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REVIEW ARTICLE

The Role of Point-of-care Ultrasound in Cardiac Arrest; A Narrative Review

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Abstract: Cardiac arrest is a life-threatening condition with a high mortality rate, necessitating prompt recognition and treatment of reversible causes to enhance patient survival. Point-of-care ultrasound (POCUS) has emerged as a useful tool that contributes to optimizing resuscitative efforts. This imaging modality offers real-time visualization that assists in detecting reversible causes such as cardiac tamponade, pulmonary embolism, tension pneumothorax and hypovolemia. This review aims to explore the expanding role of ultrasound in the assessment and management of cardiac arrest, emphasizing its utility in identifying cardiac arrest, differentiating between true pulseless electrical activity (PEA) and pseudo-PEA, detecting the reversible causes, guiding clinical decision-making, and potentially predicting outcomes. A comprehensive literature search was performed using the PubMed database from inception to April 2025. Articles were selected based on their relevance to the role and applications of POCUS in cardiac arrest.

Keywords: Point-of-care systems; ultrasonography; heart arrest; etiology; prognosis

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1. Introduction

Cardiac arrest, defined as the cessation of cardiac mechanical activity, remains a leading cause of mortality globally with survival rates largely dependent on the promptness and effectiveness of early interventions. The number of out-of-hospital cardiac arrest (OHCA) patients that receive cardiopulmonary resuscitation (CPR) is almost 90 per 100,000 individuals in the USA (1) and ranges from 47.8 to 57.9 per 100,000 in Europe (2). Moreover, the annual incidence of in-hospital cardiac arrests (IHCA) is approximately 18 per 1,000 hospitalizations in the USA (1) and 1.5-2.8 per 1,000 hospital admissions in Europe (3).

Patients experiencing cardiac arrest require prompt, immediate and targeted life-saving interventions (4). Recent advancements in point-of-care ultrasound (POCUS) technology have introduced new opportunities to improve the precision and speed of clinical decision-making during resuscitation. POCUS is considered a valuable technique in which ultrasound is performed at the patient's bedside by a clinician to quickly assess and guide treatment, particularly in emergency, critical care, and other acute settings. Initially adopted in the late 1980s for use with trauma patients, ultrasound in emergency care has seen significant growth and wider application over the past decade (5). With its capacity to provide real-time imaging, POCUS demonstrates considerable promise to guide critical interventions, assess cardiac function, and identify potentially reversible causes of cardiac arrest in patients undergoing resuscitation. Notably, the 2021 European Resuscitation Council (ERC) guidelines recommend the use of POCUS during cardiac arrest by skilled operators. It is essential that POCUS does not lead to additional or prolonged interruptions in chest compressions and should be performed within the 10 seconds during pulse check (4).

Despite the growing use of POCUS during cardiac arrest resuscitation, its precise role remains incompletely defined. There is currently no standardized protocol for its application, and the impact of POCUS on clinical outcomes is not well established. Additionally, variability in how ultrasound findings are interpreted and integrated into resuscitation efforts limits its widespread adoption. The aim of the present review is to explore the role of POCUS in the management of cardiac arrest, focusing on its applications to evaluate cardiac activity and identify the reversible causes assisting the decision-making process during resuscitation.

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2. Methods

A comprehensive literature search was performed using the PubMed database, covering all records from inception through April 2025. Articles were selected based on their relevance to the role and applications of POCUS in cardiac arrest. Search terms included: “cardiac arrest,” “point-of-care ultrasound,” “reversible causes,” “resuscitation,” “advanced life support (ALS),” and “ultrasound”. The review included randomized controlled trials, systematic reviews, meta-analyses, and large cohort studies. Only articles published in English were considered, and all references were screened for relevance.

3. Clinical applications of POCUS in cardiac arrest

Table 1 summarizes the findings of studies regarding the role of POCUS in cardiac arrest.

3.1. Confirmation of cardiac arrest

Manual pulse check has been found to lack sensitivity and specificity, and exhibit poor consistency between different healthcare professionals. Several factors such as low pulse pressure, inaccurate palpation sites, and anxious or inexperienced medical staff might contribute to this fact. A study assessing carotid pulse-checking skills among four groups of first responders (laypersons with basic life support training, emergency medical technician trainees, paramedic trainees, and certified paramedics) in 16 patients undergoing coronary artery bypass grafting found that the sensitivity for detecting central pulselessness was 90%, while the specificity was 55%. The median diagnostic delay was 24 seconds, with only 2% correctly identifying pulselessness within 10 seconds, highlighting that expecting a valid carotid pulse check within 10 seconds is likely unrealistic (6).

POCUS pulse check is a relatively new approach that has been gaining traction in the emergency setting as a non-invasive and more reliable method for assessing circulation compared to manual palpation. In this novel method, a linear probe is placed over the neck or groin replacing the rescuer’s fingers to locate the carotid or femoral artery. Once identified, chest compressions are briefly paused (< 5 seconds) and the pulsatile movement is recorded (Table 1) (7).

A prospective observational study of 23 non-traumatic cardiac arrest patients that was conducted in the North Shore University Hospital, New York, demonstrated that doppler ultrasound had a higher sensitivity (82% versus 27%), specificity (100% versus 90%) and diagnostic accuracy (88% versus 46%) for detecting a pulse compared to manual pulse check (8). Likewise, another prospective observational cohort study of 52 patients who received CPR at the emergency department (ED) showed that using femoral Doppler ultrasound was more effective than manual palpation in reducing pulse check times (8.98 seconds versus 11 seconds) (9).

POCUS pulse check seems to be feasible even among inexperienced sonographers. A prospective multicenter study using a patient simulator found that ultrasound pulse checks during CPR took less than 10 seconds, matching the duration of traditional manual palpation. Additionally, there was no significant difference in performance across various professional groups or experience levels in the ultrasound examination (10). Ultrasound has also proven to be a valuable tool allowing physicians to visualize cardiac activity and confirm cardiac arrest in the absence of cardiac movements. The subxiphoid view is commonly used during resuscitation as it enables visualization of the heart without the need to interrupt chest compressions. If the subcostal view is difficult to obtain, a parasternal long axis view can be used as an alternative. However, this view can be more challenging to acquire quickly and it is important to note that attempting this view should not delay the resumption of chest compressions (11).

Moreover, POCUS can be especially useful in differentiating pulseless electrical activity (PEA) from pseudo-PEA, two entities with different management strategies. In pseudo-PEA, no pulse is palpable, but organized cardiac activity is visible on echocardiography. It is typically caused by a pathological event that hampers the heart’s ability to sustain a blood pressure adequate for perfusing vital organs, thus it can be regarded as a profound shock state. It is commonly seen in cases of true hypovolemia due to hemorrhage, relative hypovolemia resulting from obstruction of forward blood flow (such as in pulmonary embolism, tension pneumothorax or cardiac tamponade) or a decline in vascular tone (as seen in septic shock or neurogenic shock) (12). A study from Colombia showed that the use of ultrasound in the EDs is especially beneficial to identify cardiac activity in pseudo-PEA, which can guide resuscitation efforts, improving prognosis and leading to better survival outcomes (13).

Lastly, POCUS can aid in distinguishing true asystole from fine ventricular fibrillation (VF), two conditions with different prognoses and treatment strategies. In fine VF, a shockable rhythm, there is still some residual cardiac activity and the prognosis is much more favorable compared to true asystole. Conversely, in asystole, the heart appears entirely motionless indicating very poor prognosis and defibrillation is contraindicated (14).

3.2. Identification of the reversible causes

Identifying the reversible causes of cardiac arrest is crucial because it enables physicians to apply targeted, life-saving interventions, which increases the chance of recovery and improves overall patient outcomes. Ultrasound performed at bedside is a cost-effective and safe imaging modality that can provide immediate, real-time diagnostic information that could help in the diagnosis of several reversible causes of cardiac arrest, including cardiac tamponade, tension pneumothorax, pulmonary embolism, and hypovolemia. Figure 1 shows the role of POCUS in detecting the reversible causes of cardiac arrest. It’s a non-invasive method that can be easily integrated into resuscitation efforts without disrupting other treatments (15).

Till now, multiple cardiac arrest protocols have been proposed regarding the use of ultrasound in cardiac arrest, including the SESAME-protocol (16), the Cardiac arrest ultrasound exam (C.A.U.S.E.) (17), the Cardiac Arrest Sonographic Assessment (CASA) exam (18), the PEA protocol (19) and the Echocardiographic Assessment using Subcostal-only view in ALS (EASy-ALS) protocol (20). However, in clinical practice, POCUS assessment should be highly targeted and driven by the clinical presentation. The physician, team member that performs the ultrasound, should prioritize diagnoses based on their likelihood of being the cause of cardiac arrest and use the most appropriate view to gather quick, actionable information.

3.2.1 Cardiac tamponade

It is a potentially reversible cause of cardiac arrest, that results from both traumatic (e.g. chest trauma, penetrating injuries) and non-traumatic (e.g. malignancies, aortic dissection, post-surgical complications) conditions. Although large pericardial effusions are commonly associated with cardiac tamponade, it is important to recognize that even smaller effusions, as little as 50 mL, can lead to tamponade. The most important echocardiographic signs are the presence of pericardial effusion, the collapse of right cardiac chambers and a plethoric inferior vena cava (IVC). Although, the subxiphoid window provides the clearest view of the heart during chest compressions without the need to interrupt them, the apical and parasternal long axis views can also be utilized for echocardiographic assessment (21).

3.2.2 Tension pneumothorax

It is another possible reversible cause of traumatic cardiac arrest. Ultrasound has a sensitivity of 85.7% and specificity of 95.3% in detecting pneumothorax (22). A single view along the midclavicular line in the 2nd to 4th intercostal space is typically enough to identify a clinically significant pneumothorax. Key sonographic findings include the absence of lung sliding, the stratosphere or barcode sign, the absence of B lines (vertical hyperechoic artifacts that originate from the pleural line and extend into the lung parenchyma, to the bottom of the screen without fading), and the lack of lung pulse sign (23).

3.2.3 Massive pulmonary embolism

Pulmonary embolism accounts for 2% to 5% of cardiac arrests as a reversible cause (24). Ultrasound is a valuable diagnostic tool, especially for identifying secondary signs related to this condition. Key sonographic findings include an enlarged right ventricle caused by increased pressure from the obstruction in the pulmonary artery, the D sign (the interventricular septum flattens towards the left ventricle due to right ventricular pressure), the presence of a thrombus in the right atrium or ventricle and a congested IVC (25). Ultrasound has 92% sensitivity and 64% specificity for detecting pulmonary embolism. However, sonographic signs alone are not definitive for diagnosing a massive pulmonary embolism in the setting of cardiac arrest. It is critical to integrate ultrasound with the patient history and the broader clinical context (4).

3.2.4 Hypovolemia

Hypovolemia is a potentially reversible cause of cardiac arrest, typically resulting from a reduction in intravascular volume, such as hemorrhage. However, relative hypovolemia can also occur in conditions involving severe vasodilation, such as anaphylaxis, sepsis, or spinal cord injury. Blood loss-induced hypovolemia is a major contributor to mortality in traumatic cardiac arrest. Ultrasound findings suggestive of hypovolemia in cardiac arrest include small ventricles and collapsed inferior vena cava (IVC). Depending on the underlying cause of hypovolemia, ultrasound might reveal free fluid in the abdomen or pleural cavities. Additionally, the aorta can be assessed for signs of aneurysm, which might also be the cause of hypovolemia if there is rupture. These findings, when integrated with the clinical presentation, can help identify the source of hypovolemia and guide appropriate interventions during cardiac arrest (21, 26).

3.3. Guiding interventions

Ultrasound plays a crucial role in guiding interventions during cardiac arrest allowing targeted management, such as pericardiocentesis for tamponade or needle decompression for pneumothorax. Emergent pericardiocentesis is a time-sensitive, life-saving procedure. This procedure is most effectively performed under POCUS guidance, as it significantly reduces the complication rate to 0.5%–3.7%, compared to blind or electrocardiography-assisted pericardiocentesis, which carries a complication rate of 15%–20%. Ultrasound enables the physician to select the needle insertion site where the largest visible fluid collection is closest to the skin and, thus, consider entry points beyond the subxiphoid region, such as the parasternal or apical approaches (27). POCUS can also assess the depth of the pleural interface, ensuring that the needle length is adequate to reach the target area. A pilot educational study showed that although the time required for site selection in ultrasound-guided needle thoracostomy was longer than the landmark technique, it resulted in safer and more accurate simulated needle thoracostomy placements, with fewer potential iatrogenic injuries identified (28).

Ultrasound can facilitate the cannulation of vessels, especially in cases where peripheral vascular access is difficult, due to peripheral veins collapse, obesity, or environmental challenges. POCUS guided technique helps ensure proper needle placement, improves success rates, reduces the number of attempts and minimizes delays in medical treatment (29).

Finally, transtracheal ultrasound is an essential instrument for real-time visualization confirming endotracheal intubation. Available evidence indicates that the first-pass success rate for endotracheal intubation is 84% in the ED and 78% in the prehospital setting. Auscultation of bilateral breath sounds is of limited diagnostic value for confirming proper endotracheal tube placement (30). While capnography is considered the gold standard for confirming intubation, its reliability decreases in cardiac arrest situations and can be influenced by factors such as low cardiac output, reduced pulmonary flow, airway obstruction or the use of epinephrine (31). Conversely, POCUS has a sensitivity of 98% and a specificity of 94% in detecting endotracheal tube location in the emergency setting (32).

3.4. Ultrasound as a prognostic tool

POCUS has increasingly been recognized as a prognostic tool for resuscitation outcomes in cardiac arrest patients (Table 1). This imaging modality enables continuous sonographic monitoring of cardiac activity during resuscitation efforts. Cardiac standstill on POCUS, characterized by the absence of cardiac motion, has gained widespread use as a prognostic indicator in cardiac arrest, serving as an alternative to end-tidal CO2 (ETCO2) monitoring, CPR duration, and cardiac rhythm (33, 34).

A study of 223 patients with cardiac arrest showed that those with cardiac activity on ultrasound had better clinical outcomes and were more likely to achieve return of spontaneous circulation (ROSC) compared to those without cardiac activity on POCUS and those that did not receive assessment by POCUS (35). Likewise, a non-randomized, prospective, observational study of 793 cardiac arrest patients with PEA or asystole from 20 hospitals across America found that cardiac activity on initial ultrasound was correlated with greater chance to achieve ROSC and increased survival to hospital discharge (36). A meta-analysis conducted by the SHoC investigators revealed that cardiac activity detected on POCUS has a sensitivity of 60.3%, specificity of 91.5%, a positive likelihood ratio of 6.87 and a negative likelihood ratio of 0.27 for predicting ROSC. Additionally, the presence of cardiac activity on ultrasound was associated with diagnostic odds ratios of 15.9 for ROSC, 9.8 for survival to hospital admission, and 5.7 for survival to hospital discharge (37).

Therefore, ultrasound is a critical tool in guiding the decision to terminate resuscitation, helping to avoid unnecessary interventions and allowing for a more informed, compassionate approach to patient care. However, it should not be used as the sole criterion for termination of resuscitation. The decision to cease resuscitative efforts remains multifactorial, considering clinical judgment, the patient's overall prognosis, the duration of cardiac arrest and the presence of reversible causes that might still be treatable. Ultrasound serves as an adjunct to guide clinicians, but a holistic, patient-centered approach based on current guidelines is essential in making the final decision regarding the termination of resuscitation.

3.5. Limitations of POCUS use in cardiac arrest

While POCUS offers promising benefits for guiding resuscitation, several practical barriers may limit its effectiveness and broader implementation in clinical practice. First, interpreting ultrasound images accurately during the fast-paced and stressful context of cardiac arrest demands both technical skill and clinical experience (38). Second, access to ultrasound equipment might be constrained in some healthcare environments, particularly in prehospital or resource-limited settings. Third, the use of ultrasound has the potential to delay or interrupt chest compressions by extending hands-off time. Since high-quality CPR is vital for patient survival, pauses should ideally be limited to no more than 10 seconds (39, 40). Finally, POCUS carries a risk of false-positive or misleading diagnoses, often due to extracardiac artifacts or operator bias (41). To address these issues, it is crucial to implement structured training programs, adhere to standardized imaging protocols, and interpret ultrasound findings within the broader clinical context alongside other diagnostic information.

4. Conclusions

POCUS has emerged as an essential adjunct in resuscitation efforts of cardiac arrest, offering fast, real-time insights into cardiac activity, the presence of reversible causes and the overall prognosis. In addition, it helps to determine when to terminate resuscitation, providing a more informed and compassionate care. However, this imaging modality must be used judiciously and should complement, and not replace, traditional diagnostic methods and clinical judgment. The studies referenced in this review exhibit heterogeneity in terms of design, patient populations, and settings, and the potential for publication bias should also be considered when interpreting the current evidence base. Further high-quality research, including randomized controlled trials, is warranted to assess the clinical effectiveness of POCUS-guided algorithms in improving outcomes during cardiac arrest.

5. Declarations

5.1. Acknowledgments

None.

5.2. Author contributions

E.S. conceived, designed, and coordinated the study; G.L. and E.S. drafted the manuscript; M.V., C.P., G.T. and M.D performed editing and critical revision of the manuscript; K.A., A.S., K.T. and C.T. provided fundamental guidance and supervised the project. All authors have read and agreed to the published version of the manuscript.

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5.4. Conflict of interest

All authors declare no conflicts of interest

5.5. *Ethical statement*

The article is a literature review not requiring ethical approval.

5.6. *Using artificial intelligence chatbot*

All authors declare that no artificial intelligence tools were used in the writing of this manuscript.

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Table 1: Studies investigating the diagnostic and prognostic role of point of care ultrasonography (POCUS) for cardiac arrest

Study	Year	Patients (n)	Comparator group	Outcomes
Cohen et al.	2020	23 non-traumatic CA patients	Manual pulse check	Higher sensitivity Higher specificity Higher diagnostic accuracy
Schwartz et al.	2021	52 CA patients	Manual pulse check	Shorter pulse check times
Betz et al.	2025	1 patient simulator (244 manual/200 POCUS pulse checks)	Manual pulse check	Shorter pulse check times
Aswin et al.	2023	255 patients with chest trauma	Chest radiography	Higher sensitivity in detecting pneumothorax/hemothorax Comparable specificity in detecting pneumothorax/hemothorax
Dewar et al.	2022	1 patient simulator	Landmark technique	Fewer iatrogenic injuries Higher proportion of correct location selection Longer mean time-to-site-selection
Bolvardi et al.	2016	159 CA patients	No cardiac activity on POCUS	Increased likelihood of ROSC
Atkinson et al.	2019	223 CA patients	No cardiac activity on POCUS or no POCUS exam	Increased likelihood of ROSC Longer resuscitation times Higher rates of intervention (endotracheal intubation/epinephrine)
Gaspari et al.	2016	793 CA patients	NA	Increased survival to hospital admission Increased survival to hospital discharge
Lalande et al.	2019	1,485 CA patients	No cardiac activity on POCUS or no POCUS exam	Increased likelihood of ROSC Increased survival to hospital admission Increased survival to hospital discharge

CA: cardiac arrest; NA: non-available; POCUS: point-of-care ultrasound; ROSC: return of spontaneous circulation.

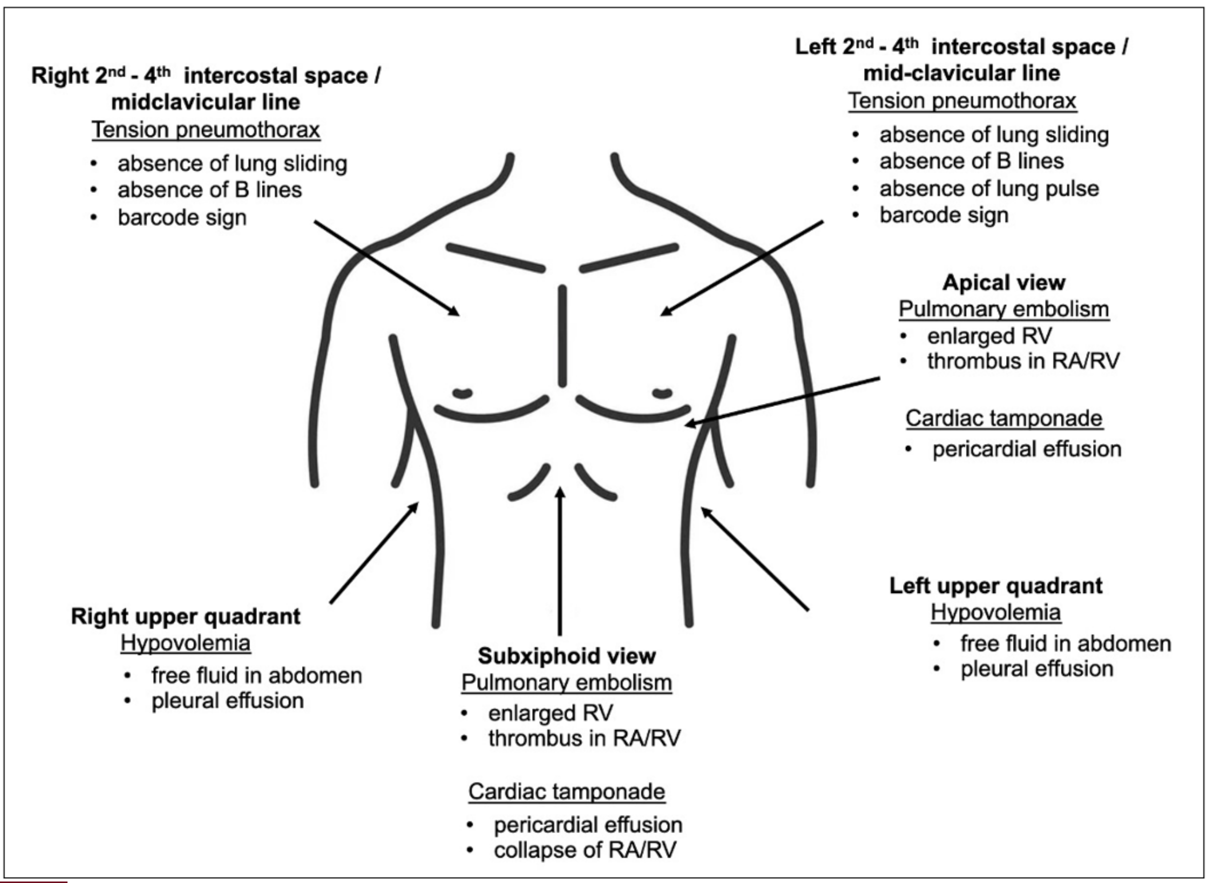

Figure 1: Point of care ultrasonography (POCUS) as a diagnostic tool for detecting the reversible causes in cardiac arrest. RA: right atrium; RV: right ventricle.