Cardiac Echocardiography

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KEYWORDS

• Cardiac echocardiography • Focused echocardiography
• Bedside echocardiography • Cardiac ultrasound • Pericardial effusion
• Cardiac tamponade • Cardiac contractility • Pulmonary embolism

KEY POINTS

- Focused cardiac echocardiography has become a critical diagnostic tool for both the emergency physician and critical care physician caring for patients with chest pain, shortness of breath, in a shock state or following trauma to the chest.
- Cardiac echocardiography allows for the immediate diagnosis of pericardial effusions and cardiac tamponade, the evaluation of cardiac contractility and volume status, and the detection of right ventricular strain that may be seen with a significant pulmonary embolus.
- Advanced echocardiography applications that utilize Doppler technology may be used for more advanced ultrasonographic examinations (cardiac valvular, hemodynamic evaluations).
- The emergent cardiac procedures, pericardiocentesis and placement of a transvenous pacemaker wire, can be performed more accurately and safely with ultrasound guidance.
- This article covers how to perform cardiac echocardiography using the standard windows, how to interpret a focused goal-directed examination, and how to apply this information clinically at the bedside.

INTRODUCTION

Cardiac echocardiography has evolved to become one of the most important clinical skills for both the emergency physician (EP) and the critical care physician (CCP). Current ultrasound technology contained in smaller and more portable units has dramatically improved in the recent past to allow for performance of focused echocardiography in the relative safety of monitored clinical areas.[1] Essential treatment of the

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patient can therefore be rendered concurrently with diagnostic echocardiography. The use of focused ultrasonography has been supported by the major emergency medicine societies, including the American College of Emergency Physicians (ACEP), the Society for Academic Emergency Medicine, and the Council of Residency Directors, all of which currently endorse residency and postresidency training in this modality as well as its clinical use.[2–5] Critical care societies have also endorsed similar guidelines in the use of echocardiography with several consensus documents over the past years.[6–8] In 2010, an important collaborative article was published jointly between the American Society of Echocardiography (ASE) and ACEP, which endorsed focused echocardiography for a defined set of emergent conditions.[9]

GOALS OF FOCUSED BEDSIDE ULTRASONOGRAPHY

The various categories of functional uses, clinical indications, and clinical goals of bedside echocardiography, as defined by ACEP, ASE and Critical Care Medicine guidelines, are summarized in **Tables 1–5**.

PERFORMANCE OF THE ECHOCARDIOGRAPHY EXAMINATION

Selection of Ultrasound Probe

A phased-array probe is typically used for cardiac echocardiography. This probe has the benefit of a small footprint that can easily fit in between the ribs. For the deeper imaging needed for echocardiography, select a frequency at the lower end of the bandwidth used for medical imaging, usually 2.5 to 3 MHz.

Imaging Modalities

Frame rate

As the heart is moving rapidly in reference to other body structures, selection of a high frame rate on the settings of the ultrasound machine will allow for optimal imaging (24 frames per second or higher); this is done by selecting the cardiac preset on the ultrasound machine, which effectively increases the imaging frame rate.

B-mode ultrasonography

Ultrasonography of the heart typically utilizes modalities that can capture both anatomy and physiology[10]; this is done by first using B-mode imaging to visualize the heart as it moves through the cardiac cycle. B-mode imaging projects the heart as a continuum of color in the gray spectrum. Brighter structures are defined as hyperechoic, darker structures as hypoechoic, and the darkest structures as anechoic. Echogenicity results from the fact that the ultrasound probe first acts as a transducer that sends sound waves into the body. The sound waves then penetrate into the body, traveling a distance until they are bounced back to the probe. Different tissue will have varying

Table 1
American College of Emergency Physicians functional categories for ultrasonographic examination

ACEP Guidelines for Emergency Ultrasound
Functional categories:
A. Diagnostic
B. Symptom or sign based
C. Therapeutic and monitoring
D. Resuscitative
E. Procedure guidance