

Resuscitative Transesophageal Echocardiography Programme in the ED: 5 Tips for Success



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Over the past few years, inspired by landmark publications,^{1,2,3} demonstrating the feasibility, safety and clinical value of transesophageal echocardiography (TEE) performed by emergency physicians (EPs), a number of U.S. hospitals have established TEE programmes based in their emergency departments (EDs). In 2017, the American College of Emergency Physicians (ACEP) published the first guidelines endorsing the use of TEE by EPs for the management of patients in cardiac arrest.⁵ Since then, interest in this new imaging modality—and its potentially lifesaving applications in the ED—has continued to grow.

Drawing on our team's experiences in implementing resuscitative TEE in the ED-ICU interface at three institutions, including the Resuscitation & Critical Care Unit (ResCCU) at University of Pennsylvania Health System, as well as recently published evidence, this article provides a step-by-step guide to developing and implementing an ED-based TEE programme. Clinician training, patient selection criteria, indications and contraindications for the use of TEE in resuscitation, potential challenges and lessons learned are discussed, providing a roadmap for successful programme development and adoption of TEE by EPs.

Tip #1. Examine the evidence and guidelines supporting resuscitative TEE

Although transthoracic echocardiography (TTE) has been widely used for diagnosis and prognosis in cardiac arrest victims, it has several disadvantages. In up to 50% of critically ill patients, TTE yields inadequate images and is especially challenging to perform in those receiving CPR.^{6,7} Moreover, specifically in cardiac arrest, there is some evidence indicating that use of TTE is associated with prolonged interruptions of chest compressions⁸ exceeding the 10 seconds advised by advanced cardiac life support (ACLS) guidelines.⁹ As stated in ACEP's guidelines TEE represents the a suitable solution to these limitations, given its ability for continuous image acquisition both during compressions and during rhythm checks, its reliability generating high-quality images and its lack of interference with chest compressions or other procedures needed during cardiac arrest.

As described in our team's study, with the systematic use of TEE in the evaluation of patients with out-of-hospital cardiac arrest (OHCA), we were able to obtain high-quality images using a 4-view protocol in 100% of cases. In 97% of cases, TEE findings had a significant diagnostic, therapeutic or prognostic impact.¹⁰ Our findings were consistent with those from other investigators who have also reported that this imaging modality has an extremely high success rate in answering crucial clinical questions in critically ill patients (97% for TEE versus 38% for TTE).¹¹ For those in cardiac arrest, TEE can provide a rapid evaluation for reversible causes, guiding changes in management, such as the use of intravenous fluids, blood products, vasopressors, thrombolysis or pericardiocentesis. TEE also allows EPs to monitor the response to any intervention in real time, including assessment of the quality of chest compressions, and can be used to guide the placement of multiple resuscitative devices such as transvenous pacemakers, cannulae for extra corporeal membrane oxygenation (ECMO), intra-aortic balloon pumps or Impella pumps.

Tip #2. Establish and leverage interdepartmental partnerships

A key lesson our teams have learned from setting up TEE programmes for EPs at three hospitals, is that implementation is best achieved through multidisciplinary collaboration. It is extremely important to find and cultivate programme allies from other departments where TEE is

already widely used as part of the standard of care, such as cardiology, cardiac anesthesiology and intensive care. Studies from anesthesiology have described similar use of TEE in resuscitation, in the setting of non-cardiac anesthesia.¹²

One of the best ways to engage with colleagues from these departments—and gain their support—is to ask them questions and seek their advice. Invite anesthesiologists, cardiologists or intensivists to hold joint multimodal didactic sessions with EPs on resuscitative TEE. Most ultrasound manufacturers sell reusable TEE probes that attach to existing machines. Vendor selection is best handled by a multidisciplinary team that includes EPs and other TEE stakeholders in the institution, such as cardiology and anesthesiology, equipment managers, administrators and biomedical engineering.

Tip #3. Develop a protocol for resuscitative TEE

An important part of implementation is establishing an institution-specific protocol that describes the indications and scope for focused (or resuscitative) TEE, that clearly differentiates this modality from comprehensive or consultative TEE. The primary indication for resuscitative TEE in the ED is cardiac arrest. After implementing it in this population at our center, we also found TEE can be clinically influential in three additional scenarios: 1) evaluation of patients in shock who have inadequate transthoracic windows³ 2) assessment of volume status in mechanically ventilated patients using superior vena cava (SVC) variation¹³ and 3) guidance of extracorporeal membrane oxygenation (ECMO) cannulation during extracorporeal CPR.¹⁴

The protocol should establish clear patient selection criteria. Our protocol includes 1) patients in cardiac arrest and 2) patients who are sedated with a definitive airway (such as endotracheal intubation or tracheostomy) in whom adequate diagnostic or hemodynamic information cannot be obtained with TTE. Absolute contraindications to TEE include patients with active upper GI bleeding, known esophageal varices or perforation, or tracheoesophageal fistulas. The protocol for a new ED-based TEE programme should also describe probe processing workflow and physician training requirements, which should be established in collaboration with hospital leadership to ensure that the protocol is accepted in both the ED and hospital wide.

Tip #4. Use structured simulator-based training

The studies cited above have demonstrated that TEE is safe, clinically impactful and easy for EPs to learn. Acquiring the motor skills needed for this modality is actually easier than TTE. The TEE probe's retrocardiac position, only millimeters behind the heart makes image generation much easier compared to TTE, where the clinician must find an acoustic window through the chest wall structures. While developing the TEE image is technically easier, interpreting these can be challenging due to the anatomic orientation with the probe behind the heart and great vessels. This is further complicated by the rotation of the ultrasound beam (omniplane), a unique feature of this modality. We have learned that providing clinicians with a solid foundation of cardiac anatomy and spatial orientation from this novel perspective, is the single most powerful training strategy. In our experience, the use of high-fidelity TEE simulator systems is crucial for both skill acquisition and maintenance of competency. Structured, goal-directed training, such as multidisciplinary didactic workshops using high-fidelity simulators, offers a highly effective method to teach TEE-naïve EPs how to perform a focused TEE examination.

In addition to simulation, training in the operating room with cardiothoracic anesthesia can provide an invaluable experience. The perioperative environment is ideal because patients are intubated, providing a controlled environment to practice probe insertion and image acquisition. Moreover, intraoperative management is a dynamic process with changes in physiological states, allowing trainees to perform serial examinations and observe a high frequency of pathological findings, such as a patient undergoing a thrombectomy in the setting of a saddle or pulmonary embolism.

Tip #5. Monitor clinical impact

An important part of establishing—and sustaining—an effective ED-based TEE programme is tracking outcomes and sharing them with programme allies and hospital leadership to help ensure ongoing support for the programme. There are several aspects of care EPs can use to monitor their results with TEE, including the following:

- Improvements in the safety and quality of care for patients who present with cardiac arrest or undifferentiated shock. Up to 50% of hemodynamically unstable patients in shock have inadequate windows when examined with TTE. Identify and keep records of those cases where the quality of images obtained with TTE was inadequate for decision making.
- Improvement in the accuracy of evaluation of cardiac arrest rhythms and type of cardiac activity. Multiple studies have found discrepancies when comparing the rhythm observed by ECG with that observed by ultrasound, with one study finding that 35% of patients thought to be in asystole had coordinated cardiac contractility.^{16,17,18} TEE can help prevent these errors by allowing direct visualisation of the presence or absence of cardiac contractility.

Also share the programme's success stories with colleagues at the institution—and at other hospitals. Spreading the word about the cases where TEE has made a difference in the management of patients, and lives saved through the information it provides, can help elevate the standard of care for critically ill patients everywhere. Encourage the programme's trainees to become ultrasound champions and ultimately trainers for the next generation of TEE users in our nation's emergency rooms.

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