

Pro: Focused Cardiac Ultrasound Should be an Integral Component of Anesthesiology Residency Training

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A STRONG BODY of evidence shows that the use of transesophageal echocardiography (TEE) by anesthesiologists has positively influenced both anesthesiology and surgical decision-making in the setting of cardiac surgery,¹ so much so that training and certification in advanced perioperative TEE is an integral part of a cardiac anesthesiology fellowship, and the use of TEE by anesthesiologists is expected in most cardiac surgery cases.²

The cardiac anesthesiology TEE experience serves as an excellent example to guide anesthesiology as it examines the utility of focused cardiac ultrasound (FCU) in noncardiac surgery.

PART 1: THE CASE FOR FOCUSED CARDIAC ULTRASOUND IN CLINICAL PRACTICE

Proper perioperative hemodynamic management is crucial in anesthesiology. Unfortunately, traditional means of cardiovascular diagnosis and monitoring have intrinsic flaws.

Physical Examination Offers Poor Diagnostic Accuracy

The *Journal of the American Medical Association's* series on evidence-based clinical diagnosis, "The Rational Clinical Examination," explains the inadequacies of many traditional physical examination maneuvers and findings used to rule in or rule out important cardiac diagnoses (eg, hypovolemia, cardiac tamponade).^{3,4}

On top of the fact that physical examination has serious intrinsic limitations, it is often poorly performed. Wray et al found that serious errors in physical examination diagnosis were made by house staff in nearly two-thirds of patients on a medical ward.⁵ Another study demonstrated that physical examination accuracy is quite poor overall and plateaus at the third-year medical student level.⁶ When using physical examination alone, senior internists miss the diagnosis of moderate-to-severe mitral regurgitation 30% of the time,⁷ and board-certified cardiologists miss the diagnosis of moderate-to-severe aortic stenosis at least 27% of the time.⁸

ECG and Invasive Cardiac Pressures are Poor Hemodynamic Monitors

Traditional perioperative cardiac diagnostic tools, although useful, also can disappoint: A 12-lead ECG will identify only 6.9% of patients with left ventricular hypertrophy (LVH).⁹ The utility of currently used hemodynamic monitors also is limited. Central venous pressure (CVP) and pulmonary artery occlusion

pressure values have no correlation to preload or "fluid responsiveness", with use of their measurement to determine fluid responsiveness being "no better than flipping a coin."¹⁰ Furthermore, use of a pulmonary artery catheter has failed to consistently improve outcomes and may even increase harm.¹¹

Focused Ultrasound is a Useful Point-of-Care Diagnostic Modality

When first-year medical students with minimal training used FCU for cardiovascular diagnoses, they far outperformed board-certified cardiologists instructed to use physical examination alone (75% v 49% accuracy, respectively).¹² Even when used by physicians *without* formal training in echocardiography, FCU allows for greater accuracy in detecting cardiac abnormalities than physical examination.¹²⁻¹⁵ In contrast to the poor accuracy and precision of cardiac filling pressures to measure preload and fluid responsiveness, FCU bedside measurements of inferior vena cava (IVC) diameter and collapsibility with sniffing—or with respiration in an intubated patient—are shown to accurately predict fluid responsiveness.^{16,17} In addition, IVC measurement is more accurate than physical examination for detecting elevated CVP.¹⁴

Focused Cardiac Ultrasound is a Valuable Diagnostic Tool in the Perioperative Setting

FCU is performed at the bedside by the treating clinician, is readily available, allows for ongoing assessment, and is simple and efficient within the relatively narrow scope of hemodynamic assessment and determining the absence or presence of serious valvulopathy, pericardial effusion, or LVH. In the perioperative setting, FCU by anesthesiologists augments

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findings from physical examination and traditional diagnostic tools and monitors.

Is the Preoperative Cardiac Assessment Complete?

Gerlach et al (2013) described a patient presenting for elective endoscopic sinus surgery who underwent FCU preoperatively to determine volume status given his known diagnosis of aortic stenosis.¹⁸ Unexpectedly, FCU revealed cardiac tamponade, which was not appreciated by physical examination.

What is the Patient's Volume Status?

Ferguson et al (2006) described the care of a 31-year-old parturient with hypertrophic cardiomyopathy presenting for cesarean section under combined spinal-epidural anesthesia.¹⁹ Intraoperative use of repeated FCU allowed for assessment of volume status and appropriate administration of fluids and vasopressors. It is interesting to note that at the beginning of the case, despite a CVP reading of 15 mmHg, FCU revealed an underfilled left ventricle.

Why Is the Patient Hemodynamically Unstable?

Augoustides et al (2005) described the intraoperative management of a 48-year-old man undergoing esophagectomy.²⁰ Near the end of the case, the patient suffered sudden and profound hypotension, and urgent FCU revealed new left ventricular inferior wall akinesis. This led to modified management to treat acute ischemic cardiogenic shock. Notably, the electrocardiogram did not show any signs of acute ischemia.

What Is the Cause of the Patient's Cardiac Arrest?

Oren-Grinberg et al (2012) described how using FCU allowed for the immediate diagnosis of pulmonary embolism in a patient with pulseless electrical activity on postoperative day 3 after toe amputation.²¹

In addition to case reports, prospective observational studies have allowed clinicians to answer some important questions regarding the use of FCU in the perioperative setting. First, several studies have confirmed FCU's *feasibility* in both elective and emergency cases and in the preanesthetic clinic, the operating room, and postoperatively, with success rates ranging from 98%-100%.²²⁻²⁸ Second, compared to a formal and complete echocardiography examination by a cardiologist, the results of FCU performed by anesthesiologists are *accurate*, with 91% agreement between perioperative FCU and formal echocardiography reported in 1 study including multiple cardiac diagnoses.²³ Third, the findings from FCU have been shown to *change management* in up to 82% of patients examined (eg, cancellation of the case, change in anesthesia modality, change in postoperative disposition, addition or avoidance of invasive monitors, addition or restriction of fluids, addition or restriction of vasoactive drugs).²³ Fourth, FCU can result in *reduced mortality*, with 1 study showing that hip fracture patients receiving preoperative FCU have lower mortality rates than patients not receiving FCU, presumably because FCU provided new information upon which subsequent interventions were based.²⁶

FCU is clearly a useful tool in clinical practice given its simplicity, efficiency, and practicality, adding valuable complementary information to physical examination.

PART 2: THE CASE FOR FOCUSED CARDIAC ULTRASOUND TRAINING IN POSTGRADUATE ANESTHESIOLOGY RESIDENCY

The next logical question becomes: Where and when should training in FCU take place? Should FCU training only be seen as an *optional additional* component of training, to be learned during off-service elective time or in a brief standardized course (similar in scope to ACLS training and certification, for instance) or as a component of specific subspecialty fellowship training programs (eg, cardiac anesthesiology)? The authors strongly believe the answer is no, and instead believe that FCU training should be incorporated as an integral component of the core postgraduate anesthesiology residency training program.

FCU Is Distinct From Echocardiography

The American Society of Echocardiography (ASE) defines echocardiography as "expertise to use advanced platforms and extensive training to analyze and interpret transthoracic images in an unlimited number of clinical scenarios,"²⁹ subject to a multitude of standards and guidelines.^{30,31} On the other hand, the ASE defines FCU as "a focused examination of the cardiovascular system performed by a physician by using ultrasound as an adjunct to the physical examination to recognize specific ultrasonic signs that represent a narrow list of potential diagnoses in specific clinical settings."²⁹ Given this definition and its narrow scope, the authors believe that the knowledge, skills, and competencies required to perform and make use of FCU should be easy to incorporate into existing anesthesiology residency training.

Focused Ultrasound Is Already Incorporated Into Specialty Training

Focused point-of-care ultrasound already has become integrated into anesthesiology residency training to secure central venous access and to perform regional anesthesia. In both of these instances, traditional techniques and methods slowly have fallen by the wayside in favor of ultrasound-guided techniques in clinical practice, and the benefits have become increasingly evident. As a result, the use of focused ultrasound in these procedures has become the de facto training paradigm in residency programs. Similarly, clinicians easily can foresee the role of FCU becoming more important in perioperative hemodynamic assessment.

Everyone Else is Doing It, So Why Isn't This Department?

At present, FCU training is a component of emergency medicine postgraduate residency training in both the US and Canada.^{32,33} Critical care medicine also has specific guidelines for the implementation of FCU within postgraduate residency training.³⁴ Even undergraduate medical training programs, having recognized the value and feasibility of FCU, and the fact that students likely will have exposure to it in both their future residency training and subsequent clinical practice, have taken great steps to establish ultrasound curricula.³⁵

It would appear that FCU has reached the tipping point at which "the uptake of a highly functional technology can be observed to behave almost like the spread of an epidemic."³⁶ As such, it would

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