REVIEW ARTICLE

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Point-of-Care Ultrasound (POCUS) – An innovative diagnostic tool in emergency and prehospital medicine

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Abstract
Introduction and Objective. Point-of-Care Ultrasound (POCUS) is a diagnostic technique that allows the rapid assessment of patients in prehospital settings. The main advantage is that it can be used in locations without standard ultrasound devices, such as ambulances, medical rescue helicopters, or accident sites. The aim of the review is to summarize the current evidence on the role and benefits of POCUS in prehospital and emergency medicine.
Review Methods. A narrative literature review was conducted using the PubMed database with the key words 'POCUS', 'ultrasound' and 'prehospital'. A total of 64 articles (January – March 2024) were identified, of which 26 met the inclusion criteria.
Brief description of the state of knowledge. When used correctly, POCUS reduces the time to surgical intervention, aids in selecting the most appropriate healthcare facility, and improves triage efficiency. Its short examination time helps reduce complications and mortality rates, which is especially important for trauma patients. Studies show that POCUS reduces hospital costs, primarily by decreasing the length of patient hospitalization. It demonstrates high sensitivity and specificity for diagnosing conditions such as pulmonary and cardiovascular abnormalities, as well as deep vein thrombosis. This makes it a valuable tool in time-sensitive situations with limited access to advanced diagnostics. POCUS has recently gained attention for its utility in out-of-hospital cardiac arrest (OHCA). When performed properly, it does not disrupt cardiopulmonary resuscitation (CPR) and can even enhance the resuscitation effectiveness.
Summary. POCUS is a rapid, cost-effective, and efficient tool that benefits patients, healthcare institutions, and the broader healthcare system.

Key words
emergency medicine, prehospital care, point-of-care ultrasound (POCUS), healthcare cost reduction, ultrasound protocols, prehospital ultrasound (PHUS)

INTRODUCTION AND OBJECTIVE

Point-of-Care Ultrasound (POCUS) constitutes an innovative diagnostic tool enabling ultrasonographic assessment in prehospital settings, such as emergency medical services (EMS), air medical services, and accident sites, where access to advanced imaging technologies is limited [1]. POCUS encompasses a variety of standardized diagnostic protocols designed to reduce examination time while optimizing diagnostic precision. These protocols typically target the pleural and abdominal cavities, pericardial sac, and pelvis, and additionally enables rapid detection of key findings, such as fluid in Morrison's pouch (Fig. 1), perisplenic fluid (Fig. 2), and fluid in the pouch of Douglas (Fig. 3). Research by Kowalczyk et al. indicates that combining multiple protocols

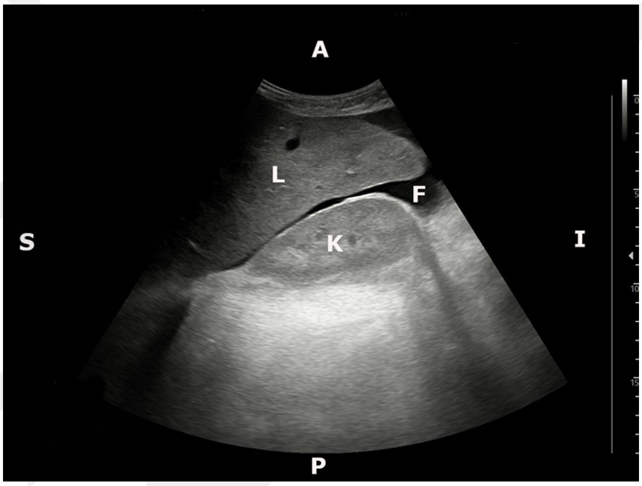

Figure 1. Fluid in Morrison pouch. Sagittal view in the right upper quadrant. L – liver, F – fluid in peritoneal cavity, K – right kidney. Directions: A – anterior, P – posterior, S – superior, I – inferior.

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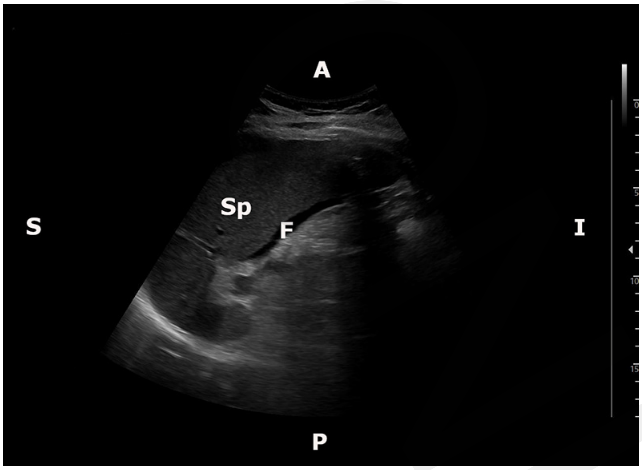

Figure 2. Perisplenic fluid. Oblique parasagittal view in the left upper quadrant. Sp – Spleen, F – fluid in peritoneal cavity. Directions: A – anterior, P – posterior, S – superior, I – inferior

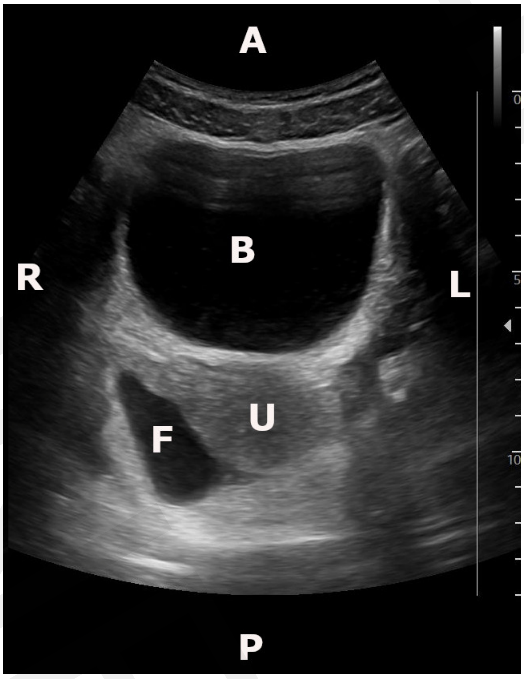

Figure 3. Fluid in the pouch of Douglas. Transverse view in mid-lower abdomen. B – urinary bladder, U – uterus, F – fluid in peritoneal cavity. Directions: A – anterior, P – posterior, R – right, L – left.

improves diagnostic accuracy compared to using a single protocol [2]. In high-pressure prehospital environments decisions must be made quickly under unpredictable circumstances. POCUS, with its portability and versatility, can guide critical decisions, including whether a patient needs transport to a specialized facility or an alternative therapeutic approach. Early use of POCUS improves triage efficiency, accelerates the identification of critical conditions, and optimizes resource allocation. In high-acuity, rapidly evolving prehospital settings, it contributes to the improvement of patient outcomes, the streamlining of patient management, and the reduction of healthcare system costs.

POCUS is also a key innovation for reducing disparities in access to diagnostic services between urban and rural areas. It ensures equitable access for all individuals, allowing people in remote regions to receive care of comparable quality and accuracy.

The objective of this study is to analyze the selected literature in order to identify the benefits, summarize the applications of POCUS in prehospital settings, and evaluate its overall utility.

REVIEW METHODS

A narrative literature review was conducted using the PubMed database with the key words: ‘POCUS’, ‘ultrasound’, ‘prehospital’. A total of 64 articles published between January – March 2024 were identified. Articles were screened based on their titles and abstracts, resulting in the exclusion of 48 studies for the following reasons: review papers, case reports, paediatric population, or articles not written in English. Sixteen articles were selected for full-text review. An additional 10 studies were included, based on citations of the assessed articles, to broaden the scope of the analysis. A total of 26 articles were included in the final analysis (Fig. 4).

Description of the State of Knowledge.

A comprehensive analysis was conducted of 26 articles that addressed the beneficial aspects of Point-of-Care Ultrasound (POCUS), and identified the most frequently cited benefits reported across these studies (Tab. 1, Fig. 5).

Reduction in time to surgical intervention. The primary benefit of Point-of-Care Ultrasound (POCUS) consistently highlighted in the literature is its ability to substantially reduce the time to surgical intervention [3]. Rapid ultrasound assessment enhances triage efficiency, and accelerates subsequent medical management [4]. POCUS can be performed in under 60 seconds, a critical advantage for patients with life-threatening conditions [5]. In the case of an accurate preliminary diagnosis being made in the prehospital setting, the trauma team receives vital information before the patient arrives. This enables direct transport to a prepared operating theatre, or, if necessary, to the most appropriate facility, such as a specialized trauma centre or Haemodynamics Unit [6]. This is particularly important for patients located far from hospitals or in rural areas with limited specialized care. The concept of the ‘golden hour’

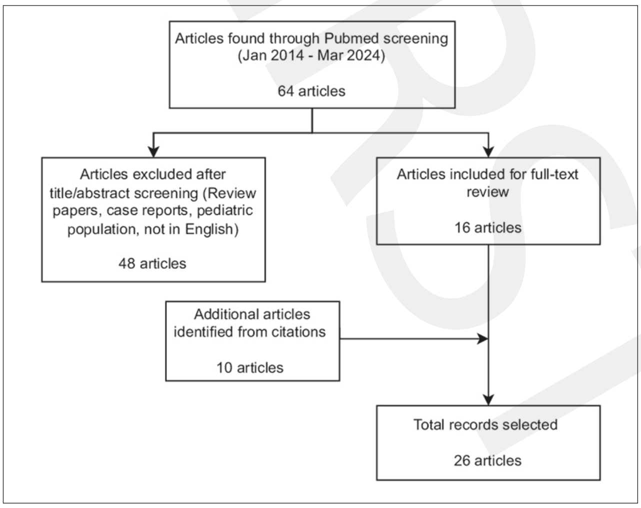

Figure 4. Flow diagram of article selection for the review.

Table 1. Benefits of the application of Point-of-Care Ultrasound (POCUS) in medical diagnostics

What are the benefits associated with the use of POCUS?	Evidence in the literature
Diagnosis modification	1. Live stream of prehospital Point-of-Care Ultrasound during cardiopulmonary resuscitation - A feasibility trial [14] 2. Point-of-care Ultrasound in cardiopulmonary resuscitation: a concise review [19] 3. Feasibility of Out-of-Hospital Cardiac Arrest Ultrasound by EMS Physicians [21] 4. Impact of Point-of-Care Ultrasound on Prehospital Decision-Making by HEMS Physicians in Critically Ill and Injured Patients: A Prospective Cohort Study [27]
Modification of prehospital treatment	1. Feasibility of Out-of-Hospital Cardiac Arrest Ultrasound by EMS Physicians [21] 2. Impact of Point-of-Care Ultrasound on Prehospital Decision Making by HEMS Physicians in Critically Ill and Injured Patients: A Prospective Cohort Study [27]
More rapid diagnosis	1. Point of care ultrasound as initial diagnostic tool in acute dyspnea patients in the emergency department of a tertiary care centre: diagnostic accuracy study [13] 2. Prehospital lung ultrasound in acute heart failure: Impact on diagnosis and treatment [17]
Selection of an alternative hospital destination	1. Prehospital Point-of-Care Ultrasound in ruptured abdominal aortic aneurysms-a retrospective cohort study [6] 2. Impact of Point-of-Care Ultrasound on Prehospital Decision Making by HEMS Physicians in Critically Ill and Injured Patients: A Prospective Cohort Study [27]
Reduction in time to surgical intervention	1. Prehospital Point-of-Care Ultrasound in ruptured abdominal aortic aneurysms-a retrospective cohort study [6] 2. Randomized Controlled Clinical Trial of Point-of-Care, Limited Ultrasonography for Trauma in the Emergency Department: The First Sonography Outcomes Assessment Program Trial [7]
Reduction in hospital length of stay	1. Randomized Controlled Clinical Trial of Point-of-Care, Limited Ultrasonography for Trauma in the Emergency Department: The First Sonography Outcomes Assessment Program Trial [7]
Pulse monitoring during cardiac arrest	1. Feasibility of Out-of-Hospital Cardiac Arrest Ultrasound by EMS Physicians [21] 2. Ultrasound use during cardiopulmonary resuscitation is associated with delays in chest compressions [25] 3. Point-of-care ultrasound use in patients with cardiac arrest is associated prolonged cardiopulmonary resuscitation pauses: A prospective cohort study [26]
Visualization and monitoring of heart rhythm during cardiac arrest	1. Point-of-care ultrasound in cardiopulmonary resuscitation: a concise review [19] 2. Feasibility of Out-of-Hospital Cardiac Arrest Ultrasound by EMS Physicians [21]
Reduction of hospital costs	1. Randomized Controlled Clinical Trial of Point-of-Care, Limited Ultrasonography for Trauma in the Emergency Department: The First Sonography Outcomes Assessment Program Trial [7] 2. Point of care prehospital ultrasound in Basic Emergency Services in Portugal [8] 3. Utilization of Point-of-Care Ultrasound as an Imaging Modality in the Emergency Department: A Systematic Review and Meta-Analysis [18]
Diagnosis of the patient without the use of radiation	1. Randomized Controlled Clinical Trial of Point-of-Care, Limited Ultrasonography for Trauma in the Emergency Department: The First Sonography Outcomes Assessment Program Trial [7] 2. Utilization of Point-of-Care Ultrasound as an Imaging Modality in the Emergency Department: A Systematic Review and Meta-Analysis [18]
Diagnosis of specific conditions	1. Prehospital point-of-care emergency ultrasound: a cohort study [22] 2. The POCUS Consult: How Point-of-Care Ultrasound Helps Guide Medical Decision Making [23]

underlines the importance of rapid intervention: delays of more than one hour after injury significantly increase the risk of complications and mortality. In the study by Melniker et al., POCUS use in trauma patients helped achieve this target, reducing the mean time from hospital admission to surgery to 55 minutes (median 48 minutes), compared to 92 minutes (median 80 minutes) for patients who did not undergo POCUS. This represents a 40% reduction in median time to operative care. Early intervention facilitated by POCUS helps reduce complications and mortality, as shown by multiple studies [7].

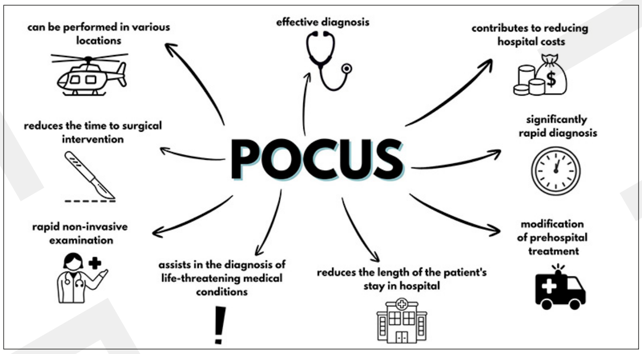

Figure 5. Benefits of using Point-of-Care Ultrasound (POCUS) during patient examination in prehospital settings

Cost savings and cost effectiveness of Point-of-Care Ultrasound (POCUS) application. Faster diagnoses reduce the need for additional tests, such as imaging, which in turn reduces hospital costs, which are also decreased due to a shorter length of hospital stay. Studies have shown that patients who underwent Point-of-Care Ultrasound (POCUS) spent fewer days in the hospital, benefitting both the patient and the healthcare system [7]. POCUS also reduces the need for transport to the Emergency Department (ED) by enabling diagnoses in the prehospital setting. Common examples include musculoskeletal disorders, which are typically not life-threatening and can often be managed through outpatient care [8]. Another advantage is the relatively low financial investment to the benefits gained. Research shows that even a few hours of training can prepare healthcare workers to use the tool effectively. High diagnostic agreement has been reported between prehospital and hospital discharge diagnoses, reaching up to 90.91%, depending on the study [9–11]. Importantly, prehospital devices are typically of lower quality than hospital equipment, yet this does not compromise diagnostic accuracy [12]. This review compared the types of devices commonly used in these studies (Tab. 2).

Table 2. Comparison of selected studies assessing the application of Point-of-Care Ultrasound (POCUS) in emergency and prehospital medicine, including

Title	Type of study	Year of publication	Number of patients	Indications for performing an ultrasound examination	Were any inclusion or exclusion criteria used?	Trauma/ non-trauma patients	Medical staff
Unlocking Diagnostic Precision: FATE Protocol Integration with BLUE and eFAST Protocols for Enhanced Pre-Hospital Differential Diagnosis of Pleural Effusion Manifested as Dyspnea in Adults-A Pilot Study [2]	Pilot study	2024	16	Dyspnea	no	non-trauma	Paramedics with certified POCUS and LUS training
Utilization Criteria for Prehospital Ultrasound in a Canadian Critical Care Helicopter Emergency Medical Service: Determining Who Might Benefit [3]	Clinical study	2017	442	Suspicion of free fluid in the abdominal cavity; pneumothorax; need to assess cardiac activity and fluid status	yes[1]	trauma + non- trauma	Physician and non-physician providers in Helicopter Emergency Medical Services (HEMS)
Determining a Need for Point-of-Care Ultrasound in Helicopter Emergency Medical Services Transport [4]	Retrospective chart review	2021	213	Hypotension	yes[2]	trauma + non- trauma	no data
Prehospital point-of-care ultrasound in ruptured abdominal aortic aneurysms- a retrospective cohort study [6]	Retrospective cohort study	2024	124	Ruptured abdominal aortic aneurysm. Ruptured iliac artery aneurysm. Impending aortic rupture	yes[3]	non-trauma	Intensive care physician
Randomized Controlled Clinical Trial of Point-of-Care, Limited Ultrasonography for Trauma in the Emergency Department: The First Sonography Outcomes Assessment Program Trial [7]	Randomized controlled clinical trial	2004	262	Blunt and penetrating trauma	yes[4]	trauma	Emergency medicine physicians, Trauma surgeons, Trauma surgery residents
Point of care prehospital ultrasound in Basic Emergency Services in Portugal [8]	Cross-sectional observational study	2022	972	no data	no	no data	Radiologist
Aeromedical Ultrasound: The Evaluation of Point-of-care Ultrasound During Helicopter Transport [9]	Prospective, observational study	2017	190	Trauma patients with suspected pneumothorax, hemothorax, or free intraperitoneal fluid	yes[5]	trauma	Advanced practice nurses and paramedics
Ultrasound on the Frontlines: Empowering Paramedics with Lung Ultrasound for Dyspnea Diagnosis in Adults-A Pilot Study [10]	Pilot study	2023	44	Dyspnea	yes[6]	no data	Certified paramedic
The Utilization of Handheld Ultrasound Devices in a Prehospital Setting [11]	Cross-sectional study	2022	169	Indications included physician-determined necessity, most frequently related to respiratory distress (dyspnea) or circulatory instability (shock)	no	no data	Emergency medicine residents
Air Medical Ultrasound: Looking Back to See What We Have Learned for the Future [12]	Prospective, observational study	2022	101	Blunt and penetrating trauma	yes[7]	trauma	Helicopter Emergency Medical Service (HEMS) Crew
Point of care ultrasound as initial diagnostic tool in acute dyspnea patients in the emergency department of a tertiary care center: diagnostic accuracy study [13]	Diagnostic accuracy study	2022	237	Dyspnea	yes[8]	non-trauma	Emergency medicine residents

study characteristics, clinical indications, and diagnostic accuracy parameters, with particular emphasis on predictive value

Impact of the ultrasound on patient management	Type of device	Sensitivity	Specificity	Predictive value
Targeted diagnosis, precise and safe treatment, enhanced quality of care	Philips Lumify ultrasound, device, Philips Ultrasound LLC, Bothell, DC, USA, 2021	1.0	0.6	0.85 (positive)
A significant difference in time to surgical intervention	no data	67.1% medical model 46.4% trauma model	79.0% medical model 95.2% trauma model	no data
Improved triage, which accelerated clinical management	no data	no data	no data	97% hypovolaemic 100% distributive shock
Reduction in time to surgery (142 min vs 232); Acceleration of diagnostic process; Direct admission to a specialized center (80% vs. 56%) Better overall survival (39% vs. 16%)	Sonosite iViz	no data	no data	no data
Patients underwent fewer CT scans, had a 64% shorter time to surgery, spent 27% fewer days in the hospital, and experienced fewer complications. Hospital charges were 35% lower compared to the control group.	no data	no data	no data	no data
Point-of-care intervention avoiding the need for hospital transport	Voluson ultrasound General Electric, from 2009 SN 7905/0845/0023 (convex or linear probe); Toshiba Némio XG ultrasound (convex probe)	no data	no data	no data
Establishing the diagnosis before hospital arrival accelerated treatment	no data	no data	no data	PPV 100% NPV 98.3%
no data	no data	no data	no data	no data (but prehospital diagnosis based on LUS was concordant with the discharge diagnosis in 90.91%, k=0.934, which indicates almost perfect agreement)
no data	Butterfly IQ handheld ultrasound machine	no data	no data	no data (the accuracy of prehospital diagnosis with final diagnosis was – 75.8%
Accurate diagnosis informs the trauma team pre-arrival, enabling direct transport to the operating room.	Butterfly IQ - HEMS Sonosite X-Porte -Trauma Team	no data	no data	HEMS: PPV 100% NPV 96.7% Trauma Team PPV 100% NPV 98%
Decreased diagnostic time	SONOSITE M Turbo	Different due to diseases Pneumonia 85.6% Acute Pulmonary Edema 88.5% Pleural effusion 100% ARDS/ALI 28.5% LV dysfunction 77.7% Acute Coronary Syndrome 50%	Different due to diseases Pneumonia 87.7% Acute Pulmonary Edema 97.7% Pleural effusion 97.7% ARDS/ALI 99.5% LV dysfunction 96.9% Acute Coronary Syndrome 100%	Different due to diseases Pneumonia - NPV 61.4% Acute Pulmonary Oedema - NPV 98% Pleural effusion - PPV 76.1% - NPV 100% ARDS/ALI - PPV 90.9% - NPV 88.9%

Title	Type of study	Year of publication	Number of patients	Indications for performing an ultrasound examination	Were any inclusion or exclusion criteria used?	Trauma/ non-trauma patients	Medical staff
Live stream of prehospital point-of-care ultrasound during cardiopulmonary resuscitation - A feasibility trial [14]	Feasibility trial	2023	42	Out-of-hospital cardiac arrest (OHCA)	yes[9]	no data	Emergency medical technician and a physician. Tele-support from specialist in anaesthesia and intensive care medicine
PrehospitaL Ultrasound in Undifferentiated DyspnEa (PreLUDE): a prospective, clinical, observational study [16]	Prospective observational study	2023	214	Dyspnea	yes[10]	non-trauma	Two-level emergency system: paramedic ambulances and prehospital physician-led teams (anaesthesiologists) in rapid response vehicles or HEMS.
Prehospital lung ultrasound in acute heart failure: Impact on diagnosis and treatment [17]	Prospective, non-randomized interventional study	2023	264	Dyspnea	yes[11]	non-trauma	Paramedics
Feasibility of Out-of-Hospital Cardiac Arrest Ultrasound by EMS Physicians [21]	Prospective observational study	2019	127	Out-of-hospital cardiac arrest (OHCA)	no	no data	Emergency medicine residents
Prehospital point-of-care emergency ultrasound: a cohort study [22]	Cohort study	2018	546	Emergencies, most commonly: dyspnea, cardiac arrest, fall, high-speed trauma.	no	trauma + non- trauma	Rescue physicians
Ultrasound use during cardiopulmonary resuscitation is associated with delays in chest compressions [25]	Prospective cohort study	2017	23	Cardiac arrest	yes[12]	non-trauma	Acute care providers
Point-of-care ultrasound use in patients with cardiac arrest is associated prolonged cardiopulmonary resuscitation pauses: A prospective cohort study [26]	Prospective cohort study	2017	82	Cardiac arrest	yes[13]	non-trauma	Radiologists and radiology residents
Impact of Point-of-Care Ultrasound on Prehospital Decision Making by HEMS Physicians in Critically Ill and Injured Patients: A Prospective Cohort Study [27]	Prospective cohort study	2023	209	Indications included physician-determined necessity	no	trauma + non- trauma	HEMS anaesthesiologist or trauma surgeon

[1] Exclusion criteria included incomplete documentation and ultrasound examinations performed solely to assist with vascular access placement.
[2] Individuals younger than 18 years of age.
[3] Patients were excluded if they met any of the following criteria: age under 18 years; lack of treatment by an intensive care physician in the prehospital setting; history of vascular intervention within the past three months; diagnosis of a thoracoabdominal aortic aneurysm, aortic dissection, or a non-ruptured aortic pathology deemed insufficiently severe to warrant surgical treatment.
[4] Patients or legal representatives who were unable to provide informed consent, as well as those requiring immediate transfer to the operating room.
[5] Patients were excluded if helicopter transport time was less than 5 minutes or if the patient had already been positioned in a specific configuration prior to the intervention.
[6] The sole indications were the presence of dyspnea and the need to obtain informed consent.
[7] Inclusion criteria: age 18 to 99 years. Exclusion criteria: pregnant patients, non-trauma patients (without blunt or penetrating injury), and patients held in correctional facilities.
[8] Inclusion criteria: The chief complaint of acute onset shortness of breath. Age group: greater than 18 years of age. Exclusion criteria: Individuals referred from an outside hospital with a known diagnosis. Dyspnea due to traumatic cause. Pregnant individuals.

Impact of the ultrasound on patient management	Type of device	Sensitivity	Specificity	Predictive value
Modification of diagnosis and management	Tablet Samsung Galaxy S7; Lumify™, Philips Ultrasound, Inc., 22100 Bothell-Everett Hwy, Bothell, WA 98021-8431, USA	no data	no data	no data
Modification of prehospital care and triage	Sonosite iViz	For acute heart failure 65%	For acute heart failure 92%	no data
Decreased time to therapy initiation (21 mins with LUS 169 mins without LUS)	Butterfly IQ (Butterfly Network Inc.)	For acute heart failure 71%	For acute heart failure 96%	no data
no data	SonoSite iViz, FUJIFILM SonoSite, Inc. , Bothell, WA	no data	no data	no data (the accuracy of prehospital diagnosis with final diagnosis was - 91% k=0.82
Modification of the target hospital destination (in 49,5% cases)	Sonosite, MicroMaxx / sector array transducer P17/5–1 MHz	no important data	Specificity for exclusion - intraabdominal fluid 97.1% -pneumothorax 100%	The Prehospital diagnosis was confirmed in 90.8% of cases
Although the pulse check duration was prolonged (21,0s with POCUS vs. 13,0s without POCUS), it was likely of no clinical significance to the patient	no data	no data	no data	<0.0001
POCUS successfully identifies reversible causes of PEA in cardiac arrest	no data	no data	no data	no data
Change of transport destination; Modification of pharmacotherapy or fluid therapy; Initiation or termination of CPR	the SonoSite M-turbo portable ultrasound machine (FIJIFILM; Bothell, Washington USA), the SonoSite Edge II portable ultrasound, machine, and the Butterfly handheld ultrasound probe (Butterfly Network; Burlington, Massachusetts USA)	no data	no data	no data

[9] Exclusion criteria included patients who required immediate transport to the hospital, those for whom resuscitation was not performed, individuals with a BMI over 35, and pregnant women.
[10] Inclusion criteria included: age ≥ 18 years, dyspnea as the main complaint, respiratory rate > 25 breaths per minute and/or oxygen saturation < 95%, and/or the need for oxygen therapy based on clinical assessment. Exclusion criteria included: trauma preceding the onset of dyspnea, previous participation in a study.
[11] Inclusion criteria: patients aged over 18 years with dyspnea as the primary symptom. Exclusion criteria: patients with hypotension (systolic blood pressure < 90 mm Hg), ECG showing ST-elevation, fever >100.4°F, trauma, and pregnancy.
[12] Patients were excluded if they were younger than 18 years of age, did not have documentation of a pulse check, or were not placed in one of three designated resuscitation rooms with continuous video monitoring capability. Patients who were placed in one of those three resuscitation rooms were also excluded if video was not available, or if the image quality was too poor for extraction of data.
[13] The Exclusion criteria included traumatic arrests, patients with ROSC prior to ED arrival, if fewer than two CPR pauses were performed, or if the video of the resuscitation was not recorded.

In summary, low-costing training of healthcare personnel, including paramedics, radiologists, emergency medicine residents, and specialized nurses, is sufficient to ensure high diagnostic performance. When combined with the use of portable devices, this approach can achieve a diagnostic accuracy of 90.91% and facilitate the initiation of appropriate treatment. One study involving the financial savings generated by POCUS estimated that the total savings of €78,070 would cover costs of purchasing and maintaining the necessary equipment over four years. This demonstrates that investing in POCUS equipment can be a cost-effective long-term strategy [8].

POCUS in dyspneic patients. According to Baid et al., dyspnea is one of the most common symptoms prompting patients to present to the Emergency Department (ED). Point-of-Care Ultrasound (POCUS) is most frequently performed in the pulmonary region. Patients with dyspnea present clinicians with a broad range of potential diagnoses, and rapid assessment is crucial due to the urgency of the condition. The use of POCUS significantly reduces diagnostic time compared to patients who do not undergo POCUS (median diagnosis time with POCUS: 16 minutes vs. 170 minutes for complex diagnoses) [13, 14]. Studies also show that lung ultrasonography performed in prehospital settings provides diagnostic accuracy comparable to that achieved in the ED [15]. POCUS demonstrates higher sensitivity than clinical examination alone for such conditions as acute heart failure, COPD (Chronic Obstructive Pulmonary Disease) exacerbations, and asthma [16]. In patients receiving therapy for heart failure, diagnostic time was reduced by over two hours [17]. Among dyspneic patients, POCUS showed 91% sensitivity and 97% specificity. Moreover, its use reduces hospital costs, accelerates delivery of appropriate care, and eliminates radiation exposure due to the nature of the examination [18].

Cardiac arrest. The use of Point-of-Care Ultrasound POCUS enables visualization of heart function, helping differentiate pulseless electrical activity (PEA) from pseudo-PEA. It also allows detection of transitions from PEA to ventricular fibrillation during pulse checks. Studies have shown that 10–35% of patients who appear to have asystole on ECG, actually demonstrate cardiac contractions on ultrasound. POCUS can identify reversible causes of sudden cardiac arrest (SCA), including tension pneumothorax, pulmonary embolism, hypovolaemia, or cardiac tamponade. This enables rapid recognition and timely implementation of treatments such as pericardiocentesis, thrombolysis, needle decompression, or fluid administration. Additionally, POCUS can assess the effectiveness of chest compressions by providing feedback on whether compressions are effectively circulating blood. This information can guide improvements in compression depth, location, and quality. These adjustments contribute to better resuscitation outcomes. For these reasons, POCUS is recommended in Advanced Cardiovascular Life Support (ACLS) guidelines, and is included as a separate step in the algorithm for managing SCA when defibrillation is not possible [14, 19–21]. Furthermore, POCUS can detect pericardial effusion, which may be life-threatening if there is progression to tamponade (Fig. 6).

Unconventional applications of POCUS. Ultrasound examination can also detect less typical conditions that may not be apparent through physical examination alone. Studies have shown high effectiveness in identifying such complaints. POCUS demonstrates high sensitivity for detecting left ventricular contractility disorders (89.4%), right ventricular overload (85.7%), and interstitial lung disease [22]. Another group of patients who benefit from POCUS are those suspected of ocular pathology. Ocular ultrasound can identify retinal detachment, vitreous haemorrhage, and elevated intracranial pressure. Diagnoses made using POCUS were confirmed in 90.8% of cases. POCUS has also proven useful in diagnosing deep vein thrombosis, a common condition among hospitalized patients. Its diagnostic accuracy is high compared to comprehensive ultrasound examinations, which may be unavailable or delayed. As previously mentioned, in life-threatening situations, time is the most critical factor [23].

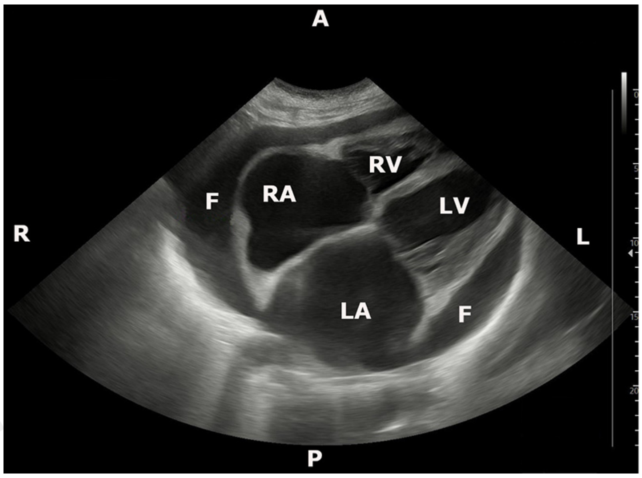

Figure 6. Pericardial fluid. Transverse infrasternal view. RA – right atrium, RV – right ventricle, LA – left atrium, LV – left ventricle, F – fluid in pericardial cavity. Directions: A – anterior, P – posterior, R – right, L – left

The results suggest that the benefits of Point-of-Care Ultrasound are closely associated with the accuracy of the preliminary diagnosis, evidenced by the high concordance between the ultrasound-based diagnosis and the final diagnosis recorded upon hospital discharge. The concordance in the analyzed studies reached as high as 90.91% [2, 10]. This is also indicated by the high positive predictive value (PPV) of 100% and negative predictive value (NPV) of 96.63% [12], and 98.3% [9], as demonstrated by Yates et al. in two distinct studies, with the second study serving as a five-year follow-up evaluation of the results obtained in the first study.

Limitations of performing Point-of-Care Ultrasound (POCUS) during cardiac arrest. In the studies included in this review, the use of Point-of-Care Ultrasound (POCUS) for pulse verification during cardiac arrest has been highlighted. Experienced clinicians have been shown to perform pulse checks within 10 seconds, in accordance with guideline recommendations [21, 24]. However, further research is needed due to the potential for prolonged pauses between compressions when pulse checks are conducted. Studies report that the average time for pulse verification with POCUS ranges from 19.3 [5] – 21 seconds [25], compared to an average of 13 seconds [25] – 14.2 seconds [5], when pulse checks are performed without POCUS. A trend towards shorter pauses has been observed among clinicians with additional experience gained during specialty training [5].

Nevertheless, these average times demonstrate a doubling of the recommended safe 10-second interval. Pulse checks can be effectively performed without POCUS which, in turn, shortens the overall time. This practice may therefore be more beneficial for patients.

Ultrasound as a feasible and suitable diagnostic tool in adverse conditions. The variability and challenges of out-of-hospital settings can complicate prehospital care. The confined space of a helicopter of the Helicopter Emergency Medical Service (HEMS) or an ambulance en route to the hospital, may initially appear to complicate the performance of ultrasound examinations. However, studies on Point-of-Care Ultrasound POCUS indicate that such conditions do not present a significant barrier to conducting these procedures. This is evidenced by the high diagnostic accuracy reported in these studies. For example, Kowalczyk et al. reported a kappa coefficient exceeding 0.8, demonstrating the substantial reliability of Lung Ultrasound (LUS) in prehospital settings. These findings suggest that, despite environmental challenges, ultrasound remains highly effective, and environmental constraints are not a significant obstacle [10].

Role of healthcare professionals in undertaking Point-of-Care Ultrasound (POCUS) in pre-hospital settings. The performance of ultrasound examinations by medically trained personnel who are not physicians is also important. In emergency medical services, whether in ambulances or air ambulance helicopters, the presence of a physician – specifically an emergency medicine specialist – varies by country. Therefore, it is important to evaluate whether paramedics should be performing these examinations. In the studies analyzed in this review, POCUS was performed by intensive care physicians, emergency medicine residents, experienced paramedics, and specialized nurses (Tab. 2). No significant difference was observed in diagnostic concordance between the initial assessments made by paramedics and those made by physicians, when each was compared to the hospital discharge diagnosis. Moreover, the reviewed studies did not highlight the need for specialized courses to perform POCUS effectively.

What's new. Nowadays, the topic of Point-of-Care Ultrasound POCUS credentialing for non-physician healthcare providers is gaining increasing attention. Across Europe, more countries are introducing legal frameworks that allow paramedics and nurses to perform emergency POCUS protocols after completing certified training programmes. Poland is a notable example. In 2024, regulatory changes explicitly permitted paramedics and nurses to conduct emergency ultrasound procedures. This is allowed after completing a certified course recognized by the Centre for Postgraduate Medical Education *(Centrum Medycznego Kształcenia Podyplomowego*). These provisions are established in the Regulation of the Minister of Health of 7 March 2024 (§ 1, item 1, letter c), and the Regulation of the Minister of Health of 2 July 2024 (§ 1 item 1, letter c, item 32) [29, 30]. In the USA, several states have launched pilot programmes in which paramedics undergo structured POCUS training and subsequently perform standardized protocols with high diagnostic accuracy [2].

The growing importance of POCUS ultrasound is reflected in novel applications, such as mass-casualty incident management. In a pilot study by Stucchi et al., medical personnel using POCUS more effectively identified occult injuries during simulated mass-casualty incidents [31].

A 2025 study by Laban et al. focused on recent advances in AI-enabled (Artificial Intelligence) software. The study showed that the software tends to overestimate B-line counts compared to experts, underscoring the need for further evaluation of these tools [32]. This highlights the need for comprehensive clinician training to ensure accurate interpretation and optimal integration of both human expertise and emerging technologies in clinical practice.

Limitations of the study. In certain cases, such as in obese patients, ambulance ultrasound devices may be insufficient, making it difficult to obtain reliable images. Prehospital ultrasonographic images are frequently not stored for later analysis. Challenging conditions and technical limitations can make effective use of the device difficult, and in some situations using the ultrasound may not even be possible. Moreover, the brief duration of prehospital examinations increases the risk of misinterpretation of findings. Achieving sufficient operator proficiency requires ongoing, structured training and practice [22].

The majority of available studies are single-centred. Future research should therefore prioritize multicenre trials with diverse patient populations. Standardized training programmes for paramedics will assist in improving the assessment of the real clinical utility of POCUS [28].

SUMMARY

Point-of-Care Ultrasound (POCUS) is a valuable complement to standard diagnostics. It allows rapid and accurate diagnosis, supports faster treatment decisions, enables early detection of critical conditions, and improves efficiency during cardiopulmonary resuscitation (CPR). By shortening patient hospitalization, reducing unnecessary medical transport, and additional imaging tests, POCUS also reduces healthcare system costs. The low implementation costs of POCUS and the short training period for medical personnel make it an accessible diagnostic tool. Its effectiveness across various medical fields, including the diagnosis of atypical conditions, further supports efficiency.

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