Medicina Intensiva 47 (2023) 526–528

medicina intensiva

http://www.medintensiva.org/en/

UPDATE IN INTENSIVE CARE MEDICINE: ULTRASOUND IN THE CRITICALLY ILL PATIENT. CLINICAL APPLICATIONS

Introduction to the update series: update in intensive care medicine: ultrasound in the critically ill patient. Clinical applications

Introducción a la serie de Puesta al día: ''Ecografía en el paciente crítico. Aplicaciones clínicas''

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Received 3 August 2023; accepted 4 August 2023

Ultrasound has become an essential imaging modality in the assessment of critically ill patients, as it provides real-time bedside images in a non-invasive or minimally invasive way (transesophageal echocardiography). Additionally, the information obtained from the ultrasound examination is interpreted and immediately added to the patient's overall assessment,[1,2] which brings undeniable value to clinical practice in the field of Intensive Medicine. This application of dynamic and real-time ultrasound is referred to as Point-of-care ultrasonography (POCUS).[3,4]

Echocardiography is the first ultrasound modality that was routinely added to intensive care units (ICUs). The main indication for echocardiography at the ICU setting is the study of cardiocirculatory function in shock, because it allows us to gather information on its etiology and can be tremendously useful as a guide and monitoring of the treatment being administered. Other common indications for echocardiography in Intensive Medicine include the assessment of heart-lung interaction, evaluation of endocarditis, aortic dissection or the study of unexplained hypoxemia.[1,5,6]

Specifically, the latest international consensus on shock and hemodynamic monitoring (Task force of the European Society of Intensive Care Medicine) recommends echocardiography as the preferred imaging modality for the initial evaluation of shock type over more invasive technologies.[7] Similarly, the Cardiological Intensive Care and CPR Working Group of the Spanish Society of Intensive Medicine, Critical Care, and Coronary Units (SEMICYUC) recommends performing a basic echocardiography in the initial stages of shock. On the other hand, in situations of hemodynamic instability where there is an inadequate therapeutic response or there is a need to delve into the pathophysiology of the process, obtaining advanced echocardiography is advised.[1] Conducting basic and advanced echocardiographic exams,

DOI of original article: https://doi.org/10.1016/j.medin.2023.08.001
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https://doi.org/10.1016/j.medine.2023.08.001

intermittently but repeatedly, contributes to a deeper understanding of hemodynamic assessment, as well as the evaluation and guidance of treatment. More comprehensive examination requires knowledge of advanced echocardiography to guarantee reliable, detailed, and more in-depth information on relevant cardiovascular function aspects in the hemodynamic management of critically ill patients. In 2014, standards for training in advanced echocardiography of the critically ill patient were published (Expert round table on echocardiography in ICU).[8]

Additionally, over the last decade, other sonographic modalities have been rapidly added to the ICU setting. The pleuropulmonary ultrasound, vascular ultrasound, and abdominal ultrasound are some of these modalities. Cranial ultrasound, like echocardiography, had been previously added to assess critically ill patients with neurological conditions. Therefore, there is extensive experience on its applicability. All these imaging modalities contribute to improving the diagnostic and therapeutic processes of different conditions affecting critically ill patients.

At the ICU setting, the ultrasound known as POCUS is performed by intensivists trained in general ultrasound. The most common form of POCUS emphasizes a basic ultrasound examination of the heart, lungs, and abdomen. Multiple protocols integrate the different ultrasound modalities, which appear to be useful in the treatment of various processes such as shock or cardiac arrest.[4]

To ensure the quality of ultrasound examinations and the reliability of decision-making in clinical practice, training in ultrasound is essential. In this regard, it is important to consider that ultrasound is an operator-dependent imaging modality that requires experienced personnel to conduct the ultrasound examinations. This could pose a significant limitation in its practical use since an incorrect interpretation of ultrasound findings could lead to serious diagnostic and therapeutic confusion, with a direct impact on the patient's outcome. Nevertheless, numerous studies have shown that intensivists with proper training can safely and reliably perform ultrasound examinations.[9,10]

This growing addition of ultrasound to the ICU setting has led numerous national intensive care societies around the world to promote structured learning of this imaging modality. On one hand, they propose basic ultrasound training for all intensivists aimed at specific g̈oal-directedöbjectives, focusing on resolving critical care-specific issues. On the other hand, advanced training in modalities like the echocardiography is intended for intensivists with a specific interest in delving into the comprehensive skills and skills required for such modality. Several years ago, joint statements from American and French societies regarding skills in ultrasound at the ICU setting were published.[5] These recommendations include the skills and skills required for different levels of knowledge in echocardiography and other ultrasound modalities at the ICU setting, including thoracic, abdominal, and vascular ultrasound. Similarly, the European Society of Intensive Care Medicine, along with representatives from other Scientific Societies, proposed standardized training requirements in ultrasound.[11] Furthermore, in 2016, guidelines on the proper use of general and cardiac ultrasound in critically ill patients were published.[12]

Alongside these educational proposals, some Scientific Societies related to critical care patients are developing accreditation programs for ultrasound performance in Intensive Medicine. Specifically, SEMICYUC has recently launched an ultrasound accreditation process called Eco-ACC. This process involves a first phase of basic general ultrasound accreditation and a subsequent phase of advanced accreditation in different types of ultrasound modalities, primarily echocardiography, pleuropulmonary ultrasound, and neurocritical patient ultrasound. These accreditation programs are crucial to ensure a high-quality standard of care for critical patients in a safe environment.

Another aspect of interest and controversy alike is the uncertainty surrounding the application of ultrasound in critical patients and its impact on clinical outcomes. On a more personal level, intensivists who perform ultrasounds undoubtedly recall numerous situations where findings from ultrasound examinations (cardiac tamponade, tension pneumothorax, etc.) and subsequent therapeutic actions have saved their patients' lives. However, in the clinical studies published so far, a clear positive impact of ultrasound on the clinical course of critically ill patients has not been convincingly proven yet. The studies evaluating the impact of ultrasound on morbidity and mortality are highly heterogeneous in terms of design, quality, population included, and objectives, which complicates drawing reliable and solid conclusions. Additionally, many intensivists have added the ultrasound to their routine clinical practice, convinced of its utility, and are not inclined to participate in prospective randomized studies. The observation conducted by Mayo et al. on the life-saving capabilities of machines at the ICU setting is intriguing.[13] According to these authors, the 3 requirements for m̈achines,ïn this case, ultrasound probes, to save lives are:

- Well-designed machines adapted to the patient's clinical situation.
- Well-trained operators with skills in critical patient ultrasound.
- Operators capable of effectively applying the results obtained to the routine clinical practice.

In conclusion, the addition of ultrasound to the ICU practice has brought about a true r̈evolutionto our routine clinical practice, as well as a paradigm shift to multiple diagnostic and therapeutic processes performed on critically ill patients. The impact of this ẗsunamiïs not limited to the clinical setting. It profoundly impacts educational, research, and innovation aspects as well. For these reasons, *Medicina Intensive* Editorial Committee has deemed it appropriate to publish a series of updates on ultrasound with a highly practical focus on clinical application in critical care units.

The coordinators of this ultrasound update series have enthusiastically embraced the challenge of its development and publication. We would like to express our gratitude to all authors of the different chapters for their dedication, commitment, and contribution to the project. We hope that the series will help intensivists gain a better understanding on the utilities of ultrasound in patient care and encourage its use in critical care units.

To conclude, we shoult mention that the information collected through ultrasound should always be added, together with other elements, to the clinical assessment of critically ill patients, such as the medical history, the physical exam,

imaging and lab test results, and information from other hemodynamic monitoring systems. Similarly, the ultrasound still requires some kind of understanding on the complex pathophysiology of critically ill patients. Like Layon AJ used to say, "... a fool with a tool is still a fool."

Authors' contributions

Ana Ochagavía, Virginia Fraile, and Lluis Zapata drafted and revised this manuscript.

References

1. Ochagavía A, Baigorri F, Mesquida J, Ayuela JM, Ferrándiz A, García X, et al. Hemodynamic monitoring in the critically patient. Recomendations of the Cardiological lntensive Care and CPR Working Group of the Spanish Society of lntensive Care and Coronary Units. Med Intensiva. 2014;38(3):154–69.
2. Ayuela Azcarate JM, Clau Terré F, Ochagavía A, Vicho Pereira R. Role of echocardiography in the hemodynamic monitorization of critical patients. Med Intensiva. 2012;36:220–32.
3. Moore CL, Copel JA. Point-of-care ultrasonography. N Engl J Med. 2011;364:749–57.
4. Lau YH, See KC. Point-of-care ultrasound for critically-ill patients: a mini-review of key diagnosis features and protocols. World of Crit Care Med. 2022;11(2):70–84.
5. Mayo PH, Beaulieu Y, Doelken P, Feller-Kopman D, Harrod C, Kaplan A, et al. American College of Chest Physicians/La Société de Réanimation de Langue Frangaise statement on competence in critical care ultrasonography. Chest. 2009;135:1050–60.
6. Schmidt GA, Koenig S, Mayo PH. Shock: ultrasound to guide diagnosis and therapy. Chest. 2012;142:1042–8.
7. Cecconi M, De Backer D, Antonelli M, Beale R, Bakker J, Hofer C, et al. Consensus on circulatory shock and hemodynamic monitoring. Task force of the European Society of lntensive Care Medicine. lntensive Care Med. 2014;40:1795–815.
8. Expert Round Table on Echocardiography in ICU. International consensus statement on training standards far advanced critical care echocardiography. Intensive Care Med. 2014;40:654–66.
9. Beaulieu Y. Bedside echocardiography in the assessment of the critically ill. Crit Care Med. 2007;35:S235–249.
10. Manasia AR, Nagaraj HM, Kodali RB, Croft LB, Oropello JM, Kohli-Seth R, et al. Feasibility and potential clinical utility of goal-directed transthoracic echocardiography performed by noncardiologist intensivists using a small hand-carried device (SonoHeart) in critically ill patients. J Cardiothorac Vasc Anesth. 2005;19:155–9.
11. Expert Round Table on Ultrasound in ICU. International expert statement on training standards far critical care ultrasonography. Intensive Care Med. 2011;37:1077–83.
12. Levitov A, Frankel HL, Blaivas M, et al. Guidelines far the appropriate use of bedside general and cardiac ultrasonography in the evaluation of critically 111 patients-part 11: cardiac ultrasonography. Crit Care Med. 2016;44:1206–27.
13. Mayo PH, Chew M, Douflé G, Mekontso-Dessap A, Narasimhan M, Vieillard-Baron A. Machines that save lives in the intensive care unit: the ultrasonography machine. Intensive Care Med. 2022;48:1429–38.