CHEST

Critical Care Transesophageal Echocardiography

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VIDEO

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.

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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 be 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 al[8] 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 actually easier with TEE than with TTE, because the probe is well positioned simply by being in the esophagus.

Posterior cardiac structures such as the left atrium (LA), the left atrial appendage, and the pulmonary veins are close to the TEE transducer and are, therefore, better seen than with TTE, whereas anterior structures such as the cardiac apex are better imaged with TTE. This is with the proviso that left atrial size measurement has not been validated with TEE, as it has been with TTE. In general, TEE gives a superior image resolution of the details of the cardiac anatomy because of the proximity of the transducer to the heart without interposition of soft tissue, bony structures, or aerated lung and because of the ability to use a higher-frequency transducer than that used with TTE. One consistent failure of TEE occurs with the measurement of tricuspid regurgitation velocity, because it is difficult to achieve an acceptable Doppler angle with TEE. TTE is superior to TEE for this application.

Indications for Critical Care TEE

- Assessment of hemodynamic failure, if TTE views are inadequate. Echocardiography is a standard component of assessment for all patients with hemodynamic failure. Therefore, TEE is indicated when TTE views are inadequate because of factors such as edema, obesity, heavy musculature, wounds, dressings, or hyperinflation. This indication is particularly relevant in postcardiac surgery patients because of limited TTE views related to the sternal incision and the presence of chest wall devices.
- Unexplained hypotension in the postcardiac surgery patient. Postoperative bleeding with localized tamponade is a life-threatening complication of cardiac surgery that requires TEE for diagnosis, because TTE views cannot rule out this diagnosis with any certainty.
- Identification of preload sensitivity. Using TEE to determine the respirophasic size variation of the superior vena cava (SVC) during mechanical ventilation cycling is easy to perform and allows for the identification of preload sensitivity.[10]
- Unexplained hypoxemia. TEE has excellent image quality for the identification of the intracardiac right to left shunt using agitated saline injection.
- Identification of aortic dissection. The ascending and descending aorta are well imaged with TEE, which is not the case with TTE.[11]
- Cardiac arrest. The cause of cardiac arrest and the adequacy of resuscitation efforts can be determined with TEE, with the advantage of continuous imaging of the heart during cardiopulmonary resuscitation.[12]
- Identification of pulmonary embolus. Central pulmonary embolus can be visualized with TEE.[13]
- Guidance of procedures. As an alternative to fluoroscopic guidance, TEE may be used for real-time guidance of a variety of procedures such as insertion of an extracorporeal membrane oxygenation catheter, intraaortic balloon pump, and transvenous pacemaker.
- Other situations in which TTE is inadequate, such as examination for intracardiac thrombus, evaluation of subtle valvular abnormalities (eg, vegetation), and detailed Doppler analysis of pulmonary venous inflow. Examination for this type of abnormality represents an overlap with the skill set that is typical for cardiology TEE but it can mastered by the intensivist.

Equipment Requirements and Maintenance

The performance of critical care TEE requires that the intensivist have 24/7 access to a TEE probe. Many portable ultrasonography machines that are used for general critical care ultrasonography in North America can be attached to a TEE probe and can yield very serviceable images. A large full-service echocardiography machine is not required.

A major impediment to training in critical care TEE in North America is that many ICU teams do not have access to a TEE probe. In seeking to acquire the TEE probe, the ICU team needs to reassure cardiology colleagues that critical TEE is performed only on intubated patients in the ICU and that, with proper training, intensivists can perform critical care TEE with a high level of competence and safety.

A TEE probe costs approximately $40,000 US. With proper care, it can be used thousands of times. Ongoing costs include those related to cleaning the probe, which is generally performed by operating room personnel who have expertise related to the care of the TEE probes used by cardiac anesthesiologists. It is highly recommended that the TEE probe be covered by an extended warranty. The ICU team has responsibility for the care and preliminary cleaning of the probe. The probe, although not a sterile instrument, must be stored in the ICU according the same protocol as that of a bronchoscope. It is best to store the probe fully extended to avoid a gradual permanent curvature of the device. Immediately following use, the probe shaft should be rinsed off to avoid dried secretions that complicate the definitive sterilization process. The control surfaces should never be rinsed or immersed during preliminary cleaning. The transducer head of the probe is delicate and may be fractured if it strikes a hard surface. The probe should be placed in a clean bag and taken to the operating room area for sterilization. During this process, the probe is tested for electrical current leak.

Safety of Critical Care TEE

TEE is a minimally invasive procedure with a low risk of complication. Hilberath et al[14] have written a comprehensive review on the risks and complications of TEE when performed by the cardiologist, cardiac anesthesiologist, and intensivists. By definition, critical care TEE is performed only on patients who are intubated and on ventilatory support in an ICU or similarly equipped emergency medicine area. For critical care TEE, the patient has an endotracheal tube in place, so the risk of airway complication is low. The patient is well monitored in an ICU environment, and the staff is singularly well equipped to identify and treat the hemodynamic effects of the sedation required for the procedure. As a result, the risk of respiratory or cardiovascular compromise is minimal when the TEE is performed by intensivists in the ICU. The major risks of critical care TEE are related to mechanical injury from probe insertion and manipulation. Minor oropharyngeal injury is uncommon and of limited clinical concern. Major injury to the hypopharynx, esophagus, or stomach, although very uncommon, may have severe clinical consequences, including the need for surgical intervention, or death. These can be avoided by appropriate patient selection and by minimizing the rotational movement of the endoscope tip while under flexion. Both absolute and relative contraindications to critical care TEE are summarized in Table 1.

It is important to attempt to obtain a history that addresses the risk of esophageal injury from review of the patient record or family/surrogate interview. This may be impossible in an intubated patient who requires TEE on an urgent basis, such as occurs in an acutely decompensating patient. In emergency situations, the intensivist must balance the risk implicit with incomplete risk assessment against the need for a potentially lifesaving procedure. This situation is very different from that of an elective TEE performed by the cardiology service, in which it is possible to obtain a complete evaluation of risk before the TEE. The risk of serious complication is low with critical care TEE. In a summary article, Hüttemann et al[4] reported no deaths in a total of 2,508 reported cases of critical care TEE. Minor complications, such as removal of the nasogastric tube, mild oropharyngeal abrasion, or transient hypotension or hypoxemia, occurred in 2.8% of cases, with no report of hypopharyngeal, esophageal, or gastric perforation. Min et al[16] reported no deaths in 10,000 consecutive instances of TEE performed by cardiologists, with one case of hypopharyngeal perforation and two cases of cervical esophageal perforation.

TABLE 1] List of Contraindications to Transesophageal Echocardiography

Contraindications
Absolute contraindications
Perforated viscus
Esophageal stricture
Esophageal tumor
Esophageal perforation, laceration
Esophageal diverticulum
Active upper GI bleed
Relative contraindications
History of radiation to neck and mediastinum
History of GI surgery
Recent upper GI bleed
Barrett's esophagus
History of dysphagia
Restriction of neck mobility (severe cervical arthritis, atlantoaxial joint disease)
Symptomatic hiatal hernia
Esophageal varices
Coagulopathy, thrombocytopenia
Active esophagitis
Active peptic ulcer disease

Adapted from Vieillard-Baron et al.[15]

To reduce the risk of thermal injury, modern-generation TEE probes are equipped with a temperature sensor. The probe turns off automatically if the probe temperature exceeds 42°C. This is an occasional problem in a patient with severe elevation of body temperature, where the probe shuts off very quickly because of the marked hyperthermia of the patient.

Patient Preparation and Probe Insertion

Intubated, patients who are mechanically ventilated require minimal airway preparation prior to insertion of the TEE probe. Our approach is to augment the IV sedation, so that the patient is deeply sedated during the TEE examination. The arterial BP, oxygen, ECGare monitored throughout the procedure. A continuous ECG signal is displayed on the ultrasound machine.

We recommend that the patient makes no spontaneous breathing effort during the procedure, to assess preload sensitivity. This may require use of a neuromuscular blocking agent.

The probe is inserted into the mouth, with the probe face in the sagittal plane orientated anteriorly. Keeping the probe in the midline, the scanner applies a gentle forward force. If there is resistance to insertion, an assistant may flex the head forward in conjunction with some anteflexion of the probe. Occasionally, there may be difficulty with blind insertion of the probe. In this case, video laryngoscopy is a useful adjunct to guide the probe into the esophagus under direct visualization.

Untoward force application of the probe against a tissue plane is the underlying mechanism for injury to the hypopharynx, esophagus, or stomach. Even though this complication is very rare, the intensivist should take every precaution when performing critical care TEE. The probe should be well lubricated, and only light force is required to insert the probe through the hypopharyngeal area to avoid inadvertent placement into the pyriform sinus; overly forceful insertion could result in a tear, perforation, or buckling of the probe.[17] Several reports describe real-time visualization of probe insertion using a variety of techniques, including the use of video laryngoscopy.[18] Guidance of probe insertion with direct visualization has been reported to reduce the rate of mild injury to the hypopharynx when compared with blind insertion.[19] There is no evidence that there is a clinically relevant difference between the methods, so blind insertion is the widely accepted and standard method of probe insertion. Once in the esophagus or the stomach, the operator avoids forceful insertion, withdrawal, flexion, and extension of the probe and does not move the probe when it is in a locked position.

Transducer Manipulation

The American Society of Echocardiography stipulates the following terms be used to describe transducer movement:

- Advancement/withdrawal of the probe. The probe is pushed or pulled in or out of the esophagus to achieve the desired image (there are depth markings on the probe).
- Flexion of the probe. Flexion of probe in four directions from the neutral position. Control knobs on the probe control this function. Anteflexion and retroflexion of the probe face are accomplished by rotation of the large control knob, whereas rotation of the small knob results in right and left flexion of the probe face.

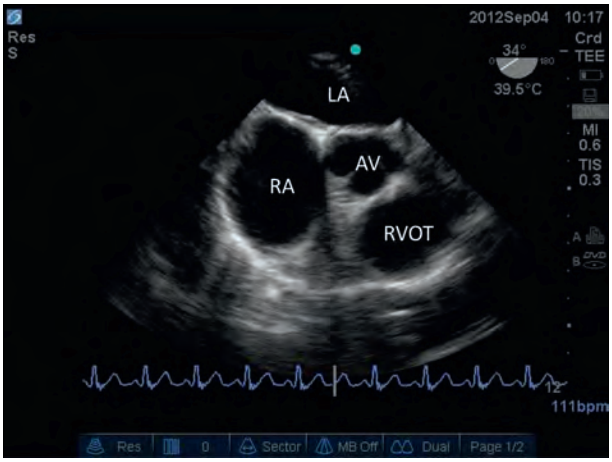

Figure 1 – *Midesophageal aortic valve short-axis view. AV = aortic valve; bpm = beats/min; LA = left atrium; RA = right atrium; RVOT = right ventricular outflow tract.*

- Turning of the probe to the right or left side. The probe is twisted in a clockwise or counterclockwise direction to look toward the right or left side.
- Rotation of the transducer. Rotation of the transducer beam plane is performed by an electronic control that rotates the transducer element. When the operator activates the rotation control, the transducer rotates to the desired scanning plane in one-degree increments. The degree of rotation of the transducer is indicated on the screen with values between 0° and 180°. In the starting position of 0° with the probe face in the anterior sagittal position, the image orientation is such that structures to the right of the transducer are projected to the left side of the screen. With 90° of transducer rotation, cephalad structures are projected to the right side of the screen.

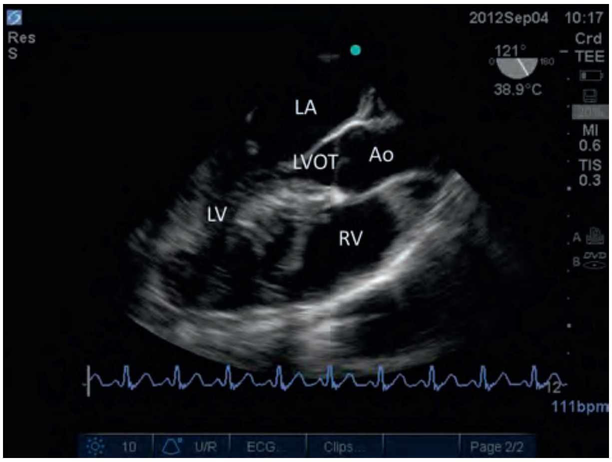

Figure 2 – *Midesophageal aortic valve long-axis view. Ao = ascending aorta; LV = left ventricle; LVOT = left ventricular outflow tract; RV = right ventricle. See Figure 1 legend for expansion of other abbreviations.*

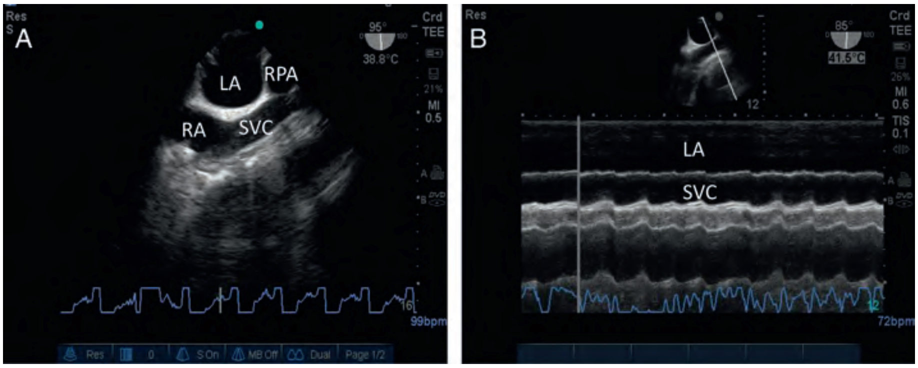

Figure 3 – *A, B, Midesophageal bicaval view (A) with M-mode of SVC (B). RPA = right pulmonary artery; SVC = superior vena cava. See Figure 1 legend for expansion of other abbreviations.*

The Critical Care TEE Examination

As defined by the American Society of Echocardiography, a full TEE examination consists of 28 standard views, many of which have accompanying Doppler measurements.[20] The number of views required for a critical care TEE examination has not been standardized. Obtaining all views that are used by cardiologists is neither practical nor necessary. We propose an examination sequence used at Hospital Ambroise-Pare in Boulogne, France, headed by Antoine Vieillard-Baron, MD, PhD, that is designed to rapidly assess the patient with hemodynamic failure and that conforms to the requirements set out in the advanced CCE training statement.[8] It is important for the training design, competency-based testing, and standardization of patient care that intensivists adopt a uniform set of required views. This is particularly important during the training period for advanced critical care TEE. The French critical care TEE examination is a minimal standard for the intensivist. If indicated, other views may be included in the examination. There is no consensus as to the order of the views for the examination. The important issue is that the intensivist masters image acquisition of all the mandatory views and performs each examination in the same sequence unless the clinical situation requires an amended image set. We favor a standardized approach to the scanning sequence to avoid missing important views. The order of views listed here is the sequence that we use in our practice. Other groups use a different order to good effect. We emphasize that this image set is designed for the assessment of hemodynamic failure in the intubated patient in the ICU or ED and should be regarded as a reasonable minimal standard for training purposes. Additional views may be used, depending on the clinical situation and the skill level of the intensivist performing the examination. Although there is no standard approach to the image set, some experts feel that a limited, goal-directed examination has significant value, particularly in an unstable patient. Once fully trained, the intensivist chooses which images are required based on the requirements of the clinical situation. This may be the standard image set or a more limited study.

The Critical Care TEE Views

1. Midesophageal aortic valve (AV) short-axis view ± color Doppler (Fig 1, Video 1)

- Rotation: 30° to 45°
- Transducer positioning: In neutral (0°) position, the probe tip is advanced into the esophagus until the AV is identified. The operator turns the probe in the appropriate direction to place the AV in the central screen position. The beam plane is rotated to between 30° and 45°, so that all three leaflets, commissures, and a coaptation point are seen.
- Clinical use: evaluation of the AV, ascending aorta, and LA

2. Midesophageal AV long-axis view ± color Doppler (Fig 2, Video 1)

- Rotation: 120° to 135°

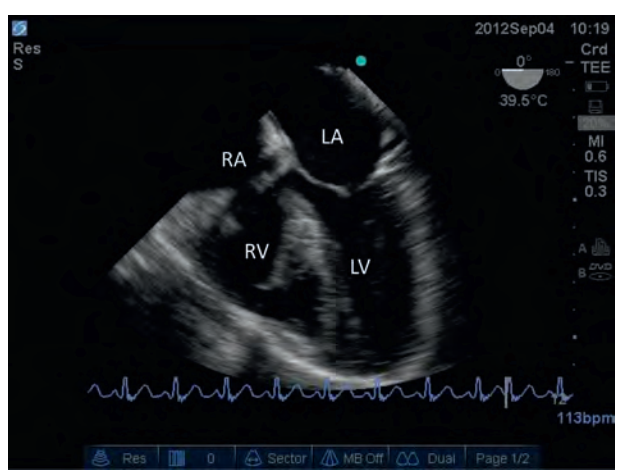

Figure 4 – *Midesophageal four-chamber view. See Figure 1 and 2 legends for expansion of abbreviations.*

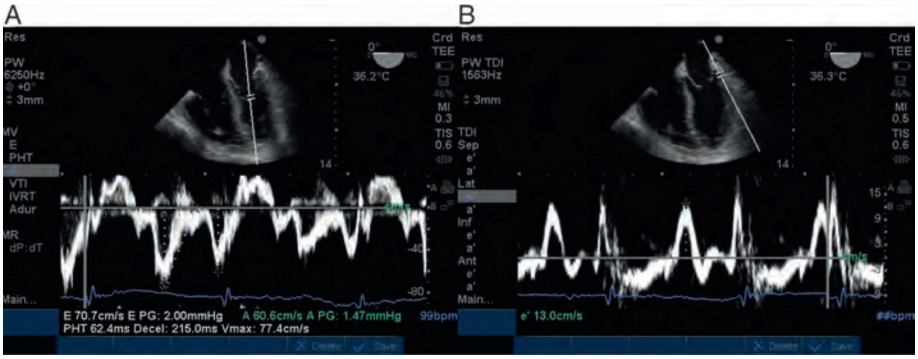

Figure 5 – *A, Mitral valve inflow. B, TDI of lateral mitral annulus. E = 70.7 cm/s; e´ = 13.0 cm/s; E/e´ = 5.4. TDI = tissue Doppler imaging.*

- Transducer positioning: From the short-axis view of the AV, the beam plane is rotated an additional 90° to visualize the left ventricular outflow tract (LVOT), AV, and proximal ascending aorta.
- Clinical use: evaluation of the AV, ascending aorta, and LA

3. Midesophageal bicaval view (Fig 3, Video 1)

- Rotation: 0° and 90°
- With the beam plane rotated back to 0°, the probe is turned in a clockwise rotation until the SVC or high right atrium (RA) is in the central screen position. The beam plane is rotated to 90° to visualize the SVC and RA in longitudinal axis.
- Clinical use: evaluation for SVC thrombus and catheter position, RA anatomy, and intratrial septum anatomy and identification of interatrial connection using agitated saline injection

4. SVC M-mode view (Fig 3)

- Rotation: 90°
- The M-mode cursor is placed perpendicular to the SVC and the resulting image is used to identify the respirophasic diameter change of the SVC.
- Clinical use: assessment of preload sensitivity. Greater than 36% respirophasic variation of the SVC diameter indicates preload sensitivity.

5. Midesophageal four-chamber view ± color Doppler (Fig 4, Video 2)

- Rotation: 0°
- With the beam plane at 0°, the probe is turned counterclockwise to place the mitral valve (MV) in the central screen position. The probe is then retroflexed and positioned to achieve a four-chamber view.
- Clinical use: comparison of the right ventricular and left ventricular (LV) chamber size and the function, anatomy, and function of the tricuspid valve, MV, and segmental wall (inferoseptal and anterolateral walls)

6. MV inflow view (Fig 5)

- Rotation: 0°
- From the four-chamber view, the MV inflow is measured by placing the pulsed-wave Doppler (PWD) sample volume at the opening of the MV valve leaflet tips.
- Clinical use: evaluation of LV diastolic function and left-sided filling pressures

7. Tissue Doppler imaging of lateral MV annulus (Fig 5)

- Rotation: 0°
- From the four-chamber view, the lateral MV annular velocity is measured by placing the tissue Doppler imaging sample volume on the lateral MV annulus. If indicated, the measurement may be made at the septal annual as well.
- Clinical use: evaluation of LV diastolic function and left-sided filling pressures

8. Midesophageal three-chamber view ± color Doppler (Fig 6, Video 3)

- Rotation: 90° to 120°

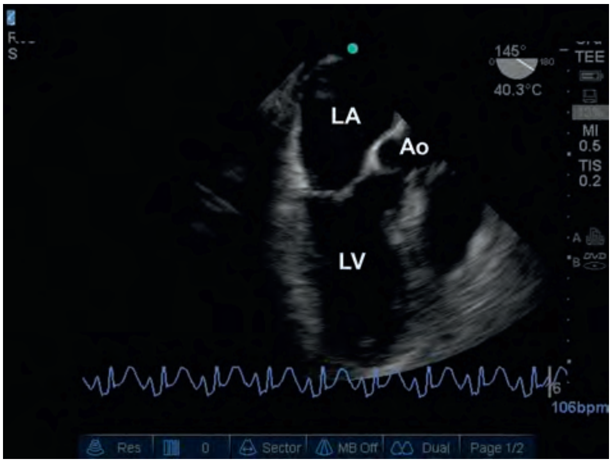

Figure 6 – *Midesophageal three-chamber view. See Figure 1 and 2 legends for expansion of abbreviations.*

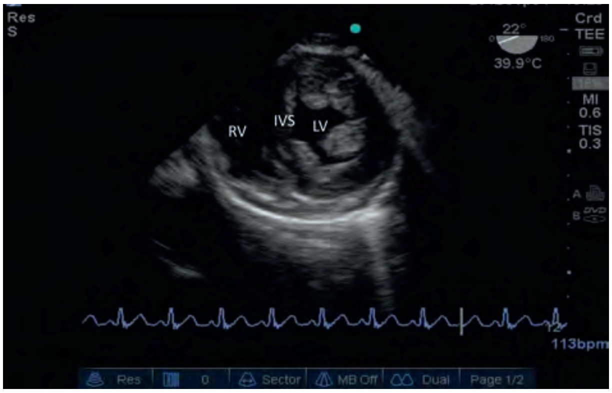

Figure 7 – *Transgastric midpapillary muscle short-axis view. IVS = interventricular septum. See Figure 1 and 2 legends for expansion of other abbreviations.*

- With the left ventricle in the central screen position, the beam plane is rotated to 90° to 120°.
- Clinical use: evaluation of the LV chamber size and function, anatomy and function of the MV and AV, LVOT anatomy, and segmental wall function (inferolateral and anteroseptal walls)

9. Transgastric midpapillary muscle short-axis view (Fig 7, Video 4)

- Rotation: 0°
- The probe is advanced into the stomach and anteflexed to obtain a cross-sectional view of the left ventricle.
- Clinical use: evaluation of the LV chamber size and function, segmental wall motion, right ventricular size and function, and septal kinetics

10. Fractional area change (FAC) (Fig 8)

- Rotation: 0°
- From a frozen image of the LV cavity at the midventricular level, the diastolic and systolic area of the left ventricle is measured to calculate the FAC. FAC = LV end diastolic volume − LV end systolic volume/LV end diastolic volume.
- Clinical use: evaluation of LV systolic function

11. Transgastric long-axis view (Fig 9, Video 4)

- Rotation: 120°
- From the transgastric short-axis view, the transducer beam plane is rotated to 120°, and the PWD sample volume is placed within the LVOT to obtain the systolic velocity time integral (VTI).
- Clinical use: measurement of LV stroke volume and evaluation of respirophasic variation of VTI

12. Transgastric deep long-axis view (Fig 10, Video 4)

- Rotation: 0°
- From the transgastric short-axis view, the probe is advanced at 0° to the apex of the heart and anteflexed to visualize the LVOT. The PWD sample volume is placed within the LVOT to obtain the systolic VTI. Lateral flexion of the probe may be required to achieve proper Doppler angle alignment.
- Clinical use: measurement of LV stroke volume and evaluation of respirophasic variation of systolic VTI

13. Upper esophageal main pulmonary artery (MPA) view (Fig 11, Video 5)

- Rotation: 0°
- The probe is withdrawn until the right pulmonary artery, which is above the LA, is identified. The probe is then rotated counterclockwise, with adjustment of the beam plane angle and retroflexion until the MPA is visualized. The PWD sample volume is place in the MPA to measure the MPA systolic VTI. The air-filled trachea makes it difficult to visualize the left pulmonary artery. The ascending aorta is visualized from this view. The right PA may be visualized from this view as well.
- Clinical use: evaluation of the pulmonary arteries and of measurements derived from the MPA VTI
- Additional views: Mastery of the preceding views is a minimal standard for competence in critical care TEE. A number of other views may be used, depending on the clinical situation. For example, evaluation of the left atrial appendage and measurement of pulmonary venous inflow may be useful for the intensivist.

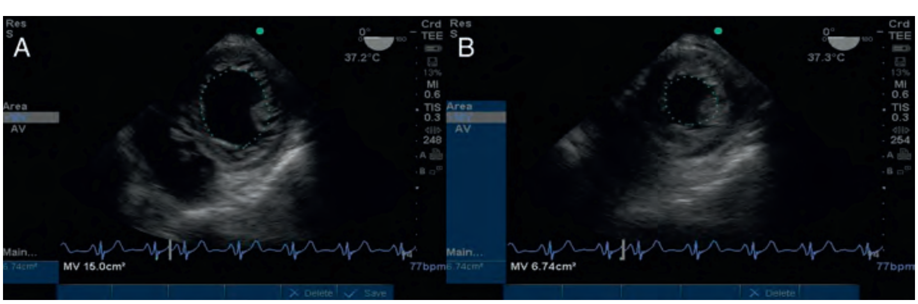

Figure 8 – *A, B, Transgastric midpapillary muscle short-axis view in diastole (A) and systole (B): calculation of fractional area change (FAC). FAC = 15 cm² − 6.7 cm²/15 cm² = 0.55 or 55%. See Figure 1 legend for expansion of other abbreviation.*

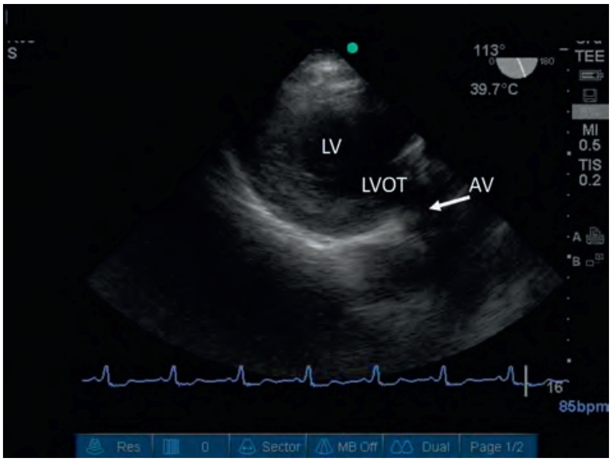

Figure 9 – *Transgastric long-axis view. See Figure 1 and 2 legends for expansion of abbreviations.*

Examination of the aorta may be performed if the aortic pathology is of concern.

14. Midesophageal descending aorta view (Fig 12, Video 5)

- Rotation: 0°
- From the transgastric view of the left ventricle, the probe is turned clockwise approximately 180° to identify the descending aorta, and the transducer is withdrawn to examine the entire descending thoracic aorta. The left pleural space may be examined for pleural effusion or lung pathology.

15. Upper esophageal aortic arch view (Fig 13, Video 5)

- Rotation 0°
- At the level of the proximal descending aorta, the probe is withdrawn, with clockwise rotation of the probe to image the aortic arch. The air-filled trachea will often block full visualization of the aortic arch.

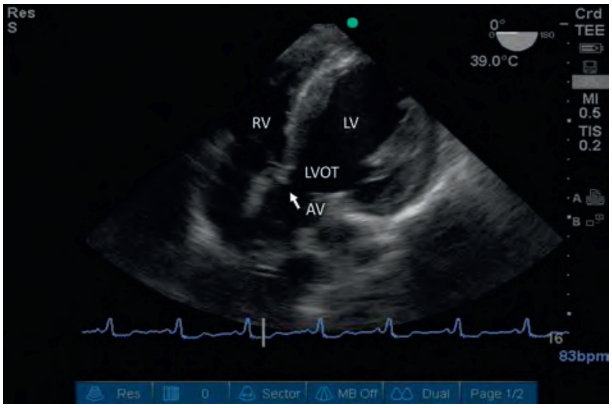

Figure 10 – *Transgastric deep long-axis view. See Figure 1 and 2 legends for expansion of abbreviations.*

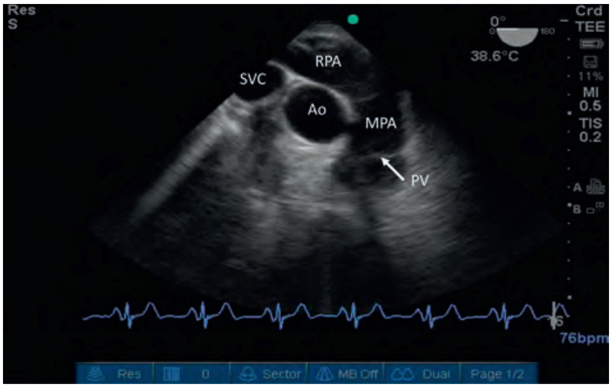

Figure 11 – *Upper esophageal MPA view. MPA = main pulmonary artery; PV = pulmonic valve; RPA = right pulmonary artery. See Figure 1-3 legends for expansion of other abbreviations.*

Goal-Directed Critical Care TEE

Benjamin et al[9] described a goal-directed TEE examination with four views using a monoplanar probe that could be performed by intensivists following a short training period. Vieillard-Baron et al[15] performed serial daily limited TEE examinations to guide therapy in patients with septic shock. A typical image set for limited-scope, goal-directed TEE includes the midesophageal four-chamber view, the transgastric midpapillary muscle short-axis view, and the midesophageal bicaval view for visualization of the SVC. The limited-scope, goal-directed TEE examination has a similar rationale as the five-view, goal-directed TTE examination[21] and has special usefulness for rapid assessment of a patient with hemodynamic failure and for brief repeated examinations to track response to therapy. Competence in limited-scope, goal-directed TEE using four basic views can be achieved with 10 supervised studies.[9] Depending on their practice needs, some physicians may elect to develop competence in limited,

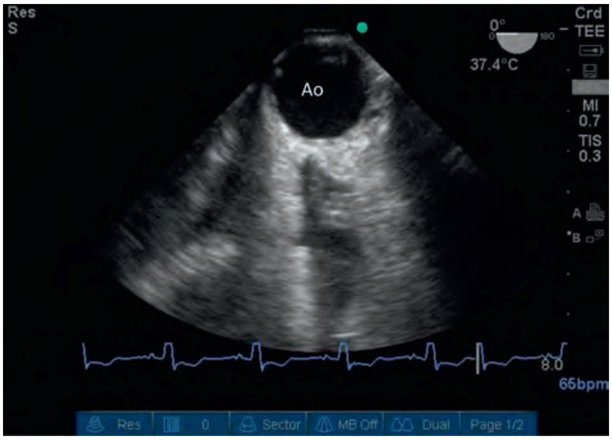

Figure 12 – *Midesophageal descending aorta. See Figure 1 and 2 legends for expansion of abbreviations.*

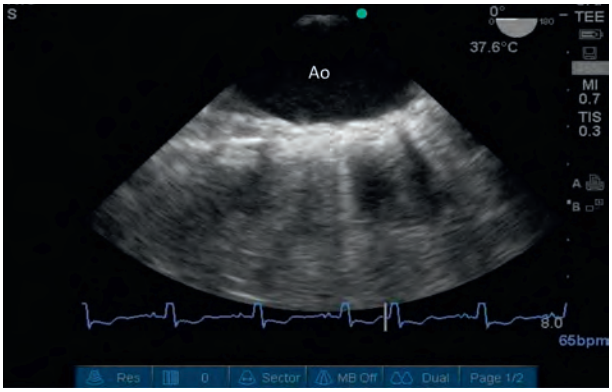

Figure 13 – *Upper esophageal aortic arch. See Figure 1 and 2 legends for expansion of abbreviations.*

goal-directed TEE, which is very useful for rapid evaluation of an unstable patient when TTE views are inadequate because of patient-specific factors.

Conclusions

Competence in critical care TEE is a useful skill for the intensivist. It requires mastery of the cognitive elements of the field, image interpretation, and image acquisition as defined in the advanced CCE training statement. Barriers to the widespread use of critical care TEE still exist in North America, but, as has been the case for general critical care ultrasonography, critical care TEE will become a standard tool in the ICU because of its usefulness and safety. This will require the development of effective training programs for intensivists to master this important component of advanced CCE.

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Conflict of interest: None declared.

Additional information: The Videos can be found in the Multimedia section of the online article.

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