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# Use of Ultrasound in the Prehospital Setting: A Scoping Review

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## Abstract

**Objectives:** With the advent of portable devices, prehospital ultrasound is increasingly available and has the potential to provide clinical and procedural decision support. This scoping review seeks to examine current literature on prehospital ultrasound, including study indications, the level of the health care professionals performing prehospital ultrasound, and reported research outcomes.

**Methods:** We searched PubMed, Embase, Web of Science, CINAHL, and Cochrane databases for research articles and conference abstracts focused on prehospital ultrasound with scans performed in the field. After title/abstract screening by 2 independent reviewers, a full-text review was performed. We excluded reviews, case reports, letters to the editor, and research published in nonEnglish language. Descriptive statistics were reported.

**Results:** We identified 9718 unique articles, and 109 were included after title/abstract review (Kappa 0.68) and full-text analysis. Annual publications increased yearly ($P < .01$). Nineteen countries were represented, with the United States having the highest number of publications (n = 34, 31.2%). Most studies were prospective (n = 74, 67.9%) with few randomized control trials (n = 6, 5.5%). Feasibility studies comprised 45.9% (n = 50) of the included publications, while clinical outcomes were the primary interest in 18 studies (16.5%). Physicians (n = 58, 53.2%) and paramedics (n = 38, 34.9%) were the most studied prehospital clinicians. The most common indication was trauma (n = 49, 45%) followed by dyspnea (n = 13, 11.9%) and cardiac emergencies (n = 10, 9.2%).

**Conclusion:** There is a growing, heterogeneous body of literature describing the use of prehospital ultrasound. Published literature was primarily

*abstract continues*

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**Abstract (continued)**

prospective and described feasibility trials. Identified gaps include a lack of studies in pediatric patients and research identifying clinical outcomes.

Keywords: *ultrasound, POCUS, emergency medical services, prehospital care*

# 1 INTRODUCTION

## 1.1 Background

Point-of-care ultrasound (POCUS) has become routinely used in emergency departments worldwide to improve clinical management and expedite diagnosis. The American College of Emergency Physicians has identified core indications for emergency ultrasound (US) to improve clinical efforts by physicians.[1] These same guidelines have suggested the benefits of US use in the prehospital environment. With increasingly portable US technology and the advent of handheld devices, access and storage for prehospital ultrasound (PHUS) has become increasingly available. The evaluation of PHUS was identified in 2011 as a research priority for prehospital care in Europe.[2]

## 1.2 Importance

PHUS may have the ability to expedite care, provide decision support for procedures, and alter transport destinations.[3–7] Previous reviews have determined the feasibility of PHUS for isolated indications such as trauma,[3–5] dyspnea,[8] and critical care.[9] Although a narrative analysis was recently published that commented on the use and training of PHUS, this study included research in educational and controlled settings.[10] Our study seeks to expand this understanding by evaluating the extent to which PHUS is utilized exclusively in the prehospital setting.

## 1.3 Goals of This Investigation

Previous research has not identified the extent to which research has been conducted in each domain of PHUS and which medical professionals are most studied. The objective of this scoping review was to map the current evidence on PHUS, define the extent of research in each category, and identify future research needs.

# 2 METHODS

## 2.1 Study Design

We performed a systematic search of 5 databases including MEDLINE, Embase, Web of Science, CINAHL, and Cochrane according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews guidelines.[11]

## 2.2 Search Strategy

The search was conducted in December 2022 and was designed to identify articles focused on PHUS. Search terms included “prehospital,” “emergency medical services,” “ultrasound,” “sonography,” and “POCUS.” The search included all articles from the inception of each database to the date of the search. See Supplementary Appendix 1 for full search strategies.

## 2.3 Selection of Studies

After elimination of duplicates, 2 independent reviewers (JW and OT) screened titles and abstracts based on predefined inclusion criteria. We included any published literature up to the search date that focused on the use of PHUS, specifying that a US scan must have been performed and scans were conducted within the prehospital arena. For military studies, we defined the prehospital arena as up to and including Role 1 (military first responders such as medics, corpsmen, etc). No exclusion was placed on study methodology or frameworks. Exclusion criteria included nonEnglish studies and systematic reviews and meta-analyses. We excluded studies that were performed solely within classroom/laboratory environments or within the hospital regardless of whether prehospital clinicians were the focus of the study. Title and abstract screening was performed using the Rayyan AI platform (Rayyan Systems Inc). Disagreements between independent reviewers were arbitrated by a third reviewer (JT) as needed.

After initial title and abstract review, the writing group decided to exclude case reports and letters to the editor based on the understanding that these small and isolated reports may skew the observed trends in our results and are subject to selection bias. Two independent reviewers (JW, OT) then reviewed all full-text publications with the same criteria. Disagreements were resolved through discussion, and reasons for exclusion were documented.

## 2.4 Data Extraction and Synthesis

Included studies were stored in citation manager software Zotero (Version 6.0.31; Corporation for Digital Scholarship), and the 2 reviewers (JW and OT) abstracted data using a standardized Google Sheets spreadsheet (Google). Abstracted data included author name, publication year, study design, country of study, prehospital clinician studied, patient population, emergency medical services (EMS) transport setting, US indication, and study performed. We determined the focus of each study from the purpose and methods identified in full-text analysis and categorized them into feasibility/pilot, sensitivity/specificity evaluation, clinical outcomes, descriptive, telecommunications, and training/education. Studies that used a simulated patient population but remained in a prehospital space were documented as simulation. We defined telecommunications as studies investigating the transmission of images from prehospital location to a hospital. We grouped studies in which the primary outcome sought to identify clinical outcomes regardless of what the clinical outcome was. Studies were then grouped based on US scans being performed in the study. Some descriptive studies and retrospective studies either did not specify the scanning protocol or used multiple different protocols or indications. We documented these studies as "Multiple Indications." Finally, EMS setting was defined based on self-report within the article and categorized as ground-based, helicopter emergency medical services (HEMS), air medical, or other (military, fixed event location, etc). HEMS included systems that utilized helicopters for on-scene deployment and stabilization. Air Medical was defined as those systems utilizing both helicopters and fixed-wing aircraft for deployment and transport.

### 2.5 Data Analysis

Descriptive statistics were calculated including frequencies and percentages for categoric variables. Cohen's Kappa was calculated to assess interrater reliability after title and abstract review. The Mann-Kendall Test was used to determine if there was a significant trend in articles published by year.

## 3 RESULTS

A total of 9718 unique publications were identified. After title and abstract review (Kappa 0.68), a total of 294 studies proceeded to full-text review. After full-text review, 109 studies were included in the final analysis (Fig 1).

The number of published studies included in our final analysis of 109 studies noted a significant increase annually since the inception of the databases, with the largest number of studies published in 2022 (n = 16, 14.7%; $P < .01$). The years 2002, 2005, and 2007 had the fewest number of studies (n = 0 for each) (Fig 2). Nineteen countries were represented in the dataset, with the United States (n = 34, 31.2%), Germany (n = 14, 12.8%), and France (n = 11, 10.1%) comprising over half of all studies.[12] One study by Taylor et al[12] was conducted jointly in Canada and the United States. An additional study did not specify location as it was conducted across military medical care areas of the British Armed Forces.[13]

Full descriptive statistics of the studies included in full-text review are shown in Table 1. The majority of studies were prospective in nature (n = 74, 67.9%), with 18 retrospective studies (16.5%) and 6 randomized control trials (5.5%).[14–19] Of these, the most frequent indication for the research was

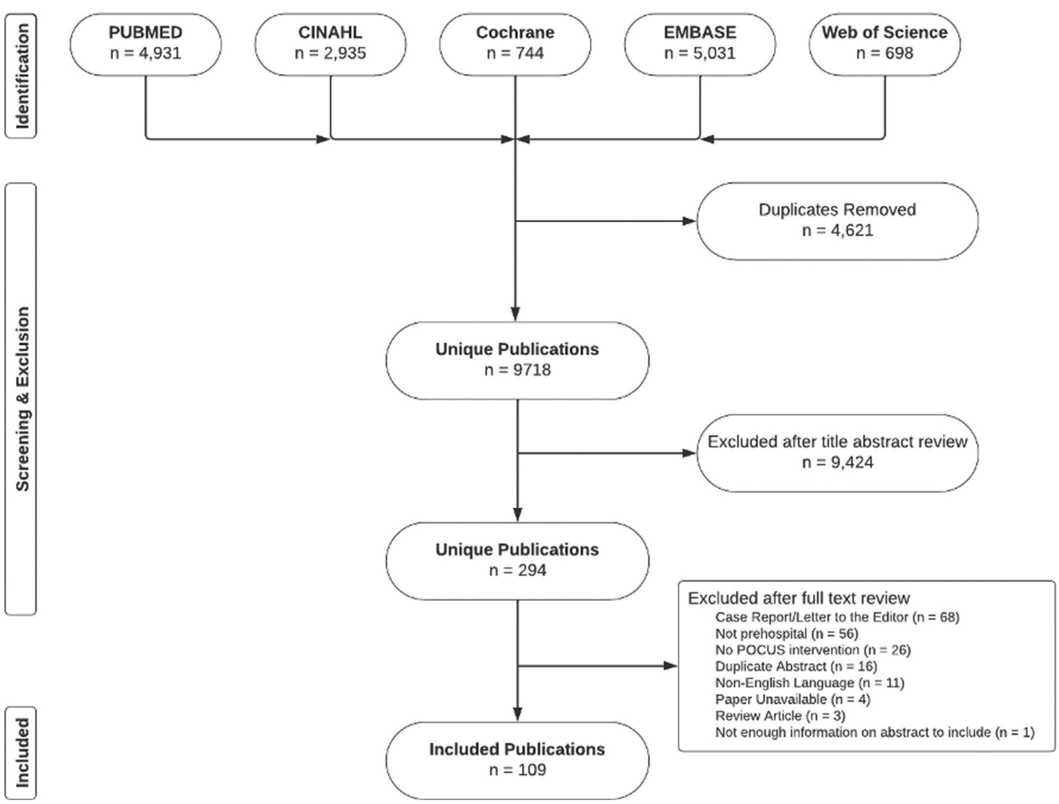


**FIGURE 1.** PRISMA flow diagram. POCUS, point of-care-ultrasound. PRISMA, preferred reporting items for systematic reviews and meta-analyses.

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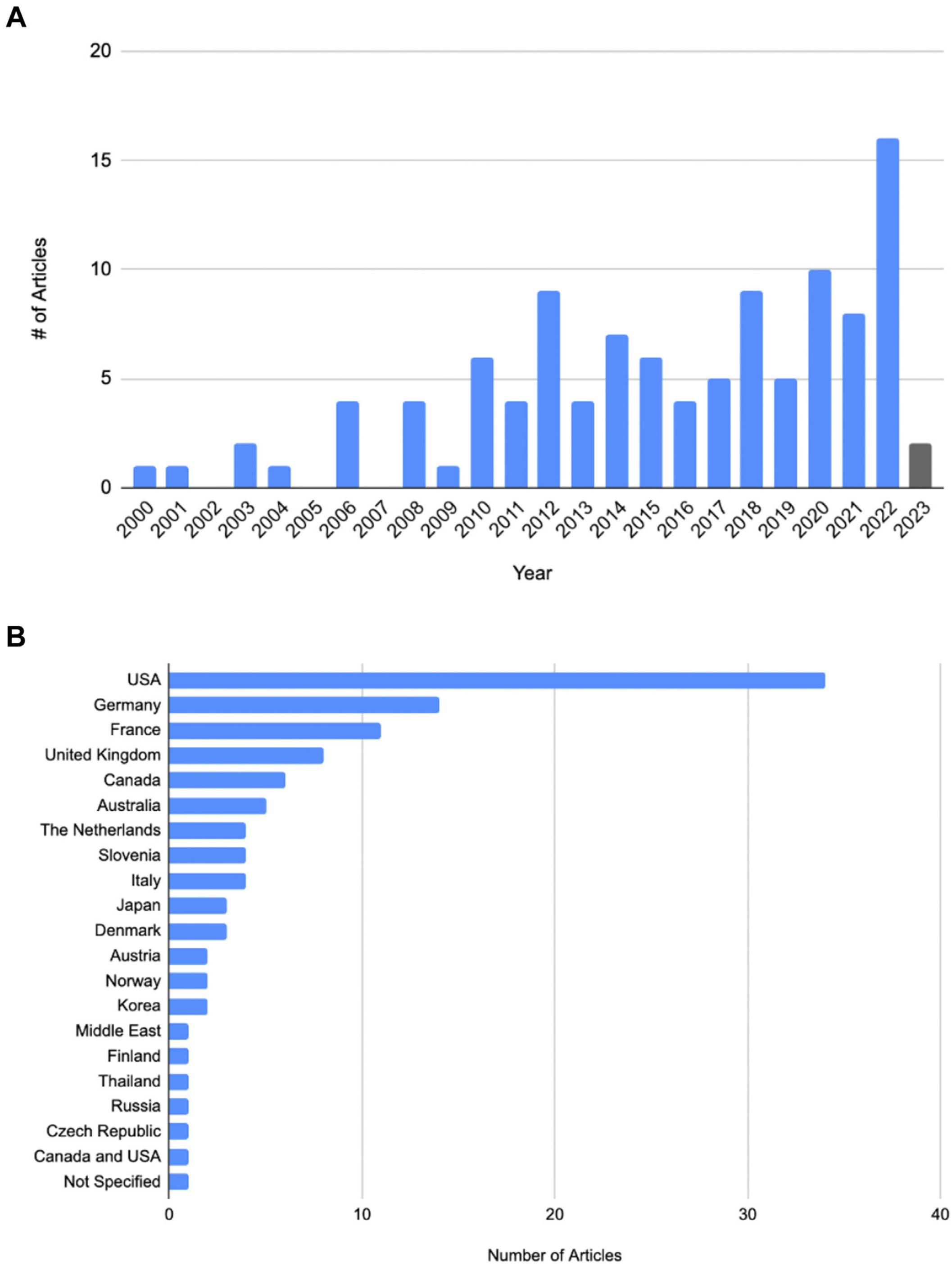


**FIGURE 2.** (A) Number of published studies by year—Study publication numbers of included studies from 2000 to 2023. Given the date of search completion, 2023 (colored in gray) shows partial data. (B) Country of research—number of included studies published in the country where research was conducted and data was collected.

development of a pilot study or evaluation of the feasibility of PHUS (n = 50, 45.9%). Other study indications included identifying changes to clinical outcomes (n = 18, 16.5%), evaluating sensitivity/specificity of PHUS (n = 16, 14.7%), evaluating the use of telecommunications (n = 13, 11.9%), and describing system-specific US use (n = 10, 9.2%).

Over half of the studies in our full-text review included prehospital scans performed by physicians (n = 58, 53.2%); paramedics were the second most studied group (n = 38, 34.9%). Nurses and EMTs performed the scans in 14 (12.8%) and 6 (5.5%) of the studies, respectively. The remaining studies (<3%) included scans performed by neurologists,

**TABLE 1.** Descriptive statistics (n = 109).

| Characteristic | Frequency | Percentage |
|---|---|---|
| Study design | | |
| Prospective | 74 | 67.9% |
| Retrospective | 23 | 21.1% |
| Randomized control trial | 6 | 5.5% |
| Study protocol | 6 | 5.5% |
| Study focus | | |
| Feasibility/pilot | 50 | 45.9% |
| Clinical outcomes | 18 | 16.5% |
| Evaluation of sensitivity/ specificity | 16 | 14.7% |
| Telecommunications | 13 | 11.9% |
| Descriptive | 10 | 9.2% |
| Training/education | 2 | 1.8% |
| EMS setting | | |
| Ground | 42 | 38.5% |
| Ground and HEMS | 7 | 6.4% |
| Ground and air medical | 3 | 2.8% |
| HEMS | 14 | 12.8% |
| Air medical | 14 | 12.8% |
| All settings | 3 | 2.8% |
| Not specified | 21 | 19.3% |
| Other | 5 | 4.6% |
| Study population | | |
| Adults only | 49 | 45.0% |
| Pediatric only | 0 | 0.0% |
| All-comers | 16 | 14.7% |
| Not specified | 31 | 28.4% |
| Simulation | 13 | 11.9% |
| Ultrasound operator studied | | |
| Physician | 58 | 53.2% |
| Paramedic | 38 | 34.9% |
| Nurse | 14 | 12.8% |
| EMT | 6 | 5.5% |
| Not specified | 4 | 3.7% |
| Neurologist | 3 | 2.8% |
| Sonographer | 2 | 1.8% |
| Air medical crew | 2 | 1.8% |
| Other | 4 | 3.7% |

EMS, emergency medical services; EMT, emergency medical technician; HEMS, helicopter emergency medical services.

prehospital sonographers, physician assistants, anesthetists, military medics, and/or firefighters.

Ground-based transport was the most frequent setting (n = 55, 50.5%) for PHUS use. HEMS and air medical transport were both prominently featured in the included studies (n = 24, 22% and n = 20, 18.4%, respectively). The EMS setting was not specified in 21 studies (19.3%), and 5 studies (4.6%) were performed either in a simulated combat setting or music festival. Adults were the most frequently studied population (n = 49, 45%). There were no identified studies focusing specifically on a pediatric population. Undifferentiated presenting patients were the target population in 16 studies (14.7%), and 31 studies (28.4%) did not specify the patient population.

**TABLE 2.** Clinical indications (n = 109).

| Clinical indication | Frequency | Percentage |
|---|---|---|
| Trauma | 49 | 45.0% |
| FAST | 36 | 33.0% |
| Pneumothorax | 9 | 8.3% |
| Fracture | 1 | 0.9% |
| Traumatic brain injury | 2 | 1.8% |
| Not specified | 1 | 0.9% |
| Dyspnea | 13 | 11.9% |
| Pulmonary edema | 7 | 6.4% |
| Not specified | 1 | 0.9% |
| Multiple etiologies | 5 | 4.6% |
| Cardiac arrest | 10 | 9.2% |
| Cardiac motion | 7 | 6.4% |
| Guiding compressions | 1 | 0.9% |
| Not specified | 2 | 1.8% |
| Chest pain | 3 | 2.8% |
| Wall motion abnormality | 2 | 1.8% |
| Not specified | 1 | 0.9% |
| Stroke (transcranial Doppler) | 4 | 3.7% |
| Shock | 1 | 0.9% |
| Multiple indications | 17 | 15.6% |
| Procedures | 9 | 8.3% |
| USGPIV placement | 2 | 1.8% |
| Nerve block | 3 | 2.8% |
| Intubation | 1 | 0.9% |
| G-tube placement | 2 | 1.8% |
| REBOA | 1 | 0.9% |
| Other | 3 | 2.8% |

FAST, focused assessment with sonography for trauma; REBOA, resuscitative endovascular balloon occlusion of the aorta; USGPIV, ultrasound-guided peripheral intravenous.

Clinical indications for PHUS are shown in Table 2. Trauma was the most frequently studied indication for PHUS (n = 49, 45%) with the Focused Assessment with Sonography in Trauma (FAST) examination specifically comprising 73% (n = 36) of these studies. Dyspnea was the next most common indication (n = 13, 11.9%) followed by studies describing multiple indications (n = 17, 15.6%). Procedural competency comprised 8.3% (n = 9) of the literature, focusing primarily on obtaining peripheral vascular access and controlling prehospital pain with nerve blocks.

## 4 LIMITATIONS

Our review has limitations that should be considered. We excluded studies that did not provide English language translations and gray literature, which theoretically may have narrowed the scope of this review. Additionally, not including studies that were performed in other areas such as simulation laboratories or hospitals with prehospital clinicians may similarly limit the indications for PHUS. With the current breadth of PHUS literature in this study, we do not suspect that this significantly influenced the identified POCUS techniques in our review. Additionally, physicians were included in the majority of studies (53.2%), and this may not be generalizable to the majority of US-based EMS systems. As a scoping review, our study does not provide commentary on the sensitivity, specificity, or accuracy of prehospital professionals in conducting these US techniques or quality of studies included within. However, given the current limited depth of PHUS research, the scoping review was appropriate to map the current breadth of literature regarding PHUS.

## 5 DISCUSSION

In this scoping review of PHUS, we identified a large heterogeneous population of studies with a yearly upward trend in the number of included publications. The majority of included studies were prospective pilots and focused primarily on trauma and dyspnea. Although many studies addressed feasibility, there were few studies that addressed clinical outcomes as their primary endpoint. We did not find any studies that specifically addressed a pediatric population. Notably, our review differs from others within the field, which have more often focused on individual indications such as trauma, dyspnea, or critical care.[3–5,8,9] Our review sought to provide additional information regarding the study design, clinical indications, and noticeable gaps in study and population. Prior reviews have attempted to describe the breadth of the current literature and focused on the historical growth of the field[20] or provided a narrative review of key clinical indications and practice environments.[10]

In this review, PHUS was found to be utilized mostly by physicians. This was a notable finding given that most studies were carried out in the United States, which primarily staffs paramedic-based systems. This may be because use of physicians does not require the development of new quality assessment and ongoing medical education systems, which are often expensive and have been previously identified as barriers to establishing PHUS.[12] Second, in studies using the Anglo-American models of EMS (such as the United States), physicians were often included in studies alongside paramedics, whereas studies from Franco-German models of EMS seemed to include physicians only. This may highlight a difference in how US is used in the prehospital field between health care professionals in different regions. Physicians who may primarily staff Franco-German models of EMS systems may adopt a 'stay-and-play' philosophy in which US is used to guide resuscitation, aid in procedural intervention, and assess for occult injuries. Alternatively, paramedics who may primarily practice in Anglo-American models of EMS may adopt a 'scoop-and-run' philosophy in which US is utilized to answer triage and destination decisions. Future research with randomized trials should explore these medical professional differences between each model of EMS and efficacy of PHUS for these differing indications.

In our review, we further noted that majority of the current research comprised descriptive accounts of PHUS or studies examining the feasibility of performing PHUS for various indications. Only 18 (16.5%) included studies that sought to identify clinical outcomes as their primary objective. The outcomes were heterogeneous and varied among all 18 studies. The most common clinical outcomes studied were changes to the final EMS destination (ie, trauma center vs medical receiving center), decision-making assistance in performing field procedures, or decision support for administering specific medications.[21–26] Four studies sought to identify the effect of PHUS on time to definitive intervention (ie, blood products, surgery, or admission to hospital).[15,27–29] Other identified clinical outcomes included triage (preventing under triage, changing surgical priority in mass casualty incidents, and predicting hospital resource utilization),[30–32] procedural support,[16,18] and pain control.[19] Finally, there were 2 study designs pending recruitment and publication that are seeking to identify patient satisfaction[33] and use of US in hypotensive patients.[34]

Although our review found the FAST examination to be the most significantly studied US technique, comprising one-third of all studies, only 2 of these studies focused on clinical outcomes. This aligned with the findings of a 2021 review on the use of PHUS in trauma, which noted zero studies addressing clinical outcomes.[3] One included study of clinical outcomes, by Lyon et al,[22] found that needle thoracostomies were performed less frequently with the utilization of PHUS. This suggests that PHUS may not only guide medical professionals to perform life-saving interventions and guide direction to appropriate transport destinations but that observed clinical outcomes may be prevention of unnecessary procedures and risk of complications. Until further research is conducted, it is unclear what the clinical benefit of prehospital FAST truly is.

In our review, we found that dyspnea and, more specifically, congestive heart failure may be another clinically important scan that may ultimately demonstrate greater clinical outcomes. Notably, it has been documented that paramedics have difficulty differentiating congestive heart failure and obstructive lung disease based on physical examination alone.[35] One study by Zanatta et al[25] suggests that identification of B-lines may help guide prehospital diuretic administration, prevent albuterol use in heart failure, and reduce time of emergency department stay. An additional study demonstrated that PHUS evaluating B-lines may decrease time to treatment of congestive heart failure by hours despite only having transport times of approximately 15 minutes.[36]

Finally, several studies suggest that paramedics may be able to correctly identify cardiac motion during pulse checks and further suggest that compressions during resuscitation of cardiac arrest patients can be guided by US to optimize left ventricular compression.[37,38] It is reasonable to suspect that PHUS transthoracic echo may provide similar benefits. Indeed, one study has already seen that based on end-tidal $CO_2$ measurements, US-guided resuscitation led to a significant improvement in compressions.[39] However, additional clinical outcomes such as return of spontaneous circulation and neurologically intact survival have not yet been researched. Future studies would benefit from investigating and determining not only the clinical benefit of these additional clinical indications but also ensure that the use of PHUS is not affecting compression ratios or impeding high-quality cardiopulmonary resuscitation.

Beyond identifying clinical indications well poised for research, our review also identified noticeable gaps in the current literature. Notably, 20% of studies did not specify the setting of PHUS, which limits the ability to identify the ideal geographic setting when comparing ground transport to air medical or HEMS transport. Moreover, there were no studies specifically conducted within a pediatric population, and they represented the minority of patients in those who included all presenting patients. Additional studies in this field may benefit from standardization in reporting of the prehospital transport setting and further inclusion of pediatric patients to delineate which population and setting may best benefit from this intervention.

Future research would be best poised to address the lack of standardization and lack of clinical outcomes research that are currently present among these included articles. The authors suggest that identifying and pursuing clinical outcomes for various indications should be the highest priority for future research to ensure the cost of establishing PHUS is met with an equivalent improvement in patient outcomes. Examples of this may include identifying mortality and morbidity differences in patients who receive PHUS for evaluation of respiratory distress and pulmonary edema or those who have US-guided compressions or pulse checks in cardiac arrest. Additionally, it should be identified that there are no significant safety concerns when PHUS is utilized, such as unnecessarily long scene times, expansion of compression ratio in cardiac arrest, or incorrect needle thoracostomy placements as these are not significantly described in the literature.

Our scoping review identified a large and growing heterogenous body of literature that describes PHUS by both physicians and nonphysicians. Most of the studies were feasibility or pilot studies. The FAST examination for trauma was the most studied intervention but was limited in providing clinical outcomes. Given the current heterogenous body of literature identifying the feasibility of PHUS, it would be pertinent for future research to focus on investigating clinical and patient-focused outcomes before investing in the cost of implementing a PHUS system. Future research may benefit from directing efforts to identify these outcomes and expanding research regarding dyspnea and cardiac arrest.

## AUTHOR CONTRIBUTIONS

JW, SS, and YL conceptualized the study. JW and OT performed data collection. JW and JT performed data analysis. JW primarily authored the paper with support from OT, JT, SS, and YL. SS and YL provided supervision of the study. JW, JT, and SS reviewed and edited the final manuscript.

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## CONFLICT OF INTEREST

All authors have affirmed they have no conflicts of interest to declare.

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## REFERENCES

1. American College of Emergency Physicians. Emergency ultrasound guidelines. *Ann Emerg Med*. 2009;53(4):550-570. http://doi.org/10.1016/j.annemergmed.2008.12.013
2. Fevang E, Lockey D, Thompson J, Lossius HM; Torpo Research Collaboration. The top five research priorities in physician-provided pre-hospital critical care: a consensus report from a European research collaboration. *Scand J Trauma Resusc Emerg Med*. 2011;19:57. http://doi.org/10.1186/1757-7241-19-57
3. Mercer CB, Ball M, Cash RE, Rivard MK, Chrzan K, Panchal AR. Ultrasound use in the prehospital setting for trauma: a systematic review. *Prehosp Emerg Care*. 2021;25(4):566-582. http://doi.org/10.1080/10903127.2020.1811815
4. Jørgensen H, Jensen CH, Dirks J. Does prehospital ultrasound improve treatment of the trauma patient? A systematic review. *Eur J Emerg Med*. 2010;17(5):249-253.

5. van der Weide L, Popal Z, Terra M, et al. Prehospital ultrasound in the management of trauma patients: systematic review of the literature. *Injury*. 2019;50(12):2167-2175.
6. Nelson BP, Sanghvi A. Out of hospital point of care ultrasound: current use models and future directions. *Eur J Trauma Emerg Surg*. 2016;42(2):139-150. http://doi.org/10.1007/s00068-015-0494-z
7. O'Dochartaigh D, Douma M, MacKenzie M. Five-year retrospective review of physician and non-physician performed ultrasound in a Canadian critical care helicopter emergency medical service. *Prehosp Emerg Care*. 2017;21(1):24-31. http://doi.org/10.1080/10903127.2016.1204036
8. Kowalczyk D, Piotrowski WJ, Rosiak O, Białas AJ. Concise, practical review on transthoracic lung ultrasound in prehospital diagnosis of dyspnea in adults. *Medicina (Kaunas)*. 2023;59(2):224. http://doi.org/10.3390/medicina59020224
9. Bøtker MT, Jacobsen L, Rudolph SS, Knudsen L. The role of point of care ultrasound in prehospital critical care: a systematic review. *Scand J Trauma Resusc Emerg Med*. 2018;26(1):51. http://doi.org/10.1186/s13049-018-0518-x
10. von Foerster N, Radomski MA, Martin-Gill C. Prehospital ultrasound: a narrative review. *Prehosp Emerg Care*. 2024;28(1):1-13. http://doi.org/10.1080/10903127.2022.2132332
11. Tricco AC, Lillie E, Zarin W, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med*. 2018;169(7):467-473. http://doi.org/10.7326/M18-0850
12. Taylor J, McLaughlin K, McRae A, Lang E, Anton A. Use of prehospital ultrasound in North America: a survey of emergency medical services medical directors. *BMC Emerg Med*. 2014;14:6. http://doi.org/10.1186/1471-227X-14-6
13. Duncan PGA, Mackey J. Point-of-care ultrasound at Role 1: is it time for a rethink? *BMJ Mil Health*. 2020;166(6):406-410. http://doi.org/10.1136/bmjmilitary-2020-001466
14. Brun PM, Bessereau J, Chenaitia H, et al. Stay and play eFAST or scoop and run eFAST? That is the question! *Am J Emerg Med*. 2014;32(2):166-170. http://doi.org/10.1016/j.ajem.2013.11.008
15. Lucas B, Hempel D, Otto R, et al. Prehospital FAST reduces time to admission and operative treatment: a prospective, randomized, multicenter trial. *Eur J Trauma Emerg Surg*. 2022;48(4):2701-2708. http://doi.org/10.1007/s00068-021-01806-w
16. Reva VA, Perevedentcev AV, Pochtarnik AA, et al. Ultrasound-guided versus blind vascular access followed by REBOA on board of a medical helicopter in a hemorrhagic ovine model. *Injury*. 2021;52(2):175-181. http://doi.org/10.1016/j.injury.2020.09.053
17. Simmons CJ, Mack LD, Cronin AJ, Monti JD, Perreault MD, Ahern BJ. FAST performance in a stationary versus in-motion military ambulance utilizing handheld ultrasound: a randomized controlled study. *Prehosp Disaster Med*. 2020;35(6):632-637. http://doi.org/10.1017/S1049023X20001028
18. Skulec R, Callerova J, Vojtisek P, Cerny V. Two different techniques of ultrasound-guided peripheral venous catheter placement versus the traditional approach in the pre-hospital emergency setting: a randomized study. *Intern Emerg Med*. 2020;15(2):303-310. http://doi.org/10.1007/s11739-019-02226-w
19. Büttner B, Mansur A, Kalmbach M, et al. Prehospital ultrasound-guided nerve blocks improve reduction-feasibility of dislocated extremity injuries compared to systemic analgesia. A randomized controlled trial. *PLoS One*. 2018;13(7):e0199776. http://doi.org/10.1371/journal.pone.0199776
20. Roantree RAG, Furtado CS, Welch K, Lambert MJ. EMS ultrasound use. In: *StatPearls*. 2024. StatPearls Publishing; 2024. Accessed August 19, 2024. http://www.ncbi.nlm.nih.gov/books/NBK442034/
21. Ketelaars R, Hoogerwerf N, Scheffer GJ. Prehospital chest ultrasound by a Dutch helicopter emergency medical service. *J Emerg Med*. 2013;44(4):811-817. http://doi.org/10.1016/j.jemermed.2012.07.085
22. Lyon R, Weaver A, Wise D, Davies G, Lockey D. Is there a role for pre-hospital chest ultrasound in trauma patients? *Resuscitation*. 2012;83:e84-e85. http://doi.org/10.1016/j.resuscitation.2012.08.218
23. Donovan JK, Burton SO, Jones SL, Phillips LM, Anderson D, Meadley BN. Use of point-of-care ultrasound by intensive care paramedics to assess respiratory distress in the out-of-hospital environment: a pilot study. *Prehosp Emerg Care*. 2023;27(6):800-806. http://doi.org/10.1080/10903127.2022.2107123
24. Ketelaars R, Holtslag JJM, Hoogerwerf N. Abdominal prehospital ultrasound impacts treatment decisions in a Dutch Helicopter Emergency Medical Service. *Eur J Emerg Med*. 2019;26(4):277-282. http://doi.org/10.1097/MEJ.0000000000000540
25. Zanatta M, Benato P, De Battisti S, Pirozzi C, Ippolito R, Cianci V. Pre-hospital lung ultrasound for cardiac heart failure and COPD: is it worthwhile? *Crit Ultrasound J*. 2018;10(1):22. http://doi.org/10.1186/s13089-018-0104-5
26. Jones RA, Tabbut M, Emerman C, Stout S. 84 The effect of thoracic ultrasound for the detection of pneumothorax on medical decisionmaking in trauma patients in the out-of-hospital setting. EM Consulte. Accessed March 11, 2024. https://www.em-consulte.com/article/925959/84-the-effect-of-thoracic-ultrasound-for-the-detec
27. Gamberini L, Tartaglione M, Giugni A, et al. The role of prehospital ultrasound in reducing time to definitive care in abdominal trauma patients with moderate to severe liver and spleen injuries. *Injury*. 2022;53(5):1587-1595. http://doi.org/10.1016/j.injury.2021.12.008
28. Onotera K, Ryan S, Jelic T. 308 The effect of point-of-care ultrasound on helicopter EMS scene times. *Ann Emerg Med*. 2020;76(4 suppl):S119. http://doi.org/10.1016/j.annemergmed.2020.09.323
29. Shaw MR, Godzdanker I, Hawbaker N, McManis BG. Guiding emergency treatment with extended focused assessment with sonography in trauma by emergency responders (GET eFASTER). *Air Med J*. 2023;42(1):42-47. http://doi.org/10.1016/j.amj.2022.09.003
30. Benhamed A, Fraticelli L, Claustre C, et al. Risk factors and mortality associated with undertriage after major trauma in a physician-led prehospital system: a retrospective multicentre cohort study. *Eur J Trauma Emerg Surg*. 2023;49(4):1707-1715. http://doi.org/10.1007/s00068-022-02186-5
31. Dubecq C, Dubourg O, Morand G, Montagnon R, Travers S, Mahe P. Point-of-care ultrasound for treatment and triage in austere military environments. *J Trauma Acute Care Surg*. 2021;91(2S suppl 2):S124-S129. http://doi.org/10.1097/TA.0000000000003308
32. Kalkwarf KJ, Goodman MD, Press GM, Wade CE, Cotton BA. Prehospital ABC score accurately forecasts patients who will require immediate resource utilization. *South Med J*. 2021;114(4):193-198. http://doi.org/10.14423/SMJ.0000000000001236
33. Eadie L, Mulhern J, Regan L, et al. Remotely supported prehospital ultrasound: a feasibility study of real-time image transmission and expert guidance to aid diagnosis in remote and rural communities. *J Telemed Telecare*. 2018;24(9):616-622. http://doi.org/10.1177/1357633X17731444
34. Tartaglione M, Carenzo L, Gamberini L, et al. Multicentre observational study on practice of prehospital management of hypotensive trauma patients: the SPITFIRE study protocol. *BMJ Open*. 2022;12(5):e062097. http://doi.org/10.1136/bmjopen-2022-062097
35. Supples M, Jelden K, Pallansch J, Russell FM. Prehospital diagnosis and treatment of patients with acute heart failure. *Cureus*. 2022;14(6):e25866. http://doi.org/10.7759/cureus.25866
36. Pre-hospital lung ultrasound impact on diagnosis. ClinicalTrials.gov identifier: NCT05461547. Updated October 8, 2024. Accessed December 31, 2023. https://clinicaltrials.gov/study/NCT05461547

37. Catena E, Colombo R, Volontè A, et al. Transesophageal echocardiography in patients with cardiac arrest: from high-quality chest compression to effective resuscitation. *J Echocardiogr*. 2021;19(1):28-36. http://doi.org/10.1007/s12574-020-00492-8
38. Fair J, Mallin MP, Adler A, et al. Transesophageal echocardiography during cardiopulmonary resuscitation is associated with shorter compression pauses compared with transthoracic echocardiography. *Ann Emerg Med*. 2019;73(6):610-616. http://doi.org/10.1016/j.annemergmed.2019.01.018
39. Zanatta M, Lorenzi C, Scorpiniti M, Cianci V, Pasini R, Barchitta A. Ultrasound-guided chest compressions in out-of-hospital cardiac arrests. *J Emerg Med*. 2020;59(6):e225-e233. http://doi.org/10.1016/j.jemermed.2020.07.005


## SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.acepjo.2025.100086


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