Chapter 32
Echocardiography and Ultrasound in the Intensive Care Unit

Pranav R. Shah
Vanderbilt University Medical Center, USA

Chad Wagner
Vanderbilt University Medical Center, USA

Andrew Shaw
Vanderbilt University Medical Center, USA

ABSTRACT

Sonography in the intensive care unit is a rapidly emerging point-of-care diagnostic tool. Literature supports the use of sonography for the evaluation of lung pathology, protocol based focused cardiac evaluation, and abdominal pathology, as well as identifying deep venous thrombosis. There is also evidence that ultrasound guided procedures such as venous access, thoracentesis, and paracentesis may decrease complications compared to a landmark based technique. However, there is ambiguity in the literature regarding definition, scope, and training in this modality as used by intensivists. The purpose of this chapter is to provide a broad overview of the role of ultrasound in the ICU and data supporting the use of point-of-care protocols. This chapter does not provide instruction on how to perform a complete transthoracic or transesophageal exam, nor does it provide a library of images of various pathologies since a reader seeking such depth would be better served by a full textbook on echocardiography.

INTRODUCTION

Sonography is emerging as a versatile tool for rapid assessment of the critically ill patient. Key factors in this trend include convenience and an intuitive understanding that visualizing the structure of interest is more accurate than surrogate measures of its function. For example, Rugolotto et al. found major differences in assessment of cardiovascular status via a physical exam performed by second year cardiology fellows versus an exam using a portable hand-held ultrasound (Rugolotto, Chang, Hu, Schnittger, &

Liang, 2002). Kobal and colleagues showed a similar phenomenon when comparing medical students with ultrasound training and a cardiologist's physical examination when assessing valvular and non-valvular cardiac pathology (Kobal et al., 2005).

Ultrasound in the cardiac intensive care unit can be used in multiple ways. It is a useful in assisting in procedures such as central venous access. It can also provide rapid, goal directed assessment of the lungs, heart, abdominal cavity, and lower extremity veins. Of note, this chapter will not cover the FAST exam for rapid evaluation of the trauma patient as a trauma patient is unlikely to be admitted to the cardiac intensive care unit.

The objective of this chapter is to briefly discuss ultrasound-guided procedures in the ICU, and to more thoroughly discuss lung ultrasound, focused cardiac ultrasound, and ultrasound training. The reader is encouraged to consult a formal textbook in sonography in order to see a library of sonographic normal and abnormal findings, or learn to perform full transthoracic (TTE) or transesophageal (TEE) exams with various Doppler modalities or 3D examination. At the end of this chapter, Table 1 provides a summary of common point-of-care views and their uses, and Figure 1 shows images acquired with a point-of-care ultrasound machine.

SONOGRAPHY FOR PROCEDURES

Central Venous Cannulation

There are numerous articles dealing with ultrasound guidance for central venous cannulation in the intensive care unit. The reader is encouraged to refer to the American Society of Echocardiography (ASE) and Society of Cardiovascular Anesthesiologists (SCA) joint guideline, published in 2011, for recommendations for vascular cannulation. For internal jugular vein cannulation, the guideline recommends that properly trained individuals use real-time ultrasound based on Level 1 evidence. For the subclavian vein, it states that the use of ultrasound for routine cannulation is not supported by literature, but for high-risk individuals, ultrasound to assess location and patency of the vein may be beneficial. For the femoral vein, the guideline states that the scientific evidence does not support routine use of ultrasound (Troianos et al., 2011).

As an aside, ultrasound techniques have been well described for femoral vein and internal jugular vein cannulation. Both static and real-time ultrasound guided cannulation techniques have also been described for the subclavian vein though they are more technically difficult. Fragou and colleagues reported on a comparison between real-time ultrasound guided cannulation and a landmark technique for subclavian vein and found the real-time technique to be superior in terms of complication rates. Their technique utilized the identification of the axillary vein between 1st and 2nd rib in the infraclavicular region in a long-axis (longitudinal) view, and watching the needle enter the vein (Fragou et al., 2011).

Arterial Cannulation

Though there are no Level 1 recommendations on the role of sonography in arterial cannulation, there are a fraction of patients in the cardiac ICU who have mechanical devices that reduce native arterial pulsatility. In this patient population, ultrasound is very useful in locating an arterial vessel and guiding cannulation.

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