INTRODUCTION

Point-of-care ultrasound (POCUS) is increasingly being used in the evaluation of patients in the hospital. One particularly important use is in the evaluation of a critically ill patient. POCUS allows real-time diagnosis that relies heavily on a high index of clinical suspicion without labs or other modalities of imaging, which have inherent delays in acquisition and interpretation. We describe the importance of POCUS in the assessment of hypotension for a septic patient with a history of renal and heart disease.

CASE PRESENTATION

A 62-year-old man was referred to the hospital after having complained of dyspnea and intermittent chest pain. He had a history of end-stage renal disease on peritoneal dialysis, type 2 diabetes mellitus, and aortic stenosis status post–26 mm transcatheter aortic valve implantation (TAVI) placed 2 months prior. During this hospitalization he was diagnosed with COVID-19. He became anemic and progressively hypoxic and was subsequently intubated and transferred to a tertiary care facility. He was treated by the intensive care unit (ICU) staff for presumed cytokine storm. Cardiology was consulted for assistance with hypotension and evaluation of the recently placed aortic valve prosthesis. Our team arrived without any prior images to review. The patient deteriorated rapidly, becoming hypotensive without a palpable pulse. Advanced cardiac life support was initiated by the ICU team. POCUS with a portable ultrasound device was performed to evaluate the patient’s clinical status. A large pericardial effusion was seen on the first image (Video 1, Figure 1). Due to the combination of hypotension and the increased intrathoracic pressure from positive pressure ventilation there was near complete compression of the heart on POCUS consistent with cardiac tamponade. With the POCUS findings and the patient’s clinical presentation, we performed an emergent pericardiocentesis using the subcostal approach. In this view the needle and the heart are in different planes, making direct visualization of the needle tip without probe manipulation difficult. Therefore, we maintained the focus on the heart rather than the needle tip for the duration of the procedure. The needle was inserted at a 30° angle to the skin, 1 cm inferior and to the left of the xiphoid aimed at the middle to left clavicle. The needle was advanced while continuously aspirating. We aspirated 60 mL of serous fluid with immediate return of spontaneous circulation. Although hemodynamic improvement was consistent with pericardial drainage, we used a repeat echo rather than agitated saline to confirm that we were not draining pleural or peritoneal fluid and that we were truly in the pericardium. Repeat POCUS demonstrated a decrease in effusion size and expansion of the heart (Video 2, Figure 2). At this point, a guide wire was advanced, and a pigtail was placed using the Seldinger technique for continued drainage. Six hundred fifty milliliters of fluid was drained. A repeat echo was performed showing resolution of pericardial effusion and normal LV function (Video 3, Figure 3).

DISCUSSION

POCUS is a useful tool in cardiac arrest. It is not only helpful in resuscitative efforts, recognizing reversible causes of arrest, but it can also identify the presence or absence of cardiac activity. Sonographic confirmation of cardiac activity leads to shorter pulse check duration while also providing improved ability to prognosticate outcomes correctly. In some Emergency Department studies, cardiac standstill carries a 100% mortality rate. The use of POCUS during cardiac arrest is discussed in the literature to improve the success of pericardiocentesis and resuscitation attempts.

Keywords: Cardiac tamponade, Point-of-care ultrasound (POCUS), Pericardiocentesis

Conflicts of Interest: None.

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arrest has also changed our approach to pulseless electrical activity. Patients with organized activity are not necessarily in cardiac arrest; rather, they may be profoundly hypotensive, representing a new phase colloquially referred to as pseudo-pulseless electrical activity. Identifying these patients is important because the presence of organized cardiac activity has been associated with increased survival. Not only have we identified a functioning heart, but POCUS may help shift the resuscitative efforts from chest compressions to targeted therapies in profoundly hypotensive patients.

It is classically taught that cardiac tamponade can be identified at bedside using Beck’s triad of muffled heart sounds, hypotension, and distended neck veins. However, this is rarely seen in practice and is undoubtedly of limited utility when a patient is in shock. Beck’s triad was identified in a surgical population who developed cardiac tamponade immediately due to hemorrhage or trauma. However, medical patients comprise a population that develops cardiac tamponade more slowly. In these cases, the sensitivity can be as low as 20% and the triad may not be seen at all. As clinical exam findings are insufficiently sensitive, two-dimensional echocardiography should be performed. Particularly, when time is of the essence, the need for quick diagnosis has made the ubiquity of POCUS a pivotal component in the care of critically ill patients.

Our case demonstrates the utility of POCUS in making a swift diagnosis leading to pericardiocentesis in a patient with hypotension and cardiac tamponade. The advantage of a handheld POCUS is its small size, portability, ease of use, and rapid image acquisition.

Multimodality imaging in suspected cardiac tamponade has been used for over 20 years and has now become the standard of care when available. Pericardiocentesis guided by echocardiography can be successfully performed over 95% of the time and may reduce both the “door to pericardiocentesis time” and hospital length of stay. Despite various success rates, the “blind” approach remains common, especially in emergency situations. Computed tomography models estimate the success rate of the blind approach can be as high as 87% using the subxiphoid approach but much lower (~60%) using the apical approach. Intuitively, when performed under echo visualization, major complication rates are likely significantly reduced.

Cardiac tamponade can be identified when there is clinical suspicion and echocardiographic evidence. POCUS machines were designed to be portable and have therefore sacrificed some capabilities such as electrocardiographic gating and image-processing power to achieve a smaller and more maneuverable machine. As technology advances, probe costs have decreased. Handheld systems are now available that use silicon chip array microsensors instead of piezoelectric crystals. This allows a single probe to be used for multiple types of exams such as cardiac and vascular. A major limitation of POCUS is image quality as the machines are inherently less powerful and the operators have less experience than full-time sonographers. Furthermore, POCUS machines are more susceptible to damage when not maintained appropriately. This can lead to electromagnetic and acoustic interference and grayscale artifacts that can significantly hinder image interpretation.

There are several structured protocols that have been studied for sonographic assessment during cardiac arrest. One such protocol is the Cardiac Arrest Sonographic Assessment (CASA) exam. This protocol consists of 4 steps conducted at sequential pulse checks and has been shown to decrease pulse check duration. POCUS findings of cardiac tamponade are largely made using two-dimensional and M-mode imaging. Doppler assessment is possible but often limited. When the pretest probability is high for cardiac tamponade, the provider should start with the subcostal view. This can be used to identify anterior or circumferential pericardial effusions and right heart collapse. A combination of either atrial or ventricular collapse can be seen in up to 90% of cases of cardiac tamponade. It is important to note that in this view, pleural, peritoneal, and right ventricular (RV) epidural fat can present as mimickers of pericardial effusions. They should be identified as extracardiac and outside the pericardium, which can be seen as a bright echogenic stripe (Figure 1). The probe can be quickly rotated and rocked upward to identify the inferior vena cava. In over 90% of patients the inferior vena cava will be enlarged with minimal respiratory variation. This yield is higher than physical exam markers for right atrial pressure, which are estimated to be absent in approximately 30% of patients. Additionally, the subcostal view can be obtained while chest compressions are ongoing, making it particularly helpful for our patient, who was in cardiac arrest at the time of the POCUS. Accordingly, we started with the subcostal view for our patient, and images were taken while compressions were being performed to minimize interruptions.

In our patient the etiology of cardiac arrest was immediately apparent. The parasternal long axis (PLAX) can also identify RV...
 minimized contamination of the procedural field.

dysfunction, pleural effusions, pericardial effusions, and many type A aortic dissections. Additionally, the PLAX gives a view of the anterior and posterior mitral valve leaflets, and the two-dimensional left atrial size in combination with color Doppler can be invaluable in the assessment of mitral regurgitation. In this view, the M-mode cursor can be placed through the RV free wall and the mitral valve leaflets. This can identify diastolic collapse of the right ventricle. This technique can be difficult on POCUS machines that do not have electrocardiographic gating. If the machine does not have this function, timing the RV free wall movement and mitral leaflet opening (diastole) in the M mode can be used to identify diastolic collapse. The parasternal short axis can be helpful for overall assessment of biventricular function, RV size, and septal motion. The apical views can be helpful to identify valvular pathology and biventricular function and allow for assessment of regional wall motion.

Not only does POCUS confirm the diagnosis, but echocardiography also offers the unique advantage of identifying the best window for safely draining the effusion. In our patient, we successfully identified a large effusion anterior to the right ventricle amenable to pericardiocentesis from the substernal window while chest compressions were being performed. This minimized any interruptions during cardiopulmonary resuscitation while preparing our equipment to optimize outcomes. Additionally, we were able to estimate the depth of the effusion and the needle length needed to safely reach the effusion without damaging the heart.

Our case demonstrates the utility of a focused cardiac ultrasound, which was appropriate in this critically ill patient with hypotension.

**CONCLUSION**

This case highlights the importance of POCUS as an adjunct to a patient’s clinical exam, leading to a rapid diagnosis and directing an intervention that led to a quick return of spontaneous circulation.