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EFFECTS AND BENEFITS OF IMPLEMENTING POINT-OF-CARE ULTRASOUND IN EMERGENCY SETTINGS: A NARRATIVE REVIEW

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Abstract: This narrative review analyzes the effects and benefits of implementing point-of-care ultrasound (POCUS) in emergency settings, based on recent scientific evidence. The findings indicate that the effectiveness of POCUS is intrinsically linked to professional training, with studies demonstrating that multimodal teaching methods, continuous supervision, and the use of innovative technologies such as artificial intelligence and augmented reality optimize operator learning and performance. In addition, the validation of portable devices and the application of telemedicine are expanding the reach of POCUS to settings beyond in-person hospital care and remote areas, increasing access to diagnosis. Clinically, POCUS demonstrates high value in optimizing triage and guiding management in specific contexts, such as orthopedic injuries and cardiopulmonary arrest. However, its usefulness varies in conditions such as chest pain investigation and has been shown to add no value in non-targeted approaches, such as acute abdominal pain. It is concluded that the benefits of POCUS in emergencies are maximized when the tool is applied judiciously to respond to specific clinical issues, supported by robust and continuous training, rather than being used as an indiscriminate screening method.

Keywords: Point-of-Care Ultrasound; Emergency; Decision; Assessment.

INTRODUCTION

The emergency environment is characterized by high pressure and the need for quick and accurate decisions, often made in uncertain scenarios with limited clinical information. Historically, medical practice in these units has relied on medical history, physical examination, and conventional imaging tests, such as X-rays and CT scans, which often involve patient transport and delays in diagnosis.

Olszynski et al. (2023) highlight the approach of point-of-care ultrasound (POCUS), *which transcends the concept of a simple portable device to become an extension of the physical examination, aiming to speed up differential diagnoses and guide invasive procedures with greater safety.Care Ultrasound*), which transcends the concept of a simple portable device to establish itself as an extension of the physical examination, aiming to speed up differential diagnoses, guide invasive procedures with greater safety, reduce exposure to ionizing radiation, and potentially optimize patient flow and hospital costs.

Despite its growing enthusiasm and adoption in emergency departments around the world, the transition of POCUS from a promising technology to a standard of care that consistently improves patient outcomes is complex. For Haak et al. (2025), its effectiveness is inherently dependent on the skill of the user, raising crucial questions about standardizing training, assessing competencies, and maintaining quality. Furthermore, it is essential to accurately delineate its role, as while its application in certain clinical settings offers unequivocal benefits, in others, its value is still debated, creating the risk of overuse or misinterpretation that does not contribute to patient care.

The objective of this study is to synthesize recent scientific evidence on the effects and benefits of implementing POCUS in emergency settings. To this end, advances in professional training and related technologies, such as artificial intelligence and augmented reality, were evaluated, as well as their diagnostic and therapeutic impact on conditions prevalent in emergency settings, and their limitations and controversies, in order to offer a balanced and up-to- y view on how and when this powerful tool can be safely and effectively integrated to truly enhance critical patient care.

METHODOLOGY

To synthesize knowledge on the topic, an integrative literature review with a qualitative approach was conducted. The bibliographic search was performed on the PubMed and BVS platforms, using the combination of the terms “pocus” AND “emergency.” The selection of studies was guided by predefined criteria, including open access publications dated between 2020 and 2025 and available in English, Portuguese, or Spanish. After removing duplicates, the articles were analyzed for relevance, and those that did not meet the central objective of the study were excluded. The initial survey returned 139 publications, 46 from PubMed and 93 from the VHL.

RESULTS AND DISCUSSION

The initial search of the databases identified a total of 139 publications. After rigorous screening based on eligibility criteria, 10 articles were selected to compose the final sample, nine from PubMed and one from the VHL. Details of this selection process are presented in the flowchart in Figure 1.

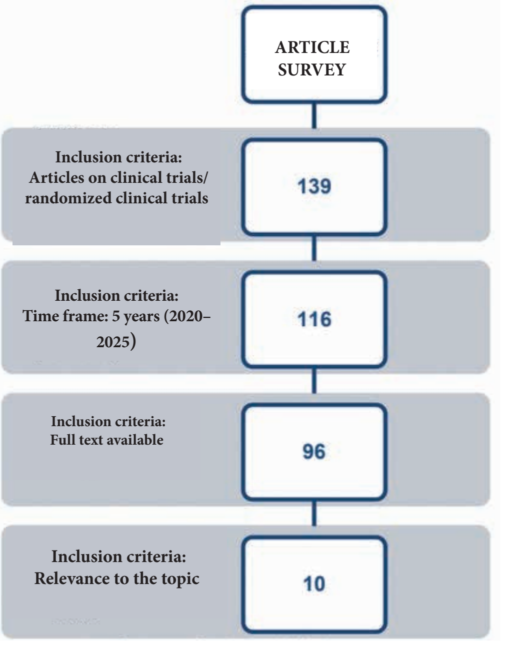

Figure **1.** Flowchart of identification and selection of articles

Source: Authors (2025)

The analysis of recent studies on POCUS reveals a multifaceted field of investigation, focused both on optimizing the approach and validating its clinical effectiveness in diverse settings. The research addresses the integration of innovative technologies, such as artificial intelligence and augmented reality, to improve the teaching-learning process and reduce the cognitive load of operators. Simultaneously, the applicability of POCUS is rigorously tested, exploring its role as a screening tool, its impact on diagnostic accuracy in different clinical contexts, and its feasibility in portable or remote-supported formats. The following results illustrate these trends, highlighting the advances, challenges, and transformative potential of POCUS in contemporary medical practice.

Table 1 below presents case studies and randomized studies.

Based on recent findings, point-of-care ultrasound is establishing itself as an increasingly integrated and multifaceted diagnostic tool. Its effective implementation depends on robust professional training, which benefits from the fusion of various teaching techniques and the aid of technologies such as artificial intelligence and augmented reality to simplify learning and reduce cognitive load. The evolution of equipment, with the validation of portable devices and the use of telemedicine, is expanding the reach of POCUS to out-of-hospital emergency settings and remote areas. Although it has proven to be a valuable and safe resource in the screening of specific conditions. In contexts such as unspecified abdominal pain or the investigation of chest pain, its diagnostic performance can be variable, emphasizing that the value of the tool lies in its judicious application and continuous supervision to ensure proper applicability.

Liu et al. (2025) evaluated the effectiveness of a diversified teaching approach to train emergency residents in the use of point-of-care ultrasound (POCUS) in cases of shock. When comparing a group that received this new multimodal method with another that followed traditional teaching, the results showed that participants in the new training performed significantly better in both theoretical and practical assessments.

Karni et al. (2025) explored an artificial intelligence (AI) tool that provides real-time guidance to simplify training for beginners in cardiac ultrasound. The study compared a group that received training with an instructor and AI feedback with a control group that received only instructor guidance. The results indicated that the AI-assisted group performed significantly better in acquiring more complex cardiac images.

Haak et al. (2025) evaluated the accuracy of point-of-care ultrasound for diagnosing clavicle fractures when performed by emergency physicians. The study, conducted in eight emergency departments, compared the results of POCUS performed by trained physicians with those of X-rays, the reference method. The results demonstrated that ultrasound is a highly accurate tool, with 93% sensitivity and specificity for identifying fractures, as well as good agreement in the assessment of bone displacement.

Based on the results analyzed by Leidi et al. (2024), when a mentoring program was introduced, the considerations were extremely effective in the following aspects: the supervised participants performed a much higher number of exams and, after six months, demonstrated significantly greater proficiency, especially in cardiac ultrasound, which requires more skill.

Liao et al. (2024) compared augmented reality (AR) technology as a means of improving the training of physicians in ultrasound-guided procedures, specifically in the insertion of central venous catheters. The traditional method, which requires looking at a separate

Author	Year	Type of study	Main conclusions
Liu et al.	2025	Clinical trial (n=100)	The integration of multiple teaching techniques, including POCUS in cases of shock, effectively improves learning and the quality of professional training.
Karni et al.	2025	Clinical Trial (n= 44)	The study concluded that the use of artificial intelligence proved beneficial for teaching the most challenging parts of the procedure.
Haak et al.	2025	Clinical Trial (n= 167)	PoCUS is a useful and safe adjunctive tool in the triage of patients with clavicle injuries, helping to optimize the decision on who really needs further testing.
Leidi et al.	2024	Randomized Clinical Trial (n= 23)	Structured and continuous supervision is essential to ensure that residents not only use POCUS frequently, but also maintain and improve their skills over the long term.
Liao et al.	2024	Clinical Trial (n=47)	Augmented reality (AR) technology technology significantly reduced participants' cognitive load, effort, and frustration, with particularly notable benefits for younger physicians and women.
Gibbons et al.	2024	Randomized Clinical Trial (n= 98)	The study concluded that the accuracy of a portable ultrasound device is comparable to that of a standard cart-based model, supporting its use in clinical practice.
Zarama et al.	2024	Randomized Clinical Trial (n= 5043)	although cardiac ultrasound may be a useful tool in the investigation of chest pain, its diagnostic performance varies considerably and should be evaluated within the specific clinical context.
Brau et al.	2024	Randomized Clinical Trial (n=256)	The systematic application of POCUS in selected non y patients with abdominal pain does not improve diagnostic accuracy.
Elmi et al.	2024	Case Series (n=25)	The method is effective and has great potential to increase diagnostic capacity, especially for populations in rural or remote areas with limited access to health services.
Hafner et al.	2024	Randomized Clinical Trial (n=42)	Ultrasound with tele-support proved to be a viable and safe tool for the out-of-hospital emergency setting.

Table 1. Characterization of articles by year of publication, type of study, and main conclusions Source: Authors (2025)

screen, was compared with the use of an AR viewer that projects the ultrasound image directly into the professional's field of view. The results showed that AR improved performance, making trainees faster in crucial steps and reducing neck strain.

Gibbons et al. (2024) compared the diagnostic accuracy of new portable ultrasound devices with traditional, larger, cart-based models. To do this, a randomized clinical trial was conducted in which adult patients were examined with one of the two types of devices. The results showed that the diagnostic accuracy of the portable device was very similar to that of conventional equipment, with the portable device even demonstrating superior sensitivity.

Zarama et al. (2024) considered cardiac ultrasound to diagnose myocardial ischemia in patients with chest pain in the emergency room. By synthesizing 29 studies, the research found an overall sensitivity of 79.3% and a specificity of 87.3%. The analysis also demonstrated that the accuracy of the exam is significantly influenced by factors such as the timing of the exam and the patient's cardiac history.

Brau et al. (2024) investigated whether routine use of point-of-care ultrasound (POCUS) improves the accuracy of initial diagnosis in patients with acute abdominal pain in the emergency department. Through a randomized clinical trial, a group undergoing POCUS was compared with a control group that received only standard care. Contrary to expectations, the results showed no advantage in the use of POCUS: the rate of correct diagnoses was similar between the groups, and there was no difference in length of hospital stay or number of additional tests requested.

Elmi et al. (2024) analyzed the feasibility of lay patients performing lung ultrasounds on themselves at home using a portable device with remote guidance from a physician via telemedicine. The results demonstrated a high success rate, with 96% of the images obtained being considered of adequate quality for interpretation by specialists. In addition, all participants reported a positive experience, highlighting the ease of the procedure and the potential to expand access to medical care.

Hafner et al. (2024) considered the safety and feasibility of using ultrasound with remote support from a specialist during cardiac arrest care in a prehospital setting. The research demonstrated that the technique is safe, as the examination was performed during scheduled breaks to check heart rhythm, without increasing the time of interruption of chest compressions. In addition to being safe, the method proved to be clinically useful, as in 25% of cases, the ultrasound findings changed the diagnosis of the cause of the arrest and, consequently, the treatment strategy.

There is a strong consensus on the need to improve training. Studies such as those by Liu et al. (2025) and Leidi et al. (2024) highlight the superiority of multimodal teaching methods and mentoring programs to ensure learning and skill retention. Karni et al. (2025) and Liao et al. (2024) demonstrate how cutting-edge technologies, such as artificial intelligence and augmented reality, can accelerate proficiency and reduce cognitive load during training. The feasibility of this expansion is reinforced by the validation of the accuracy of portable devices (Gibbons et al., 2024) and their innovative application in telemedicine, enabling remote support in cardiac arrests (Hafner et al., 2024) and even patient-guided self-exams (Elmi et al., 2024).

Regarding clinical effects and benefits, evidence points to a significant impact, but one that is conditional on correct application. Research such as that by Haak et al. (2025) and Hafner et al. (2024) confirms the high accuracy of POCUS for specific diagnoses, such as clavicle fractures, and its ability to alter therapeutic approaches in critical situations, such as cardiopulmonary arrest. However, its usefulness is not universal. Zarama et al. (2024) show that accuracy for myocardial ischemia is variable, while the study by Brau et al. (2024) serves as a fundamental counterpoint, finding no benefits in the routine and untargeted use of POCUS for acute abdominal pain. Together, the findings suggest that the value of POCUS is maximized when used as a targeted diagnostic tool to answer specific clinical questions, rather than as an indiscriminate screening approach, reinforcing that the benefits are intrinsically linked to clinical indication and operator competence.

FINAL CONSIDERATIONS

The combined analysis of the studies consolidates point-of-care ultrasound as a fundamental and transformative tool in emergency medicine, whose effectiveness depends directly on the synergy between user training, technological innovation, and judicious clinical application. Evidence shows that its successful implementation requires investment in ongoing training, enhanced by new technologies such as artificial intelligence and augmented reality, which accelerate proficiency and reduce cognitive load. Clinically, POCUS demonstrates its greatest value when used to answer objective questions, exhibiting high accuracy in specific diagnoses and altering conduct in critical scenarios, but its indiscriminate use for general complaints proves less advantageous. Therefore, the future of POCUS in emergency care is more focused on refining approach methodologies and establishing protocols that guide its rational use, ensuring that its potential to improve patient outcomes is consistently achieved.

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