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Systematic Review Article

POINT-OF-CARE ULTRASOUND IN THE INITIAL ASSESSMENT OF TRAUMA PATIENTS IN EMERGENCY DEPARTMENT: A SYSTEMATIC REVIEW

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ABSTRACT

Background: Trauma is a major global cause of mortality and disability, particularly in young adults. Rapid identification of life-threatening injuries in the emergency department is essential, but although computed tomography is the diagnostic gold standard, its use is limited in unstable patients due to time, transfer, and radiation concerns. **Objectives:** This systematic review aims to assess the diagnostic accuracy and clinical utility of point-of-care ultrasound in the early evaluation of trauma patients presenting to the emergency department, with a focus on its impact on clinical decision-making and emergency management.

Materials and Methods: This systematic review was conducted in accordance with PRISMA guidelines. A comprehensive literature search was performed in PubMed, Scopus, Web of Science, and Google Scholar. Eligible study designs comprised randomized controlled trials, cohort, case–control, and cross-sectional studies, review articles. Non-English articles, studies lacking extractable data, or those without clear outcome measures, editorials, commentaries, conference abstracts, were excluded. After screening 1,290 records and removing duplicates, 17 studies met the inclusion criteria and were included in the final analysis.

Results: FAST (Focused Assessment with Sonography for Trauma) showed high specificity but variable sensitivity for detecting intra-abdominal injury and frequently influenced clinical management by reducing unnecessary laparotomy, CT, and diagnostic peritoneal lavage. eFAST (Extended Focused Assessment with Sonography for Trauma) offers rapid, real-time information during the assessment of complex trauma patients by detecting pneumothorax, hemothorax, and free fluid suggestive of hemopericardium or hemoperitoneum.

Conclusion: FAST and eFAST aid rapid trauma assessment and decision-making. eFAST demonstrates high diagnostic accuracy and greater sensitivity than chest radiography for pneumothorax, supporting its use as a first-line bedside tool, while CT remains essential for definitive evaluation.

Keywords: Trauma, Point-of-care ultrasound, FAST, eFAST, Emergency department.

INTRODUCTION

Trauma is a major global public health problem and remains one of the leading causes of mortality and disability, particularly among young adults. Early recognition of life-threatening injuries and rapid initiation of appropriate management during the initial assessment in the emergency department (ED) are critical determinants of patient outcomes. Traditional diagnostic modalities used during trauma resuscitation include clinical examination, plain radiography, and computed tomography (CT). Although CT is considered the gold standard for the detection of many traumatic injuries, its use may be limited in hemodynamically unstable patients, requires patient transfer out of the resuscitation area, and exposes patients to ionizing radiation.

Based on Rozycki GS et al., 1993, findings, ultrasound was identified as particularly valuable in four clinical situations during the assessment of injured patients: (1) individuals sustaining blunt injuries to the thorax or abdomen; (2) patients in whom pericardial tamponade is clinically suspected; (3) those with multisystem trauma and unexplained hypotension where the bleeding source is unclear; and (4) pregnant patients with blunt trauma, in whom rapid, noninvasive evaluation is essential.[1] The use of ultrasound in trauma care varies widely across regions and remains a subject of debate (Scalea TM et al., 1999).[2]

Extended FAST (eFAST) using thoracic ultrasound is increasingly recognized for detecting post-traumatic pneumothorax, including occult cases that may be missed on supine anteroposterior chest radiography. However, the effectiveness of hand-held ultrasound devices for this purpose has not yet been adequately studied (Kirkpatrick AW et al., 2004).[3]

Despite its widespread adoption, reported diagnostic accuracy and clinical impact vary across studies, influenced by factors such as operator experience, injury severity, and patient characteristics. Therefore, a systematic synthesis of the available evidence is required to better define the role of POCUS (point-of-care ultrasound) in the initial assessment of trauma patients in the ED.

This systematic review aims to evaluate the existing literature on the use of POCUS during the initial assessment of trauma patients in the emergency department, focusing on ultrasound modalities employed, diagnostic outcomes, and impact on clinical management.

Objectives

This systematic review aims to evaluate the diagnostic accuracy and clinical utility of point-of-care ultrasound in the early assessment of trauma patients presenting to the emergency department, and to assess its impact on clinical decision-making, patient outcomes, and emergency management practices across different healthcare settings.

MATERIALS AND METHODS

The review conducted in accordance with the PRISMA guidelines. A comprehensive literature search was performed using databases including PubMed, Scopus, Web of Science, and Google Scholar using key words Trauma, Point-of-care ultrasound, FAST, eFAST, Emergency department. Studies published in English evaluating the use of POCUS in the initial assessment of trauma patients in the emergency department were included. Eligible study designs included randomized controlled trials, cohort studies, case–control studies, and cross-sectional studies, review articles. Non-English papers without extractable data, lacked clear outcome measures or evaluable results, editorials, commentaries, conference abstracts, were excluded.

Titles, abstracts, and full texts were independently screened by two reviewers, with disagreements resolved by consensus. Data extraction and quality assessment were performed independently using standardized tools appropriate to study design. Due to heterogeneity among studies, a qualitative synthesis was conducted.

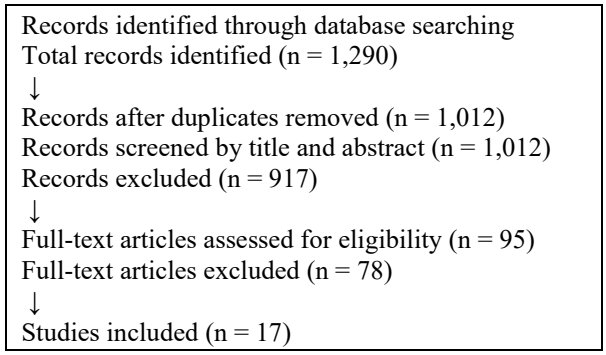

Figure: PRISMA Flow chart of Study Selection Process

RESULTS AND DISCUSSION

Focused Assessment with Sonography for Trauma (FAST)

Rozycki GS et al., 1993, referred to the technique of sonographic scanning for free fluid with clear emphasis on four specific areas of attention: (1) right upper quadrant; (2) left upper quadrant; (3) pelvis; and (4) pericardium.[1]

Rozycki GS et al., 1995, concluded that ultrasound (US) should be used as the main adjunct in trauma assessment due to its speed, diagnostic reliability, and potential cost efficiency.[4]

Meta-analysis by Chaijareenont C et al., 2020, demonstrates that FAST is a reliable tool for identifying clinically significant intra-abdominal hemorrhage in patients with major pelvic fractures. In hemodynamically unstable patients, a positive FAST can guide timely decision-making for abdominal exploration, with a high likelihood of detecting surgically treatable bleeding.[5]

Six key areas with significant controversy or practice variability were addressed through an ad hoc consensus process: (1) ultrasound terminology and technique, (2) organ-specific applications, (3) scoring systems, (4) interpretation of positive and negative findings, (5) credentialing and training, and (6) future ultrasound applications (Scalea TM et al., 1999).[2]

FAST has high specificity, making it an effective confirmatory modality in trauma evaluation. It plays an important role during the initial assessment, and emergency physicians can perform the examination competently after limited focused training (Brenchley J et al., 2006).[6]

Stengel D et al., 2015, found that while FAST is a common tool with high specificity, its low sensitivity limits its reliability. While it may reduce the number of CT scans performed, the authors concluded there is insufficient evidence to prove that FAST-based

pathways improve patient outcomes or mortality compared to primary CT evaluation.[7]

In a prospective study evaluated 419 trauma admissions by comparing patients managed with FAST to those without FAST, examining demographic characteristics, resuscitation duration, and post-resuscitation management. FAST findings altered clinical management in 59 patients (32.8%), preventing unnecessary laparotomy in one case, computed tomography in 23 cases, and diagnostic peritoneal lavage in 15 cases. Its use reduced CT rates from 47% to 34% and lavage rates from 9% to 1%, underscoring the significant impact of FAST on trauma decision-making (Ollerton JE et al., 2006).[8]

FAST and eFAST are rapid bedside ultrasound tools for trauma evaluation. FAST identifies free fluid suggestive of hemoperitoneum, hemothorax, or hemopericardium, while eFAST additionally detects pneumothorax. FAST has high specificity but variable sensitivity, particularly for solid organ injuries, which may be underestimated in stable patients; repeat examinations improve accuracy. eFAST is more sensitive than chest radiography for pneumothorax and hemothorax, and inferior vena cava (IVC) assessment may assist in differentiating shock in hypotensive trauma patients (Richards JR et al., 2017).[9]

Table 1: Overview of included studies, main findings and clinical implication

Author (Year)	Main Findings	Clinical Implication
Rozycki GS et al. (1993)	Defined 4 standard views: RUQ (right upper quadrant, LUQ (left upper quadrant), pelvis, pericardium	Standardized FAST examination technique
Rozycki GS et al. (1995)	Recommended US as primary adjunct due to speed, reliability, cost-effectiveness	Supported FAST as main adjunct trauma tool
Scalea TM et al. (1999)	Identified 6 controversial areas (terminology, technique, scoring, interpretation, credentialing, future use)	Highlighted need for standardization & training
Chaijareenont C et al. (2020)	High reliability for detecting surgically significant intra-abdominal hemorrhage; useful in hemodynamically unstable patients	Guides urgent surgical decision-making
Brenchley J et al. (2006)	High specificity; effective confirmatory tool	Suitable for emergency physician use
Stengel D et al. (2015)	High specificity but low sensitivity; insufficient evidence for improved mortality/outcomes	CT remains essential
Ollerton JE et al. (2006)	FAST altered management in 32.8%; reduced CT (47%→34%) & lavage (9%→1%)	Reduces unnecessary procedures
Richards JR et al. (2017)	eFAST detects pneumothorax better than (CXR) Chest X-ray ; FAST has high specificity but variable sensitivity; IVC aids shock assessment	Expanded role of eFAST in trauma evaluation

Extended Focused Assessment with Sonography for Trauma (eFAST)

Kirkpatrick AW, et al, 2004, Comparative study of 225 trauma patients, 52 (22%) had pneumothorax, most of which were occult on chest X-ray. eFAST and chest X-ray agreed in most cases, but eFAST detected more missed pneumothoraxes. Compared with CT, eFAST showed higher sensitivity than chest X-ray, while both tests maintained very high specificity and strong diagnostic value.[3]

Comparative study by Samuel AE et al., 2018 found that eFAST findings were positive in 13.3% of cases and negative in 86.7%, with complete agreement between emergency medicine residents and radiology consultants.[10]

Systematic review and meta-analysis by Netherton S et al., 2019, suggests that eFAST is a useful bedside tool for ruling in pneumothorax, pericardial effusion, and intra-abdominal free fluid in the trauma setting. Its usefulness as a rule-out tool is not supported by these results.[11]

eFAST offers rapid, real-time information during the assessment of complex trauma patients by detecting pneumothorax, hemothorax, and free fluid suggestive of hemopericardium or hemoperitoneum. However, its limitations must be recognized, and its use should align with established guidelines, where eFAST serves as a supportive adjunct rather than a definitive investigation in major trauma (Desai N et al., 2017).[12]

A retrospective analysis by Shwe S et al., 2020, found that among 1,597 trauma patients, 1,507 met criteria for eFAST, yet 27% did not have a billed examination. Of these cases, 22% had mention of eFAST in provider notes without a formal procedure record, while 78% lacked any chart documentation despite confirmation of the study through ultrasound quality assurance (QA) records.[13]

FAST and eFAST are widely used in trauma care, enabling rapid bedside identification of life-threatening injuries, reducing unnecessary laparotomies, and supporting timely decision-making. Although computed tomography is the diagnostic gold standard, FAST remains highly valuable due to its accessibility, speed, low cost, and minimal risk, making it an essential component of modern trauma assessment (Savoia et al., 2023).[14]

Table 2: Overview of included studies, key findings and clinical implication

Author (Year)	Key Findings	Clinical Implication
Kirkpatrick AW et al. (2004)	22% had pneumothorax (many occult on CXR); eFAST detected more missed pneumothoraxes than CXR; higher sensitivity than CXR vs CT; both had high specificity	eFAST superior to CXR for pneumothorax detection; valuable bedside tool
Samuel AE et al. (2018)	eFAST positive in 13.3%, negative in 86.7%; complete agreement between EM residents & radiology consultants	High interobserver reliability; suitable for trained EM physicians
Netherton S et al. (2019)	Useful for ruling in pneumothorax, pericardial effusion, intra-abdominal free fluid	Limited exclusion value
Desai N et al. (2017)	Rapid real-time detection of pneumothorax, hemothorax, hemopericardium, hemoperitoneum; limitations exist	Should be used as adjunct, not definitive test in major trauma
Shwe S et al. (2020)	27% lacked billed eFAST exam; 22% documented in notes only; 78% no chart documentation despite ultrasound QA confirmation	Highlights documentation & billing gaps
Savoia et al. (2023)	FAST/eFAST reduce unnecessary laparotomies; CT remains gold standard; FAST valuable due to accessibility & speed	Essential adjunct in modern trauma care

CONCLUSION

The evidence supporting FAST-based diagnostic pathways for suspected blunt abdominal or multiple trauma remains limited. Marked heterogeneity across studies restricts quantitative findings to exploratory interpretation, and large confirmatory randomized trials are unlikely to be undertaken. Overall, FAST appears to have no clear effect on trauma-related mortality or morbidity. Demonstrating non-inferiority of FAST compared with CT-based strategies would require extremely large sample sizes, making such trials impractical (Stengel D et al., 2015).[7]

eFAST has similar specificity but higher sensitivity than chest X-ray for detecting occult pneumothorax. Positive findings should guide clinical management or CT use based on hemodynamic stability, while CT remains essential for complete pneumothorax detection (Kirkpatrick AW et al., 2004).[3]

Overall, eFAST demonstrated high diagnostic performance, with sensitivity of 90.4%, specificity of 99.2%, positive predictive value of 95.0%, negative predictive value of 98.4%, and an accuracy of 98% (Samuel AE et al., 2018).[10]

Ultrasound should be the first-line diagnostic tool for patients with precordial wounds or blunt truncal trauma due to its speed and accuracy. Given its high sensitivity and specificity in hypotensive patients, a positive ultrasound finding supports prompt surgical intervention without delay (Rozycki et al., 1998).[15]

The meta-analysis by Ebrahimi A et al., 2014, demonstrated that chest ultrasound has greater diagnostic accuracy than supine chest radiography for pneumothorax detection, remaining superior even after adjustment for study heterogeneity.[16]

When CT is used as the reference standard, ultrasound demonstrates greater sensitivity than supine anteroposterior chest radiography for detecting traumatic pneumothorax. Ultrasound also enables reliable differentiation of pneumothorax size, showing good concordance with CT findings (Blaivas M et al., 2005).[17]

FAST and eFAST are valuable rapid bedside diagnostic tools in trauma assessment, demonstrating high diagnostic performance and accuracy. They show higher sensitivity and comparable or superior specificity compared with conventional chest radiography for detecting pneumothorax and other traumatic injuries. Ultrasound is particularly useful in hemodynamically unstable patients, where positive findings can guide immediate clinical management or surgical intervention. However, despite these advantages, CT remains the reference standard for comprehensive evaluation, and the overall impact of FAST on trauma-related mortality and morbidity remains uncertain.

Further research is needed to strengthen the evidence base for FAST and eFAST, refine their clinical applications, and optimize their integration into trauma management pathways.

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