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The Utility Of Point-Of-Care Ultrasound (POCUS) In TheEmergency Department: A Systematic Review

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Abstract

Point-of-Care Ultrasonography (POCUS) has increasingly become a pivotal tool in emergency medicine, offering significant improvements in diagnostic accuracy andpatient care. This systematic review aims to evaluate the utility of POCUS in emergency settings, focusing on its impact on diagnostic accuracy, patient management, and the implications of POCUS training for emergency medicine residents. Following PRISMA guidelines, a comprehensive search across major databases, primarily PubMed, was conducted in November 2023. The review included clinical trials, observational studies, and controlled clinical trials, focusing on the utility of POCUS in emergency departments. Out of 305 articles identified, 8 studies met the inclusion criteria and were analyzed. The review encompassed diverse studies with a total of 1203 participants, demonstrating the effectiveness of POCUS in various emergency scenarios. Key findings include the improvement of diagnostic accuracy for conditions like acute dyspnea and Acute Decompensated Heart Failure (ADHF), the utility of POCUS in pediatric emergency care, and its role in ocular emergencies. POCUS was also found to influence patient care decisions significantly, changing diagnostic impressions and management plans. Additionally, POCUS training for emergency medicine residents led to increased ultrasound usage and improved patient management efficiency. POCUS has emerged as a transformative tool in emergency medicine, enhancing diagnostic accuracy, guiding clinical decision-making, and improving patient care outcomes. Its applications range from general emergency scenarios to specialized pediatric and ocular emergencies. The integration of POCUS training in emergency medicine residency programs is crucial for harnessing its full potential. As technology advances, POCUS is

CC License CC-BY-NC-SA 4.0	poised to continue revolutionizing patient care in emergency settings, affirming its indispensable role in modern medical practice. ***Keywords: Point-of-Care Ultrasonography, POCUS, Emergency Department, DiagnosticAccuracy, Pediatric Emergency.***

Introduction:

In 1819, René Laennec's publication of 'L'auscultation médiate' marked the debut of a groundbreaking medical instrument: the stethoscope. It quickly became a staple in clinical settings and a symbol of medical science, though it also faced scrutiny over its diagnostic reliability. Two centuries later, Point of Care Ultrasonography (POCUS) is reshaping clinical practice. This technology, used at the patient's bedside, assistshealthcare providers in basic diagnostic queries, procedure guidance, and therapeutic decision-making. When POCUS first emerged, American radiologist Roy Filly approached it with caution, considering it a powerful yet potentially misused tool, akin to the stethoscope of the future. The role of POCUS, whether as a supplement to or a substitute for the stethoscope, continues to be a topic of discussion. Gaining proficiencyin POCUS requires considerable effort, but its popularity is attributed to its superior diagnostic precision compared to traditional clinical assessments and standard X-rays. POCUS, characterized by its rapid, bedside, and non-invasive imaging, provides emergency physicians with real-time diagnostic capabilities crucial in acute care settings. As a tool that complements clinical assessment, POCUS has shown remarkable efficacy in improving diagnostic accuracy, expediting patient management, and enhancing the overall quality of emergency care [1].

The utility of POCUS in emergency departments (EDs) extends across a myriad ofclinical scenarios. In trauma care, POCUS has replaced more invasive diagnostic procedures, enabling rapid evaluation of abdominal, cardiac, and thoracic injuries. The Focused Assessment with Sonography in Trauma (FAST) exam is a prime example of how POCUS has become indispensable for the rapid assessment of trauma patients [2].

In cardiac emergencies, POCUS assists in the prompt diagnosis of life-threatening conditions such as pericardial effusion, cardiac tamponade, and acute heart failure. The ability to rapidly evaluate cardiac function at the bedside is a critical aspect of emergency cardiac care, particularly in settings where traditional echocardiography is not readily available [3].

POCUS also plays a pivotal role in obstetric and gynecological emergencies. In early pregnancy, for instance, it aids in differentiating between normal intrauterine pregnancy and ectopic pregnancy, thereby guiding appropriate and timely interventions [4].

Beyond these specific applications, POCUS has been instrumental in guiding various procedures in the ED, such as vascular access, thoracentesis, and paracentesis. The real-time visualization of anatomical structures significantly reduces the risk of complications and improves procedural success rates [5].

Despite its extensive utility, the implementation of POCUS varies significantly across different healthcare settings. Factors influencing its utilization include operator training, availability of ultrasound equipment, and institutional protocols. There is also an ongoing debate regarding the required level of training and competency for emergency physicians to effectively use POCUS [6].

Given the rapid evolution and expanding scope of POCUS in emergency medicine, there is a need for a comprehensive systematic review. Such a review should aim to evaluate the current evidence on the utility of POCUS in various emergency scenarios, examine its impact on patient outcomes and healthcare efficiency, and identify potential areasfor further research and development.

Methodology

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)guidelines were followed for this systematic review.

Study Design and Duration

This was a systematic review conducted in November 2023.

Search strategy

To retrieve the relevant research, a thorough search was conducted across major databases, Using PubMed Mainly as a search engine for studies. We only searched in English. The following keywords were converted into PubMed Mesh terms and used to find studies that were related; "Utility," "POCUS," “Point-of-care,” “Ultrasound” "emergency," "department," and “usage,” The Boolean operators "OR" and "AND" matched the required keywords. Among the search results were publications in full English language, freely available articles, and human trials.

Selection criteriaInclusion criteria

We considered the following criteria for inclusion in this review:

- Studies that investigate utility of POCUS in ER
- Clinical Trials.
- Observational Studies.
- Controlled clinical trials.
- Comparative studies.
- Free full text accessible articles.

Exclusion criteria

- Systemic reviews.
- Studies that focused on usage of POCUS in non ER
- Article reviews.
- Meta-analysis.
- Studies earlier than 10 years.
- Case reports, letters to the editors, and replies to conflicts.
- Non-English language.

Data extraction

Duplicates in the search strategy output were found using Rayyan (QCRI) [7]. To determine the titles and abstract relevance, the researchers used a set of inclusion/exclusion criteria to filter the combined search results. The reviewers carefully read each paper that matches the requirements for inclusion. The authors provided other methods of resolving disputes with some thought. The authors extracted data about the study titles, authors, study year, country, participants, gender, diagnostic tool, main outcomes, and conclusion.

Strategy for data synthesis

Summary tables were created using information from pertinent research to give a qualitative overview of the results and study components. Following data extraction for the systematic review, the most effective strategy for utilizing data from the included study articles was selected.

Risk of bias assessment

Using the ROBINS-I risk of bias assessment approach for non-randomized trials of therapies, the included studies' quality was assessed [8]. The seven themes that were assessed were confounding, participant selection for the study, classification of interventions, deviations from intended interventions, missing data, assessment ofoutcomes, and choosing of the reported result.

Results Search results

A total of 305 study articles resulted from the systematic search, and 217 wereautomatically removed. Title and abstract screening were conducted on 88 studies, and 49 studies were excluded. 39 studies were sought for retrieval, and only 17 articles were retrieved. Finally, 17 studies were screened for full-text assessment;

9 Studies were excluded for either having inappropriate study methodology or results. 8 eligible study articles were included in this systematic review. A summary of the study selectionprocess is presented in

Figure 1.

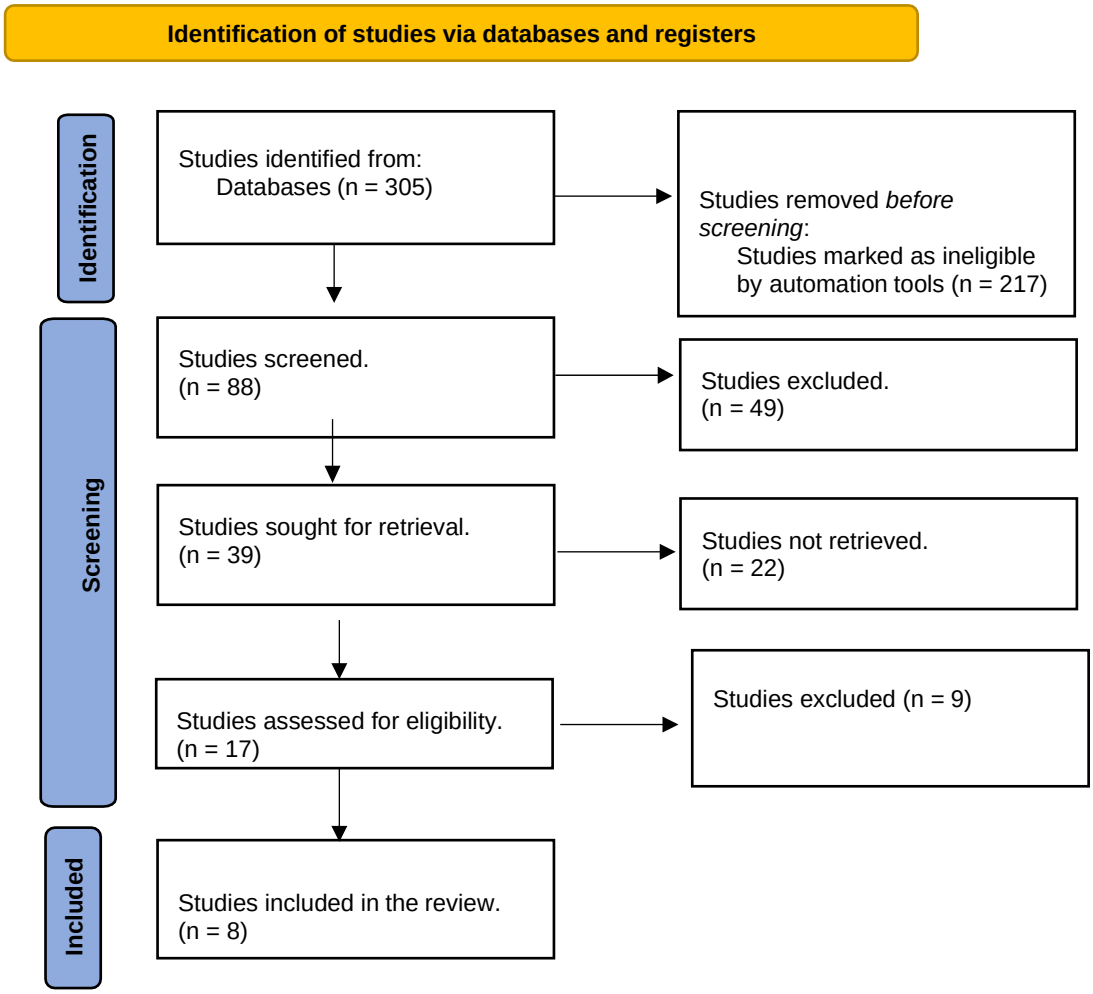

Figure (1): PRISMA flowchart summarizes the study selection process.

Characteristics of the included studies

Table 1: Sociodemographic Characteristics of Included Participants

Table 1 presents sociodemographic details of participants from seven distinct studies [9-16], each with a unique design and geographical setting. The participant numbers vary across studies, with the largest cohort observed in Zoabi M, et al. 2021 [11] from Haifa, Israel, involving 621 participants. The total number of participants was 1203.

Regarding gender distribution, most of the studies included higher percentage of males than females. Mantuani D, et al. 2016 [9] from California, USA, and Zieleskiewicz L, et al. 2021 [12] from Marseille, France, reported high male percentages of 63% and 66%,respectively. In contrast, Partyka C, et al. 2022 [10] in Australia and New Zealand had anearly balanced gender ratio with 49.9% males. Moake MM, et al. 2022 [16] from SouthCarolina, USA, also had a significant male presence with 61.3%.

The studies covered a range of age groups. Mantuani D, et al. [9] and Lahham S, et al. 2019 [13] focused on older age groups with mean ages of 58.2 and 51 years, respectively. Conversely, Zoabi M, et al. [11] and Moake MM, et al. [16] concentrated on pediatric populations with mean ages of 5.5 and 6.5 years, respectively. Partyka C,et al. [10] also observed a middle-aged group with a mean age of 51.1 years.

Study designs included prospective observational, retrospective case series, and cohort studies, reflecting a wide methodological diversity. Locations spanned from the USA to France, Israel, Australia, New Zealand,

Taiwan, and Guyana, South America, indicatinga broad geographical representation.
In summary, the participants in these studies varied widely in number, age, and male representation, with studies conducted in diverse global locations and utilizing different research designs.

Table (2) highlights the clinical outcomes of studies examining POCUS: these studies explored the use of point-of-care ultrasound (POCUS) in various emergency department (ED) settings, with objectives ranging from assessing its impact on diagnostic accuracy and patient care to measuring its influence on training and procedural readiness.

Main Results:

- Mantuani D, et al. 2016 [9]: Showed significant improvement in diagnostic accuracy for acute dyspnea using the "triple scan" POCUS approach, particularlyfor ADHF diagnosis.
- Partyka C, et al. 2022 [10]: Demonstrated extensive use of POCUS across EDs in Australia and New Zealand, revealing its substantial impact on altering or confirming initial diagnoses.
- Zoabi M, et al. 2021 [11]: Found that a POCUS decision-support algorithmeffectively diagnosed transient synovitis in pediatric patients.
- Zieleskiewicz L, et al. 2021 [12]: Reported that POCUS-guided protocols improved immediate diagnosis accuracy and reduced time to treatment in acuterespiratory or circulatory failure cases.
- Lahham S, et al. 2019 [13]: Indicated high sensitivity and specificity of POCUS in diagnosing ocular conditions like retinal detachment and vitreous hemorrhage.
- Chen WL, et al. 2021 [14]: Noted that a comprehensive POCUS training programsignificantly improved POCUS utilization among emergency medicine residents.
- Kissoon DV, et al. 2020 [15]: Showed that POCUS greatly influenced patient caredecisions in the ED, affecting both patient disposition and medication administration.
- Moake MM, et al. 2022 [16]: Found that POCUS frequently identified high-risk gastric content in pediatric patients undergoing PSA, questioning the utility offasting-based delays in PSA.

Key Findings: The overall outcomes of all studies are divided into three key findings.

- **Diagnostic Accuracy and Patient Care Impact**: This is the main point of most studies. Studies by Mantuani D, Partyka C, Zoabi M, Zieleskiewicz L, andLahham S converge on the conclusion that POCUS significantly improves diagnostic accuracy and patient care in various emergency settings.
- **Training and Utilization**: Chen WL's study highlights the importance of POCUStraining in enhancing its use among residents, suggesting an educational impact.
- **Pediatric Care:** Moake MM's study challenges traditional fasting guidelines before PSA in pediatric patients, proposing a more nuanced risk assessmentapproach.

Comparative Analysis:

- **Diagnostic Improvement:** While all studies demonstrate the utility of POCUSin improving diagnostic accuracy, the degree of improvement varies with the condition being diagnosed (e.g., high for ADHF and ocular conditions, moderatefor transient synovitis).
- **POCUS in Training**: Chen WL's study uniquely focuses on the educational aspect, linking training to increased usage and potentially more efficient patientmanagement.
- **Pediatric Focus**: Moake MM's study stands out for its focus on pediatric care,specifically examining the risk assessment for PSA, a consideration not directlyaddressed in other studies.

Overall Synthesis:

These studies collectively underscore the versatility and impact of POCUS in emergency medicine. They highlight its role in enhancing diagnostic accuracy, guiding patient management, and shaping resident training. The findings advocate for a broaderadoption of POCUS in clinical practice, coupled with tailored training programs to maximize its potential benefits across various medical scenarios.

Figure (2) summarizing the key findings of studies included**:**

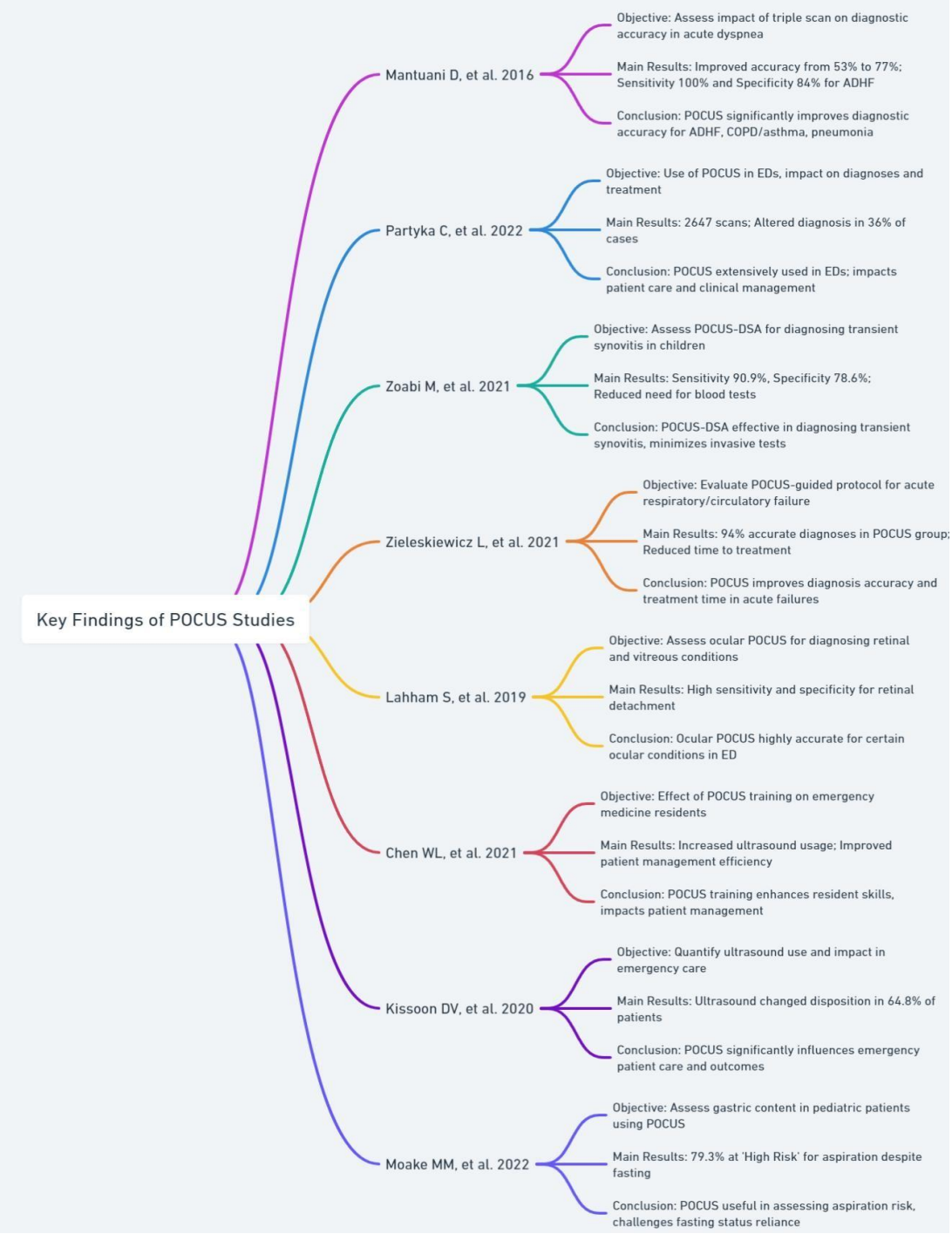

Figure (2)

Table (1): Sociodemographic characteristics of the included participants.

Study	Study design	Location	Participants	Age range (mean) in years	Males (%)
Mantuani D, et al. 2016. [9]	Prospective, observational	California, USA	57	58.2	63%
Partyka C, et al. 2022. [10]	Prospective, observational	Australia and New Zealand	26	51.1	49.9%
Zoabi M, et al. 2021. [11]	Retrospective case series	Haifa, Israel	621	5.5	69%
Zieleskiewicz L, et al. 2021. [12]	Prospective, observational, controlled study	Marseille, France	165	-	66%
Lahham S, et al. 2019.	Prospective diagnostic study	California, USA	225	51	60%

[13]					
Chen WL, et al. 2021. [14]	Retrospective cohort study	Taiwan	16	-	-
Kissoon DV, et al. 2020.[15]	Cross-sectional observational analysis	Guyana, South America	-	-	-
Moake MM, et al. 2022. [16]	Prospective observational study.	South Carolina, USA	93	6.5	61.3%

Table (2): Clinical characteristics and outcomes of the included studies.

Study	Objective	Results	Outcomes/Conclusion
Mantuani D, et al. 2016. [9]	evaluate the impact of a "triple scan"(TS) POCUS exam,	The study found that the overall accuracy Of physicians' diagnostic impressions	POCUS, specifically the triple scan approach, significantly improved
	Comprising abbreviated echocardiography, lung ultrasound, and IVC collapsibility assessment,on the diagnostic impression of physicians treating patients with acute dyspnea.	increased from 53% to 77% after the TS. The TS was particularly effective in diagnosing acute decompensated heart failure (ADHF), with 100% sensitivity and 84% specificity post-TS.	immediate diagnostic accuracy for conditions like ADHF, COPD/asthma, and pneumonia in patients with acute dyspnea, and was highly useful in immediately ruling out ADHF.
Partyka C, etal. 2022. [10]	The study aimed to describe the characteristics, performance, accuracy, and significance of POCUS in the ED, using an expanded version of the ACEM-mandated special skills placement logbook to develop a clinical qualityregistry.	A total of 2647 ultrasound scans were recorded, with the majority being used for diagnostic assessment. About 36% of scans altered the original provisional diagnosis, and another 37% confirmed clinical suspicions. The most common modalities were basic echocardiography,eFAST, and right upper quadrant scans.	The multicentered registry provided a detailed description of POCUS highlighting its significant role in changing or confirming diagnoses and guiding patient management.
Zoabi M, et al.2021. [11]	evaluate the effectiveness of a POCUS decision-support algorithmin diagnosing transient synovitis in children with nontraumatic hip tenderness in a pediatric ED	The algorithm was applied to 621 patients,showing a sensitivity of 90.9% and specificity of 78.6% for diagnosing transient synovitis. It correctly identified 539 cases of transient synovitis andmisdiagnosed 6 cases.	The POCUS decision-support algorithm demonstrates high sensitivity and positive predictive value. It reduces the need for unnecessary blood tests
Zieleskiewicz L, et al. 2021. [12]	assess the impact of a POCUS-guided management protocol on the accuracy of immediate diagnoses in patients with acute respiratory or circulatory failure in a hospital ward.	The POCUS group had a higher rate of accurate immediate diagnoses (94%) compared to the control group (80%). Time to treatment was shorter, and in-hospital mortality rates were lower in the POCUS group.	Using a handheld POCUS device at the bedside improved the accuracy of diagnoses, reduced time to treatment, and potentially improved survival rates in patients with acute respiratory or circulatory failure.
Lahham S, etal. 2019. [13]	determine the effectiveness of ocular POCUS for diagnosing retinaldetachment, vitreous hemorrhage,and vitreous detachment inemergency department patients	POCUS showed high sensitivity and specificity for diagnosing retinal detachment (96.9% sensitivity, 88.1% specificity) and reasonable effectiveness for vitreous hemorrhage. However, it was less sensitive for vitreous detachment.	While POCUS cannot replace an ophthalmologist's definitive diagnosis, it can significantly aid emergency medicine practitioners in managing ocular symptoms.
Chen W L, etal. 2021. 4]	aimed to evaluate the impact of a comprehensive residency-based POCUS training program on ultrasound utilization among ED residents.	After completing the training, the residents' POCUS utilization increased significantly from 0.15 to 0.41 ultrasound studies per patient per year. The distribution of POCUS examinations across	Implementing a comprehensive POCUS education program significantly enhanced the utilization of POCUS among emergency medicine residents, suggesting its positive impact on resident training and patient
		various body regions also changed, with notable increases in echocardiography, soft tissue, and abdominal regions.	care in the ED.
Kissoon DV, etal. 2020. [15]	Assess the impact of POCUS on patient care in the emergency department, particularly focusingon how it changed patient disposition or medication management.	Of the 426 ultrasound studies, 196 had pathologic findings. POCUS influenced patient care in 78.6% of cases, either changing the patient's final disposition or the medication used.	POCUS is frequently used at the Georgetown Public Hospital and has a significant impact on patient care, frequently influencing patient management decisions.

Moake MM, etal. 2022. 16]	evaluate the gastric content of pediatric patients in the emergency department undergoing procedural sedation and analgesia (PSA) using point-of-care ultrasound (POCUS).	Of the 93 patients, 79.3% were classified as 'High Risk' for aspiration based on POCUS findings, despite a median fasting time of 6.25 hours. The study found no significant change in risk status over time and no serious adverse events.	POCUS frequently showed 'High Risk', challenging the utility of delaying PSA based on fasting status alone. This suggests a need for a more comprehensive risk-benefit approach inpediatric PSA planning.

Discussion:

The recent advancements in Point-of-Care Ultrasonography (POCUS) have significantly impacted the landscape of emergency medicine, as evidenced by a series of studies conducted between 2016 and 2022. These studies, ranging from Mantuani D, et al. [9] in 2016 to Moake MM, et al. [16] in 2022, have collectively demonstrated the diverse applications and profound implications of POCUS in various emergency settings.

The sociodemographic data from seven POCUS studies [9-16] reveal a diverse participant pool across various global locations, with a total of 1203 participants.Notably, the largest cohort was in Zoabi M, et al. 2021 [11] with 621 participants. Gender distribution varied, with studies like Mantuani D, et al. 2016 [9] and Zieleskiewicz L, et al. 2021 [12] reporting higher male percentages, while Partyka C, et al. 2022 [10] had a nearly balanced gender ratio. Age groups ranged from pediatric populations in Zoabi M, et al. [11] and Moake MM, et al. [16] to older adults in Mantuani D, et al. [9] and Lahham S, et al. [13]. The studies encompassed diverse methodologies and were conducted in locations including the USA, France, Israel, Australia, New Zealand, Taiwan, and Guyana, reflecting a wide geographical andmethodological diversity.

Enhancing Diagnostic Accuracy and Confidence: Mantuani D, et al. [9] in 2016 and Partyka C, et al. [10] in 2022 both focused on the diagnostic impact of POCUS. Mantuani's study highlighted the effectiveness of a triple scan POCUS approach in improving diagnostic accuracy for acute dyspnea from 53% to 77%, particularly in conditions like ADHF, COPD/asthma, and pneumonia. Similarly, Partyka's research underscored the extensive use of POCUS in emergency departments (EDs), where it altered initial diagnoses in 36% of cases and confirmed them in 37%. Both studies collectively emphasize the role of POCUS in enhancing diagnostic confidence and accuracy in emergency medicine.

Other emergency medicine (EM) studies have explored a multi-organ POCUS protocol, similar to the TS approach, which combines abbreviated echocardiography, lung ultrasound, and IVC assessment for undifferentiated dyspnea. Some of these studies specifically investigated the diagnosis of Acute Decompensated Heart Failure (ADHF). Kajimoto et al., Anderson et al., and Russell et al. reported varying sensitivities (94%, 34%, and 83% respectively) [17-19] and specificities (91% for both Kajimoto and Anderson, and 83% for Russell) for POCUS as a standalone test for ADHF. Notably, Russell et al. observed an increase in the specificity of physician diagnosis for ADHF from 44% to 83% with the use of POCUS. Two other studies conducted in 2014 evaluated the impact of multi-organ POCUS, alongside patient history and physical examination, on the accuracy of initial diagnoses by treating physicians. Pirozzi et al.

conducted a randomized controlled trial (RCT) comparing assessments with and withoutPOCUS, finding a significant reduction in diagnostic discordance (5% in the POCUS group vs. 50% in the control group). Lauresen et al. also conducted an RCT but used a slightly different POCUS protocol, including proximal DVT assessment and allowing physicians access to other diagnostic test results. They found a higher rate of correct initial diagnoses in the POCUS group (88%) compared to the control group (63.7%). These studies collectively highlight the potential of multi-organ POCUS in improving diagnostic accuracy for conditions like ADHF in emergency settings. [9, 20, 21]

a promising trend in the application of POCUS was found, where it is increasingly used as a multifaceted tool to address specific clinical queries. For instance, cardiac assessments combined with lung ultrasound are frequently employed to evaluate dyspnea, accounting for 26% of such cases. This approach is particularly effective in examining ventricular function and detecting signs of interstitial pulmonary edema, suchas B-lines. Additionally, flank pain, often indicative of renal colic, is the primary reason for conducting AAA (Abdominal Aortic Aneurysm) scans. In cases of atraumatic shock, a combination of eFAST, echocardiography, and AAA scans is commonly used, following the principles of the 'RUSH' protocol (Rapid Ultrasound in SHock examination). This trend underscores the value of POCUS in enabling clinicians at the bedside to make informed decisions based on patient history and physical examination, rather than engaging in a broad, non-specific search for potential pathologies. [10]

Specialized Applications in Pediatric and Ward Patients: Zoabi M, et al. [11] in 2021 and Zieleskiewicz L, et al. [12] in the same year explored specialized applications of POCUS. Zoabi's study demonstrated the efficacy of a POCUS decision-support algorithm in diagnosing transient synovitis in children, highlighting its potential to reduce invasive procedures. Zieleskiewicz's research evaluated a POCUS-guided protocol for patients with acute respiratory or circulatory failure, showing improved diagnostic accuracy and reduced time to treatment. These studies illustrate the versatility of POCUS in addressing specific clinical scenarios in pediatrics and acute wardsettings.
The enhanced diagnostic capabilities of POCUS likely contribute to the earlier initiationof treatment and a decrease in additional examinations in the POCUS group compared to the control group. In emergency situations, POCUS can be used for a focused assessment, including evaluations of cardiac function, ventricular filling, signs of tamponade, valvular activity, venous status, pleural conditions, and deep venous flow. When POCUS leads to a diagnosis, interventions can be more precisely directed at the identified issue, thereby minimizing the need for further tests and reducing the risk of unnecessary treatments. While we did not evaluate the cost implications, it is reasonable to infer that reduced resource utilization would also lead to lower healthcarecosts. [12, 22-24]

POCUS in Ocular Emergencies and Training Impact: Lahham S, et al. [13] in 2019 and Chen WL, et al. [14] in 2021 explored further dimensions of POCUS. Lahham's study revealed the high sensitivity and specificity of ocular POCUS in diagnosing retinal and vitreous conditions, suggesting its potential in preventing vision loss. Chen's research focused on the impact of POCUS training on emergency medicine residents, showing significant improvements in ultrasound usage and patientmanagement efficiency. These findings highlight the importance of POCUS training and its application in less conventional areas like ocular emergencies.

Influencing Patient Care and Management: Kissoon DV, et al. [15] in 2020 and Moake MM, et al. [16] in 2022 examined the influence of POCUS on patient care. Kissoon's study at Georgetown Public Hospital Corporation emphasized how POCUS affected patient disposition and medication management, changing final dispositions in 64.8% of patients. Moake's research assessed the risk of aspiration in pediatric patients using POCUS, challenging the reliance on fasting status alone for procedural sedation and analgesia.
POCUS has been instrumental in enhancing patient care outcomes in emergency departments. A retrospective study in Tanzania revealed significant changes in clinicians' diagnostic impressions and plans in 29% of cases following ultrasound use, with patient disposition plans altered in 45% of cases due to ultrasound findings. Similarly, in Rwanda, where a continuous training program for ultrasound is in place, it was found that ultrasound influenced clinical decision-making 81.3% of the time, particularly affecting medication administration and admission decisions. Additionally, a smaller study in Liberia indicated that ultrasound modified patient management in 62% of cases across the hospital, with 28% of these instances occurring in the emergency department. These findings collectively underscore the substantial impact of POCUS on medical practice and patient care in various settings. [25-28]. These studies collectively underscore the significant role of POCUS in guiding clinical decision-making and patient management in emergency settings.

Conclusion:

The collective insights from these studies underscore the transformative role of POCUS in emergency medicine. From enhancing diagnostic accuracy and confidence to specialized applications in pediatrics and acute care, the scope of POCUS is vast and impactful. Its role in training emergency medicine residents and influencing patient care decisions further highlights its integral place in modern medical practice. As technology advances, the potential for POCUS to revolutionize patient care in emergency settings continues to grow, making it an indispensable tool in the arsenal of emergency medicine.

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