Transesophageal Echocardiography: Guidelines for Point-of-Care Applications in Cardiac Arrest Resuscitation

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Cardiac arrest is one of the most challenging patient presentations managed by emergency care providers, and echocardiography can be instrumental in the diagnosis, prognosis, and treatment guidance in these critically ill patients. Transesophageal echocardiography has many advantages over transthoracic echocardiography in a cardiac arrest resuscitation. As transesophageal echocardiography is implemented more widely at the point of care during cardiac arrest resuscitations, guidelines are needed to assist emergency providers in acquiring the equipment and skills necessary to successfully incorporate it into the management of cardiac arrest victims. [Ann Emerg Med. 2017;■:1-7.]

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BACKGROUND: TRANSESOPHAGEAL ECHOCARDIOGRAPHY IN EMERGENCY POINT-OF-CARE APPLICATIONS

Cardiac arrest is one of the most challenging patient presentations managed by emergency care providers. Stress, high stakes, and diagnostic uncertainty lead to challenging management decisions often guided by pulse palpation, auscultation, and guesswork. For these reasons, emergency care providers have increasingly used transthoracic echocardiography tool management of cardiac arrest patients. Although advanced cardiac life support (ACLS) and European Resuscitation Council guidelines have recently endorsed echocardiography in arrest, cardiology and anesthesiology professional societies have endorsed echocardiography since the mid-1990's.[1-4] To date, there has been no official endorsement of the use of transesophageal echocardiography by emergency care providers in cardiac arrest patients.

During the last 20 years, emergency physicians have used transthoracic echocardiography for both diagnosis and prognosis in patients with cardiac arrest.[5-9] However, transthoracic echocardiography has a number of disadvantages. Time spent imaging the heart is time without lifesaving compressions. Transthoracic echocardiography provides inadequate images in up to half of critically ill patients and is even more challenging in patients receiving chest compressions.[10,11] Conversely, transesophageal echocardiography has been shown to provide adequate images in nearly all patients, adding important management-changing information compared with transthoracic echocardiography.[11]

The earliest description of transesophageal echocardiography dates back to 1976, but it was not until 1980 that this tool was used for hemodynamic monitoring in the intraoperative setting.[12-15] In the following decades, its use during cardiac arrest was further explored largely by cardiologists and anesthesiologists.[14,15] Since 2008, 4 studies describing transesophageal echocardiography use during cardiac arrest by emergency medicine providers have demonstrated its feasibility and advantages in this environment.[16-19]

MACHINE ACQUISITION, MAINTENANCE, AND CLEANING

Because transesophageal echocardiography transducers require a significant initial investment, it is important for emergency physicians to understand the procurement and maintenance processes for the equipment. Similar to the purchasing process for other ultrasonographic equipment, vendor selection is best accomplished by a multidisciplinary team that includes the ultrasonographic director, equipment managers, biomedical engineering, administrators, and other transesophageal echocardiography stakeholders in the hospital such as cardiology and anesthesiology. The purchasing process should include obtaining bids from multiple manufacturers and organizing a clinical evaluation process. It is imperative to ensure transesophageal echocardiography transducer

compatibility with the existing or prospective emergency department's (ED's) point-of-care ultrasonographic equipment. Other criteria for equipment selection should include the cost and expected life span of the transducer, preventive maintenance costs, quality of the warranty, reputation of the vendor, and information technology systems integration.[20]

Preventive maintenance is essential in establishing a point-of-care transesophageal echocardiography program because the transducers are delicate and more easily damaged than other ultrasonographic transducers. Service agreements for transesophageal echocardiography probes from vendors should be considered and may be cost-effective for hospitals with biomedical engineering departments that do not have the resources or expertise to perform planned or urgent maintenance. There is a high probability a probe will require repair within the first 5 years of purchase, and a service agreement will minimize expenses associated with probe replacement. Qualified biomedical personnel should perform inspections of the transducers regularly according to the manufacturer's specifications. When not in use, transesophageal echocardiography transducers should be stored at room temperature in protective cases or dedicated cabinets to prevent damage.[20]

Transesophageal echocardiography transducers come in contact with mucous membranes; thus, high-level disinfection is required between patients. The process for cleaning and disinfection of transesophageal echocardiography probes is similar to that for endoscopy equipment, and should be available within a hospital system.[21] Immediately after performance of the study, the probe should be cleaned with soap and water to remove visible material before disinfection. High-level disinfection is then performed in a disinfectant solution (eg, glutaraldehyde) for a specific period according to the manufacturer's guidelines. The transducer should be subsequently rinsed with sterile or filtered water to remove residual chemicals and wiped dry with a soft towel. Use of cleaning solutions or lubricants not recommended by the manufacturer may damage probes and void the warranty. Proper documentation of cleaning is required to ensure adherence to infection control standards and should follow hospital policy for high-level disinfection.

DIRECTED IMAGING PROTOCOL FOR TRANSESOPHAGEAL ECHOCARDIOGRAPHY

An essential tenet of point-of-care ultrasonography is the ability to scale the complexity of the ultrasonographic examination to the clinical scenario and indications.[22] Although a comprehensive transesophageal echocardiography examination may consist of 28 views, in cardiac arrest a less complex, goal-directed protocol is essential to the integration of transesophageal echocardiography into this resuscitative scenario.

Our recommended imaging sequence is designed for efficiency and should be considered the minimum standard of care for transesophageal echocardiography in ED cardiac arrest patients. We have developed a 3-view protocol that was based on the following values:

1. Preservation of the endorsed scope of ED echocardiography
2. Views that are anatomically familiar and relatable to commonly used transthoracic echocardiography views
3. The need for efficiency
4. The need for redundancy to corroborate important findings across multiple planes of interrogation

The protocol includes the following views (Table and Video E1 [available online at http://www.annemergmed.com]): midesophageal 4-chamber view (Figure 1), midesophageal long-axis view (Figure 2), and transgastric short-axis view (Figure 3).

In a recent report articulating the application of transesophageal echocardiography in critically ill patients presenting to the ED, the majority of patients received 3 views (midesophageal 4-chamber, midesophageal long-axis, and transgastric short-axis views) to impart a diagnostic and

Table. Goals of ED echocardiography and the corresponding transesophageal echocardiography views and findings.

Goal	Transesophageal Echocardiography View	Findings
Identification of organized cardiac activity	Midesophageal 4 chamber, midesophageal long axis, transgastric short axis	Organized cardiac contractility versus cardiac standstill
Gross assessment of left-sided systolic function	Midesophageal 4 chamber, transgastric short axis, midesophageal long axis	Evaluation of myocardial thickening, endocardial excursion, and mitral valve movement
Assessment for right ventricular enlargement	Midesophageal 4 chamber, transgastric short axis	Increased RV:LV ratio, septal flattening
Intravascular volume status	Midesophageal 4 chamber, transgastric short axis, midesophageal long axis	Underfilled ventricles
Identification of pericardial effusion	Midesophageal 4 chamber, transgastric short axis	Presence of pericardial fluid