

Assessment of Volume Status Using Ultrasonography

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KEYWORDS

• Ultrasound • Ultrasonography • Volume status • Shock • Hypovolemia

KEY POINTS

- Critical care ultrasonography is useful in determining volume status in critically ill patients when the provider is trained and competent in the skill.
- Critical care ultrasonography leads to a prompt diagnosis and a more appropriate management of the critically ill patient.
- The increasing critical care patient population coupled with the shortage of critical care physicians amplifies the need for advanced practice providers to be competent in the management of critically ill patients.

INTRODUCTION

Assessment of volume status is fundamental when treating patients with hemodynamic instability.¹ The mean systemic filling pressure is decreased in an unstable, hemodynamic shock state resulting in an inadequate cardiac preload and cardiac output. This is present in hemodynamic instability caused by hypovolemia or vasodilation.² More importantly, a prolonged hypovolemic state decreases tissue perfusion, resulting in multiorgan dysfunction and organ failure, leading to increased mortality.^{1,3} Many tools have been developed and used to evaluate and monitor volume status in patients with hemodynamic instability, but most are invasive and not without risk.¹

Ultrasonography is a noninvasive modality that can be used to evaluate volume status in critically ill patients. When combined with the clinical examination, critical care ultrasonography can lead to prompt diagnosis and help guide treatment in critically ill patients with hemodynamic instability. Critical care ultrasonography is convenient, safe, and useful when evaluating volume status in the critically ill patient population. It consists of 2 examinations: general critical care ultrasonography and basic critical

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care echocardiography.⁴ The general critical care ultrasonography examination involves assessment and evaluation of the lungs, pleura, abdomen, and vasculature, whereas the basic critical care echocardiogram involves evaluation of the heart and inferior vena cava (IVC).⁴ Additionally, ultrasonography can be used for procedural guidance to decrease the risk of complications.⁵

BACKGROUND

Ultrasonography was introduced to medicine in the 1950s.⁶ At this time, machines were large and stationary, limiting the usability and accessibility of most populations within the acute setting, including patients requiring intensive care. Large, bulky ultrasound machines were difficult to transfer let alone be taken to the bedside of critically ill patients in intensive care unit rooms where there were space restraints. These restraints prevented rapid evaluation with ultrasonography. With the advancements of technology, ultrasound machines are now small, portable, and easy to transfer to the patient's bedside to evaluate and manage the patient's condition promptly.^{6,7}

Historically, ultrasound examinations were limited to the subspecialties of obstetrics, cardiology, radiology, and anesthesiology, until the 1990s when ultrasonography use expanded to include emergency medicine. The Focused Assessment with Sonography for Trauma (FAST) examination was developed and used within emergency medicine to assess trauma patients for hemopericardium and hemoperitoneums.⁶ The efficiency, accuracy, and rapid access allowed evaluation of specific trauma conditions, which in turn decreased hospital length of stay, treatment costs, time to definitive diagnosis or operation, and mortality.^{8,9}

Emergency medicine ultrasonography curriculum and Emergency Ultrasound Guidelines have since been developed and published by the Society of Academic Emergency Medicine.⁶ Recently, the Society of Critical Care Medicine has incorporated ultrasonography examination into recommended routine evaluation of the critically ill patient. It is used to assess and interpret imaging promptly and manage the patient condition leading to improved treatment options and plans.⁵

In 2009, the American College of Chest Physicians and La Société de Réanimation de Langue Française published the consensus statement for critical care ultrasonography, which led to the international expert statement on training standards.^{10,11} Use of ultrasonography in the critical care population allows providers to assess and interpret imaging in real time, providing a more prompt diagnosis and management of potentially life-threatening conditions. Ultrasonography has evolved from minimal use among a select group of medical specialties to guiding and directing the management of the most acutely ill patients within emergency and critical care medicine.⁵

IMPORTANCE

The American College of Chest Physicians and La Société de Réanimation de Langue Française consensus statement on critical care ultrasonography includes 2 focused examinations: a general critical care ultrasonography examination and a basic critical care echocardiogram. The general critical care ultrasonography examination includes evaluation of the lungs, pleura, abdomen, and vasculature. The basic critical care echocardiogram includes the evaluation of the heart and IVC. The consensus statement recommends that all critical care providers be trained and competent in general critical care ultrasonography and basic echocardiography.¹¹

Traditionally, physicians were the sole providers using ultrasonography in practice. As a result of the growing population and increase in acuity of critically ill patients, advanced practice providers, including nurse practitioners and physician assistants,

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