Resuscitative Transesophageal Echocardiography: A Game Changer for Cardiac Arrest

BY PATRICK OCKERSE, MD, & JIMMY FAIR, MD

Managing patients in cardiac arrest is difficult. We often have little to no information about the patient coding right in front of us, and the tools we have to guide our resuscitation provide limited help. Guidelines rely on pulse check and rhythm analysis, both of which are error-prone. (*Resuscitation* 2010;81[11]:1527.)

End-tidal capnography and arterial lines can be useful for evaluating the adequacy of compressions and for signaling return of spontaneous circulation (ROSC), but they provide no information on reversible causes of arrest or cardiac rhythm. Placing an arterial line can be time-consuming and technically difficult intra-arrest. An ideal monitor would be one that can be placed easily and is able to assess cardiac activity, identify reversible causes of cardiac arrest, and evaluate adequacy of compressions.

Lucky for us, there is now such a modality with these qualities that should be considered for better cardiac arrest management: transesophageal echocardiography (TEE).

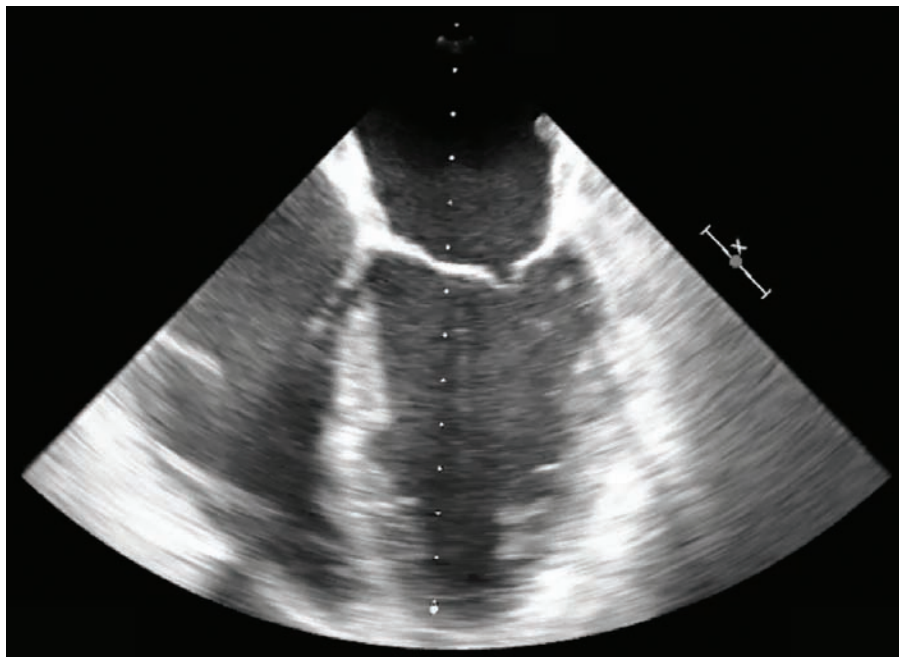

Image 1. TEE mid- E4 view.

TEE can be intimidating. Traditionally it is thought of as a comprehensive evaluation of the heart performed by a specialist. Resuscitative TEE, however, is different from comprehensive TEE because the goal is simply to guide cardiac arrest management. Its use is well within the scope of practice for emergency physicians. Trans*thoracic* echocardiography (TTE) is more familiar to emergency physicians and can also be used to guide cardiac arrest management, but image acquisition with TTE can be difficult in the recommended 10-second window for pulse checks—and recent evidence shows it likely leads to harmful delays in compressions. (*Resuscitation* 2017;119:95.)

Continuous Imaging

TEE is superior to TTE because it can obtain continuous imaging throughout compressions. And images are not affected by body habitus, subcutaneous air from CPR, and space limitations on the chest due to defibrillator pads and external compressions.

Placing a TEE probe is no more difficult than placing an oral-gastric tube. Once an endotracheal tube is in place, the TEE probe is simply advanced into the esophagus until an image of the heart is obtained. Ideally, this should be performed during a pause in chest compressions to minimize the small chance of esophageal or oropharyngeal injury.

The first image encountered after insertion of the probe is the mid-esophageal four chamber (mid-E4) view where all four chambers are visible. (Image 1.) This view is analogous to the apical four chamber view on TTE, and can easily assess cardiac activity and provide information on the potential cause of arrest. If an extra physician is not available to operate the TEE probe, it may be secured to an IV pole once the mid-E4 view is obtained. It can then be left untouched as a monitor providing constant, continuous visualization of the heart for the remainder of the resuscitation.

Cardiac activity is easy to identify on TEE during pulse checks. If no activity is present, compressions can immediately be restarted, limiting long pauses in CPR. If cardiac activity is present, it may be organized in the case of ROSC or disorganized in the case of a shockable rhythm. It is well-established that early defibrillation of shockable rhythms improves outcomes. (*Circulation* 2015;132[18 Suppl 2]:S444.)

Diagnosing Other Conditions

Evidence also shows that telemetry alone may be inadequate at recognizing shockable rhythms when compared with echocardiography (*Resuscitation* 2010;81[11]:1527), such as misinterpretation of fine ventricular fibrillation as asystole. TEE evaluation can quickly identify shockable rhythms, so opportunities to defibrillate are not missed.

Implementing TEE in Your ED

BY PATRICK OCKERSE, MD

Initiating resuscitative TEE in the emergency department requires strategic planning, and may present challenges that vary from site to site. Here are some helpful tips to get TEE in your ED:

- Review your hospital's privileging policies for ultrasound. A global privileging policy is preferred because it does not distinguish between the types of scans that can be performed. If the policy is exam-specific, be sure that it uses broad terms such as "cardiac ultrasound" or "point-of-care echocardiography," which can justify TEE's use.
- Build a team of interested parties. You will need support. This may be someone in your ED or a colleague from anesthesiology, critical care, cardiology, or thoracic surgery. Anesthesiology and critical care may already be using TEE as a resuscitation tool, and this can be a good place to start. If you can't find anyone interested at your institution, you may find interest regionally or nationally, but the closer they are to your hospital system, the more support they will be able to provide.
- Pitch your plan to your ED leadership team. Their support is imperative. You cannot do this without them.
- Practice. Get some hands-on time with a TEE probe. This can happen in the OR, a SIM lab, or at a conference. There is no replacement for practice. Resuscitations are fast-paced and intense. It's best to practice in a controlled, stress-free environment before jumping in.
- Write a protocol for resuscitative TEE use. Be sure to include the indications, placement technique, and targeted views. Don't forget to include a plan for the care of the TEE, such as who will clean it, where it will be stored, and who will be responsible for its upkeep.
- Purchase a TEE probe. This may be the hardest hurdle to overcome. First, determine if TEE is compatible with your department's current ultrasound machines. Not all are, and the potential for future TEE additions should be considered when purchasing new machines. When pitching this purchase to your institution, use terms such as "patient safety," "quality," "value," and "saving lives." After all, one life saved more than justifies the cost of the probe.

There is no one-size-fits-all pathway for initiating a resuscitative TEE program in your ED, but these tips may get you started.

With constant visualization of the heart, success of defibrillation can be immediately evaluated, and if needed, a repeat shock can be delivered before the next pulse check.

TEE will sometimes reveal a state of organized cardiac activity with such severely limited function that no pulse is palpable. This would traditionally fall into the management pathway for pulseless electrical activity (PEA). The PEA treatment pathway is the same as asystole, and assumes there is a true electromechanical dissociation of the heart. Organized cardiac activity visible on TEE, however, more accurately represents a state of profound hypotension better described as pseudo-PEA. (*J Int Med Res* 2010;38[4]:1458.)

A different approach may be necessary for treating this previously unidentifiable state. Some success has been documented using high-dose vasopressors (*J Int Med Res* 2010;38[4]:1458), but further investigation is needed to assess the best management strategy in treating pseudo-PEA.

Reversible causes of arrest can often be identified when organized cardiac activity is present. (*Anest Analg* 2006;102[6]:1653.) Left ventricular failure due to acute coronary syndrome with myocardial infarction may be observed with obvious segmental wall motion abnormality. Pulmonary embolism can be detected by visualizing a clot-in-transit or suspicion of pulmonary embolism dramatically increased with finding a dilated right ventricle with decreased systolic function and a McConnell's sign. Pericardial effusion with tamponade is readily identified with TEE as well as hypovolemia.

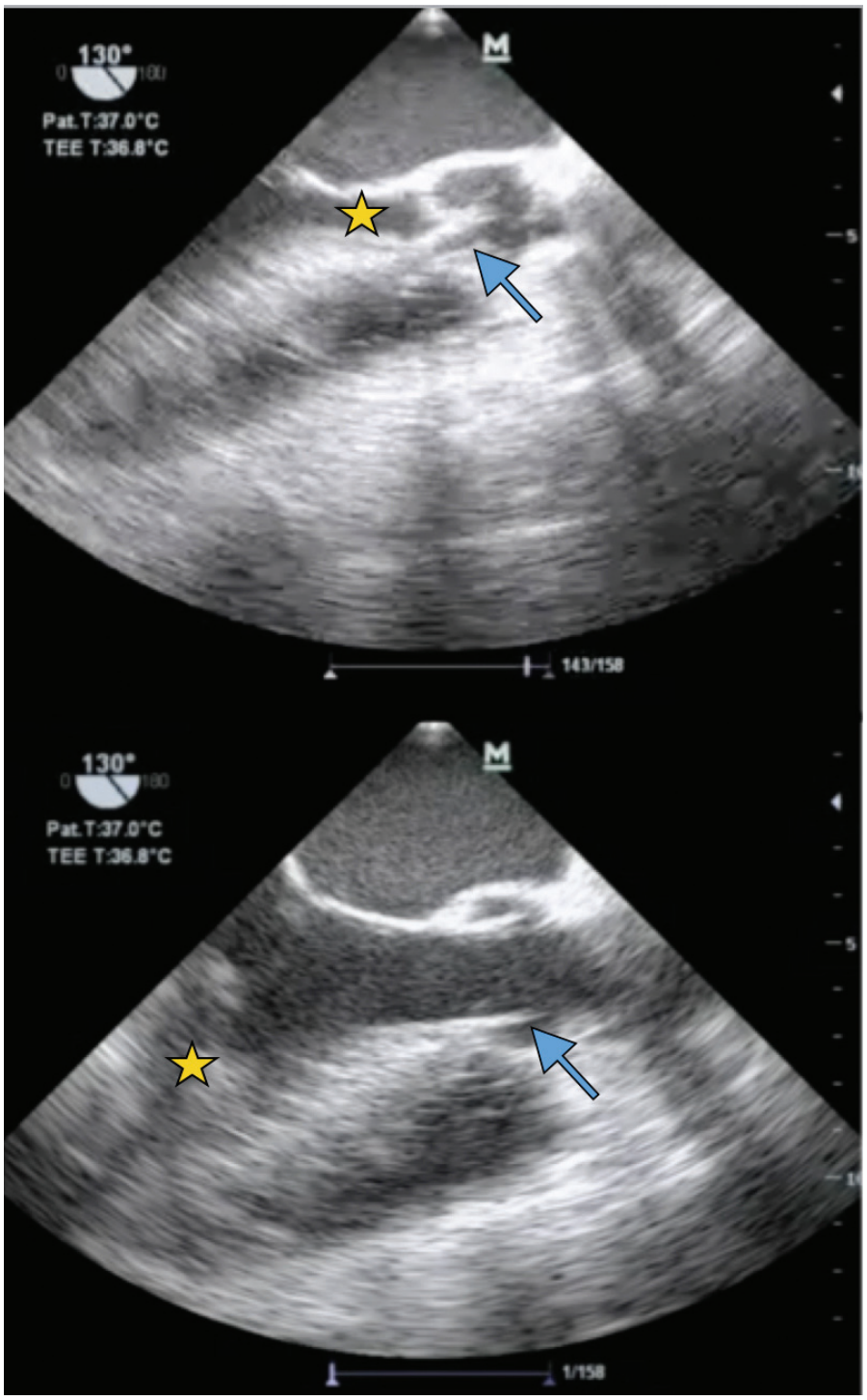

Image 2. TEE mid-E long view with external compressions. The point of maximal compression (star) is moved over the left ventricle on the bottom, and a more open aortic valve (arrow) is visible with compressions.

Invaluable for EPs

These findings can prompt life-saving interventions such as thrombolytics, pericardiocentesis, or fluids or blood products. Now that extracorporeal cardiopulmonary resuscitation is being considered at select centers for cardiac arrest victims as a bridge for reversible causes of arrest, the accurate identification of exactly which reversible cause is present can be valuable in helping guide decisions of cannulation in addition to guiding the cannulation itself. (*Am J Emerg Med* 2016;34[8]:1637.)

The mid-E4 view on TEE is adequate for assessing cardiac activity and identifying reversible causes of arrest. A second view known as the midesophageal long axis (mid-E long), however, is also easily attained, and it can evaluate chest compression quality. High-quality compressions are the foundation of successful resuscitation. With the mid-E long view, the aortic valve is visible, and the opening of the aortic valve may be a good surrogate for monitoring compression quality. External landmarks on the chest can be unreliable because their use can lead to compression of the aortic outflow tract, potentially impairing flow up to 80 percent of the time. (*Resuscitation* 2007; 75[2]:305.)

The mid-E long view on TEE can improve chest compression quality by ensuring that the aortic outflow tract is not occluded, and the valve is opening and closing with compressions. The external site of compressions on the chest can be adjusted to improve cardiac output during CPR. (*Resuscitation* 2013;84[9]:1203.) (Image 2.) Some evidence suggests a benefit in directing compressions over the left ventricle. (*Prehosp Emerg Care* 2017;21[2]:272.) TEE can uniquely identify where maximal compression is occurring and allow for appropriate adjustments to be made.

Additional benefits of TEE include continuous monitoring of cardiac function once ROSC is achieved, which allows early identification of decompensation and rearrest. More advanced applications such as TEE-guided ECMO cannula placement if ROSC is not achieved are also possible. (*Am J Emerg Med* 2016;34[8]:1637.) Even without these advanced applications, emergency physicians can use TEE to easily assess cardiac activity, identify reversible causes of arrest, and evaluate the quality of chest compressions for improved cardiac arrest management. Learning this skill is invaluable for emergency physicians and is possible with minimal training. (*Crit Ultrasound J* 2015;7[1]:27; *J Emerg Med* 2016; 50[2]:286.)

Simply put, TEE is a game changer for managing cardiac arrest, and should be considered by all emergency physicians. **EMN**

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