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Fast, accurate, and cost-effective: E-FAST's breakthrough in optimizing thoracic trauma management

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ABSTRACT

Objective: Evaluating the diagnostic accuracy of extended focused assessment with sonography for trauma (E-FAST) for detecting pneumothorax, hemothorax, and pulmonary contusions using thoracic computed tomography (CT) as the reference standard.

Material and Methods: Retrospective analysis of 202 adult thoracic trauma patients (2016-2021). E-FAST diagnostic accuracy was calculated using CT as reference standard.

Results: E-FAST was performed in 149 patients (74%), who presented with significantly higher injury severity (injury severity score: 25 vs. 17; p=0.018) and hemodynamic instability. E-FAST demonstrated 90% sensitivity for pneumothorax, 86% for hemothorax, and 95% specificity for both conditions. Positive predictive values were 92% for pneumothorax and 89% for hemothorax. E-FAST was superior to chest radiography for detecting pleural complications and facilitated immediate thoracic drainage in 39.1% of cases. Cost analysis revealed four-fold reduction compared to CT.

Conclusion: E-FAST demonstrated high diagnostic accuracy for pneumothorax and hemothorax compared to CT, while also showing superior performance to conventional radiography. E-FAST facilitates rapid bedside assessment and immediate surgical decision-making in critically injured patients. However, the significant selection bias toward critically injured patients limits the conclusions regarding the independent impact on clinical outcomes.

Keywords: Thoracic injuries, ultrasonography, focused assessment with sonography for trauma, emergency medicine, decision making

INTRODUCTION

Thoracic trauma is the second most frequent unintentional injury and the third most common cause of death in polytrauma patients, after abdominal injury and head trauma (1). Among patients with severe trauma, thoracic injuries account for 25% of fatalities (2). Patients with severe injuries and critical thoracic trauma present with the highest rates of prehospital intubation, cardiopulmonary resuscitation, emergency chest tube placement, blood transfusion, and urgent surgical intervention. Prompt recognition, diagnosis, and appropriate management are mandatory to improve outcomes, particularly in tertiary hospitals that manage complex cases. Traditional diagnostic modalities, including chest radiography (CXR) and computed tomography (CT), are clinically effective but constrained by radiation exposure, logistical limitations, and substantial costs, particularly in resource-limited healthcare settings. This highlights the need to explore diagnostic alternatives such as thoracic ultrasonography.

The extended focused assessment with sonography for trauma (E-FAST) has emerged as a rapid, reproducible, noninvasive, and cost-effective bedside tool for thoracic trauma evaluation, demonstrating high sensitivity and specificity for detecting pulmonary contusions, pneumothorax, and hemothorax, and doing so without exposing patients to ionizing radiation (3).

Despite the growing global adoption of E-FAST, data on the diagnostic accuracy, clinical impact, and economic benefits of E-FAST in tertiary hospitals in Brazil remain limited.

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This retrospective study evaluated E-FAST utilization in 202 patients with thoracic trauma at a regional trauma center, with the primary objective of determining the diagnostic accuracy of E-FAST for detecting pneumothorax, hemothorax, and pulmonary contusions, using thoracic CT as the reference standard. The secondary objectives included comparing the diagnostic performance of E-FAST with that of conventional CXR, assessing the impact of E-FAST on surgical decision-making and immediate treatment, evaluating the cost-effectiveness of E-FAST implementation, and determining the influence of E-FAST on clinical outcomes. This study aimed to validate the E-FAST as an effective tool for optimizing thoracic trauma management in high-volume tertiary settings.

MATERIAL and METHODS

This retrospective study reviewed the medical records of 476 patients treated at the Emergency and Trauma Surgery Service at University Hospital of Pontifícia Católica de Campinas, a tertiary referral center with 31 years' experience in complex trauma management, between January 2016 and December 2021. Adults (aged ≥18 years) with confirmed thoracic trauma were included in the study. Patients were excluded if patients aged <18 years, died upon trauma bay admission, or had incomplete medical records, resulting in a final sample size of 202. Incomplete records that were not imputed were excluded to ensure data reliability.

The primary outcome was length of hospital stay (days), with secondary outcomes including the need for mechanical ventilation, the use of vasoactive drugs, and mortality. Data extracted from electronic medical records included demographic variables (age and sex), epidemiological variables (trauma mechanism and time from event to admission), clinical variables [revised trauma score (RTS), thoracic trauma severity score (TTSS), injury severity score (ISS), injury burden, and initial management], and diagnostic and treatment variables. The E-FAST, CXR, and CT findings were systematically compared.

E-FAST examinations were performed at the discretion of attending trauma surgeons, emergency physicians, or general surgery residents (second- and third-year) with variable levels of ultrasound experience, following standardized institutional protocols. The decision to perform E-FAST was not randomized and instead followed institutional protocols that prioritized unstable or high-risk patients, typically those presenting with clinical signs of thoracic injury.

Pneumothorax evaluation involved assessing the anterior chest wall (2^{nd}-6^{th} intercostal spaces, clavicular line) with a linear probe. Normal lung sliding appears as a "marching ants" or "sandy beach" pattern. The absence of pleural sliding combined with a "stratosphere" or "barcode" sign on M-mode served as the diagnostic criterion for pneumothorax. The presence of a lung point is considered pathognomonic of pneumothorax. Hemothorax detection employs two complementary approaches: Curvilinear probe placement in the lower intercostal spaces (6^{th}-8^{th}, posterior axillary line) to detect pleural fluid, which appears as anechoic or hypoechoic areas; and identification of the spinal stripe superior to the diaphragm in bilateral upper-quadrant views. All examinations were performed during the primary survey to guide definitive management.

Statistical Analysis

The diagnostic accuracy of e-FAST was assessed by calculating sensitivity and specificity for detecting pulmonary contusions, pneumothorax, and hemothorax, using thoracic CT as the reference standard.

To address potential selection bias, we performed stratified analyses based on the ISSs and hemodynamic status. Propensity score analysis was conducted to balance the baseline characteristics between patients who underwent E-FAST and those who did not. Chi-square tests were used for categorical variables and Mann-Whitney U tests for continuous variables. Multiple logistic regression was performed to identify independent predictors of E-FAST utilization while controlling for potential confounders, including age, injury mechanism, hemodynamic status, and ISSs. The diagnostic performance was estimated with 95% confidence intervals (CI). A sensitivity analysis was performed to assess the robustness of our findings across different patient subgroups. Statistical significance was set at $p<0.05$, and analyses were performed using SPSS v26, Minitab 21.2, and Excel 2010.

Direct costs were calculated using institutional billing data from the Brazilian Sistema Único de Saúde (SUS). Indirect costs, including personnel time, equipment maintenance, training requirements, and potential costs associated with false-positive results, were not included in this analysis, which represents a limitation of the economic evaluation.

This retrospective, single-center study introduces several potential sources of bias, including selection bias (preferential use of E-FAST in critically ill patients), information bias (variable documentation quality and single-center analysis), and temporal bias (evolving protocols over the 5-year study period). The non-randomized nature of E-FAST utilization and the variable experience of operators represent additional limitations that may affect the generalizability of our findings to other institutions.

The study received approval from the University Hospital of Pontifícia Católica de Campinas-Campinas Research Ethics Committee (CAAE: 58584822.0.0000.5481, number: 466/12, date: April 27, 2022).

RESULTS

Of the 476 medical records reviewed, 202 adults with thoracic trauma were included in the final analysis after excluding 274 cases. The study population demonstrated a significant male predominance (77.9; n=156), with a mean age of 43.6±2.9 years (95% CI).

Emergency medical service transport was used in 69% of cases (n=138), with SAMU 192 representing the most frequent prehospital response system (35.5%). Notably, 79% of patients were admitted within two hours of the traumatic event; prehospital response times were <30 min. The mean hospital length of stay was 8.5±3.6 days, and the mean RTS was 6.29±0.16.

Among the 202 patients, blunt trauma predominated in 172 cases (85.1%), whereas penetrating injuries occurred in 30 patients (14.9%). Road traffic injuries (RTI) were the most common mechanism of injury (41.3%), followed by interpersonal violence (31.8%) and falls (25.4%). Accidental falls occur predominantly from a standing height and are more prevalent among older patients (90%). Within the RTI category, two-wheeled vehicle accidents represented the largest subset (19.2% of the total cases), followed by motor vehicle collisions and rollovers (16.7%). The mechanisms of trauma included penetrating injuries (gunshot wounds in 28 cases, 13.8%; stab wounds, 9.9%) and assaults with blunt objects (11.3%) (Table 1).

Most patients (n=148; 72.9%) were hemodynamically and respiratorily stable on admission to the intensive care unit. Hemodynamic instability (SBP <90 mmHg, base excess >-5, or lactate >3.5 milimol/L) was observed in 30 patients. Regarding injury distribution, 107 patients presented with multisystem trauma involving regions beyond the thorax, whereas only 11.8% of patients sustained isolated thoracic trauma.

Specific thoracic lesions included rib fractures in 141 patients (84 with displacement), simple pneumothorax in 63 patients, simple hemothorax in 38 patients, hemopneumothorax in 17 patients, pulmonary contusion in 15 patients, massive hemothorax in 7 patients, and tension pneumothorax in 4 patients. The TTSS distribution indicated injuries ranging from moderate to severe, with a mean TTSS of 10.2±6.8.

Associated injuries were frequent. Orthopedic fractures occurred in 80 patients, of whom 60% had fractures involving the lower extremities and 27% had pelvic fractures. Traumatic brain injury was present in 70 patients (34.7%), and abdominal and facial trauma affected 46 patients (22.8%). Among the intra-abdominal injuries, splenic trauma was the most common (n=28), followed by hepatic laceration (n=19), diaphragmatic injury (n=10), renal trauma (n=8), and mesenteric injury (n=5). Spinal cord trauma and soft-tissue injuries occurred in 25 and 22 patients, respectively. The mean ISS was 18±4.5; 65% of patients had an ISS >15 (Tables 2 and 3).

Non-operative management with clinical observation was implemented in 66% of cases, whereas 30% required immediate thoracic drainage. Digital thoracostomy followed by tube drainage was necessary in 3% of patients, and an emergency department thoracotomy for resuscitation was performed in 1% of patients. Forty patients required thoracic reintervention, with repeat thoracic drainage the most common procedure, followed

Table 1. Trauma mechanisms in 202 patients

Mechanism	Number	Percentage	Category
Motorcycle	39	19.3	Blunt
Falls	36	17.8	Blunt
Motor	32	15.8	Blunt
Gunshot	28	13.9	Penetrating
Assault	23	11.4	Blunt
Stab	20	9.9	Penetrating
Falls	14	6.9	Blunt
Pedestrian	6	3	Blunt
Bicycle	2	1	Blunt
Horse	2	1	Blunt
Total	202	100	

Blunt trauma: 172 patients (85.1%), Penetrating trauma: 30 patients (14.9%).

Table 2. Thoracic injury patterns

Injury	Number	Percentage	Severity
Rib	141	69.8	84
Simple	63	31.2	-
Simple	38	18.8	-
Hemopneumothorax	17	8.4	-
Pulmonary	15	7.4	-
Massive	7	3.5	-
Tension	4	2	-

Mean thoracic trauma severity score: 10.2±6.8 (moderate to severe injuries).
Patients may have multiple thoracic injuries.

Table 3. Associated extra-thoracic injuries

Injury	Patients	Prevalence	Specific
Orthopedic	80	39.6	Lower Pelvis Upper
Traumatic	70	34.7	All
Abdominal trauma	46	22.8	Splenic Hepatic Diaphragmatic Renal: 8 (17.4%) Mesenteric
Spinal	25	12.4	All
Soft	22	10.9	-

Mean ISS: 18±4.5 (65% of patients with ISS >15)
ISS: Injury severity score, Note: Patients may have multiple associated injuries.

by thoracoscopy; there were also two delayed thoracotomies for empyema or retained hemothorax.

E-FAST was performed in 149 patients (74%) during the admission evaluation. CT was performed in 153 patients (78%), and CXR was performed in 115 (59%).

Significant differences were observed between patients who underwent E-FAST and those who did not. Patients selected for the E-FAST examination presented with a higher mean (ISS: 25 vs. 17; p=0.018), increased hemodynamic instability (50% vs. 32.1%; p=0.014), greater requirement for mechanical ventilation (43.4% vs. 15.5%; p<0.001), and more frequent vasoactive drug support (33.8% vs. 8.8%; p<0.001).

Among the patients who underwent E-FAST, immediate thoracic drainage was performed in 39.1% (n=59) based on the ultrasound findings. In 83% of the cases requiring thoracic decompression, the procedure was performed in the emergency department.

CT imaging identified a mean of 2.54 thoracic lesions per patient, compared with 2.18 per patient among patients without CT evaluation (p=0.025). E-FAST demonstrated superior performance compared with radiography for early assessment of severity (p<0.001 for hemodynamic instability). The diagnostic performance of E-FAST and comparative results are presented in (Tables 4 and 5).

E-FAST utilization was associated with increased morbidity, as 19% of patients were discharged with thoracic sequelae compared with 7.6% of patients without E-FAST (p=0.021). Patients who underwent E-FAST had higher mean values for (RTS: 6.46 vs. 6.00), (ISS: 25 vs. 17), and (TTSS: 17 vs. 7) (p=0.018).

E-FAST guided immediate surgical decision-making and facilitated prompt thoracic drainage in 39.1% of cases (n=59; odds ratio: 0.61, 95%; CI: 0.30-1.25). Diagnostic time was reduced by 20-50 minutes in patients who underwent E-FAST compared with those who underwent conventional imaging workflows.

The overall mortality rate was 9.2% (n=17), with multi-organ failure being the primary cause of death.

Table 4. E-FAST diagnostic performance (using CT as reference standard)

Condition	Sensitivity	Specificity	PPV	NPV	Accuracy	95% CI
Pneumothorax	90%	95%	92%	94%	93%	86-97%
Hemothorax	86%	95%	89%	93%	92%	86-97%
Pulmonary	75%	95%	88%	89%	88%	81-94%

E-FAST vs. chest radiography performance
• Pneumothorax detection : E-FAST 90% vs. CXR 65% sensitivity (p<0.001)
• Hemothorax detection : E-FAST 86% vs. CXR 71% sensitivity (p<0.05)
PPV: Positive predictive value, NPV: Negative predictive value, CI: Confidence interval, CT: Computed tomography, E-FAST: Extended focused assessment with sonography for trauma.

Table 5. CT vs. E-FAST comparative diagnostic performance

Parameter	CT imaging	E-FAST	Statistical
Total	153 (75.7%)	149 (73.8%)	-
Mean	2.54±1.2	2.18±1.0	p=0.025*
Comprehensive	153/153 (100%)	142/149 (95.3%)	p<0.001*
Complex	High	Limited	-
Associated	98/153 (64.1%)	45/149 (30.2%)	p<0.001*

Clinical decision impact:
• CT- guided management changes : 89/153 (58.2%)
• E-FAST- guided immediate interventions: 59/149 (39.6%)
• Diagnostic concordance (when both performed): 127/134 (94.8%)
Diagnostic role definition:
• CT: Gold standard for comprehensive injury assessment and surgical planning
• E-FAST: Rapid screening tool for immediate life-threatening injuries
*: Statistically significant difference (p<0.05), CT: Computed tomography, E-FAST: Extended focused assessment with sonography for trauma.

DISCUSSION

Thoracic trauma represents a significant global health burden, contributing to approximately 25% of all direct trauma-related deaths (4). Our epidemiological findings are consistent with established patterns: Young males (18-40 years) accounted for 77.9% of cases, and RTI were the leading mechanism (41.3%). This disproportionate incidence among young adults emphasizes the critical need for targeted prevention strategies, including enhanced road safety education programs, particularly in middle-income countries (5,6). The high ISS and TTSS scores in our series underscored the complexity of the injuries, with 65% of patients having ISS >15 and frequent multisystem involvement.

The predominance of prehospital transport via SAMU 192 (69% of cases) and the high proportion of patients arriving within two hours (79%) reflect Brazil's improved emergency infrastructure and align with the critical "golden hour" concept (7). This improvement can be attributed to three key factors: Effective triage protocols, consistently trained first responders, and streamlined communication systems

That facilitate rapid transport to definitive trauma care facilities in the United States. However, motorcycle-related trauma (19.2%) and interpersonal violence (31.8%) remained significant concerns in urban settings. Penetrating injuries are often more severe (8). Although blunt trauma is typically associated with higher overall mortality rates, most penetrating thoracic injuries in our series progressed to hemodynamic instability, requiring massive transfusion protocols and immediate surgical interventions.

Multiple studies have validated the diagnostic superiority of E-FAST over conventional imaging. Ding et al.'s (9) meta-analysis reported a pooled sensitivity of 88-99% for ultrasound-based diagnosis of pneumothorax, whereas contemporary literature reports 81-95% sensitivity for hemothorax detection (10-15). Our findings align with this evidence, demonstrating 90% and 86% sensitivity for pneumothorax and hemothorax, respectively, with 95% specificity for both conditions.

Its superior performance compared with supine CXR (sensitivities of 90% vs. 65% for pneumothorax; $p<0.001$) supports current trauma guidelines that recommend ultrasound as the preferred initial imaging modality for unstable patients. This superior performance is particularly relevant because small- and medium-sized pneumothoraces and hemothoraces may be missed on supine CXR; this is especially important in our setting, where 79% of patients arrive within two hours of injury, and underscores the need for rapid diagnostic capabilities during the critical initial assessment period.

CT remains the gold standard for comprehensive thoracic trauma evaluation, providing definitive diagnostic information and injury characterization that E-FAST cannot fully replace. Our finding that CT identified a mean of 2.54 thoracic lesions per patient, compared with 2.18 lesions in patients without CT evaluation ($p=0.025$), reinforces CT's superior comprehensive diagnostic capability. Our institutional protocol appropriately positions E-FAST as a rapid screening tool that complements, rather than replaces, CT imaging. However, the diagnostic limitations of this technique must be considered. Operator variability and patient-related factors, such as subcutaneous emphysema, pleural adhesions, and chronic obstructive pulmonary disease, can compromise diagnostic accuracy and potentially lead to confusion with trauma-related changes.

E-FAST facilitated immediate thoracic drainage decisions in 39.1% of cases, with 83% of decompressions performed in the emergency department, demonstrating its value in rapid therapeutic decision-making. This capability aligns with contemporary management, which favors nonoperative approaches (66% of our cases), while enabling prompt intervention when indicated (16,17). The integration of E-FAST with institutional protocols emphasizing image-based criteria for thoracic drainage (30% of cases) supports evidence-based decision-making. Our implementation of the "35-mm rule" for pneumothorax observation and of the >300 mL threshold for hemothorax drainage aligns with the current literature supporting selective management approaches (18-23).

Another common dilemma faced by trauma surgeons is managing hypotensive patients with penetrating thoracoabdominal injuries, particularly in determining which cavities require surgical exploration. Therefore, bedside ultrasonography is mandatory in such situations. Matsushima et al. (24) demonstrated that pericardial FAST examination was highly sensitive and could reliably determine the need for pericardial exploration, whereas positive abdominal FAST findings warranted exploratory laparotomy.

Study Limitations

The most significant limitation of our study was the substantial selection bias in E-FAST utilization. Patients who underwent E-FAST presented with significantly higher (ISS: 25 vs. 17; $p=0.018$) greater hemodynamic instability (50% vs. 32.1%; $p=0.014$), and increased requirements for intensive interventions, including mechanical ventilation (43.4% vs. 15.5%; $p<0.001$) and vasoactive drug support (33.8% vs. 8.8%; $p<0.001$). This selection pattern, while clinically appropriate for prioritizing critically ill patients, creates a fundamental bias that precludes valid conclusions about the independent impact of E-FAST on clinical outcomes, such as mortality, length of stay, or morbidity. The observed association between E-FAST utilization and increased morbidity (thoracic sequelae: 19% vs. 7.6%; $p=0.021$) likely reflects the

underlying severity of illness rather than the causal effect of the diagnostic modality.

The retrospective, single-center design of our study introduces important limitations that must be considered when interpreting our findings. Data from a single Brazilian tertiary trauma center may not be generalizable to other healthcare systems with different resources, protocols, or patient populations. The retrospective nature of the study introduces potential documentation bias and limits our ability to control for confounding variables that could influence diagnostic accuracy or clinical outcomes. Furthermore, our institutional protocols and operator experience may differ from those of other centers, potentially affecting the reproducibility of our results.

A significant limitation of this study is the lack of a systematic assessment of the operator's experience and training levels. Ultrasound is inherently operator-dependent, and variations in physicians' expertise, training, and experience with E-FAST can significantly affect diagnostic accuracy. This limitation is well-documented in the recent literature and represents a persistent challenge in E-FAST implementation. Tan et al. (25) demonstrated that general surgery residency programs have non-standardized E-FAST training approaches, with some relying solely on Advanced trauma life support protocols, while others employ mixed methods, leading to significantly lower sensitivity rates (35.6%). A positive resident-performed E-FAST was generally accurate (85.6%), but its sensitivity was considerably lower than reported in the literature. Similarly, our institution did not maintain formal records of individual operator competency assessments or standardized training during the study period.

The impact of operator variability is further illustrated by Khosravian et al. (26), who found that 29.8% of E-FAST examinations at a level-1 trauma center were undocumented, technically limited, or incomplete, with the thoracic portion of the E-FAST among the most common sources of diagnostic error. While structured training programs have shown promise, with Cevik et al. (27) reporting an 88% pass rate after standardized 1-hour didactic sessions plus a 4-hour practical training for medical students, the absence of universal competency standards across institutions limits the reproducibility and generalizability of E-FAST diagnostic accuracy studies, including our findings. Furthermore, inadequate documentation practices are highlighted by Shwe et al. (28), who found that 78% of E-FASTs lacked any documentation in the patient's chart, even though an E-FAST was recorded and reviewed during ultrasound quality assurance. These findings underscore the critical need for standardized training protocols and competency-based assessment programs to optimize E-FAST reliability and ensure consistent diagnostic performance across different healthcare settings.

Additional limitations include temporal bias during the five-year study period due to evolving protocols, and a cost analysis limited to direct examination costs that did not capture indirect costs, training requirements, or potential costs associated with false-positive results that may lead to unnecessary interventions.

A fourfold reduction in the cost of E-FAST compared with CT (USD 15 vs. USD 60) represents substantial potential savings for high-volume trauma centers. However, this analysis considered only the direct examination costs and did not account for training requirements, equipment maintenance, or potential costs associated with false-positive results. In addition to economic considerations, E-FAST offers significant radiation safety advantages. Patients in our institution receive 5-10 mSv of radiation exposure per thoracic CT examination, which is approximately ten times that of CXR. E-FAST provides a radiation-free diagnostic alternative, which is particularly important in trauma settings where multiple imaging studies may be required.

Despite limitations due to selection bias, our findings support the integration of E-FAST into trauma protocols for rapid initial assessment, particularly in resource-limited settings where CT availability may be restricted. The Brazilian healthcare system faces substantial challenges in the management of trauma victims, with Campinas facing obstacles such as hospital overcrowding and limited resources. In this context, optimizing CT utilization through selective application is critically important to avoid diagnostic overutilization and reduce healthcare costs.

The utility of E-FAST in mass casualty scenarios was demonstrated during the 2023 earthquakes in Türkiye. Taşkın et al. (29) reported that blunt thoracic trauma was observed in 95.5% of earthquake victims, with 103 patients (57.5%) undergoing E-FAST evaluation in the emergency department. Their study highlighted how E-FAST enabled rapid and accurate clinical decision-making in resource-constrained disaster settings, reinforcing the critical role of point-of-care ultrasound in the assessment of thoracic injuries during mass-casualty events.

When combined with CT for detailed injury characterization, as implemented in our institutional protocol, this approach is consistent with established clinical guidelines. CT should not be replaced when comprehensive diagnosis is required; however, E-FAST serves as a useful adjunct to CT (30). Our institutional protocol demonstrated that the bedside E-FAST application significantly reduced diagnostic time by 20-50 minutes compared with conventional imaging workflows, facilitating rapid surgical decision-making.

Future research should prioritize several key areas to address the limitations of our study. Prospective multicenter randomized controlled trials are needed to eliminate selection bias and determine the true impact of E-FAST on clinical outcomes.

Comprehensive cost-effectiveness analyses should include indirect costs, costs associated with avoided complications, training requirements and associated costs, and costs of false-positive interventions. The development of structured training programs with competency assessments is essential to address operator variability and improve reproducibility across institutions.

CONCLUSION

E-FAST demonstrated high diagnostic accuracy for pneumothorax (90% sensitivity, 95% specificity) and hemothorax (86% sensitivity, 95% specificity) with CT as the reference standard, and it outperformed conventional radiography. E-FAST facilitates rapid bedside assessment and immediate surgical decision-making in critically injured patients. However, the significant selection bias toward critically injured patients limits the conclusions regarding the independent impact on clinical outcomes. These findings support the integration of E-FAST as a complementary diagnostic tool in thoracic trauma protocols.

Ethics

Ethics Committee Approval: The study received approval from the University Hospital of Pontifícia Católica de Campinas-Campinas Research Ethics Committee (CAAE: 58584822.0.0000.5481, number: 466/12, date: April 27, 2022).

Informed Consent: Informed consent was obtained from the parents of all patients or their guardians.

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Footnotes

Author Contributions

Surgical and Medical Practices - G.P.M., J.L.B.A.; Concept - G.P.M., V.F.K., E.S.H., J.L.B.A.; Design - H.H.F.M., V.A.L.M.; Data Collection or Processing - V.F.K., H.H.F.M.; Analysis or Interpretation - G.P.M., V.F.K., V.A.L.M.; Literature Search - G.P.M., E.S.H., V.F.K.; Writing - G.P.M., V.F.K., J.L.B.A.

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