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## Ultrasound in Emergency Medicine

### FOCUSED TRANSESOPHAGEAL ECHOCARDIOGRAPHY BY EMERGENCY PHYSICIANS IS FEASIBLE AND CLINICALLY INFLUENTIAL: OBSERVATIONAL RESULTS FROM A NOVEL ULTRASOUND PROGRAM

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**Abstract—Background:** Emergency physicians frequently employ transthoracic echocardiography (TTE) to assist in diagnosis and therapy for patients with circulatory failure or arrest. In critically ill patients, transesophageal echocardiography (TEE) offers several advantages over TTE, including reliable, continuous image acquisition and superior image quality. Despite these advantages, TEE is not widely used by emergency physicians. **Objective:** Report the feasibility, findings, and clinical influence observed from the first described TEE program implemented in an emergency department (ED) point-of-care ultrasound program. **Methods:** This was a retrospective review of all ED TEE examinations carried out between February 1, 2013 and January 30, 2015. TEE images and report details (including operator, indication, findings, and clinical recommendation[s]) were exported from the institutional ultrasound archive and analyzed. The electronic chart of each patient was subsequently reviewed for the presence of any complications related to the examination and their clinical course in the hospital. **Results:** A total of 54 TEE examinations were performed by 12 different emergency physicians. All patients were intubated, and 98% of the

examinations were determinate. The most common indications for TEE were intracardiac arrest care in 23 (43%), postarrest management in 14 (26%), and undifferentiated hypotension in 16 (40%). Probe insertion was successful in all cases. TEE imparted a diagnostic influence in 78% of cases and impacted therapeutic decisions in 67% of cases. **Conclusion:** From our analysis of a single-center experience, ED-based TEE showed a high degree of feasibility and clinical utility, with a diagnostic and therapeutic influence seen in the majority of cases. Focused TEE demonstrated strongest uptake among intubated patients with either undifferentiated shock or cardiac arrest. © 2015 Elsevier Inc.

**Keywords—**point-of-care ultrasound; echocardiography; resuscitation; imaging; ultrasound; transesophageal echocardiography; cardiac arrest; new technology; critical care

#### INTRODUCTION

Cardiac ultrasound is a well-accepted component of contemporary emergency medicine practice. Effective applications of emergency department (ED)-based cardiac ultrasound include the identification of pericardial effusion (medical or traumatic), differentiation of shock, assessing left ventricular function, and guiding treatment and prognosis in cardiac arrest (1–7).

Ethics approval was completed. Dr. Robert Arntfield is an educational consultant for Sonosite. Dr. Jacob Pace, Mr. Michael Hewak, and Dr. Drew Thompson have no conflicts of interest.

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The transthoracic approach to echocardiography (TTE) is the preferred method of cardiac ultrasound in the ED. Despite its widespread use, TTE has important limitations. User factors (varying skill in image generation and level of experience), patient factors (obesity, mechanical ventilation, subcutaneous emphysema, ongoing cardiopulmonary resuscitation [CPR]), and logistical factors (interruptions of CPR to acquire images during cardiac arrest) may limit the acquisition of reliable, high-quality TTE images. These factors are often at play in critically ill patients, and may explain why TTE images are frequently poor or inadequate in this population (8).

In contrast, transesophageal echocardiography (TEE) offers a reliable acoustic window via the esophagus, lessening variability in image generation and generally assuring high-resolution images. TEE has been shown to outperform TTE in answering high-stakes, clinical questions in the critically ill, and demonstrated great promise in cardiac arrest for addressing reversible causes and guiding intra-arrest procedures (9–13). Further, TEE may be carried out during cardiac arrest without interrupting chest compressions.

Despite these advantages, uptake of TEE in the ED has been limited. Acceptance may be limited due to many potential factors, including transducer cost, invasiveness, and barriers to emergency physician training (lack of teachers and established ED curriculum), as well as hospital culture.

The purpose of this retrospective review is to describe the feasibility, findings, and clinical impact of TEE in the ED from the first 2 years of a novel ED TEE program.

## METHODS

### *Design*

This was a retrospective review of all ED TEE examinations performed between February 1, 2013 and January 30, 2015, after the introduction to a tertiary care ED. The study was approved by our institution's Research Ethics Board (REB #105354).

### *Setting*

The setting for this study was an academic emergency medicine program comprising two EDs (one of which is a regional trauma center) with total annual visits of 140,000. At least one point-of-care ultrasound machine and an immediately accessible TEE probe are available at each site.

### *Data Acquisition*

TEE examinations performed from February 1, 2013 until January 30, 2015 were reviewed in our ED ultrasound

database (Qpath, Telexy Healthcare, Maple Ridge, BC, Canada). The relevant details of the examination (entered by the operator at the time of the examination) were retrieved from the Qpath archive and included: date of examination, operator, examination indication, probe insertion details, TEE views obtained, examination findings, recommended clinical actions, the utilization of additional ultrasound modalities for the same patient, ED discharge diagnosis, and disposition of the patient. Data were abstracted by author MH, who was trained by and underwent regular supervision by author RA. Data were populated into a preformed data abstraction tool (spreadsheet).

The electronic medical record of each patient was subsequently reviewed for the presence of any documented aerodigestive complications related to the examination.

## DATA ANALYSIS

Data obtained from the TEE examination reports consisted of both categorical (through drop-down fields and check boxes) and free text (Figure 1). Free text data, such as indication, clinical background, and examination interpretation, were analyzed by the authors and categorized into predefined, discrete categories. Diagnostic and therapeutic decisions related to the examination were extracted from the "recommended clinical actions" section of the examination report.

To explore any incremental influence of TEE beyond what TTE might be able to provide, examination findings were further divided into "basic" echocardiographic findings and TEE-specific findings. Basic echo findings were derived from the scope defined by the American Society of Echocardiography/American College of Emergency Physicians consensus on ED echocardiography (14). TEE-specific findings included those findings made possible through the unique acoustic window of TEE (e.g., during CPR, visualization of the ascending aorta) or the enhanced structural resolution of the modality (e.g., fine ventricular fibrillation).

### *TEE Program Structure*

*Training.* A group of 14 emergency physicians participated in a 4-h TEE workshop comprised of didactic teaching and simulator-enhanced hands-on training and led by an emergency physician (RA) with expertise in both TTE and TEE. The workshop featured both didactic (2 h) and simulation-based (2 h) training. The educational workshop emphasized the generation and interpretation of a focused protocol of four discrete TEE views: the mid-esophageal four-chamber, the transgastric short-axis, the mid-esophageal long-axis, and the mid-esophageal bicaval view. A full description of this training and results has recently been published (15).

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