Use of Ultrasound in Cardiac Arrest: A Systematic Review of Current Evidence

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Abstract

Introduction: *In recent years, point-of-care ultrasound (POCUS) has been used. Ultrasound has emerged as a highly relevant tool in emergency practice and intensive care medicine. Its use in cardiac arrest situations aims to provide real-time information on the patient's cardiac and thoracic conditions, allowing the identification of reversible causes such as cardiac tamponade, pulmonary embolism, tension pneumothorax, and severe hypovolemia.*

Objective: *To synthesize and critically analyze the current scientific evidence on the use of ultrasound during cardiac arrest, focusing on its diagnostic, prognostic, and therapeutic impacts.*

Methods: *This study constitutes a systematic review, classified as exploratory and descriptive. The research was conducted using bibliographic research in electronic databases on methods associated with SLR (Systematic Literature Review) and the applications of SMARTER (Simple Methods for Continuous and Alternative Methods). Multi-Attribute Rating Technique using (Exploiting Rankings).*

Results: *A comprehensive systematic literature search yielded a total of 4490 articles related to the topic, of which 26 articles were eligible for inclusion in this systematic review.*

Conclusion: *This study demonstrated that the use of ultrasound as an auxiliary tool during cardiopulmonary arrest represents a significant advance in emergency clinical practice.*

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Introduction

Cardiopulmonary arrest (CPA) represents one of the most serious and challenging medical emergencies in both hospital and pre-hospital settings, characterized by the sudden and unexpected interruption of effective blood circulation, leading to the cessation of vital functions [1]. Despite advances in cardiopulmonary resuscitation (CPR) strategies, survival rates remain low, especially outside the hospital setting [2,3]. It is estimated that less than 10% of patients affected by out-of-hospital CPA survive to hospital discharge, reinforcing the need to improve diagnostic accuracy and the efficiency of interventions during initial care [4].

In recent years, point-of-care ultrasound (POCUS) has emerged as a highly relevant tool in emergency practice and intensive care medicine [5]. Its use in cardiac arrest situations aims to provide real-time information on the patient's cardiac and thoracic conditions, allowing the identification of reversible causes such as cardiac tamponade, pulmonary embolism, tension pneumothorax, and severe hypovolemia. The rapid application of ultrasound during CPR pauses allows for greater precision in decision-making, without significantly interfering with chest compressions [6-8].

The use of ultrasound during cardiac arrest is incorporated into advanced life support protocols, such as Advanced Cardiovascular Life Support (ACLS), although controversies still exist regarding the ideal timing of its application and the direct impact on patient survival [9]. POCUS provides visual evidence that helps distinguish between true pulseless electrical activity (PEA) and pseudo-PEA, improving diagnostic accuracy and allowing for targeted interventions [10,11].

Several observational studies and clinical trials have demonstrated that integrating ultrasound into the management of cardiac arrest can alter the therapeutic course in a significant proportion of cases [12-15]. The ability to detect cardiac contractile activity in patients without a palpable pulse, for example, has relevant prognostic implications, as it is associated with higher rates of return of spontaneous circulation (ROSC) and hospital survival [16].

In the clinical setting, ultrasound offers advantages that go beyond identifying reversible causes of cardiac arrest [17]. Its application also allows for optimizing airway management, monitoring the response to resuscitation maneuvers, and assessing associated complications such as pneumothorax or tamponade [12,18]. These multiple possibilities make POCUS a valuable support tool for multidisciplinary teams in emergency and intensive care units.

However, the use of POCUS in CPR still faces methodological and practical challenges. Performing the examination requires adequate training and operator experience, and it is essential to minimize the pause time in chest compressions to avoid compromising coronary flow. Furthermore, variations in imaging protocols hinder the standardization of findings and limit the generalization of results across different studies [19].

The literature also reveals discrepancies regarding the effectiveness of ultrasound in predicting clinical outcomes. While some authors report a strong association between the presence of cardiac contractility and the return of spontaneous circulation, others observe no significant difference in terms of overall mortality [20]. This variability reinforces the need for systematic reviews that gather and critically evaluate the available evidence, in order to guide the rational use of this technology in the context of cardiac arrest.

Therefore, the present study aims to synthesize and critically analyze the current scientific evidence on

the use of ultrasound during cardiac arrest, focusing on its diagnostic, prognostic, and therapeutic impacts. It seeks to identify the benefits, limitations, and clinical implications of this practice in light of contemporary studies, contributing to the improvement of emergency care protocols and the strengthening of evidence-based practices in emergency medicine.

Methods

This study constitutes a systematic review, classified as exploratory and descriptive. The research was conducted using bibliographic research in electronic databases on methods associated with SLR (Systematic Literature Review) and the applications of SMARTER (Simple Methods for Continuous and Alternative Methods). Multi-Attribute Rating Technique using (Exploiting Rankings). The work carried out is of a qualitative-quantitative nature. The qualitative analysis of the data was performed intuitively and inductively during the review of the theoretical framework. It is also quantitative through the use of the multi-criteria method. In addition, there is also a numerical experimental study in order to simulate a situation of article selection based on the observed criteria.

The bibliographic research was conducted in the following databases: Web of Science; Science Direct; Wiley; Springer Link; Taylor and Francis; and PubMed. Additionally, searches were performed using bibliographic references from studies that addressed the topic in a relevant way on the Google Scholar search platform.

The database search was conducted using the terminology registered in the Health Sciences Descriptors created by the Virtual Health Library, developed from Medical Subject. The US National Library of Medicine 's headings allow the use of common terminology in Portuguese, English, and Spanish. This study sought to investigate the literature on the use of ultrasound in cardiac arrest. To this end, the descriptors "Ultrasonography"; "Cardiopulmonary arrest"; "Point-of-care echocardiography (POCUS)"; and "Cardiopulmonary resuscitation" were used, initially in English, and subsequently in Spanish and Portuguese.

As a tool to support decision-making in the selection and prioritization of articles, a set of criteria were considered essential to represent the state of the art of the research topic. This method has the following characteristics: (i) rigorous logic allows the method to be accepted as a decision support tool; (ii) simple to understand and apply with easily interpretable results.

References from selected works were also searched for other documents of potential interest. Once qualified for full text in the evaluation, articles were included in the qualitative review if they met the following inclusion criteria: a) contained data on cardiopulmonary arrest; b) contained data on cardiac arrest; c) contained data on Point-of-care echocardiography (POCUS) and; d) cardiopulmonary resuscitation. Articles were excluded if they were reports, posters, or conference abstracts. There was no review of confidential health information, and the study was not interventional. Therefore, ethics committee approval was not required. In the end, a total of 26 articles were obtained that met the desired characteristics for the study.

Four independent researchers extracted data from articles that met the inclusion criteria and recorded them in a "data extraction form" generated in Microsoft Excel on the Use of Ultrasound in Cardiac Arrest. From this form, the authors and year of publication, study abstract, study type, measured outcome, limitations, and conclusions of the main selected studies were included, as shown in Table 1.

Results

A comprehensive systematic literature search yielded a total of 9464 articles related to the use of ultrasound in cardiac arrest. Of these, 25 studies were excluded due to overlapping data. Based on this, the SMARTER (Simple) method was chosen. Multi-Attribute Rating Technique using Using the Exploiting Rankings methodology, 178 articles suitable for full-text screening were selected. Of these, 134 articles were included for data extraction, and 108 were excluded based on exclusion criteria, leaving 26 eligible articles for inclusion in the systematic review. Figure 1 describes the article selection strategy for this topic.

Figure 1: Article search strategy
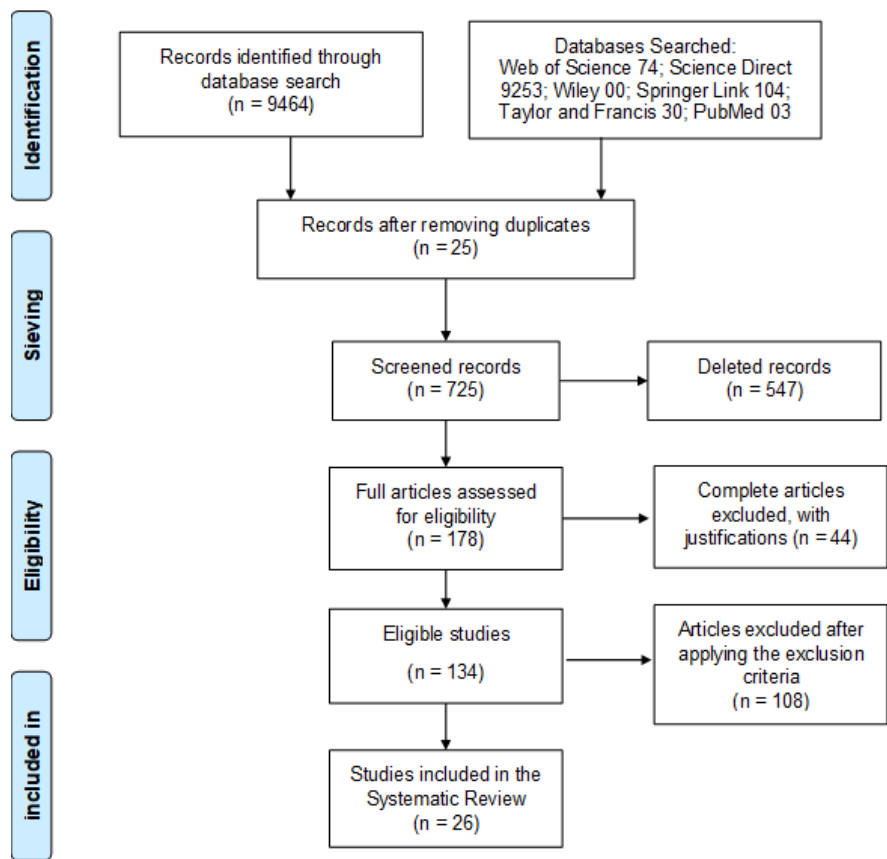
Source: Authors (2025)

Table 1: Main Selected Studies and their findings

Author/ Year	Summary	Type of study	Measured result	Limitations	Conclusions
Alfoti et al. (2024)	This systematic review analyzed the use of point -of - care ultrasound (POCUS) in emergency and intensive care settings, focusing on the role of nursing. The study highlighted how POCUS improves diagnostic accuracy, clinical decision-making, and care efficiency, especially when nurses are properly trained.	Systematic review	The main variable analyzed was the effectiveness of POCUS in clinical practice, including diagnostic time, diagnostic accuracy, and impact on decision-making in critical situations.	Limitations include heterogeneity among the included studies, differences in training protocols, and a lack of methodological standardization.	Training nurses in the use of POCUS (Point-of-Care Uncertainty) increases the quality and efficiency of care in emergency and ICU settings, recommending structured training policies.
Anderson et al. (2021)	This study investigated best practices for the education and training of resuscitation teams in cases of in-hospital cardiac arrest. The objective was to identify strategies that improve team performance and patient survival.	Narrative review and analysis of evidence-based practices	Team performance outcomes, resuscitation success rates, and the impact of educational interventions (simulations, feedback, and team learning) on clinical outcomes were measured.	The limitations relate to the lack of randomized clinical trials and the variability between institutions regarding training programs.	Frequent training, realistic simulations, and continuous feedback significantly improve team performance and in-hospital cardiac arrest outcomes.
Ávila-Reyes et al. (2021)	This narrative review examines the use of point- of - care ultrasound (POCUS) during cardiopulmonary arrest, addressing its application in identifying reversible causes, confirming cardiac activity, and supporting real-time clinical decision-making. The article highlights the role of POCUS in improving management during cardiopulmonary resuscitation.	Narrative review	Outcomes related to the detection of residual cardiac activity, identification of reversible causes of cardiac arrest, and impact on survival and therapeutic decisions were evaluated.	Limitations include a lack of standardization in protocols for the use of POCUS during CPR and heterogeneity in the available studies.	In conclusion, POCUS is a valuable tool for guiding resuscitation, but it requires adequate training and clear protocols to avoid delays in chest compressions.

Source: Authors (2025)

Author/Year	Summary	Type of study	Measured result	Limitations	Conclusions
Chan; Sieg; Singh (2023)	The study describes the use of ultrasound integrated into neonatal resuscitation to distinguish between true aortic resuscitation (APR) and pseudo-APR in infants. It demonstrates how POCUS allows the identification of hidden mechanical cardiac activity. contributing to better decision-making and potential improvement in clinical outcomes.	Study observational and descriptive	The main result The presence of cardiac activity was measured. Detectable mechanical changes via ultrasound in patients initially diagnosed with ASD. Pulse recovery and survival rates were also assessed immediate.	Limitations include small size sampling and lack of long-term data.	The use of ultrasound during Resuscitation in infants is useful for identifying pseudo-PEA, avoiding unnecessary interruptions and allowing for more interventions targeted.
El Kadi et al. (2022)	Comprehensive review on the use of ultrasound with contrast and derivative techniques (sonothrombolysis and sonoperfusion in diseases Cardiovascular. The article explores the diagnostic potential and therapeutic of these techniques, especially at events ischemic strokes and cardiac arrest situations.	Review literature (narrative)	The impact of was assessed. use of contrast ultrasound improved myocardial visualization, reperfusion tissue, and thrombolysis assisted by ultrasound.	Limitations include still having access to clinical data limited and need for larger clinical trials.	It is concluded that ultrasound with contrast and sonothrombolysis shows promising potential for diagnosis and treatment cardiovascular, which may to integrate advanced resuscitation protocols in the future.
Gudivada; Krishna; Narayan (2023)	The article discusses the use of Ultrasound as an essential tool in emergencies cardiopulmonary, Highlighting its role in the rapid diagnosis of reversible causes, such as cardiac tamponade Pneumothorax and pulmonary embolism. The study emphasizes the usefulness of point-of-care ultrasound (POCUS) to improve clinical management in critical situations.	Narrative and educational review	The following were evaluated: diagnostic benefits ultrasound in emergencies, diagnostic accuracy and impact on behavior clinic.	Limitations include absence of standardization between protocols and skill dependency operator.	It concludes that POCUS is a indispensable tool in emergencies cardiopulmonary,promoting quick and safe decisions, and recommends continuous training for healthcare professionals.

Source: Authors (2025)

Author/Year	Summary	Type of study	Measured result	Limitations	Conclusions
Johnson et al. (2025)	The article discusses the foundations and the challenges of clinical research in echocardiography, exploring the Methodological, ethical, and technological requirements of clinical trials using cardiac ultrasound. It also analyzes future opportunities to improve the use of Echocardiography in clinical practice and in multi-center research.	Revision conceptual and methodological	They were analyzed indicators such as Quality of evidence in echocardiographic trials, methodological parameters, and potential innovations technological factors that impact clinical outcomes and scientific.	Limitations related to the scarcity of studies randomized and controlled and to heterogeneity in imaging protocols	It concludes that there is a need for standardization and validation multi-center methods echocardiography, as well as integration with AI and automation to strengthen clinical research.
Lau; See (2022)	A brief review of the main points. POCUS protocols in critically ill patients, covering cardiac applications, pulmonary and abdominal. The The article summarizes the Features essential diagnostics and practical recommendations for efficient use of bedside ultrasound in units of intensive care.	Narrative review (mini-review)	The impact of was Assessed POCUS about time of diagnosis, accuracy diagnostic, and reduction of additional tests in seriously ill patients	Limitations include scarcity of comparative trials and variability in experience of operator.	It concludes that POCUS is a indispensable extension of physical examination in patients Critics, and should be part integrated into the routine of intensive care with structured training and specific protocols.
Magon et al. (2024)	Clinical review addressing the use of point-of-care ultrasound (POCUS) in adults during cardiac arrest, highlighting its applicability in diagnosis. Rapid detection of reversible causes and real-time monitoring. This study discusses the role of POCUS in supporting decision-making during emergency care.	Clinical review narrative	Evaluation of effectiveness and applicability of POCUS in identifying the causes of cardiac arrest (such as buffering, pulmonary thromboembolism and pneumothorax) and in return monitoring of spontaneous circulation (ROSC).	The main limitations include variability in the ability of operators, lack of standardization of protocols and possibilities Delays in chest compressions can occur if the examination is not conducted properly.	It can be concluded that POCUS is a valuable tool, Since which is integrated into Protocols well-structured and With trained professionals.

| Maringelli et al. (2025) | This narrative review explores the role of ultrasound in emergency management, emphasizing its use as a rapid diagnostic tool in critical conditions, including cardiac arrest It highlights the versatility of ultrasound in emergency care and its impact on diagnostic accuracy. | Narrative review | Impact assessment of use of ultrasound in initial management of medical emergencies, with a focus on improving diagnostic accuracy and in reduction of time until therapeutic intervention. | Limitations related to the heterogeneity of studies included and to lack of controlled clinical trials. | The authors conclude that the Ultrasound is essential in emergency environment and must be incorporated routinely, with proper training and Standardization of protocols |

Source: Authors (2025)

Author/ Year	Summary	Type of study	Measured result	Limitations	Conclusions
Paul; Panzer (2021)	This review examines the use of point-of-care ultrasound (POCUS) during cardiac arrest, describing its applications in differentiating rhythms, guiding interventions, and identifying reversible causes. It presents a critical analysis of existing protocols and available evidence.	Narrative systematic review	Evaluating the usefulness of PO-CUS in differentiating between true cardiac activity and pseudo asystole, identifying treatable causes, and predicting prognosis.	Limitations include a scarcity of randomized trials, methodological differences between studies, and a lack of consensus on the ideal duration of use during CPR.	In conclusion, POCUS improves clinical reasoning and personalized care, but requires rigorous training and integration with resuscitation protocols.
(Wawe-ru-Siika; Plüddemann; Heneghan (2022)	The study addresses training in focused cardiac ultrasound (Focused Cardiac This review of Ultrasound (FoCUS) for non-cardiologist professionals discusses its applicability, the content of teaching programs, and its impact on clinical practice. It highlights how structured training enables rapid diagnoses in emergency and intensive care settings.	Narrative review (educational and clinical)	Evaluating the effectiveness of FoCUS training among non-cardiology specialist physicians, measuring diagnostic accuracy and decision-making ability after training.	Limitations include heterogeneity of training programs, variation in training time, and lack of international standardization.	In conclusion, FoCUS is highly beneficial when there is systematic training and adequate supervision, being a safe and efficient tool for initial cardiac assessment in critical settings.
Westersund (2024)	This study analyzes the use of point-of-care ultrasound (POCUS) in the pre-hospital setting during cardiac arrest, exploring how the tool can assist in clinical decisions and increase diagnostic accuracy before arrival at the hospital. The author discusses usage protocols and integration with resuscitation algorithms.	Narrative review and analysis of emergency clinical protocols	Evaluation of the impact of POCUS on the detection of reversible causes of cardiac arrest in the pre-hospital setting and on improving decision-making by emergency teams.	Limitations include a scarcity of controlled studies and logistical challenges (portable equipment, available time, and staff training).	It can be concluded that POCUS has significant potential to optimize pre-hospital care, provided it is applied by trained professionals and integrated with advanced life support protocols.

Source: Authors (2025)

Discussion

The use of ultrasound in cardiopulmonary arrest (CPA) has gained prominence in recent years as a diagnostic tool and to support decision-making during cardiopulmonary resuscitation [27]. Point-of-care ultrasound (POCUS) allows for the immediate assessment of cardiac and thoracic structures, providing real-time information on the patient's hemodynamic status [7,19]. Recent studies have demonstrated that the application of POCUS in CPA situations contributes to the detection of potentially reversible causes, classified as " Hs and Ts," which are fundamental to the success of resuscitation [12-15].

Several studies indicate that ultrasound is capable of identifying critical conditions such as cardiac tamponade, tension pneumothorax, massive pulmonary embolism, and severe hypovolemia [12,23-25]. When diagnosed quickly, these pathologies can be treated immediately, increasing the chances of return of spontaneous circulation (ROSC) [22]. Therefore, POCUS becomes an important tool in the management of patients in cardiac arrest, especially in emergency and intensive care settings.

In addition to diagnosing reversible causes, ultrasound has proven useful in differentiating between true pulseless electrical activity (PEA) and pseudo-PEA rhythms. Identifying residual cardiac motion can help in deciding whether to continue or discontinue resuscitation maneuvers, avoiding both premature cessation and unnecessary maintenance of chest compressions in cases without contractility. This ability to directly assess cardiac function gives the method a strategic role in individualizing patient care in cardiac arrest [10].

The reviewed literature, however, highlights the importance of adequate training for professionals who use ultrasound during cardiac arrest [12]. Diagnostic accuracy and image interpretation depend on the operator's experience and mastery of appropriate echocardiographic windows [26]. Emergency ultrasound training programs have been recommended as an essential part of resuscitation team training, in order to ensure that the examination is performed quickly, effectively, and without compromising the continuity of resuscitation maneuvers [21].

Another widely discussed point is the additional time that the use of ultrasound can introduce during cardiac arrest care. Although the examination provides valuable information, its inappropriate use can lead to prolonged pauses in chest compressions, reducing cerebral and coronary perfusion. For this reason, international guidelines, such as those of the American Heart Association (AHA), recommend that ultrasound be performed exclusively during the pauses already planned for checking the heart rhythm, limiting itself to periods of less than 10 seconds [7,12,24].

The results of this review corroborate previous findings that ultrasound, when integrated into the advanced life support protocol, increases diagnostic efficiency and guides critical therapeutic decisions. Although studies vary in methodology, there is consensus on the benefit of incorporating POCUS into emergency practice. However, there are gaps regarding the standardization of protocols, interpretation criteria, and a direct correlation between the use of ultrasound and long-term survival rates.

It is important to emphasize that most of the studies included in this review have limitations, such as small sample sizes, lack of randomization, and differences in operator experience. These variables can impact the results and restrict the generalizability of the findings. Therefore, there is a need for multicenter research with robust designs and homogeneous methodologies that allow for a more precise evaluation of the impact of ultrasound on the clinical outcomes of cardiac arrest.

The discussion highlights that ultrasound plays a growing and promising role in the management of cardiopulmonary arrest. Its use allows for rapid and accurate diagnoses, improves decision-making, and contributes to more targeted interventions. However, for its application to be effective, continuous training of emergency teams, standardization of usage protocols, and further studies confirming its efficacy and safety are essential. In this way, POCUS (Point-of-Care Ultrasound) is consolidated as an indispensable tool in modern emergency medicine and in optimizing care during cardiopulmonary resuscitation.

Final Considerations

This study demonstrated that the use of ultrasound as an auxiliary tool during cardiopulmonary arrest represents an important advance in emergency clinical practice.

Point-of-care ultrasound (POCUS) allows for the rapid identification of reversible causes, such as cardiac tamponade, tension pneumothorax, and pulmonary embolism, in addition to enabling the evaluation of myocardial contractility and the effectiveness of resuscitation maneuvers.

The studies analyzed demonstrate that the use of ultrasound during cardiopulmonary resuscitation contributes to more assertive clinical decisions, reduces the time to intervention, and can positively influence survival outcomes. However, methodological heterogeneity is observed among the research, and there is a need for standardization in the protocols for use and training of professionals.

Therefore, it can be concluded that ultrasound is a promising and highly relevant tool in the context of cardiac arrest, and should be systematically incorporated into advanced life support practices. However, further controlled, multicenter clinical studies are recommended to consolidate current evidence and define objective parameters for its application during cardiopulmonary resuscitation.

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