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POINT-OF-CARE ULTRASOUND IN CARDIAC ARREST

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Abstract: Point of care ultrasound (POCUS) is a versatile, non-invasive bedside diagnostic tool that increases the sensitivity of conventional physical examination to assess congestion in these patients. It also helps to monitor the effectiveness of decongestive therapy and has prognostic significance. POCUS ultrasound for the management of critically ill patients is increasingly performed by intensivists or emergency Doctors. Results from needs surveys among intensivists reveal an emphasis on basic cardiac, pulmonary, and abdominal ultrasound, which are the most common POCUS modalities in the intensive care unit. Therefore, our aim is to describe the main diagnostic features of basic cardiac, pulmonary and abdominal ultrasound as practiced by intensivists or emergency Doctors in terms of accuracy (sensitivity, specificity), clinical utility and limitations. We also intend to explore POCUS protocols that integrate basic cardiac, pulmonary and abdominal ultrasound and highlight areas for future research.
Keywords: Critical care, Echocardiography, Point-of-care testing, Sensitivity and specificity, Ultrasonography.

INTRODUCTION

Point of care ultrasound (POCUS) is a versatile, non-invasive bedside diagnostic tool that increases the sensitivity of conventional physical examination to assess congestion in these patients. It also helps to monitor the effectiveness of decongestive therapy and has prognostic significance.

Misdiagnosis in medicine and critical care is prevalent, with autopsy studies showing substantial misdiagnosis (WINTERS et al. 2012). Point-of-care ultrasound (POCUS) fills a gap to reduce diagnostic uncertainty and some features can also guide prognosis and management. However, image acquisition and interpretation need to be done with

skill and caution to avoid inadvertent over or underdiagnosis of abnormalities. Misdiagnoses of POCUS due to inexperience can lead to errors in treatment that can worsen patient outcomes or even be fatal (BLANCO et al. 2016). Each POCUS professional must be aware of this and follow up or evaluate with alternatives when applicable. It is still important that any form of POCUS be preceded by a clinical examination, which provides additional information for diagnosis and treatment.

There is an increase in the application of POCUS for the management of critically ill patients, performed by intensivists or emergency Doctors, who are not radiologists or sonographers. POCUS is inexpensive, non-invasive, and can be readily available at the bedside. It is therefore an important skill set for anyone caring for critically ill patients.

POCUS can be too brief to have an in-depth interrogation of any pathology found and a more detailed scan is not practical in a busy intensive care unit (ICU) or emergency department. Excessive imaging and measurement time may delay further clinical assessments or treatments. If abnormalities are found or if a comprehensive evaluation is needed, a formal transthoracic echocardiogram or follow-up computed tomography (CT) scan may be arranged at a more opportune time.

Results from needs surveys among intensivists reveal an emphasis on basic cardiac, pulmonary, and abdominal ultrasound (LAU et al. 2020), which are the most common POCUS modalities in the ICU. Thus, our aim is to describe the main diagnostic features of cardiac ultrasound from a case experience report as practiced by intensivists or emergency Doctors in terms of accuracy (sensitivity, specificity), clinical utility and limitations. We also intend to explore POCUS-based protocols that integrate these ultrasound capabilities.

MATERIAL AND METHODS

From the following clinical case, a review of the narrative literature of facts will be assembled. A 58-year-old man presents to the emergency department with sudden-onset chest pain and dyspnea. Shortly after being taken to a room, he goes into cardiac arrest. Chest compressions are started. You wonder if ultrasound could help in the management of this patient in cardiac arrest. It was also hoped that this study could contribute to making the development and implementation as successful as possible. Therefore, the aim of this study was to use action research methodology to introduce, study, interrogate and clarify the relationship between point-of-care ultrasound in cardiac arrest, in order to meet the local needs of specific patients.

RESULTS

WHAT IS THE BEST APPROACH TO USING ULTRASOUND IN CARDIAC ARREST?

Ultrasound is a valuable adjunct to the management of cardiac arrest among appropriately trained clinicians (as defined by the individual society, but typically consisting of a training course with the completion of >25 reviewed ultrasound exams in a given application). The use of ultrasound during cardiac arrest can be divided into core (subxiphoid and parasternal cardiac views), supplemental (lung and inferior vena cava views), and additional (pulse checking, endotracheal tube placement, deep vein thrombosis [DVT], aorta and FAST seen) (ATKINSON et al. 2017). Although a subxiphoid or parasternal view can be used, a recent study of experienced ultrasound users found that parasternal long view demonstrated significantly better cardiac image quality with a shorter time to image acquisition compared to subxiphoid (GASPARI et al. 2022). When performing a cardiac ultrasound, it is critical

to minimize delays in chest compressions. Strategies to reduce delays include: placing the probe in position prior to checking the pulse (to help mark the heart view and reduce image acquisition time); record the image prospectively and analyze it after the resumption of compressions; use structured protocols to assess an aspect (eg, cardiac tamponade, right ventricular dilatation) by pulse checking; having a Doctor separate from the code team leader to perform the ultrasound when possible; and have a dedicated timer to limit image acquisition time. Doppler ultrasound may also be useful for detecting arterial flow as an adjunct to manual arterial pulse checks.

WHAT DIAGNOSES CAN BE EVALUATED WITH ULTRASOUND DURING CARDIAC ARREST?

There are several diagnoses that can be identified using focused ultrasound during cardiac arrest. As part of the cardiac assessment, clinicians may assess for pericardial effusion with cardiac tamponade, right ventricular dysfunction suggestive of pulmonary embolism, presence of a clot in transit (for example: visible thrombus in the heart), and ventricular fibrillation (ATKINSON et al. 2017). The lungs may be evaluated for pneumothorax, hemothorax, or massive pleural effusion. Endotracheal tube placement can be evaluated, which can be particularly valuable as quantitative capnography is less accurate for confirmation in patients without return of spontaneous circulation (GOTTLIEB et al. 2020, GOTTLIEB et al. 2018). Finally, additional examination of lower limb veins (eg, DVT), aorta (eg, aneurysm or aortic dissection), or FAST examination (eg, hemoperitoneum from trauma, ruptured ectopic pregnancy) may be performed based on the clinical scenario.

HOW RELIABLE IS RIGHT VENTRICULAR DILATION FOR SUSPECTED PULMONARY EMBOLISM IN CARDIAC ARREST?

Although focused cardiac ultrasound can be used to identify the presence of right ventricular dilatation in the setting of shock secondary to pulmonary embolism, current evidence suggests that it may be less reliable among patients in cardiac arrest. Animal and human studies have demonstrated that right ventricular dilatation is frequently observed in patients with cardiac arrest from a variety of causes, including arrhythmias, respiratory failure, and circulatory failure in the absence of pulmonary embolism (WARD et al. 2016). Right ventricular dilation appears to be progressive as cardiac arrest continues and must not be used alone to diagnose pulmonary embolism in later stages of cardiac arrest. However, right ventricular dilation may be more suggestive of pulmonary embolism if performed early in cardiac arrest with a consistent history (eg, sudden-onset chest pain or dyspnea) or in the presence of DVT. Because right ventricular dilation can also be seen in chronic pulmonary hypertension, clinicians must also assess the thickness of the right ventricular free wall. A thin wall (diameter < 5 mm) is suggestive of an acute etiology (ALERHAND et al. 2021).

WHAT IS THE ROLE OF ULTRASOUND IN SUSPECTED CARDIAC TAMPONADE?

Ultrasonography can be valuable for the diagnosis and treatment of cardiac tamponade. Cardiac tamponade must be considered in the context of any patient with pericardial effusion in cardiac arrest. Sonographic findings suggestive of cardiac tamponade include pericardial effusion in the context of right ventricular diastolic collapse (high specificity), right atrial systolic collapse

(high sensitivity), or plethoric inferior vena cava (high sensitivity) (ALERHAND et al. 2019). It is important to note that cardiac tamponade depends primarily on the rate of fluid accumulation rather than the total volume, and can occur with relatively minor strokes if it is acute (ALERHAND et al. 2019). Once diagnosed, ultrasound is the preferred method to guide drainage and has been shown to be highly successful with a low rate of complications (SALEN et al. 1999).

HOW ACCURATE IS CARDIAC ULTRASOUND TO PREDICT POST-ARREST OUTCOMES?

Despite its widespread use for intraarrest prognosis, high-quality evidence to support the independent use of cardiac ultrasound for this purpose is lacking. Although cardiac activity seen on ultrasound is associated with better chances of return of spontaneous circulation and survival in non-traumatic, non-shockable cardiac arrest, and may provide valuable information in the management of non-traumatic pulseless electrical activity (PEA) or asystole, ultrasound must not be viewed as the sole predictor in determining the outcome. Patients with traumatic cardiac arrest without cardiac activity on ultrasound have a high probability of death and an insignificant chance of survival (LALAND et al. 2021). Importantly, cardiac activity must involve visualized movement of the heart walls (eg, isolated valve movements would not qualify as cardiac activity). To improve the reliability of ultrasound as a prognostic tool in cardiac arrest, future research must focus on standardizing the definition of cardiac motion, strengthening study quality, and evaluating transesophageal versus transthoracic echocardiography during CPR. Currently, a Bayesian approach is reasonable, including ultrasound as a tool in the prognostic process.

FINAL CONSIDERATIONS

You perform a cardiac ultrasound during the first pulse check, being conscious so as not to delay the resumption of compressions. You identify a dilated right ventricle with a thin right ventricular free wall and no pericardial effusion. Based on previous symptoms and POCUS findings, you start intravenous thrombolysis. The patient achieves the return of spontaneous circulation and is transferred to the intensive care unit.

Cardiac, lung and abdominal ultrasound must be part of the skill set of doctors dealing with critically ill patients. Being operator dependent, the accuracy of POCUS in detecting or excluding abnormalities can be influenced by operator experience. The influence of POCUS findings on treatment also depends on the clinician's experience. Several protocols combining different POCUS modalities have been described, but the validity of these protocols in different settings still needs to be studied. There is a growing body of evidence describing the accuracy of POCUS applications, and with increasing experience and competence, accuracy is expected to improve. POCUS must be considered a tool to confirm a diagnosis, as an extension of the physical examination. More evidence is needed to recommend it as a standard of care.

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