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Editorial

Transthoracic Echocardiography and the Field of Cardiothoracic Anesthesiology: Where Do We Stand?

IN RECENT YEARS, physicians from specialties other than cardiology have shown immense interest in the utility of transthoracic echocardiography (TTE) in their respective clinical arena because of its noninvasive and diagnostic features. Professional societies such as the American College of Emergency Physicians, Society of Critical Care Medicine, American College of Chest Physicians, and Society of Cardiothoracic Anesthesiologists all have put great effort into creating live courses, workshops, and didactics to educate clinicians in performing and interpreting echocardiography. However, these courses are tailored to specific clinical situations (eg, focused assessment with sonography in trauma, point-of-care ultrasound) and represent a limited set of acquired data aimed to facilitate quick decision-making.

In the January issue of the *Journal of American Society of Echocardiography*, the American Society of Echocardiography (ASE) published new guidelines for performing a comprehensive TTE examination.[1] The main goal of this document is to establish standards for high-quality cardiac ultrasound imaging by outlining the elements of a comprehensive TTE examination. In addition, it provides guidance for technical performance of the examination, including image optimization, scanning maneuvers, and machine settings. This document also describes best practices for obtaining linear or complex measurements in order to improve reproducibility among different operators.

A complete TTE study is defined by the Intersocietal Accreditation Commission as a study that "…examines all of the cardiac chambers and valves and the great vessels from multiple views." It also should integrate Doppler assessment of flow across every cardiac valve, which may help in the categorization and grading of valvular lesions and other disease processes.[2] With this in mind, the TTE guideline writing group proposed a comprehensive imaging sequence that may thoroughly assess the heart. The suggested TTE imaging protocol included 4 imaging windows that are acquired in the following order: parasternal, apical, subcostal, and suprasternal notch. In theory, an infinite number of views may be obtained by fine adjustments of the ultrasound transducer in those imaging windows; however, the writing group focused on the essential 14 standard views and their derivatives that constitute a complete examination.[1]

Several views may be obtained in the parasternal window, including long axis, right ventricular outflow, and right ventricular inflow. By rotating the transducer 90 degrees, the apical, midpapillary, basal, aortic valve short-axis, and right ventricular inflow-outflow views may develop. By contrast, the following 7 standard views are obtained in the apical window: 4-chamber, right ventricle–focused, 5-chamber, coronary sinus, 2-chamber, long-axis, left atrium and pulmonary vein–focus. The subcostal window allows for visualization of the most dependent part of the ventricles immediately above the diaphragm and for assessment of the great vessels. Two views–4 chamber and short axis–may be obtained in the subcostal window. Finally, the aortic arch with its branches and the proximal descending aorta are visualized in the suprasternal notch long-axis view.[1] The maneuvers to find the best possible imaging plane are well-described in the new guidelines, which provide an important resource for "troubleshooting" the views.

The writing group also integrated 2D imaging with other ultrasound-based imaging modalities, such as Doppler, strain, and 3D imaging, into the new TTE guidelines. Surprisingly, the writing group did not endorse the inclusion of routine linear M-mode quantification in the standard TTE examination despite acknowledging its widespread use in measurements for tricuspid annular plane systolic excursion and inferior vena cava collapsibility index. The writing group only recommended the inclusion of M-mode quantification if performed by an experienced echocardiographer.[1] Another interesting point made by the writing group involved Doppler measurements of cardiac chambers, valves, and great vessels. The new TTE guidelines state that although flow measurements of the same structure (valve) can be obtained in several imaging views, the view that offers the best spectral envelope quality and the highest velocity should be used for quantification.[1]

The value of perioperative TTE is indisputable for anesthesiologists in various settings, from the preoperative evaluation to the critical care unit. Canty and Royse detailed their experience with anesthesiologist-performed perioperative echocardiographic examinations.[3] Ten of the 36 TTE studies

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performed in the preoperative assessment clinic revealed new cardiac pathologies, 8 of which required a delay in surgery for further investigation. In 39 day-of-procedure TTE examinations before the scheduled surgery, nearly half resulted in significant patient management alterations (case cancellation, subsequent thoracentesis or pericardiocentesis, or changes made to intended intraoperative plan of care). Preoperative findings that required alterations to anesthetic management were much more common in emergency cases than in elective cases in that report, as one might expect.[3] The influence and importance of anesthesiologist-performed perioperative TTE are perhaps greatest in the preoperative emergency case, for which the complete history is unknown, the patient cannot report functional level, and routine testing is not available.

Intraoperative care can also be optimized with timely TTE use by diagnosing cardiac-related problems and/or patient's response to therapeutic interventions. Kratz et al. reported the use of intraoperative TTE on 50 consecutive patients who developed hemodynamic instability during a period of noncardiac surgery; management decisions were altered in 66% of all patients based on the TTE findings, including for 4 patients diagnosed with left ventricular failure, 2 with right ventricular failure, and 6 with varying degrees of previously undiagnosed aortic stenosis.[4] Even though these factors likely are considered by anesthesiologists who are intervening on a patient with an unstable condition, it is unlikely that diagnosis of right-sided heart failure would be made promptly in a patient undergoing noncardiac surgery without echocardiography. Notably, they reported no interruption of general surgical procedures while performing TTE.[4]

Perhaps the most important consideration is that TTE may even alter patient outcomes to the point of adding a survival advantage. A study of more than 200 intensive care patients who were critically ill with undifferentiated shock found a survival benefit at 28 days in the patients whose care was guided by "limited echocardiography" compared with patients who received standard medical care.[5] In addition, there was a reduction in incidences of acute kidney injury and more days alive without hemodialysis in those who received echocardiography-guided care.[5]

Although often used interchangeably in the literature, a "limited" TTE study is different from a "focused" study in many aspects. A focused study is performed to identify the presence or absence of a suspected cardiac pathology; whereas a limited examination is performed to answer a more complicated clinical question. It often requires a deeper and broader knowledge base, utilizing qualitative and quantitative data, to analyze and interpret echocardiographic findings.[6] In other words, a limited TTE study is inherently a comprehensive examination but with a reduced number of images to address the specific cardiac concern. Practitioners who perform limited TTE studies are expected to have the ability to expand the scope of the study by not only obtaining additional views from different acoustic windows but also interpreting the results, as needed.[1] Therefore, to use limited TTE studies to their full potential, a fundamental understanding of the latest comprehensive TTE guidelines is absolutely required.

As discussed earlier, anesthesiologists are optimally positioned to use TTE to evaluate physiologic readiness for surgical interventions, prescribe perioperative therapies, and assess response to treatments provided. However, cardiac anesthesiologists are perhaps even more so the ideal physicians to perform and interpret TTE, given the requisite experience with perioperative transesophageal echocardiography (TEE) and cardiovascular physiology. They are already well-versed in the basic principles of ultrasound physics, common imaging artifacts and pitfalls, and the controls on the ultrasound machine. Moreover, they are well-informed of the latest ASE guidelines for cardiac chamber quantification and valvular abnormality assessments. Although not officially acknowledged by the Core Cardiovascular Training Statement 4 task force because of specialty differences, National Board of Echocardiography (NBE)–certified cardiac anesthesiologists in advanced perioperative TEE often are considered by institutional credentialing committees to have at least achieved level II training in echocardiography, which allows them to "...provide independent interpretation of echocardiograms."[7]

Even though other noncardiology providers may perform focused TTE, we believe that cardiac anesthesiologists should, at the very least, have the competencies to perform and interpret a limited TTE examination with proper training. This is especially important for those who serve as perioperative consultants.[8] Even though the 2019 ASE TTE guidelines recommend more than 100 "images to acquire" for a full TTE protocol study, the majority of intraoperative clinical questions can be answered with a few selected TTE views.[9] The main obstacle for cardiac anesthesiologists to complement their daily practice with limited TTE examination is the lack of direct experience in TTE image recognition and acquisition. Many cardiac anesthesiologists are (1) unaccustomed to visualizing cardiac structures in TTE views and (2) unfamiliar with the acoustic windows and transducer maneuvers to obtain optimal TTE images.

On-the-job informal TTE learning is certainly a starting point; however, because the procedure is highly operator-dependent and poorly acquired images may omit important clinical information, we advocate for formal educational efforts supported by the American Council of Graduate Medical Education (ACGME). Currently, the ACGME has strict TEE proficiency standards for all cardiothoracic anesthesia fellowship trainees. The ACGME program requirements state that trainees must "demonstrate competence in advanced-level perioperative TEE" by "...[meeting] NBE requirements for certification in advanced perioperative TEE." Disappointingly, the same requirement document only briefly mentions that the trainees must "demonstrate knowledge of non-invasive cardiovascular evaluation ... including [TTE] ..." without further explanation of what this requirement entails.[10]

We strongly call for the ACGME to emphasize formal TTE education, in addition to perioperative TEE, for participating adult cardiothoracic anesthesiology fellowship programs. Several studies have shown the success of incorporating TTE education in the busy anesthesiology residency curriculum.[11,12] The ACGME also should encourage fellowship programs to establish learning environments conducive of TTE education

such as dedicated time and resources. TTE lecture content may overlap with existing TEE didactics; therefore, the focus of TTE education for cardiothoracic anesthesiology fellows should be on practical hands-on experience. Novel learning strategies such as simulation and quantitative feedback may facilitate retention of both motor and cognitive skills.[13,14] Based on objective parameters such as duration of training and number of studies performed and interpreted, the NBE also should develop realistic processes or pathways for noncardiology providers to be not only examination testamurs but also certified in adult TTE.

There really is no reason for practicing cardiac anesthesiologists to not take advantage of their unique background and perform routine TTE examinations, whether they are focused, limited, or comprehensive. Echocardiography is well on its way to becoming the "21st century stethoscope," and the contemporary cardiac anesthesiologist should be the leader of this progress. We hope that this excellent comprehensive TTE guideline published by the ASE will spark the interest in the community for adding TTE expertise to their clinical armamentarium.

Conflicts of Interest

There are no conflicts of interest for any of the authors.

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