

Critical Care Transesophageal Echocardiography

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Critical care transesophageal echocardiography (TEE) is useful in characterizing shock states encountered by intensivists when transthoracic echocardiography (TTE) gives insufficient information or when more detailed analysis of cardiac structures is needed. It is safe, feasible, and easy to learn and is a recommended component of advanced critical care echocardiography. This article reviews critical care TEE regarding training, equipment, comparison with TTE, indications, safety, and standard views of critical care TEE. It should be considered a companion article to a recent two-part series in *CHEST* that focused on advanced critical care TTE. Included with this article is an online supplement that has a representative series of critical care TEE images with clinical commentary. *CHEST* 2015; 148(5):1323-1332

ABBREVIATIONS: AV = aortic valve; CCE = critical care echocardiography; FAC = fractional area change; LA = left atrium; LV = left ventricular; LVOT = left ventricular outflow tract; MPA = main pulmonary artery; MV = mitral valve; NBE = National Board of Echocardiography; PWD = pulsed-wave Doppler; RA = right atrium; SVC = superior vena cava; TEE = transesophageal echocardiography; TTE = transthoracic echocardiography; VTI = velocity time integral

This article reviews critical care transesophageal echocardiography (TEE) and should be considered a companion article to a two-part series in *CHEST* that focused on advanced critical care transthoracic echocardiography (TTE).^{1,2} Included with this article is an online supplement that has a representative series of critical care TEE images with clinical commentary.

In North America, it is uncommon for intensivists to perform TEE. Critical care specialists who come from an anesthesiology training background may be competent in TEE; however, they are few in number. In Europe and Australia, many intensivists use TEE on a regular basis, and training in advanced critical care echocardiography (CCE), including TEE, is offered as an option during the fellowship period.

All intensivists should be skilled at basic CCE, but only a smaller number need be competent in advanced CCE, which includes critical care TEE. As summarized in the recent international consensus statement on training standards for advanced CCE (advanced CCE training statement), competence in critical care TEE is an important component of advanced CCE.³

The advanced CCE training statement describes in detail the training needed to achieve competence in TEE. The document was developed as a cooperative project sponsored by the major critical care societies in Europe, North America, and the Asia Pacific region. Because the approach has been validated by our international colleagues, the North American intensivist should regard the document as a roadmap

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to follow to achieve competence in both advanced critical care TEE and TTE. This article reviews the technical, training, and operational aspects of CCE. For a comprehensive review of the clinical usefulness of critical care TEE, the reader is referred to two definitive articles on the subject.^{4,5}

This article was designed primarily for the frontline intensivist who is interested in developing competence in comprehensive critical care TEE as defined in the advanced CCE training statement. It will also be of interest to those physicians who want to develop skill in limited-scope, goal-directed TEE for use when basic TTE is insufficient to address the clinical question.

Training in Critical Care TEE

Competence in critical care TEE requires mastery of the cognitive elements of the field, which are readily available through standard textbooks, review articles, and Internet-based resources. Training in image interpretation requires that the learner has access to a comprehensive image set that is representative of both normal variants and a wide variety of abnormalities that may be encountered in the critically ill patient. Training in image acquisition may be challenging for the North American intensivist, because it requires supervision by faculty who are skilled at critical care TEE. Few programs currently have this type of resource, but, as skill in critical care TEE becomes more widespread, this will become less of a problem. In the interim, there are several possibilities. The intensivist may work with a cardiology colleague. This is an ideal situation, because the cardiologist has expert-level knowledge in image acquisition. A good alternative is an alliance with a cardiac surgical anesthesiologist. The use of TEE is routine during cardiac surgery, and the operating room is an ideal training environment. Training in image acquisition for TEE can also be facilitated through the use of TEE simulators.⁶

In North America, there is no national-level certification available to noncardiologists that covers combined TTE and TEE. The National Board of Echocardiography (NBE) limits certification in TTE and TEE to physicians who have completed training in cardiology. However, the intensivist can fulfill the requirements for competence in echocardiography as defined by the cardiology societies and can complete the echocardiography board examination.⁷ The NBE does offer certification in perioperative TEE (without TTE) at both the basic and the advanced level but it limits certification to physicians who have completed training in anesthesiology.

Nonanesthesiology intensivists may take the basic or advanced certification examination, but they cannot achieve certification.

In terms of the number of studies required to achieve competence in critical care TEE, Charron et al⁸ have determined that 31 supervised studies is generally sufficient to achieve competence in image acquisition. The advanced CCE training statement establishes that 35 studies is a reasonable target, with the proviso that some trainees may require more studies if 35 is not sufficient. This number is lower than that required by the NBE to achieve certification in TEE for the cardiologist (150 studies) or anesthesiologist (150 studies for basic-level perioperative and 300 for advanced perioperative). However, this lower number is well supported by the available literature when the goal of training is competence in image acquisition that meets the clinical needs of the intensivist. Some critical care physicians may choose to deploy TEE for rapid assessment of hemodynamic failure in the ED by using a limited number of views without the need for competence in the more comprehensive critical care TEE. For physicians who do not have practice needs that require full training in critical care TEE, competence in limited-scope, goal-directed TEE using four basic views can be achieved with 10 supervised studies.⁹

Comparison of TTE and TEE

Critical care TTE and TEE have much in common. Many of the image planes and views are similar, differing only in how they are projected onto the screen. The methods used for evaluation of the cardiac anatomy and function are identical, and, in both cases, hemodynamic measurements rely on Doppler-based measurements for the calculation of blood flow velocities, cardiac pressures, valve function, and stroke volume. The reader is referred to the two-part series on advanced CCE in *CHEST* for a complete discussion of these elements of the examination, because they apply equally to both forms of echocardiography.^{1,2} This article focuses on the aspects of critical care TEE that are unique to the technique, such as indications, safety, probe insertion, and image acquisition.

The main differences between critical care TTE and TEE relate to the method of image acquisition. Instead of having direct manual control of the transducer, the intensivist learns to manipulate the position of the transducer remotely, because it is positioned in the esophagus or stomach. Although this takes practice, it is our observation that mastering probe manipulation is

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