Test file: The Impact of Point-of-Care Ultrasound on the Triage and Management of Blunt Chest Trauma Patients

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Abstract

Objective: To assess the clinical impact of point-of-care ultrasound (POCUS) on the triage speed, diagnostic accuracy, and patient outcomes in blunt chest trauma (BCT). Methods: A retrospective observational study was conducted on 328 BCT patients admitted to our level 1 trauma center between January 2020 and December 2022. Patients were divided into the POCUS group (n=168) and the conventional assessment group (n=160) based on whether POCUS was performed during initial triage. The primary outcomes included time to definitive diagnosis, rate of unnecessary computed tomography (CT) scans, and 30-day mortality. Secondary outcomes covered length of hospital stay, ICU admission rate, and incidence of missed injuries. Results: The POCUS group had a significantly shorter time to definitive diagnosis (22.5 ± 8.6 min vs. 58.3 ± 14.2 min, P<0.001) and a lower rate of unnecessary chest CT scans (12.5% vs. 38.8%, P<0.001) compared with the conventional group. The 30-day mortality rate was 5.4% in the POCUS group and 10.6% in the conventional group (P<0.05). The incidence of missed injuries was 2.4% in the POCUS group, which was significantly lower than 8.8% in the conventional group (P<0.01). No statistically significant difference was observed in ICU admission rate between the two groups (P>0.05). Conclusion: The application of POCUS during initial triage of BCT patients can shorten diagnostic time, reduce unnecessary radiation exposure from CT scans, decrease missed injury rates, and improve short-term survival outcomes.

Keywords: Point-of-care ultrasound; Blunt chest trauma; Trauma triage; Diagnostic accuracy; Patient outcomes

1. Introduction

Blunt chest trauma is a common and potentially life-threatening injury, accounting for approximately 25% of all trauma-related hospital admissions and 40% of trauma deaths worldwide [1]. Rapid and accurate identification of life-threatening injuries, including hemothorax, pneumothorax, cardiac tamponade, and rib fractures with associated pulmonary contusion, is crucial for optimizing patient outcomes [2]. Conventional initial assessment of BCT relies on clinical examination, chest radiography (CXR), and subsequent CT scanning, but these methods have limitations: CXR has low sensitivity for detecting occult pneumothorax and small hemothorax, while CT involves ionizing radiation and may cause delays in definitive treatment [3]. Point-of-care ultrasound, a portable and radiation-free diagnostic tool, has emerged as a valuable adjunct in trauma care over the past decade [4]. The extended focused assessment with sonography for trauma (E-FAST) protocol, which includes chest ultrasound evaluation, enables clinicians to quickly identify pleural and pericardial abnormalities at the bedside [5]. Despite widespread adoption of POCUS in trauma triage, its direct impact on patient survival and resource utilization in BCT remains incompletely elucidated, particularly regarding the reduction of unnecessary CT scans and missed injuries. This study aims to fill this gap by comparing the diagnostic and clinical outcomes of BCT patients managed with and without POCUS during initial triage.

2. Materials and Methods

2.1 Study Population

The study included adult patients (≥18 years old) with BCT admitted to the Johns Hopkins Hospital Level 1 Trauma Center from January 2020 to December 2022. BCT was defined as chest injury caused by blunt force (e.g., motor vehicle collisions, falls, assaults) with evidence of chest wall tenderness, dyspnea,

abnormal breath sounds, or abnormal CXR findings. Inclusion criteria were: (1) presentation to the emergency department (ED) within 1 hour of injury; (2) complete medical records including initial assessment data, imaging reports, and follow-up outcomes; (3) no penetrating chest injuries or pre-existing thoracic diseases (e.g., chronic obstructive pulmonary disease, lung cancer). Exclusion criteria were: (1) GCS score ≤ 8 with inability to cooperate with clinical assessment; (2) transfer from other hospitals with prior imaging or intervention; (3) death within 1 hour of ED arrival before completion of initial assessment. The study was approved by the Institutional Review Board of Johns Hopkins University (IRB No. 2023-0649), and the requirement for informed consent was waived due to its retrospective design.

2.2 Assessment Protocols

POCUS Group: Initial triage was performed by trauma surgeons trained in E-FAST protocol. POCUS examination of the chest included evaluation of the anterior and lateral chest walls for pneumothorax (absence of lung sliding) and hemothorax (anechoic fluid in the pleural space), as well as pericardial assessment for tamponade. The POCUS findings were used to guide immediate clinical decisions: patients with positive findings (e.g., large hemothorax, cardiac tamponade) underwent emergent intervention, while those with negative or indeterminate findings underwent selective CT scanning based on clinical judgment.

Conventional Group: Initial triage relied on clinical examination and CXR. Patients with abnormal CXR findings or high clinical suspicion of severe injury underwent emergent CT scanning; others were observed with serial clinical assessments.

2.3 Outcome Measures

Primary outcome measures were: (1) time to definitive diagnosis, defined as the interval from ED arrival to confirmation of the primary thoracic injury; (2) rate of unnecessary chest CT scans, defined as CT scans that did not alter management or reveal clinically significant injuries not detected by initial assessment; (3) 30-day mortality rate. Secondary outcome measures included: (1) length of hospital stay; (2) ICU admission rate; (3) incidence of missed injuries, defined as injuries identified more than 24 hours after initial assessment that required a change in management.

2.4 Statistical Analysis

Continuous variables were presented as mean ± standard deviation (SD) and compared using the independent samples t-test. Categorical variables were expressed as frequencies and percentages, with comparisons performed using the χ^2 test or Fisher's exact test. A two-tailed P value < 0.05 was considered statistically significant. All analyses were conducted using SPSS 28.0 (IBM Corp., Armonk, NY, USA).

3. Results

3.1 Baseline Characteristics

A total of 328 patients were included in the study, with 168 in the POCUS group and 160 in the conventional group. There were no significant differences in baseline characteristics between the two groups, including age, gender, injury mechanism, GCS score on admission, and Injury Severity Score (ISS) (P>0.05) (Table 1). The most common thoracic injuries in both groups were rib fractures, pneumothorax, and hemothorax.

3.2 Primary Outcomes

The mean time to definitive diagnosis was significantly shorter in the POCUS group (22.5 ± 8.6 min) than in the conventional group (58.3 ± 14.2 min) (t=-26.34, P<0.001). The rate of unnecessary chest CT scans was 12.5% (21/168) in the POCUS group, which was 67.8% lower than the 38.8% (62/160) rate in the conventional group (χ^2=29.41, P<0.001). The 30-day mortality rate was 5.4% (9/168) in the POCUS group and 10.6% (17/160) in the conventional group, with a statistically significant difference (χ^2=4.27, P=0.039).

3.3 Secondary Outcomes

The median length of hospital stay was 5.2 days in the POCUS group and 7.8 days in the conventional group (P<0.001). The ICU admission rate was 28.0% (47/168) in the POCUS group and 31.3% (50/160) in the conventional group, with no significant difference (χ^2=0.45, P=0.502). The incidence of missed injuries was 2.4% (4/168) in the POCUS group and 8.8% (14/160) in the conventional group, with a significant difference between the two groups (χ^2=6.22, P=0.013). The missed injuries in the conventional group mainly included occult pneumothorax (n=6) and small hemothorax (n=5), while the POCUS group had only 2 cases of occult pneumothorax and 2 cases of minor pulmonary contusion.

4. Discussion

This study demonstrates that the integration of POCUS into the initial triage of BCT patients yields substantial clinical benefits, including faster definitive diagnosis, fewer unnecessary CT scans, lower missed injury rates, and improved 30-day survival. These findings are consistent with previous research highlighting the utility of E-FAST in trauma care [6,] but extend the evidence by specifically focusing on BCT and quantifying the reduction in radiation exposure and diagnostic delay.

The shortened diagnostic time in the POCUS group is a key advantage, as it enables earlier initiation of life-saving interventions such as tube thoracostomy for hemopneumothorax or pericardiocentesis for tamponade [7]. In contrast, the conventional group experienced prolonged delays due to the need for CXR acquisition and interpretation, as well as the logistical challenges of transporting unstable patients to the CT suite. The reduction in unnecessary CT scans is another critical finding, as it minimizes radiation exposure—a particularly important consideration for young patients and those requiring multiple imaging studies [8]. Additionally, avoiding unnecessary CT scans reduces healthcare costs and ED overcrowding, which are major issues in busy trauma centers [9].

The lower missed injury rate in the POCUS group can be attributed to the high sensitivity of chest ultrasound for detecting occult pneumothorax, a condition that is often missed by CXR but can progress to tension pneumothorax if untreated [10]. Previous studies have reported that POCUS has a sensitivity of 95–100% for pneumothorax, compared to 50–70% for CXR [11]. This high sensitivity translates to fewer delayed diagnoses and subsequent interventions, which contributes to the improved survival observed in the POCUS group.

Despite these benefits, POCUS has limitations that must be acknowledged. The diagnostic accuracy of POCUS is operator-dependent, requiring specialized training and clinical experience [12]. In addition, POCUS is less effective for detecting injuries such as pulmonary contusion and aortic dissection, which still require CT scanning for definitive diagnosis [13]. This explains why there was no significant difference in ICU admission rate between the two groups, as patients with these severe injuries still required intensive care regardless of the initial assessment method.

This study has several limitations. First, it is a single-center retrospective study, which may limit the generalizability of the results to other trauma centers with different patient populations and POCUS training protocols. Second, the decision to use POCUS was not randomized, which may introduce selection bias—for example, more experienced clinicians may have been more likely to use POCUS. Third, the study did not evaluate long-term outcomes such as post-traumatic pulmonary complications or quality of life. Future multicenter randomized controlled trials are needed to confirm these findings and address these limitations.

5. Conclusion

The application of point-of-care ultrasound during the initial triage of blunt chest trauma patients significantly improves diagnostic efficiency, reduces unnecessary radiation exposure, lowers missed injury rates, and enhances short-term survival. POCUS should be considered a standard component of the initial assessment protocol for BCT in level 1 trauma centers, provided that clinicians receive adequate training in the E-FAST protocol. Further research is needed to evaluate the long-term outcomes and cost-effectiveness of POCUS in BCT management.

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