: tachycardic 130, tachypneic 30, afebrile.

Labs: glucose 719, K 7.0, bicarbonate 10, anion gap 21, Cr 2.88 (baseline 1.46).

Exam: abdominal wound with purulent discharge.

Diagnostic Assessment

BAL & lung biopsy: Grew *Aspergillus fumigatus*.

Neuroimaging: Multiple embolic infarcts, ventriculitis, hydrocephalus.

TEE: Vegetation on mitral valve/papillary muscle, consistent with *Aspergillus* endocarditis despite negative blood cultures.

Therapeutic Intervention

Broad-spectrum antifungal regimen (isavuconazole, liposomal amphotericin B, micafungin, with intrathecal dosing).

Neurosurgical interventions: EVD, endoscopic ventricular washout, VP shunt.

TEE-guided vegetectomy performed to debulk mitral valve vegetation.

Outcome

Post-vegetectomy, visible vegetation load reduced (see videos)

Pulmonary and wound infections improved; CNS disease stabilized but with residual deficits.

Prognosis guarded due to extent of embolic injury and immunosuppression.



[Click here to view the TEE images!](#)



Discussion

Percutaneous vegetectomy is a minimally invasive strategy for managing large or embolic-prone vegetations in patients who are deemed high-risk for open surgery. Using catheter-based aspiration or debulking devices under real-time imaging, this approach allows for intracardiac removal of vegetative lesions without the morbidity and mortality related to an open-heart procedure and cardiopulmonary bypass. In the context of invasive fungal endocarditis, particularly in solid organ transplant recipients with prohibitive operative risk, percutaneous vegetectomy can provide immediate reduction of infectious fungal burden and embolic potential of infectious lesions, thereby complementing systemic antifungal therapy. Although evidence is limited to case reports and small series, early experiences suggest that this technique may offer meaningful source control in scenarios where conventional surgery is not an option.

In percutaneous vegetectomy, TEE is indispensable for both procedural planning and intraprocedural guidance. Prior to intervention, TEE is vital to allow precise characterization of vegetation locations, size, attachment, and mobility, which informs the team of the patients' candidacy for vegetectomy. During the intervention, real-time TEE is necessary to provide continuous visualization of catheter, exposure of the funnel of the aspiration device, its positioning and activation. Stable live imaging ensures adequate engagement of the vegetations being targeted followed by confirmation of successful removal while monitoring for complications such as valvular damage, perforation, or residual mass. Post-procedurally, TEE is necessary to assess the effectiveness of the debulking and rule out pericardial effusion or embolic debris.

Heart transplant patients offer significant challenges as their cardiac anatomy can be non-standard due to nature of anastomoses. In addition, surgical changes such as suture lines and tissue characteristics throughout the heart can lead to artifacts and dropout in imaging. Techniques such as multi-planar reconstruction and 3D imaging are vital to fully delineate vegetation locations, morphology, and effects on adjacent structures. For the purposes of the procedure, controlled imaging with smooth transitions between images is vital to guide the cardiologists in optimizing positioning of intra-cardiac devices and suction of infective lesions. In this way, TEE serves as both the diagnostic gold standard and the procedural "roadmap" for safe and effective percutaneous intracardiac vegetectomy.

Conclusion

This case highlights the challenges of diagnosing and managing disseminated aspergillosis in transplant recipients, and the potential adjunctive role of surgical source control even in critically ill hosts.

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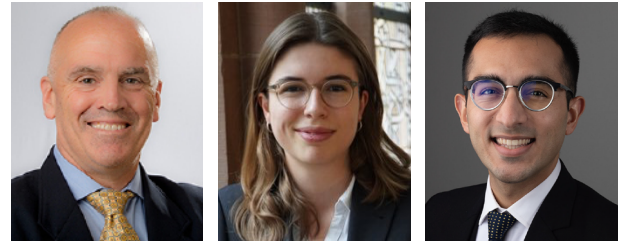


Perioperative Acidosis

Andrew Maslow, MD - *Brown University, Providence*

Elena Ahrens, MD - *Philipps University Marburg, Germany*

Adil Al-Karim Manji, MD - *BIDMC, Boston*



Metabolic acidosis is a frequent acid–base disturbance defined by a decrease in blood pH due to reduced serum bicarbonate. It arises from excessive acid production, bicarbonate loss, or impaired renal excretion of hydrogen ions. For anesthesiologists and critical care physicians, prompt recognition via arterial blood gas analysis (BGA) is essential to guide therapy and ensure patient safety.

Perioperative Metabolic Acidosis

In the perioperative setting, metabolic acidosis may develop from hypoperfusion and lactic acidosis, excessive chloride from large-volume saline infusions, or renal dysfunction during major surgery. Early recognition is critical because even mild acidosis can impair myocardial contractility, alter drug responses, and worsen outcomes under anesthesia. Balanced crystalloids, optimized fluid management, and vigilant BGA monitoring reduce the risk.

Metabolic acidosis is not a disease itself but a marker of underlying pathology. A structured, stepwise approach, integrating pH, PaCO₂, anion gap, compensation, and surgical context, ensures rapid diagnosis and targeted intervention. In both critical care and the perioperative period, timely correction of acidosis significantly improves patient outcomes.

Feature	Metabolic Acidosis	Metabolic Alkalosis
Primary Disturbance	↓ HCO ₃ ⁻ (acid accumulation or bicarbonate loss)	↑ HCO ₃ ⁻ (H ⁺ loss or bicarbonate gain)
pH	↓ (acidic)	↑ (alkaline)
Primary Lab Finding	↓ HCO ₃ ⁻ , ↓ pH	↑ HCO ₃ ⁻ , ↑ pH
Compensation	↓ PaCO ₂ via hyperventilation (respiratory compensation)	↑ PaCO ₂ via hypoventilation (respiratory compensation)
Base Excess/Deficit	Negative base excess (base deficit)	Positive base excess (base surplus)
Potassium (K ⁺)	Elevated (shift from cells)	Low (K ⁺ shifts into cells with H ⁺ loss)
Calcium (Ca ²⁺)	Ionized Ca ²⁺ increases (less albumin binding)	Ionized Ca ²⁺ decreases (more bound to albumin)
Sodium (Na ⁺)	May appear low in dilutional states	Usually normal
Chloride (Cl ⁻)	↓ in high anion gap; ↑ in hyperchloremic acidosis	↓ in chloride-responsive alkalosis (e.g., vomiting)
Common Causes	- Lactic acidosis - DKA - Renal failure - Diarrhea	- Vomiting - Diuretics - Hypokalemia - Alkali intake
Anion Gap	May be high or normal	Usually normal
Clinical Clues	Rapid breathing (Kussmaul), hypotension, confusion	Muscle cramps, paresthesia, arrhythmias

[Click here to view Dr. Andrew Maslow's presentation on perioperative acidosis!](#)



[Click here to view a presentation on blood gas analysis for anesthesiologists!](#)

[Click here to attempt questions on acid base disorders!](#)



GLOBAL HEALTH

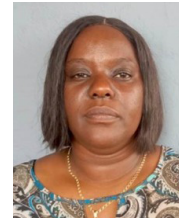
Management of a Neonate with Respiratory Decompensation in PACU: Case Considerations and Clinical Insights

Ama A.A. Taplah, CRNA, RN, BSN, MS
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Janet Dewan, CRNA, PhD
Northeastern University, Boston

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BIDMC, Boston

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Phebe-Esther Bacon College of Health Sciences, Liberia



These transnational online BAAC Grand Rounds are planned by a Liberian/US committee made up of practicing clinicians under the leadership of Patricia O'Connor MS CRNA and Aaron Sonah, RNA, BSN, MS. Ms O'Connor is the Chief Nurse Anesthetist in the Department of Anesthesia, Critical Care and Pain Medicine at BIDMC and Mr. Sonah is a lead faculty in the Nurse Anesthesia Program at the Phebe-Esther Bacon College of Health Sciences, Lutheran University in Liberia which is the sole Nurse Anesthesia Program in Liberia.

Ama A. A. Taplah, MS, RNA is the Operating Room Manager at the JFK Medical Center in Monrovia. The John Fitzgerald Kennedy Medical Center (JFK) is Liberia's National Medical Center and main referral hospital and serves as a hub of specialized services for the country. It has 500 beds and completes approximately 650 cases per month.

Janet Dewan, PhD, CRNA is the Associate Program Director for the Nurse Anesthesia Program at Northeastern University who has worked to promote global anesthesia and surgery throughout her career.

Each month, the Boston-Africa Anesthesia and Critical Care Collaborative (BAAC) hosts transnational online grand rounds to promote case-based learning and knowledge exchange around anesthesia practice across resource-limited settings in Liberia. The July session, presented by Ama Taplah focused on the management of a 3-kg neonate undergoing myelomeningocele repair who experienced respiratory decompensation in PACU. Janet Dewan supplied case preparation support and commentary.

Case Report

A 10-day old, 3-kg female presented for repair of a ruptured lumbosacral (Lumbosacral) myelomeningocele without signs of infection. On exam, the baby was well developed with lower extremity reflexes intact and normal vital signs for age. Hemoglobin was 20 g/dl and all labs were normal for age. Airway assessment was described as normal with room-air oxygen saturation of 98%.

After premedication with dexamethasone 3 mg, paracetamol (acetaminophen) 45 mg and ceftriaxone 150 mg, the patient was positioned for induction. Full standard monitors, including ETCO₂, were applied. Propofol 20 mg and suxamethonium 6 mg, supplemented by sevoflurane 3%, provided good conditions for intubation with a size 2.5 cuffed McCove endotracheal tube (ETT). The cuff was inflated with 0.5ml of air to seal. Anesthesia was maintained with isoflurane 1-2% and fentanyl 6 mcg. Both surgery and anesthesia were uncomplicated intraoperatively, with minimal blood loss and 30 ml IV crystalloid administered. The baby was extubated with a clear airway, crying, in the OR and transported to the PACU with oxygen available. Oxygen saturation was 100%.

After one hour in the PACU, the anesthesia team was alerted to infant respiratory distress. The neonate displayed grunting, nasal flaring, sternal retractions, and oxygen saturation decreased to 88%. Oxygen was administered via a well-fitting nasal cannula, the baby was repositioned, empiric antibiotics were administered, and full NICU monitors restored. The neonate was transported to the NICU. The baby improved over the next 48 hours and was discharged from the hospital without evidence of complications.

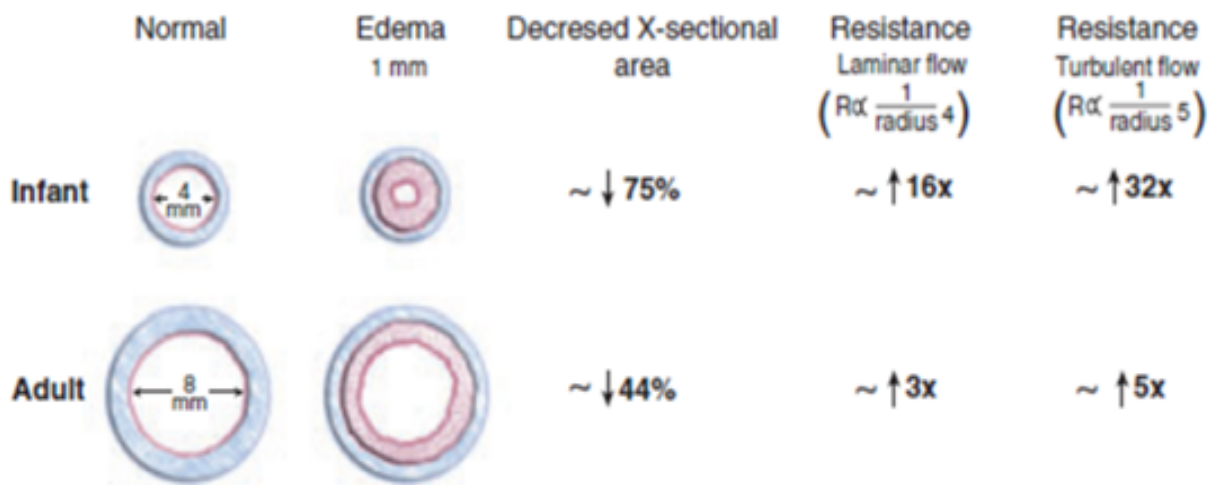


Clinical Considerations in Postop Respiratory Decompensation

Post operative respiratory distress is not uncommon in infants and small children. Early recognition and appropriate supportive interventions are key. Anatomic and physiologic differences between the infant and adult respiratory systems make neonates exquisitely vulnerable to desaturation, fatigue, and distress. In this case, besides infant airway anatomy, sensitivity to the respiratory-depressant effects of anesthetics and central CNS-associated issues were considered. Whatever the cause(s), rapid recognition and skilled, evidence-based interventions are essential to avoiding preventable adverse outcomes.

Infant airways differ from the adult anatomically, resulting in unique considerations. The infant larynx is located more cephalad at about C2-3 (adults at C4-5); the infant tongue and head are proportionately larger, and babies are obligate nasal breathers. The narrowest point in the infant airway is below the glottis at the cricoid ring and the diameter is only about 4 mm at 10 days of age (adult diameter >15 mm). The infant chest wall, with immature musculature and cartilaginous compliance, collapses inward with negative pressure of gasping inspiration. There are fewer and less developed alveoli, leading to high lung compliance, low elastic recoil pressure, and a proportionately smaller FRC reserve, while metabolic oxygen consumption (VO_2/kg) is approximately double that of adults. All of this contributes to more rapid desaturation.

Figure 1. Comparison of adult and infant airways with 1mm edema reducing tracheal radius.



**(Image from The Pediatric Airway. In book: A Practice of Anesthesia for Infants and Children)*

Post-intubation edema is common, and its effects on the airway radius and—thus laminar (then turbulent) gas flow—are more pronounced in the small infant airway (fig 1). As the infant struggles to inhale against the obstruction, the compliant chest wall collapses inward (retractions), increasing atelectasis and further decreasing the respiratory zone. Infants also have a diminished response to hypoxia and hypercarbia; therefore, early recognition of deterioration is key to preventing apneic respiratory arrest.

Although this patient's airway appeared clear immediately after ETT removal in the OR, signs of subglottic edema often become apparent about an hour after extubation as post-traumatic edema accumulates. PACU nursing personnel notified the pediatric nurse anesthetist of the baby's deterioration as soon as desaturation occurred, and treatment with a well-fitting nasal cannula (which can deliver CPAP to this obligate nasal breather), additional monitoring, and repositioning was initiated. Recommendations include administering a steroid (this patient received dexamethasone), well-fitting nasal cannula oxygen, postoperative warmed gases, and nebulized epinephrine. Reintubation should be avoided unless lifesaving.

A recent prospective study of 150 intubated ICU pediatric patients suggests that statistically significant risk factors for symptomatic post-intubation stridor are younger age and use of cuffed ETTs. Many anesthetists have returned to using uncuffed ETTs for infants and checking leak pressure.



Besides anesthesia expertise, nursing care is essential to ensure best care for vulnerable infants. This patient was first recovered in the general PACU because of the long NICU transport from the OR. Recognizing the need to update PACU nurse knowledge for neonate recovery, Mrs. Taplah and the anesthesia team have already delivered a PACU training for general care of postoperative neonates at her hospital, ensuring that nurses are empowered to call an early alert when symptoms emerge which is crucial.

Most anesthesiologists would recognize the need for experienced and specialized skill to anesthetize a 10-day old infant for major surgery. This case demonstrates the high-quality, context-relevant, and evidence-based care that can be delivered in both the OR and perioperatively in a lower-resourced area. Sharing case-based experiences, outcomes, and recommendations can improve the quality of care everywhere.

Key Take-Aways

1. The infant airway and respiratory system differ significantly from the adult's.
2. Small size, high compliance, high oxygen consumption and undeveloped compensatory reflexes leave the neonate vulnerable to respiratory decompensation.
3. Beyond the OR anesthesiologists can provide education by sharing expertise with nursing caregivers.
4. Collegial and evidence-based case discussions can be used to share learning with colleagues.

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[Click here to watch the case report presentation and discussion!](#)



Ultrasound Curriculum for Anesthesiologists in India

Shweta Yemul Golhar, MD

Huma Syed Hussain, MD



The Global Health Initiative at Beth Israel Deaconess Medical Center (BIDMC) has officially launched the second cohort of its Point-of-Care Ultrasound (POCUS) curriculum, which began in May 2025. This structured program continues BIDMC's commitment to advancing clinical education and diagnostic capacity in global health settings.

Participants are currently engaged in foundational and systems-based modules, including ultrasound physics, lung, cardiac, gastric, and trauma-focused protocols such as RUSH and FAST. These modules are designed to strengthen clinical decision-making and enhance bedside diagnostic skills, particularly in resource-limited environments.

On August 04, 2025, a virtual session was conducted by Dr. Shweta Golhar, focusing on cardiac ultrasound. The session began with an introduction to key concepts, followed by a simulator demonstration and then live demonstration of the cardiac ultrasound exam using interactive clinical scenarios. Later, Dr. Golhar presented a series of case-based images, prompting discussion and application of principles in real-world contexts. Images submitted by participants were anonymously reviewed, allowing for constructive feedback and group learning in a supportive environment.

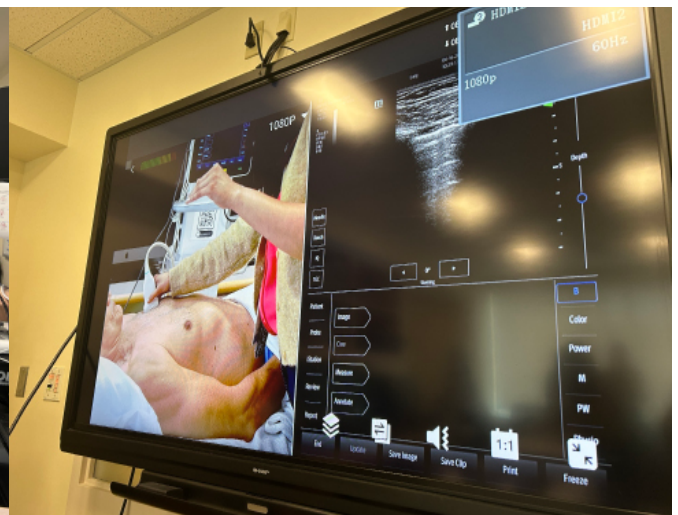
The session was well-received and reflects BIDMC's dedication to high-quality global medical education, emphasizing practical skills, peer engagement, and ongoing mentorship.



[Click here to view the live demonstration of the Cardiac POCUS exam.](#)



[Click here to view the Cardiac POCUS presentation featuring case discussions and imaging examples.](#)





Retroperitoneal Approach to Open AAA Repair

Sumeeta Kapoor, MD

Robina Matyal, MD



Case Report:

A 78-year-old male weighing 81 kg, with no known drug allergies, was transferred from an outside hospital for management of an enlarging abdominal aortic aneurysm (AAA). His past medical history was significant for coronary artery disease status post stenting of the left anterior descending and right coronary arteries, benign prostatic hyperplasia, hyperlipidemia, and nephrolithiasis. He had recently experienced an episode of acute kidney injury (peak serum creatinine 1.7 mg/dL, improving to 0.7 mg/dL) and a urinary tract infection complicated by delirium. His past surgical history included colorectal surgery. Current medications included aspirin, clopidogrel, atorvastatin, subcutaneous heparin, amlodipine, and oxycodone. Laboratory investigations were within normal limits. The patient was scheduled for surgical repair of the infrarenal AAA.

Nuclear Myocardial Perfusion Scan demonstrated normal myocardial perfusion with a left ventricular ejection fraction greater than 65% at rest and post-stress.

Transthoracic Echocardiography revealed normal biventricular function, mildly dilated aortic root and ascending aorta, and an echobright density in the inferior vena cava—raising the possibility of thrombus versus artifact.

Computed Tomography (CT) Angiography of the chest, abdomen, and pelvis showed aneurysmal dilation of the ascending thoracic aorta (42 mm), descending thoracic aorta (46 mm), and infrarenal abdominal aorta (up to 6 cm), the latter extending to the aortic bifurcation with eccentric mural thrombus and irregular lumen. The right common iliac artery was also dilated (2.6 cm). Multiple ulcerated atherosclerotic plaques were noted in the aortic arch and descending thoracic aorta, without evidence of dissection, intramural hematoma, retroperitoneal or mediastinal hematoma, or active contrast leak.



[Click here to view the TTE clips and CT images!](#)

Anesthesia Considerations for Retroperitoneal Approach to Open AAA Repair

Indications

The retroperitoneal approach to open abdominal aortic aneurysm (AAA) repair is often chosen in select patients, including those with complex or inflammatory aneurysms, horseshoe kidney, hostile abdomens from prior surgery, or significant pulmonary disease, as it can reduce respiratory compromise compared with the transperitoneal approach.

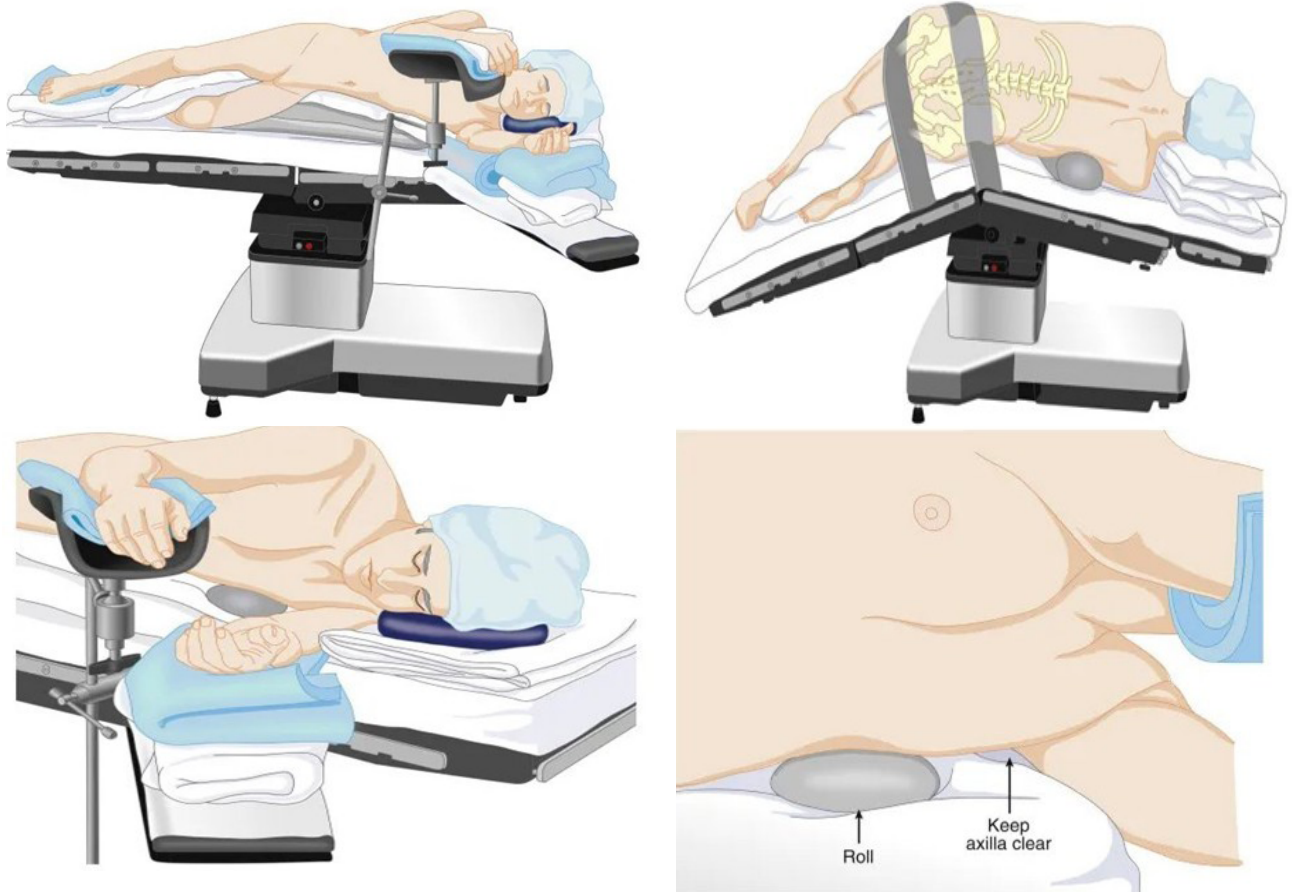
Complications	Incidence
Cardiac	4.9-12.2%
Renal (including need for dialysis)	3.3-13.3%
Pulmonary	8-12%
Bowel ischemia	0.8-3.1%
Wound complications	0.4-2.1%
Perioperative mortality	3.8-4%
Spinal cord ischemia	<0.2(unruptured), 0.7% (ruptured)
Long term complications (incisional hernia, small bowel obstruction)	2-8%



Preoperative Considerations

In the preoperative area, a thorough evaluation is essential, including review of imaging to determine the aneurysm's location and size. Large-bore peripheral intravenous access, arterial line placement, and consideration for epidural or regional block should be completed, along with transthoracic echocardiography, type and screen, and ensuring that crossmatched blood is immediately available in the operating room. Intraoperatively, induction is followed by central venous line placement, preferably on the left side. Prior to positioning, all vascular access lines and monitoring cables should be secured, with their function reconfirmed after positioning. The left posterolateral retroperitoneal approach is performed with the patient in a modified right lateral decubitus position lying on the right side with the pelvis angled slightly. The operating table is broken approximately 5–10 cm above the left iliac crest and flexed 20–30 degrees into a reverse V shape to expand the space between the costal margin and iliac crest. The left arm is positioned across the chest and supported, while the left thigh is elevated with blankets or a beanbag to relax the iliopsoas muscle and improve exposure of the distal aorta and left iliac arteries; however, this approach provides limited access to the right iliac vessels. A suction beanbag is used to stabilize the patient throughout the procedure.

Physiologic effects include decreased mean arterial pressure, reduced right ventricular preload with risk of hypotension, increased vagal tone causing bradycardia, V/Q mismatch, and potential nerve or pressure injuries. Continuous monitoring of perfusion to the dependent arm is critical.



Intraoperative Management

Hemodynamic stability must be maintained during positioning and throughout critical surgical steps. This may involve the use of vasoactive boluses and infusions, rapid fluid delivery systems (Hotline, Belmont), cell salvage, and point-of-care monitoring including arterial blood gases (ABG), activated clotting time (ACT), thromboelastography (TEG), and transesophageal echocardiography (TEE). Pre-clamp, intra-clamp, and post-clamp strategies mirror those used in the midline transperitoneal approach. Renal protection measures, such as the use of diuretics,



mannitol, or bicarbonate, should be discussed with the surgical team before clamp placement, with reference to institutional protocols.

Heparin administration should follow the surgeon's instructions via central line access, with ACT checked five minutes post-administration. If ACT fails to rise appropriately, a heparin resistance protocol should be initiated. Closed-loop communication when administering heparin and reporting ACT results is essential.

During aortic cross-clamping, an immediate increase in blood pressure is expected. The lower body warming device should be turned off, and more pronounced hemodynamic changes should be anticipated with supraceliac or suprarenal clamps. Esmolol boluses may be used for tachycardia and hypertension, while nitroglycerin can reduce preload and afterload. Fluid boluses should be administered via a warming device and titrated to invasive or noninvasive hemodynamic parameters. Frequent sampling for ACT, ABG, coagulation studies, and TEG is recommended.

Prior to clamp release, preparation includes increasing respiratory rate, providing a fluid bolus to raise central venous pressure by 2–4 mmHg, and ensuring vasoactive agents are ready for rapid administration. Blood pressure should be raised to a systolic >130 mmHg, and a recent ABG should be available. The surgical team should be informed to unclamp gradually while the anesthesiology team monitors urine output, laboratory results, and cardiac function. Caution is advised when repositioning the patient to supine postoperatively.

Pharmacologic Considerations

Systemic heparinization is administered via central line with ACT checks five minutes post-dose; heparin resistance should be anticipated and managed. The role of tranexamic acid (TXA) in open AAA repair is less defined than in other surgeries, though it may be considered selectively.

Postoperative Care

Postoperative management includes determining extubation readiness based on preoperative status and intraoperative events, with disposition to the post-anesthesia care unit (PACU) or intensive care unit (ICU) as appropriate. Analgesia may be provided via epidural, erector spinae plane (ESP) block, or intravenous medications. Blood pressure targets should be maintained, with close monitoring for acute kidney injury (AKI). Surveillance for retroperitoneal hematoma in unstable patients may involve bedside ultrasonography or postoperative CT angiography. Neurological monitoring for spinal cord ischemia (SCI) is warranted, particularly after extensive aortic cross-clamping.

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Pre X-Clamp

Induction:

- Avoid HTN

Post-induction:

- Obtain baseline ABG + ACT
- Place OGT/NGT after confirming with surgeon
- Bair hugger upper and lower
- Connect all infusions

Pre-clamp:

- Limit IVF
- MAP 65-75 mmHg
- Heparin as per surgeon request through CVL and check ACT 5 mins after - ENSURE CLOSED LOOP COMMUNICATION when giving heparin and ACT results
- If ACT not rising, refer to Heparin resistance protocol
- Renal protection strategy should be discussed with surgeon prior to clamp placement – Lasix, mannitol, bicarb, refer to protocol

Consider starting epidural at low rate

During X-Clamp

Anesthetic management:

During X-Clamp:

- Increase in BP will occur immediately post X-clamp
- Turn off lower body Bair hugger
- Anticipate more profound hemodynamic changes for Supraceliac/supra-renal clamp
- Esmolol boluses if tachycardic and hypertensive
- Titrate Fentanyl
- Nitroglycerin to decrease preload and afterload
- Fluid bolus from hot line and titrate to invasive/non-invasive parameters (CVP/PPV/LIDCO/TTE/TEE)
- Frequent blood sampling – ACT/ABG/Coags/TEG
- Consider renal protection for Supraceliac/supra-renal clamp – refer to protocol

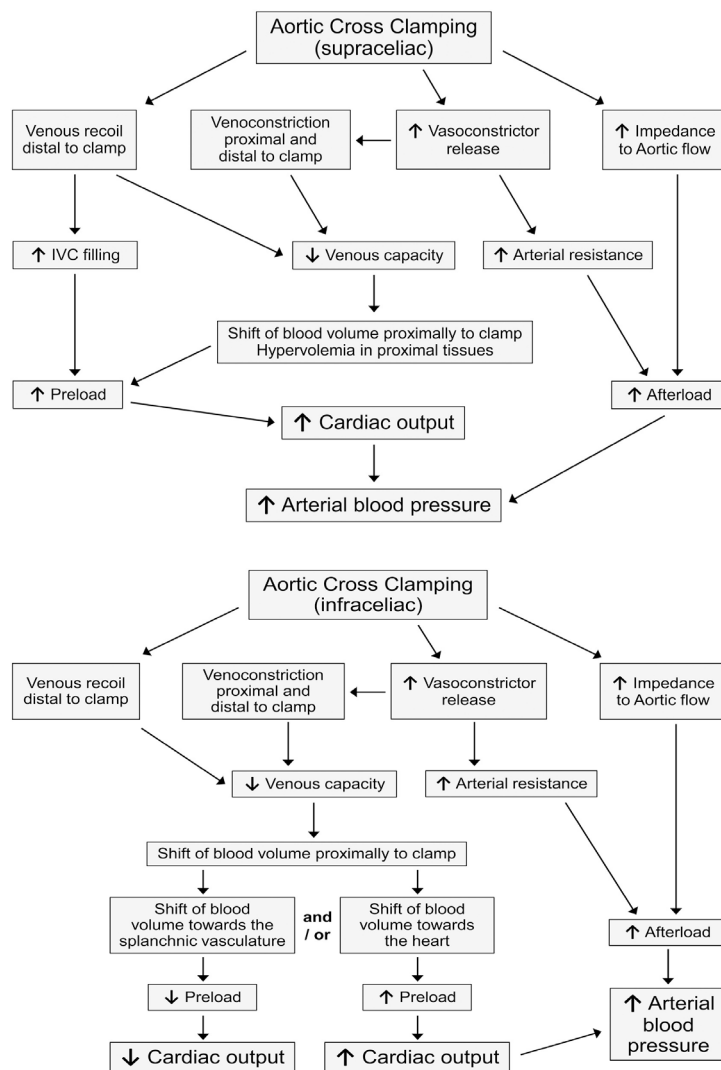
Preparation for X-Clamp release:

- Increase respiratory rate
- Fluid bolus to increase CVP by 2-4 mmHg
- Prepare vasoactive agents and prepare for volume resuscitation
- Increase BP to SBP > 130 mmHg
- Ensure recent ABG
- Communicate with surgeon to unclamp slowly
- Monitor urine output/ABG/Coags/TEG/TTE

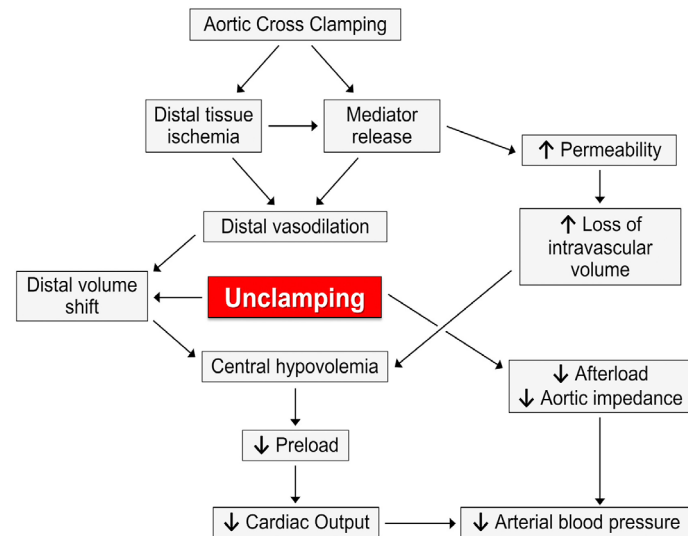
Post X-Clamp release

- If no preparation, there will be a significant decrease in BP post X-Clamp release.
- Maintain MAP > 65 mmHg through IVF resuscitation as guided by invasive/non-invasive measurements.
- Titrate vasoactive agents if required
- Monitor ionized Ca^{++} and replenish if required.
- Repeat ABG q 15mins to monitor lactate/electrolytes until plateau.
- Early transfusion of blood products if required – ensure communication with surgical team regarding EBL and bleeding in surgical field.
- Regular labs to monitor Coags/TEG
- Monitor urine output
- Transfuse cell saver blood
- Commence epidural at low-rate w/o bolus if not already started at incision and so long as hemodynamically stable and no ongoing bleeding
- Protamine to be given in small boluses and check ACT when finished.

X-Clamp Pathophysiology



Post X-Clamp release Pathophysiology



*Zammert, Martin, and Simon Gelman. "The pathophysiology of aortic cross-clamping." Best practice & research. *Clinical Anaesthesiology* vol. 30,3 (2016): 257-69. doi:10.1016/j.bpa.2016.07.006

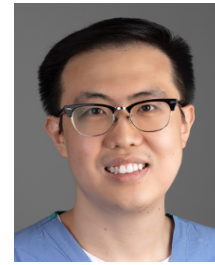


ECHO CORNER

Managing Pulmonary Embolism

Yifan Bu, MD

Sumeeta Kapoor, MD



Case Presentation

Pulmonary embolism (PE) is the third leading cause of cardiovascular death, affecting approximately 1 in 1,000 persons worldwide. Percutaneous catheter-based thrombectomy has emerged as a promising treatment for acute PE. Anesthesia management in such cases is particularly challenging, as patients can deteriorate rapidly.

We present the case of a 43-year-old female (77 kg) transferred from an outside hospital to our facility for thrombectomy. The patient experienced sudden-onset chest pain and shortness of breath 30 minutes prior to arrival at the outside hospital. On presentation, she was sinus tachycardic with oxygen saturation of 70%, which improved to 96% on high-flow nasal cannula. CT pulmonary angiography revealed a saddle PE with multiple bilateral segmental emboli and severe right heart strain. She was started on a heparin infusion and transferred to BIDMC. On arrival, she remained alert and oriented but continued to experience chest pain.

Past medical history included hypertension, chronic kidney disease (IgA nephropathy), preeclampsia (2011), obesity (on tirzepatide), smoking, and CKD. She had no known drug allergies.

Initial Evaluation

ED Vitals: BP 119/76 mmHg, HR 117/min, RR 18/min, SpO₂ 94% (on high-flow oxygen), Temp 36.4 °C.

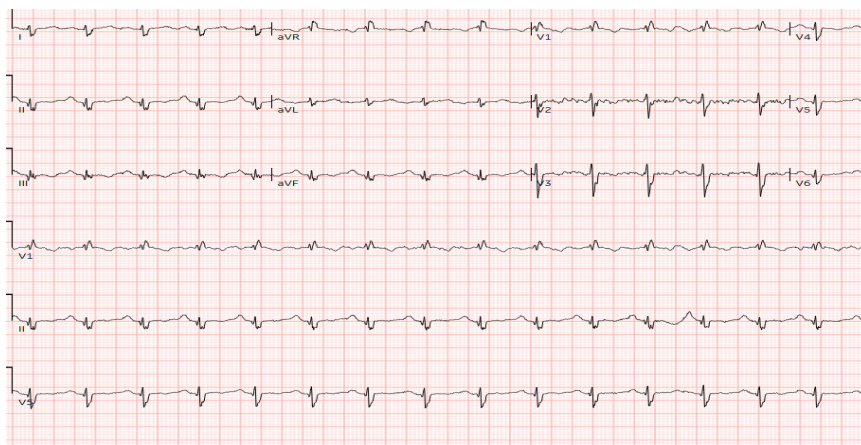
Bedside transthoracic echocardiography (TTE) demonstrated right ventricular (RV) strain. Imaging also revealed a left popliteal vein DVT.

ICU Admission Findings: HR 104, BP 109/86, SpO₂ 95% on room air, GCS 15. Exam notable for minor bibasilar crackles; otherwise normal cardiovascular and abdominal exams with intact peripheral pulses.

Labs: Troponin was initially elevated but normalized on repeat.

Medications: Jardiance (last dose 2 days prior), Lisinopril (2 days prior), and tirzepatide (1 week prior).

ECG: Sinus tachycardia, incomplete RBBB, and RV hypertrophy.



[Click here to view TTE clips!](#)

[Click here to view CTA!](#)

Echocardiography Findings

- Severely dilated RV with moderate global hypokinesis.
- Abnormal septal motion consistent with RV pressure/volume overload.
- Mild–moderate tricuspid regurgitation with high-normal pulmonary pressures.
- Left ventricular (LV) systolic function low-normal (EF 50–55%), Grade I diastolic dysfunction.
- No pericardial effusion, valvular abnormalities, or septal defects.



Anesthesia Management

Pre-procedure evaluation emphasized hemodynamic stability, RV function, and comorbidities. An additional 18G IV and left radial arterial line were placed. Although the plan was monitored anesthesia care (MAC), preparations were made for conversion to general anesthesia if instability occurred. The patient received oxygen by facemask and was sedated with IV midazolam, lidocaine, fentanyl, and a propofol infusion. Continuous IV heparin was maintained during the procedure. She remained hemodynamically stable throughout without the need for vasopressors or inotropes. The thrombectomy was successful, and the patient was discharged two days later on oral anticoagulation.

Discussion

PE is defined as obstruction of the pulmonary arterial tree, impairing distal blood flow. The estimated incidence in Western populations is 60–120 per 100,000 persons annually. Risk factors may be inherited (e.g., thrombophilia) or acquired (e.g., immobility, trauma, surgery, malignancy, pregnancy, OCP use, serious illness).

Clinical presentation ranges from asymptomatic to sudden cardiovascular collapse. The most common symptoms are acute chest pain and dyspnea, as in this patient. Differential diagnoses include acute coronary syndrome, tamponade, pericarditis, pneumothorax, and aortic dissection. Diagnosis relies on targeted history and physical examination, ECG, chest imaging, troponin, D-dimer, ABG, and CT pulmonary angiography, with bedside ultrasound playing a key role in unstable patients.

Management of pulmonary embolism (PE) involves rapid risk stratification, including assessment of hemodynamic stability, right ventricular dysfunction, and biomarkers, followed by supportive care with oxygen therapy and hemodynamic optimization. Anticoagulation with either direct oral anticoagulants or heparin remains the cornerstone of treatment, while advanced therapies such as systemic thrombolysis, catheter-directed interventions, surgical embolectomy, or ECMO are reserved for high-risk or deteriorating patients. Catheter-based thrombectomy, in particular, requires a multidisciplinary approach. From the anesthetic perspective, care is especially challenging due to underlying RV dysfunction, the potential for sudden decompensation, and the need for rapid escalation. Optimal management includes invasive monitoring, cautious titration of anesthetic agents, vigilant hemodynamic and respiratory support, and preparation for conversion to general anesthesia or mechanical circulatory support if the patient becomes unstable.

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COAGULATION CORNER

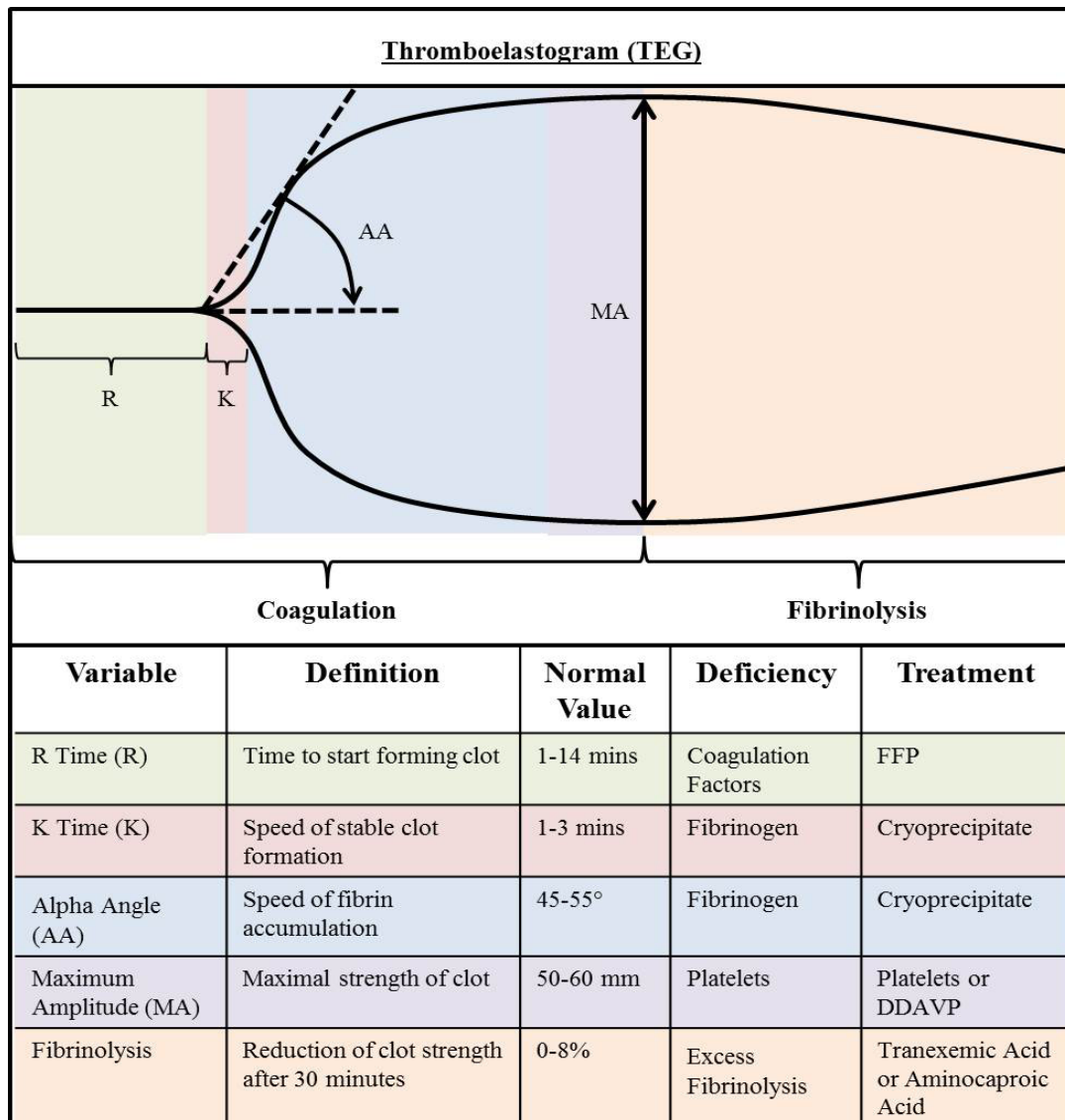
A Comprehensive Analysis of Coagulation Dynamics and Clinical Applications

Sumeeta Kapoor, MD
Robina Matyal, MD



What is Thromboelastography (TEG)?

Traditional coagulation tests do not show the mechanical properties of clot over time because PT and PTT both terminate at low thrombin levels and before fibrin is polymerized. TEG provides a comprehensive view of a hemostatic profile, assessing the hemostatic potential of whole blood, as compared to a traditional coagulation monitoring. TEG measures viscoelasticity of whole blood from initiation of fibrin formation to maximal platelet clot strength and through fibrinolysis.



Click here to view the [lecture on TEG!](#)



Which parameters are used to measure clot strength?



Role of TEG in vascular surgery!

TEG measures clot strength over time, focusing on:

- Clot rate (R, in mins) - Time it takes for first measurable clot to form.
- Clot strength (max. amplitude MA, in mm) - Strength of the clot.
- Clot stability (lysis LY30, in %)-- Breakdown of the clot.

Graphical tracing and numerical results are reported for each measurement and results are highlighted orange if they fall outside the reference range.

Citrated Kaolin (CK): An intrinsic pathway activated assay identifies underlying hemostatic characteristics and risk of bleeding or thrombosis.

Citrated Kaolin with Heparinase (CKH): Eliminates the effect of heparin in the test sample and used in conjunction with Kaolin assessed the presence of systemic heparin.

Citrated Rapid TEG (CRT): An intrinsic and extrinsic pathway activated assay speeds the coagulation properties.

Citrated Functional Fibrinogen (CFF): Used in conjunction with Kaolin or RapidTEG can assess relative contribution of platelets and fibrin to overall clot strength.

Case:

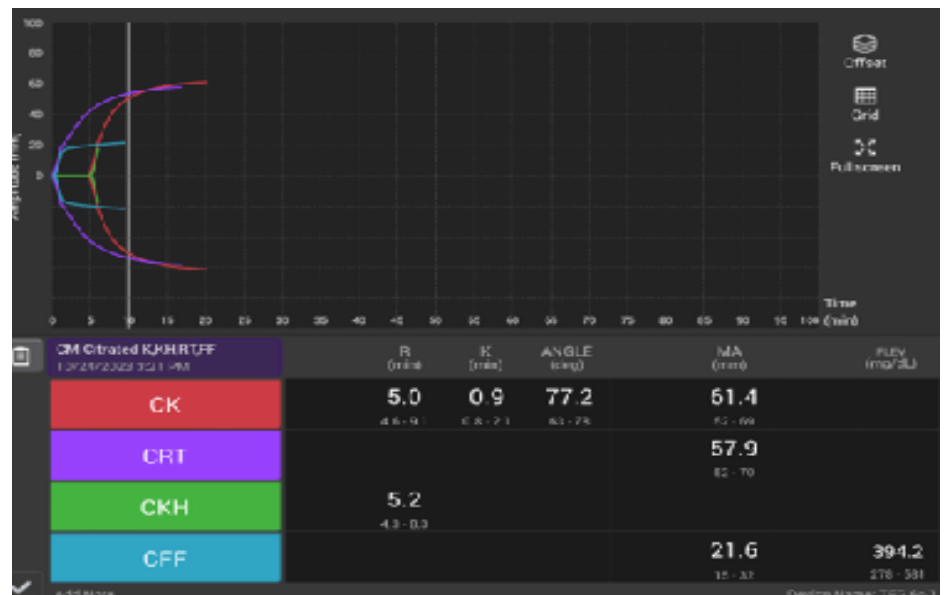
An 86-year-old man with an 11 × 15 cm infrarenal abdominal aortic aneurysm underwent open AAA repair. Approximately two hours into the procedure, the following tracing was recorded.

Why does it look like this?



At the end of the case, a repeat TEG was done for educational purposes.

How did we fix the issue?



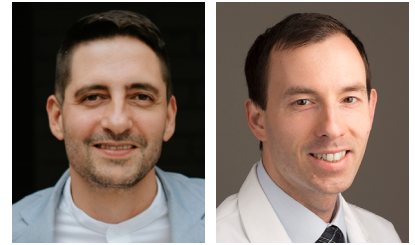


REGIONAL CORNER

Obturator Nerve Block

Juan Puerta Martinez, MD

Andrey Rakalin, MD



Obturator nerve block is an uncommon nerve block to be performed as an isolated procedure. Although, for many surgeries, one would love for the local anesthetic to spread to the obturator nerve, it is rare for obturator nerve to be specifically targeted. Here we present a case of a 44-year-old male admitted with large left thigh sarcoma for surgical resection. Sarcoma was located in the exact distribution of an obturator nerve distribution and a successful obturator nerve block allowed the patient to have an excellent post-operative pain control. Patient granted consent for this case presentation.

Case Presentation

44-year-old male presented for surgical resection of a large left thigh sarcoma after a 6-month history of progressive swelling in the left thigh. Patient underwent imaging and a biopsy, which confirmed an undifferentiated pleomorphic sarcoma located in the adductor compartment. He had received neoadjuvant pembrolizumab and radiation therapy. Past medical history was significant for hypertension and anxiety. He denied prior adverse anesthetic events. Functional capacity exceeded 10 metabolic equivalents (METs).

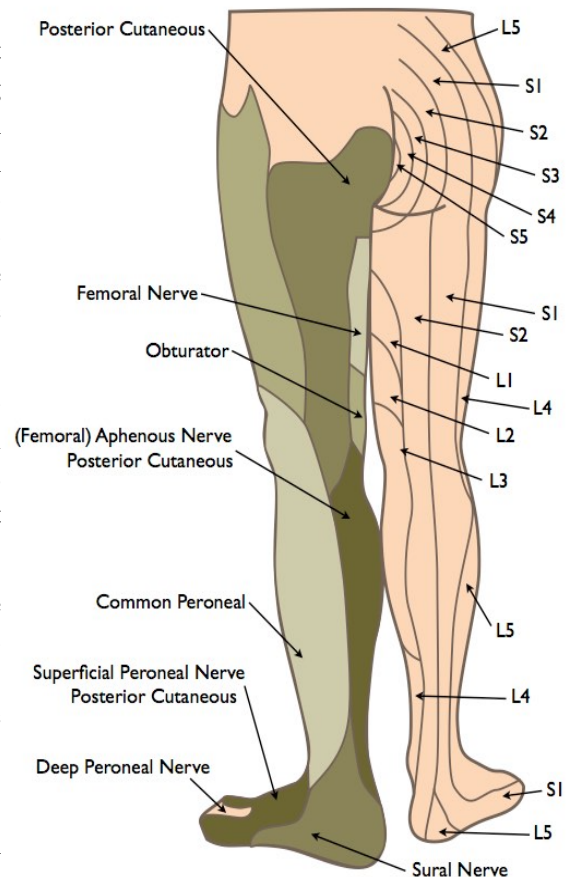
Physical exam revealed a large mass in medial left thigh. Airway examination was unremarkable (Mallampati II, normal neck mobility, good mouth opening). Preoperative vital signs were: blood pressure 155/84 mmHg, heart rate 67 bpm, height 1.78 m, weight 97.5 kg (BMI 30.85 kg/m²).

Preoperative MRI demonstrated a heterogeneous soft tissue mass measuring 13.4 × 11.4 × 19.5 cm, centered in the adductor magnus muscle. The lesion displaced adjacent musculature, exerted mass effect on the deep femoral vessels and the sciatic nerve, and was associated with marked perilesional edema.

A left obturator nerve block was performed in preoperative area. After midazolam 2 mg was administered for anxiolysis and skin infiltrated with 1 mL of 1% lidocaine, a 100 mm echogenic block needle was inserted under ultrasound guidance. The anterior and posterior branches of the obturator nerve were targeted in separate injections. Twenty milliliters of 0.25% bupivacaine were deposited into the anterior fascial compartment between the adductor longus and adductor brevis muscles, and 20 mL into the posterior fascial compartment between the adductor brevis and adductor magnus muscles. Correct spread was confirmed in both planes with ultrasound.

Subsequently, patient was taken to the operating room where general anesthesia was induced and patient underwent surgical resection uneventfully. Additional intraoperative analgesia included fentanyl 125 µg, hydromorphone 1 mg, and ketorolac 30 mg. Patient remained hemodynamically stable throughout the case and was successfully extubated.

On arrival to Post-Anesthesia Care Unit (PACU) patient reported excellent pain control with complete analgesia (numeric rating scale pain score 0/10). Pain remained well controlled in PACU and was transferred to the surgical





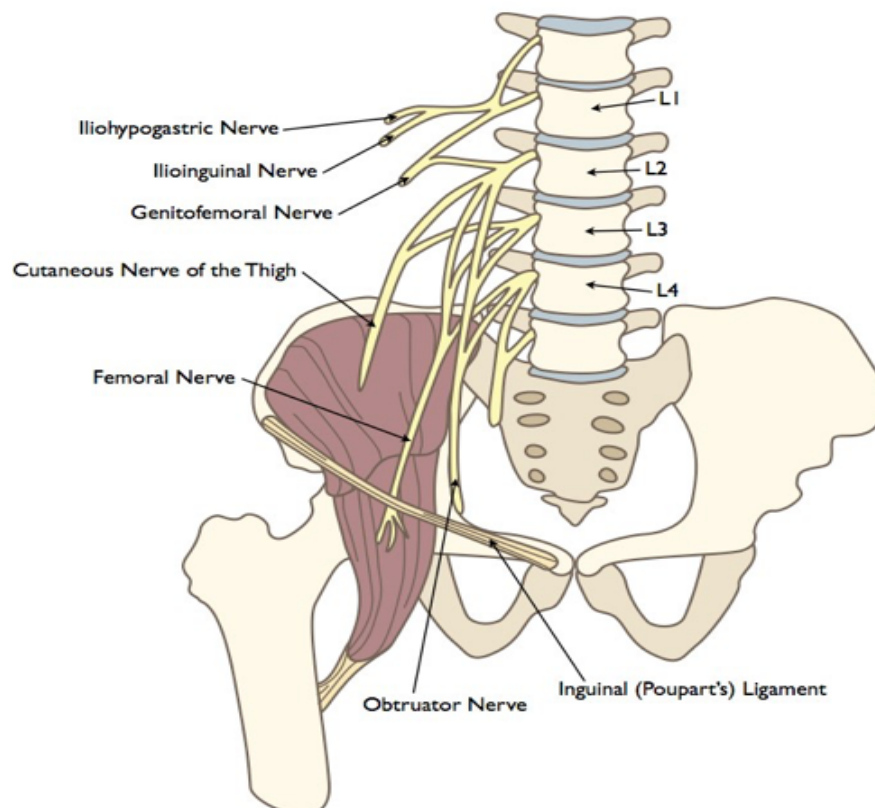
ward with the following regimen: acetaminophen 1 g every 8 hours, oxycodone 5 mg PRN, and hydromorphone PRN. He was discharged home the following morning.

Obturator Nerve Anatomy

The obturator nerve (ON) originates from the lumbar plexus, arising from the ventral rami of L2–L4. It has the most medial course of all lumbar plexus branches, descending along the medial border of the psoas major before exiting through the obturator canal. After emerging from the canal, it travels superficial to the obturator externus and deep to the pectineus muscle, where it typically bifurcates into anterior and posterior divisions. There is considerable variability in the location of this bifurcation (Yoshida). At the distal portion of the adductor longus, the anterior division may communicate with the saphenous nerve and can send branches to the medial thigh; in some dissections, it also provides articular branches to the medial knee. The posterior division usually passes through the adductor hiatus and, together with branches from the tibial nerve, contributes to the formation of the popliteal plexus in the popliteal fossa.

The obturator nerve provides motor innervation to the adductor muscles of the thigh, which beyond their primary role in hip adduction play an important role in pelvic stability and balance during gait. The anterior branch typically supplies the adductor longus and gracilis muscles, whereas the posterior branch most often innervates the obturator externus and the adductor magnus (in conjunction with the tibial nerve). Both divisions usually innervate the adductor brevis muscle.

While its motor distribution is relatively consistent, the ON's sensory innervation is more variable. Traditional dermatome maps suggest that the anterior branch supplies cutaneous sensation to the medial thigh; however, when studied (Bouaziz et al.) no discernible cutaneous sensory loss was found in more than half of patients who underwent a targeted obturator nerve block. The obturator nerve contributes to anterior hip joint innervation via proximal intrapelvic branches and lower posterior branches. Its terminal articular branch to the knee partially innervates the posterior articular capsule, cruciate ligaments, menisci, and synovial membrane. Contributions to the anteromedial knee capsule has been described as well (Gardner).





Approach, Technique, and Positioning

Positioning the patient supine with the leg externally rotated and partially abducted, and the knee flexed helps to bring the target area closer to the skin (Buyukfirat). In our case we used the distal approach to block anterior and posterior branches separately. Although, in many descriptions a linear probe is used, we chose to use a curvilinear lower frequency probe to better visualize deep anatomy and allow for extended field of view. A 100 mm echogenic needle was inserted in a lateral-to-medial direction, in-plane with the ultrasound probe, advancing through the pectineus toward the deep hyperechoic interfascial structure representing the posterior division of the obturator nerve. This division is typically located between the adductor brevis and adductor magnus muscles. After confirming adequate spread of local anesthetic between the adductor brevis and adductor magnus, the needle was redirected to hyperechoic interfascial plane between the adductor longus and adductor brevis muscles, where the anterior division is located. Adequate spread was verified, needle was withdrawn and ultrasound images were captured.

Obturator nerve is a unique block that is not often performed in isolation. However, in this case, appropriate anatomic correlation and block indication coalesced to allow excellent pain control in this patient. Furthermore, the learning of these advanced techniques supports fellowship training in regional anesthesia and acute pain medicine.

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MICHAEL LI CORNER

Identifying Pleural Effusion on Ultrasound

Michael Li, MD



In lung ultrasound both the “curtain sign” and the “spine sign” are important sonographic findings, particularly when assessing the posterior and lateral chest (known as the PLAPS point) for pulmonary pathologies.

Curtain Sign

The curtain sign is a sonographic characteristic of the inferior-most part of the lateral lung, specifically at the costophrenic recess. Its recognition is crucial as it indicates the normality of the basal and peripheral parts of the lung in the costophrenic recesses.

Normal Curtain Sign: In a healthy and aerated lung, the curtain sign demonstrates two key features:

- **Dynamic movement:** As the lung expands during inspiration, the leading edge of the lung curtain appears to move downwards, covering more of the intra-abdominal structure. This movement is caused by lung expansion and is not perfectly synchronous with the diaphragm’s movement of intra-abdominal structures.
- **Non-visualization of the lateral diaphragm:** The lung curtain always covers and obscures the lateral aspect of the diaphragm and upper abdomen, regardless of the respiratory cycle phase.

Abnormal Curtain Sign: The failure to demonstrate either or both of these normal features signifies an abnormal or lost curtain sign, pointing towards pathological changes.

A dynamic lung curtain with the lateral diaphragm still visible is often the earliest sonographic sign of a pleural effusion, usually detected at the most dependent part of the chest. Even a small effusion can fill the costophrenic recess, leading to compression of adjacent lung tissue. In this stage, the lung curtain remains dynamic but is unable to fully obscure the lateral diaphragm throughout the respiratory cycle, particularly during expiration. As the effusion enlarges, the diaphragm becomes progressively more exposed, and in massive effusions the dynamic movement of the curtain may disappear altogether.

Spine Sign (Thoracic Spine Sign)

The spine sign, also known as the thoracic spine sign, is a crucial indicator for the presence of pleural effusion. It is best assessed at the PLAPS point.

Normal Spine Sign: In a normal lung, you should be able to see the spine only up until the edge of the diaphragm but never passing the diaphragm. This is because the lung’s air above the diaphragm prevents any sound waves from passing through.

Abnormal Spine Sign: In the presence of pleural effusions, sound waves can pass through the pleural fluid, allowing the vertebral bodies of the spine to be seen above the diaphragm. Therefore, visualization of the spine extending past the diaphragm indicates a pleural effusion or consolidation. The spine sign, when found at the PLAPS point along with a pleural effusion, aids in proper diagnosis.



[Click here to view ultrasound clips!](#)



PODCAST CORNER

The Clinics in Medical Education team recently sat down with Dr. Sara Neves, Program Director of the Anesthesia Residency at Beth Israel Deaconess Medical Center, for a podcast interview. In the discussion, Dr. Neves shared valuable insights into what her team and program leadership look for in residency applicants, offering guidance for future candidates preparing to enter the field of anesthesiology.



[Click here to watch our team interview Dr. Neves!](#)

Join us for an engaging podcast video featuring Dr. Christopher Kim and Dr. Sumeeta Kapoor as they discuss pulmonary arterial hypertension and right ventricular dysfunction through insightful case presentations. Their conversation blends clinical expertise with practical examples, making complex concepts accessible and relevant for everyday practice. Don't miss this opportunity to learn from their perspectives and deepen your understanding of these challenging conditions.



[Click here to watch Dr. Kim and Dr. Kapoor dive into a discussion!](#)

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Audio & Visual Lesson



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

