



Efficacy of point - of -care ultrasound "POCUS" in initial trauma assessment using the e- fast protocol . A single-center observational study.

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Abstract

Introduction: Trauma is defined as injuries resulting from an external force that affect two or more organs, or as any injury that presents at least one life-threatening injury. The most frequent mechanism of trauma is related to road traffic accidents, followed by penetrating trauma, among which gunshot wounds stand out. The management of trauma patients has been addressed in guidelines and protocols, which have developed multiple scales that allow for the evaluation of survival prognosis, as well as the effectiveness of diagnostic tools such as ultrasound. Objective: To establish the efficacy of point-of-care ultrasound in the initial assessment of trauma using the eFAST protocol.

Methodology: This thesis work had a quantitative approach, with a non-experimental, cross-sectional, prospective, analytical, and observational design.

Results: The trauma cases were primarily abdominal in nature. Of the 63 patients studied who met the selection criteria, 12 were positive, and 51 were negative. Sensitivity (91.7%), specificity (100%), positive predictive value (100%), and negative predictive value (98.1%) were calculated. Discussion: The diagnostic results of the trauma patient evaluation using the eFAST protocol are consistent with those of previously published studies, as are the sensitivity and specificity.

Conclusion: The diagnoses from the eFAST protocol matched the patients' definitive diagnoses with high accuracy, and the procedure demonstrated high sensitivity and specificity.

Keywords :

Trauma, Polytrauma, POCUS, Point-of-care ultrasound, eFAST.

Abbreviations

ATLS: Advanced Trauma Life Support.

Supplementary information

No supplementary materials are declared.

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Authors' contributions

Andrés Jesús Huerta Gil: Conceptualization, Research, Writing – original draft, Resources, Software, Supervision.

Carlota Palma Estrada: Methodology, Data Curation, Formal Analysis, Fundraising, Project Management, Validation, Visualization, Writing – Review and Editing.

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Availability of data and materials

The datasets used and analyzed during this study are available to the corresponding author upon reasonable request.

Introduction

Trauma refers to external and internal injuries involving one or more organs and systems, caused by high or low energy, and which pose a risk to life [1]. The leading causes of trauma in low- and middle-income countries, which are the most populated, are road traffic accidents involving vehicle collisions. Other causes include falls from heights, crush injuries, explosion injuries, and sports-related incidents, among others.

Trauma types are defined according to the affected region; for example, blunt cardiac trauma is classified into two entities: cardiac rupture and myocardial contusion. Eighty percent of patients with cardiac rupture die at the scene; 50% present with associated severe head trauma (TBI), and 43% present with abdominal trauma. Liver trauma occurs in 5% of trauma admissions and, due to its size, is the most frequently affected solid organ in both blunt and penetrating trauma. Renal trauma and urinary tract involvement account for less than 10% of injuries in polytrauma patients. The kidney is the most frequently injured organ in this system. Renal injury is observed in up to 5% of trauma cases and in 10% of abdominal trauma cases [2].

Pulmonary injuries are observed in almost 75% of severe chest traumas. The most frequent mechanisms are those related to motor vehicle accidents, such as direct trauma to the anterior chest wall against the steering wheel and lateral impact injuries; falls from heights, crush injuries, and gunshot wounds are also frequent causes of contusion [2].

Trauma patients require comprehensive management, as they may present with both immediate and delayed complications. Conventionally, a physical examination, laboratory tests, and imaging studies are performed, ordered as needed: X-rays, CT scans, and, last but not least, a chest and abdominal ultrasound, a rapid, highly sensitive examination that complements early diagnosis and prognosis [2]. In the United States, trauma is the leading cause of death among individuals aged 1 to 44, according to the American Society for the Surgery of Trauma, and it is essential to reduce these rates through adequate training of healthcare personnel [3]. At the Latin American level, trauma cases in Chile constitute a significant problem, accounting for 10% of hospital discharges and representing the fourth leading cause of death, at 8.9%, of which 13.1% are male, and 39% are in the 10-49 age group [4]. Among the causes of violent deaths reported in Ecuador in 2016, 8,689 deaths were recorded; the most frequent causes were, first, accidental injuries; second, traffic accidents; and, subsequently, with a lower percentage, suicide and interpersonal assaults [5]. Of these 8,689 deaths, 3,396 were due to external causes, such as accidental injuries, of which 2,330 were men, and 1,066 were women; As the second

leading cause of death, we found 2,894 people who died from road traffic accidents, of which 2,332 were male, and 562 were female [5].

Proper trauma management relies on accurate diagnosis. The Extended Focused Ultrasound Assessment in Trauma (e-FAST) examines five areas for free fluid in approximately 2–3 minutes: perihepatic or hepatorenal space, pericardium, perisplenic, pelvis or pouch of Douglas, and pleural cavity. The e-FAST protocol has recently been incorporated into the Advanced Trauma Life Sciences secondary classification. Advanced Trauma Life Support (ATLS) is used to detect hemopericardium and hemoperitoneum rapidly. Technological advances have enabled the acquisition of portable ultrasound devices that can be used in challenging field and aeromedical environments. Although not yet widespread, portable ultrasound units are now being used by Emergency Medical Services (EMS) systems operating in out-of-hospital settings.

In less complex healthcare facilities, having these types of resources would improve management due to the timely detection of pathologies resulting from trauma, thus reducing complication and mortality rates. In secondary-level hospitals, the initial assessment of polytrauma patients can be hampered by the lack of 24-hour ultrasound service availability for various reasons, delaying timely diagnosis and appropriate management. The use of complementary diagnostic tools in the training of general practitioners should be updated and strengthened, as ultrasound has become a standard technique in other countries during patient examinations.

At the IESS Los Ceibos General Hospital in northern Guayaquil, the rate of trauma patients treated in the emergency department is very high, and injury severity is assessed using clinical protocols. Therefore, it would be highly beneficial for medical personnel in this area to use practical tools, such as low-cost, portable handheld devices, to screen for injuries that, in the short- and medium-term, can lead to patient death. The objective of this study was to evaluate the effectiveness of point-of-care ultrasound (PoCUS) in the initial assessment of trauma using the e-FAST protocol.

Materials and methods

Studio design

This study is observational. The source is retrospective.

Scenery

The study was conducted in the emergency department of the IESS Los Ceibos North General Hospital, part of the Ecuadorian Social Security Institute, located in Guayaquil,

Guayas Province, Ecuador. The research period ran from November 1, 2021, to March 31, 2022.

Participants

Records of adult patients diagnosed with trauma and who had signed informed consent and who underwent eFAST were included. Records of incomplete cases were excluded.

Variables

The variables were: age, sex, origin, cause of polytrauma, affected systems (CNS, respiratory, cardiac, abdominal organs, pelvic organs), level of severity of trauma, ultrasound diagnosis, and final diagnosis.

Data sources/measurements

The source was indirect; an electronic form was completed using data from the institutional medical records. For the case search, multiple searches were performed for patients diagnosed with trauma according to ICD-10 codes S00-S99 and T00-T99.

Biases

Observation and selection bias were avoided by applying participant selection criteria. To prevent potential interviewer, information, and memory biases, the principal investigator maintained data collection under a set of guidelines and with records approved in accordance with the research protocol. Two researchers independently analyzed each record in duplicate, and variables were entered into the database after their consistency was verified.

Study size

The sample was probabilistic. In 2024, Guayaquil recorded 3,396 adult deaths due to trauma. With five large hospitals, it is expected that at least 20% of these patients (679 cases) will be referred to the IESS hospital. With a hospitalization rate of 11.2%, the population consists of 76 cases per year. With a 95% confidence level, a 5% confidence interval, and an expected frequency of 50%, the calculated sample size was 63 cases. Epi Info™ version 7.2 (CDC, Atlanta, March 9, 2025) was used.

Quantitative variables

The variables were treated as continuous, as their entire original distributions were used. No mathematical transformations (such as logarithms or square roots) were applied. Outliers were identified using a Tukey diagram, and extreme values were addressed through primary source verification. Missing data were handled by exclusion. No dichotomization or categorization was used for the continuous variables.

Statistical analysis

Qualitative variables were analyzed using frequencies and percentages. An analysis of the eFast diagnostic tests is presented, comparing them with the final diagnosis. The statistical package used was IBM Corp., released in 2018. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp.

Results

Participants

A total of 63 patients who met the inclusion criteria were analyzed, allowing us to reach 100% of the sample.

Characteristics of the study group

There were 63 patients, with a mean age of 38 ± 14.8 years. Five cases (7.9%) were over 64 years old; 39 cases (57.1%) were between 18 and 39 years old; and 22 cases (34.9%) were between 40 and 64 years old. Sixteen patients (25.4%) were women, and 47 (74.6%) were men. All cases were due to accidental causes ([Table 1](#)).

Table 1. Description general of patients.

Category	Variable	N=63
Age by category	>64 years	5 (7.9%)
	18-39 years	36 (57.1%)
	40-64 years	22 (34.9%)
Sex	Women	16 (25.4%)
	Man	47 (74.6%)
Origin	Rural	7 (11.1%)
	Urban	50 (79.4%)
	Marginal urban	6 (9.5%)
Trauma Score	Critical	4 (6.3%)
	Moderate	59 (93.7%)
Initial clinical diagnosis	Multiple superficial trauma	33 (52.4%)
	Superficial trauma affecting other combinations of body regions	30 (47.6%)

Type of injury

There were 51 negative cases (81%) and 12 cases with various chest and abdominal lesions diagnosed by ultrasound ([Table 2](#) and [Table 3](#)). In 1 case, a chest x-ray was performed (1.6%), and in 11 cases, CT scans (17.5%).

Table 2. Cavities and organs affected by trauma and evidenced by the eFAST protocol at the patient's bedside.

	Evidenced injuries	Frequency	Percentage
Main cavity affected	AB	48	76.2%
	EXT	1	1.6%
	TX	14	22.2%
	PELVIS	0	0%
	AVE	N/A*	N/A*
Affected cavities	AB	21	33.3%
	AB, EXT	4	6.3%
	AB, TX	13	20.4%
	PV, EXT	1	1.6%
	TX	9	14.3%
	TX, AB, CRA, EXT	1	1.6%
	TX, AB, PV, EXT	13	20.6%
	TX, PV, EXT	1	1.6%
Affected organs	Organs massifs abdominal exercises	48	76.2%
	EXT	1	1.6%
	HEART	14	22.2%

*N/A: No applies due to that in the protocol e- fast No value cranium . AB: abdomen. CRA: skull. EXT: Extremities. TX: thorax.

Table 3. POCUS specific for lesions.

	Frequency n=63	Percentage
Hemopneumothorax	1	1.6%
Hemopericardium	1	1.6%
Abdominal Hemorrhage	7	11.1%
Hemothorax	2	3.2%
Negative	51	81.0%
Pneumothorax	1	1.6%

Case management

Most cases were managed clinically and conservatively ([Table 4](#)).

Diagnostic tests

According to the diagnostic test calculations, a prevalence of 19.05% was determined, with a sensitivity of 100%. The sensitivity was 91.7%. The area under the curve was 99.0% ($P<0.0001$) ([Figure 1](#)).

Discussion

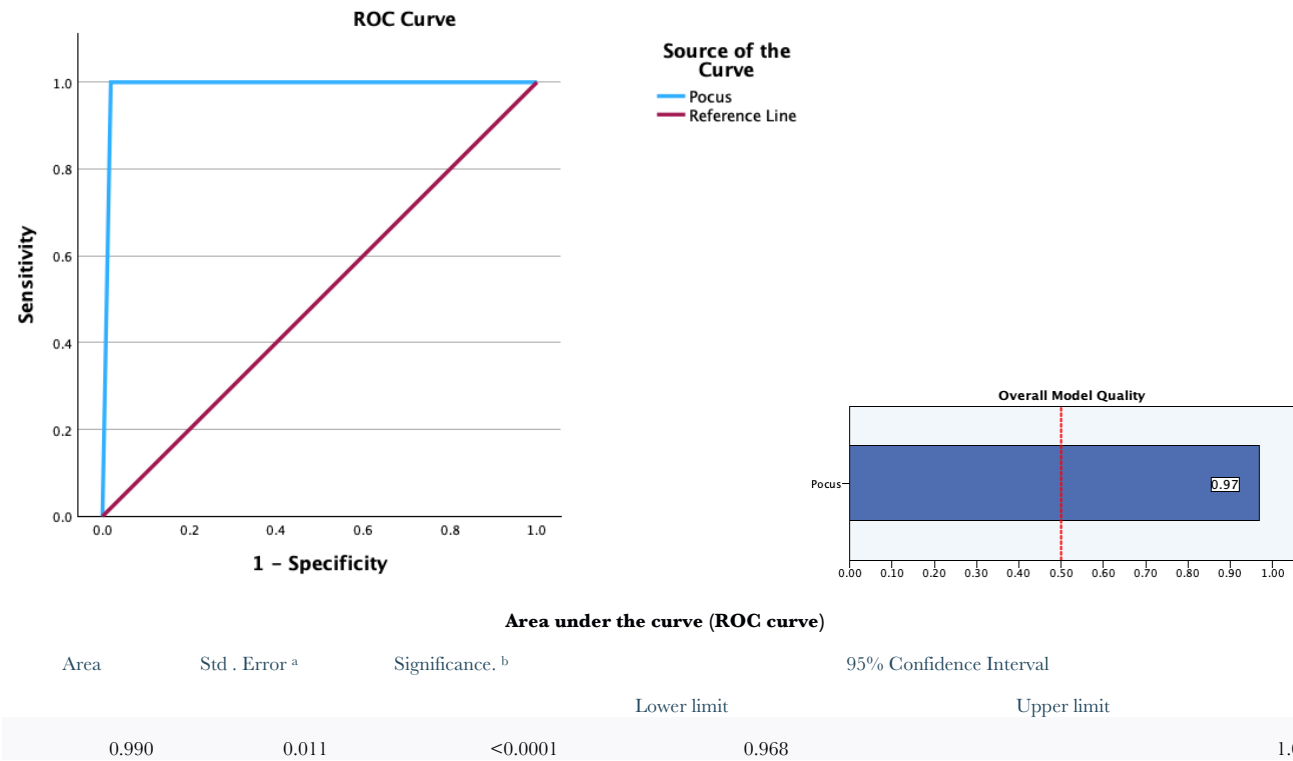
According to prior research, no studies have been conducted in Ecuador evaluating the diagnostic accuracy of the EFAST test performed by general practitioners with basic training in point-of-care ultrasound (PoCUS), as implemented in this case for trauma patients. Therefore, this constitutes the first research work on this topic.

The findings of this study suggest that point-of-care ultrasound (PoCUS) helps detect hemoperitoneum, hemothorax, and pneumothorax in the initial management of trauma patients, due to its high sensitivity, specificity, and positive predictive value. In this study, we found that the sensitivity, specificity, positive predictive value, and negative predictive value were 91.7%, 100%, 100%, and 98.1%, respectively. In a study by Bode et al., the sensitivity, specificity, and positive predictive value of EFAST were 92%, 100%, and 100%, respectively [6]. A similar study by Hsu et al. suggested that the sensitivity, specificity, and positive predictive value of EFAST should be 80%, 100%, and 100%, respectively. This provides evidence that EFAST can be considered one of the most reliable detection modalities for correctly identifying free air in the pleural cavity or free fluid in the peritoneal, pleural, or pericardial cavity.

Table 4. Diagnosis and management of patients with polytrauma .

Diagnostics and management		Frequen cy n=63	Percentag e
Diagnoses and interventions	Splenectomy + Laparotomy exploratory	1	1.6%
	Hemopneumothorax traumatic	1	1.6%
	Secondary traumatic hemorrhage and recurrent	4	6.3%
	Traumatic hemothorax	2	3.2%
	Laceration liver + Laparotomy exploratory	1	1.6%
	Traumatic pneumothorax	1	1.6%
	Other superficial injuries of the abdomen, region lumbosacral and pelvis.	11	17.5%
	Trauma closed abdomen hemorrhage secondary and recurrent traumatic.	1	1.6%
	Trauma of the heart with hemopericardium	1	1.6%
	superficial injuries , No specified	36	57.1%
Management	Trauma superficial that affect other combinations of regions of the body	4	6.3%
	Clinical + Medical discharge	51	81.0%
	Conservative	7	11.1%
	Laparotomy	2	3.2%
	Chest Tube	3	4.8%

Figure 1. ROC curve of the ultrasound diagnostic method (POCUS).



Of the patients who required EFAST in this study, the majority were men (74.6%), consistent with a similar study that reported 74% were male. This gender difference is further highlighted by the higher rate of disability-adjusted life years (DALYs) from transportation injuries in men compared to women [7]. A study by Singh et al. also demonstrated a higher male prevalence in motor vehicle accidents [8]. This could be due to men's greater participation in outdoor and high-risk activities, such as driving, construction work, heavy lifting, etc., compared to women.

Early diagnosis and timely intervention in trauma patients with thoracic and abdominal injuries can save lives. In this study, most EFAST examinations were completed within 2–5 minutes ($n=63$, 100%). A survey by Tunuka et al. also found that most EFAST examinations were completed in less than 5 minutes [9].

Among thoracic and abdominal injuries, abdominal trauma is more frequent. Among intra-abdominal traumas, solid organs, such as the liver and spleen, are most frequently injured. In this study, the most frequently injured intra-abdominal organs in blunt trauma were the liver and spleen, which is consistent with the study by Zwingmann et al. [10]. A survey by Arumugam et al. demonstrated that the liver is the most commonly involved organ, followed by the spleen [11]. Most traumas were managed conservatively, and only a few patients were hemodynamically unstable; these underwent emergency exploratory laparotomy, which is consistent with other research [12].

Among the false-negative cases, the first and only one was a grade II splenic injury, reported within 3 hours of the injury, which yielded a positive result on repeat testing; an abdominal CT scan was subsequently performed. EFAST has a limited capacity to detect relatively small fluid accumulations in the early post-traumatic phase [13]. Furthermore, EFAST is a subjective technique that requires a trained, competent, and experienced physician.

The point-of-care unit (POCUS) is a constantly evolving diagnostic tool used in outpatient, inpatient, and emergency department settings. Diagnostic time decreases, and accuracy increases when POCUS is combined with clinical examination and diagnostic or therapeutic procedures. POCUS is also helpful in resource-limited settings [14].

The American College of Emergency Physicians (ACEP) indicates that there are two ways to demonstrate ultrasound proficiency: For medical residency, physicians must submit a certificate confirming completion of residency training, including at least 150 scans and didactic activities. For standardized point-of-care ultrasound (POCUS) proficiency, a letter from the residency program certifies at least 16 hours of

continuing medical education (CME) and completion of at least 25 ultrasound examinations. This training must have been conducted under the supervision of a specialist with advanced POCUS training, or the education must have been documented and reviewed to ensure technical proficiency and proper interpretation of the examinations [12].

The increase in the availability of different modalities for certification in the use of ultrasound under continuing medical education through courses and diplomas with university endorsement fosters the enthusiasm of physicians who are interested in learning and implementing the use of ultrasound in an integrated way and at the patient's bedside in the assessment of patients under their care [13–14].

It is essential that both hospitals and universities accept the challenge of developing continuing education programs to enable their physicians to gradually achieve competence in performing ultrasound studies, interpreting images, and integrating point-of-care ultrasound (POCUS) into clinical reasoning.

Conclusions

The diagnoses derived from trauma, obtained using the eFAST protocol at the patient's bedside, were: hemopneumothorax, hemopericardium, abdominal hemorrhage, hemothorax, and pneumothorax. A sensitivity of 91.7% and a specificity of 100% were established for the eFAST protocol in point-of-care (PoCUS) mode as a diagnostic method for detecting cavity injuries in trauma patients included in the study sample upon admission.

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Statements

Ethics committee approval and consent to participate

The study was approved by the bioethics committee of the Faculty of Medical Sciences, University of Guayaquil.

Publication consent

It was not required, as the present study does not publish images, radiographs, or specific patient studies.

Conflicts of interest

The research has no financial interests or conflicts of interest.

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