Impact of Point-of-Care Ultrasound in Triage on Diagnosis and Treatment of Trauma Patients in a Resource-Limited Setting in East Africa

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Abstract

BACKGROUND

Emergency Department Point-of-Care Ultrasound (ED-POCUS) has shown promise in expediting the management of patients in resource-limited settings. This study aimed to evaluate the clinical impact of triage-based ED-POCUS using the Extended Focused Assessment with Sonography for Trauma (E-FAST) exam for the evaluation of blunt trauma patients in the Accident & Emergency Department (A&E) of a large tertiary public hospital in East Africa.

METHODS

This was a non-randomized, prospective, quasi-experimental study of adult patients presenting with blunt torso trauma to the A&E of Kenyatta National Hospital in Nairobi, Kenya. The before group received usual care, and the intervention group underwent an E-FAST exam after triage in addition to usual care. The primary outcome was defined as the occurrence of and time to intervention, such as transfusion of blood products, chest tube insertion, or transfer to the operating theatre. Secondary outcomes included time to intravenous fluids (IVF), first speciality consultation, time from consult to specialist evaluation, disposition, length of hospital stay, and in-hospital mortality.

RESULTS

The usual care group (before ultrasound) included 149 patients, and 99 patients were enrolled in the E-FAST (after ultrasound) cohort. The occurrence of and time to the composite primary outcome did not differ significantly between the two groups (p=0.61 and p=0.56, respectively). Of the secondary outcomes, time to IVF was significantly shorter in the E-FAST compared with the usual care group (median 5.5 minutes (IQR 16.0) vs 32.8 (117.5).

CONCLUSION

The use of the E-FAST exam at triage in blunt trauma victims did not significantly improve the time to surgical intervention or transfusion of blood products. However, there was improved time to IVF resuscitation.

Keywords: *Triage, Ultrasound, Emergency Medicine, Trauma*

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Introduction

Point-of-care ultrasound (POCUS) has become common in emergency departments (ED) in high-income countries globally [1]. Multiple studies have established the utility of POCUS in the setting of cardiac and pulmonary emergencies, trauma[2-4], acute abdomen[5,6], obstetric emergencies[7], testicular torsion[8], deep vein thrombosis[9,10] and appendicitis[11]. Moreover, the use of ultrasound in the emergency department significantly enhances diagnostic certainty and influences both treatment planning and the decision to pursue additional imaging in cases of undifferentiated hypotension [12].

The body of literature addressing POCUS use in low- and middle-income countries (LMIC) remains relatively limited, but rapidly growing[1,13]. Ultrasound has enormous potential as a diagnostic tool in LMIC as it is portable, relatively inexpensive, and does not expose the patient to radiation. In addition, studies show that minimal training can greatly increase diagnostic skills, representing a good return on investment [1]. A recent systematic review [13] found that POCUS use may change clinical decision-making in up to 70% of cases.

The FAST exam (Focused Assessment with Sonography for Trauma) is one of the most established point-of-care ultrasound modalities. This exam makes use of a portable ultrasound machine at an injured patient's bedside to evaluate for blood in the peritoneal, pleural and pericardial spaces [1, 12, 14-16]. The Extended Focused Assessment with Sonography for Trauma (E-FAST) includes evaluation for pneumothorax [17]. The FAST is a key part of the primary survey in hypotensive blunt trauma patients and is included in the Advanced Trauma Life Support (ATLS) guidelines [18].

The use of E-FAST is an established practice in the management of injured patients in higher-income countries, but its practice in LMICs is nascent. In resource-limited settings such as Kenyatta National Hospital (KNH) in Nairobi, Kenya, multiple structural factors lead to delays in the evaluation, diagnosis, speciality consultation and definitive care for patients in the emergency department. These delays lead to potential increases in morbidity and mortality. However, E-FAST use has shown promise in expediting the workup and treatment of patients in resource-limited and disaster settings [19-22].

As ultrasound is utilised more frequently in LMICs, it will be increasingly important to understand the ways in which this powerful tool could be used most efficiently in healthcare facilities in resource-limited areas. One of the uses with the most potential is in triage. Prior studies have shown that triage pathways that incorporate POCUS result in increased efficiency, cost-effectiveness, and reduced reliance on CT scanning compared to pathways that utilise CT exclusively [23-25]. Thus, the routine use of POCUS at triage has the potential to reduce the time to diagnosis and expedite care interventions.

This study aimed to evaluate the clinical impact of performing E-FAST exams at the time of triage via point-of-care ultrasound in patients with blunt injuries on interventions and times to treatment at the KNH A&E in Nairobi, Kenya

Methodology

Study design and setting

This was a non-randomised, prospective, quasi-experimental study of patients presenting with blunt trauma to the A&E of KNH. KNH, the largest hospital in Kenya, is an 1800-bed national referral facility located in Nairobi [26]. The study was carried out in the A&E at KNH. The study team was composed of an interdisciplinary team of stakeholders of patient care in the A&E, including members from the departments of Radiology, Surgery, and A&E. The surgery department (primary consulting team) was involved in the development of our scanning protocol and consulting physicians (postgraduate registrars) were made aware of the process.

Study populations

Inclusion and exclusion Criteria. Adult patients who were victims of suspected blunt torso trauma, triaged red, orange, or yellow via the South African Triage Scale (SATS), were included [28]. Blunt torso trauma is an injury to the body by forceful impact, involving the chest, abdomen, pelvis and/or back. We also included patients with severe head trauma and penetrating trauma in whom blunt torso trauma could not otherwise be ruled out. Patients below the age of 18 and patients whose trauma was isolated to an extremity or whose injury occurred >1 week prior were excluded. Patients were enrolled by trained research personnel between 7:00 a.m. and 10:00 p.m. This was a convenience sample based on the availability of resources. The research assistant was placed at triage to assist the triage nurse and to identify patients who met the inclusion criteria. The triage nurse performed the initial evaluation, and the research assistant documented the time that the triage evaluation was completed.

Sample size determination

The sample size of 70-165 patients per group was based on a priori estimates of power of 80%, with a two-sided alpha = 0.05, using the following standard sample size equation: $n = 2 (Z_{1-\alpha/2}+Z_{1-\beta})^2 * \alpha^2/\Delta^2$. This was based on clinical significance (between a 10-to-30-minute time differences) and standard deviations from prior ultrasound literature [29, 30].

Data collection

For all enrolled patients, demographic information, triage information, mechanism of injury, transfer status, initial Glasgow Coma Scale (GCS) and revised Trauma Score were collected. We documented the time that the following actions were taken: triage, specialist consult, specialist evaluation, and performance of surgical intervention (defined as the initiation of blood transfusion, placement of a chest tube, or departure from A&E to the operating room for surgery). All patients were followed throughout their A&E and hospital stay, and the following data were documented: additional A&E imaging, time of A&E disposition, hospital length of stay, and in-hospital mortality. For patients in the E-FAST group, we documented the time of E-FAST performance, E-FAST results, and the time of notification of any positive or negative results. Study data were collected and managed using REDCap electronic data capture tools hosted at KNH [27].

Outcomes. The primary outcome was a composite of blood transfusion, chest tube insertion, and/or transfer to surgery. Patients receiving any of these interventions were categorised as having the primary outcome. We compared the time to the first intervention of the composite outcome between the usual care and E-FAST groups, as these interventions may result from abnormal E-FAST findings [31]. Secondary outcomes included time to IV fluid resuscitation, transfusion, chest tube placement, intubation, consults, operating room arrival, hospital length of stay, mortality, additional imaging tests, and total hospital bill.

Phase 1: Usual Care /Before. The first part of the study involved enrolling all patients who met inclusion criteria, collecting information on baseline characteristics, primary outcome data and following the patients through their Emergency Department stay and inpatient hospitalisation to collect the secondary outcome data. Patient management decisions were at the discretion of the treating physicians, who were not part of the study team. Patients were enrolled from 31st May, 2019, to 2nd Aug, 2019 (before = "before the introduction of E-FAST", termed = "Usual Care").

Phase 2: E-FAST /After. For the second part of the study, a trained and fully credentialed healthcare provider (operator) performed an E-FAST exam after check-in by the triage nurse. Patient management decisions were also at the discretion of the treating physicians. The E-FAST results were placed in the patient's chart and were available to the treating physicians. All enrolled patients in the "usual care" and "E-FAST" groups were followed prospectively through their A&E and hospital stay.

Patients recruited before the intervention are referred to as the "Usual Care" group. Patients recruited following the intervention (implementation of POCUS in trauma) are referred to as the "E-FAST" group. Patients were enrolled from Oct 15, 2019, to May 25th, 2021 (after = "introduction of E-FAST", termed = "E-FAST").

Ultrasound protocol. E-FAST imaging was performed by trained and credentialed physicians, including those from the Canadian POCUS global outreach program and US Emergency Medicine Board-certified physicians. The exam used a Butterfly iQ, smartphone-connected, ultrasound probe (Butterfly Network, Inc.) to assess Morison's pouch, pericardial space, splenorenal fossa, recto-vesicular space, and pleura for pneumothorax. All images and cine loops were saved to a secure cloud, with each assigned an ID linked to the patient's ID in the REDCap database. The operator documented their interpretation (positive, negative, or indeterminate) in the patient's chart and the REDCap database.

Data analysis

Demographic characteristics of participants are described using n and percentage in the two groups. For the primary outcome, groups are compared using Chi-square with exact p-values. Continuous time metric data were compared using the Rank Sum test as the distributions were skewed. Secondary outcomes are presented as median and interquartile range (IQR) for continuous data and frequency with percentages for categorical data.

Ethical considerations

This study was approved by the KNH Ethics Review Committee (#P44/01/2018) and the University of North Carolina (UNC) Institutional Review Board (#17-2634). Patients consented to inclusion in the study and POCUS examination by informed consent. Consent was waived in specific circumstances whereby consent could not be obtained due to the patient's medical condition (i.e. critical illness, altered mental status); however, consent was then sought from the participant's legally authorised representative.

Results

The usual care group included 149 patients, and 99 patients were enrolled in the E-FAST group. (Figure 1). The majority of patients were male (88.6% and 86.9%) and between the ages of 18-49 (89.3% and 82.8%). The most common mechanisms of injury were road traffic accidents (32.9 and 47.5%), assaults (22.5 and 22.2%), motorcycle/bicycle crashes (12.1 and 11.1%), pedestrian trauma (11.4 and 1%), and falls (10.1 and 11.1%). Participants arrived as transfers from outside the hospital, 47.7% and 32.3%. The majority of participants were triaged as "Very Urgent" (77.9% and 66.7%) (Table 1).

In the E-FAST group, 29 patients had positive results (29.3%), six patients were indeterminate (6.1%), and 63 patients had negative results (63.6%) based on POCUS at the time of triage. Of the 29 patients with positive E-FAST results, twelve had pneumothorax (41.4%), twelve had pleural effusion (41.4%) twelve had fluid in Morrison's pouch (41.4%), eight had fluid in the splenorenal recess (27.6%), six had pelvic free fluid (20.7%) and three had pericardial effusion (10.3%). Out of the patients with positive E-FAST findings, 16 had only one E-FAST finding (55.2%), 10 patients had two or three findings (34.4%), and three patients had 4 separate ultrasound findings (10.3%) (Table 2).

The composite outcome occurred in 9 usual care patients and 8 E-FAST patients. The occurrence of the composite primary outcome did not differ significantly between the two groups (p=0.53) (Table 3a). Of the secondary outcomes, time to IVF was statistically significantly shorter in the E-FAST compared with the usual care group (median 5.5 minutes (IQR 16.0) vs 32.8 (117.5)). The remainder of the secondary outcomes did not show a statistically significant difference between the two groups. (Table 3b).

Discussion

In this prospective study, we found no statistically significant differences in the primary composite outcome (blood transfusion, chest tube and/or surgery) or in time to its first component. There were also no differences in overall resource use or mortality. These findings contrast with a retrospective study from a high-income setting, which found E-FAST useful for identifying patients at risk of haemorrhage and guiding resource allocation [32]. That study recommended E-FAST as an early decision tool to direct high-risk patients to surgery and others to further imaging. Given these conflicting results, a randomised controlled trial is needed for stronger evidence.

Of our secondary outcomes, the use of E-FAST led to faster initiation of IV fluid resuscitation. This finding could indicate that E-FAST findings may have helped signal the patients who could benefit from more attention and resuscitation from the A&E staff. From a resource perspective, IV fluids are more readily accessible to the A&E staff while blood supply is chronically limited in Kenyan hospitals [33].

Few prospective studies have evaluated the utility of E-FAST at triage in the African region. A study performed in Mulago Hospital in Uganda showed that the use of FAST to evaluate blunt trauma patients soon after arrival predicted which patients had a high likelihood of requiring a laparotomy [34]. However, that study did not have a comparison arm and did not report on time to surgical intervention, overall resource utilisation or patient mortality. In a larger study of 1556 trauma patients evaluated at Ifakara referral hospital in Tanzania, 283 (18.1%) received an E-FAST exam, and 53 (18.7%) had positive findings [35].

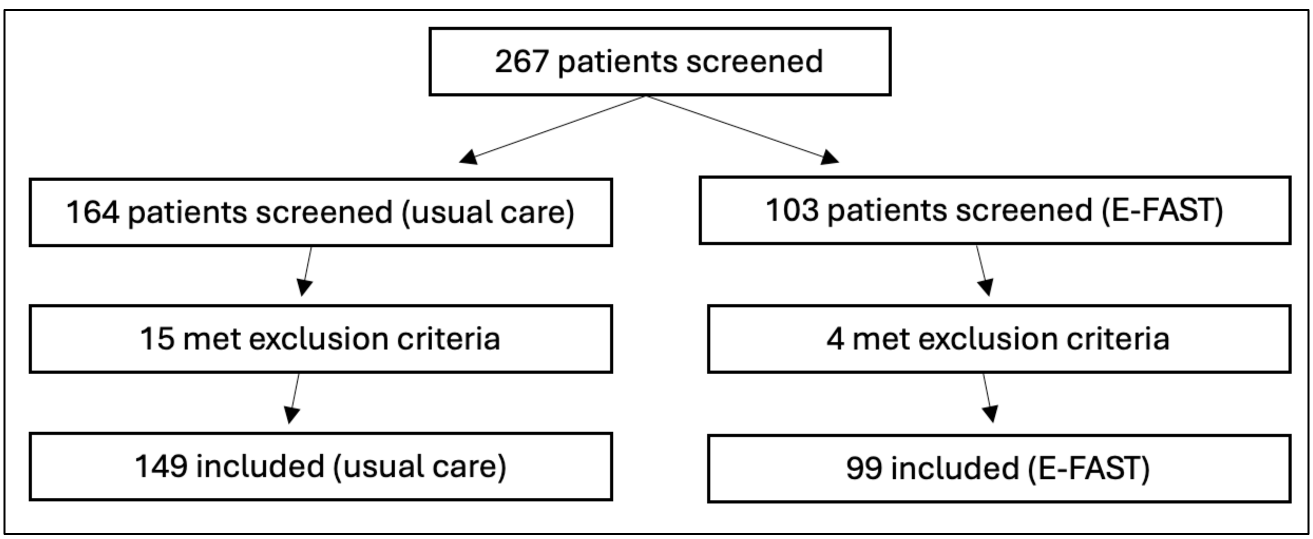

Figure 1:
Enrolment Flow Diagram (before = usual care, after = E-FAST)

Per that study, the patients with positive findings were transferred directly to the theatre for surgery. Thus, the E-FAST was used to identify patients with urgent surgical needs and helped prioritise surgical intervention without requiring additional imaging.

This is desirable in low-resource settings where CTs are limited. While these prior works suggest that the use of E-FAST at triage is useful for the early identification of patients who require surgical intervention, they are limited by the lack of comparator groups.

Several studies demonstrate the array of applications and benefits of POCUS use for patients in Kenya. POCUS has shown feasibility among rural healthcare providers [36, 37] as well as improving patient referral processes [38]. Novel applications through remote training and quality insurance (for example, project ECHO- "Extension for Community Healthcare Outcomes") have shown promise [39]. It is also possible that trauma POCUS may demonstrate greater clinical impact in rural settings in Kenya, rather than in a more advanced healthcare setting, such as KNH.

Table 1
Demographic Characteristics

Variables	Categories	Usual Care (n=149)		E-FAST (n=99)	
Age	18-49	133	(89.3)	81	(82.8)
	≥50	11	(7.4)	8	(8.1)
	Unknown	5	(3.4)	10	(10.1)
Sex	Male	132	(88.6)	86	(86.9)
	Female	16	(10.7)	12	(12.1)
	Unknown	1	(0.7)	1	(1.0)
Mechanism of Injury	Road Traffic Accident	49	(32.9)	47	(47.5)
	Assault	38	(25.5)	22	(22.2)
	Motorcyclist or Bicyclist	18	(12.1)	11	(11.1)
	Fall	15	(10.1)	11	(11.1)
	Pedestrian	17	(11.4)	1	(1.0)
	Burn	2	(1.3)	0	(0.0)
	Other	10	(6.7)	8	(7.1)
Time of Triage	Morning (7 am-12 pm)	62	(41.6)	31	(31.3)
	Afternoon (12 pm-5 pm)	69	(46.3)	57	(57.6)
	Evening(5pm-10pm)	17	(11.4)	11	(11.1)
	Unknown	1	(0.7)	0	(0.0)
Transferred from another facility?	No	76	(51.0)	65	(65.7)
	Yes	71	(47.7)	32	(32.3)
	Unknown	2	(1.3)	2	(2.0)
Triage Level SATS	Emergency (Red)	15	(10.1)	32	(32.3)
	Very Urgent (Orange)	116	(77.9)	66	(66.7)
	Urgent (Yellow)	18	(12.1)	1	(1.0)
Glasgow Coma Score (GCS)	Mild (13-15)	132	(88.6)	84	(84.9)
	Moderate (9-12)	6	(4.0)	6	(6.1)
	Severe (3-8)	11	(7.4)	9	(9.1)
Revised Trauma Score	Less than 2	0	(0.0)	0	(0.0)
	2 to less than 4	1	(0.7)	1	(1.0)
	4 or more	148	(99.3)	97	(97.9)
	Unknown	0	(0.0	1	(1.0)

Key: All data are presented as n (%) unless otherwise noted.

Limitations

We did not find any prospective comparative "before and after" studies that looked at the impact of E-FAST at triage on subsequent patient management decisions and patient outcomes in an emergency department in a low-resource setting.

Table 2
POCUS E-FAST Results in the E-FAST Group

Variables	Categories	n (%)	
E-FAST result (n=99)	Positive	29	(29.3)
	Indeterminate	6	(6.1)
	Negative	63	(63.6)
	Not done	1	(1.0)
E-FAST positive findings* (n=29)	Pneumothorax	12	(41.4)
	Fluid-Morrison's Pouch	12	(41.4)
	Fluid-splenorenal recess	8	(27.6)
	Pericardial effusion	3	(10.3)
	Fluid-pelvis	6	(20.7)
	Pleural effusion	12	(41.4)
Number of findings (n=29)	1	16	(55.2)
	2	5	(17.2)
	3	5	(17.2)
	4	3	(10.3)

Key: *not mutually exclusive

Table 3a
Primary Outcomes

	Usual Care n=149		E-FAST n=99		p-value
Composite outcome	9	(6.0)	8	(8.1)	0.53
Packed red blood cells transfused	5	(3.4)	4	(4.0)	
Chest tube placed	1	(0.7)	4	(4.0)	
Transfer to the operating room	3	(2.0)	2	(2.0)	

Key: Data are presented as n (%)

Table 3b
Secondary Outcomes

	Usual Care (n=149)		E-FAST(n=99)		p-value
Time to intravenous fluids (minutes), (n=110)	32.8	(117.5)	5.5	(16.0)	<0.01
Time to packed red blood cell transfusion (minutes), (n=8)	127.8	(100.3)	88.9	(587.7)	>0.99
Time to chest tube placement (minutes), (n=4)	374.1	n/a**	422.7	(517.7)	0.65
Time to intubation (minutes), (n=12)	185.7	(177.7)	99.5	(127.1)	0.37
Time to first consult (minutes), (n=137)	61.1	(262.5)	96.0	(292.8)	0.14
Time to consult seen (minutes), (n=124)	130.5	(299.0)	130.0	(300.0)	0.31
Time to the operating room (minutes), (n=5)	675.2	(827.9)	1,291.2	(708.3)	0.40
Time to disposition (minutes), (n=198)	699.1	(527.0)	599.7	(641.6)	0.92
Number of additional imaging tests, (n=248)	1	(1)	2	(1)	0.24
Hospital length of stay (days), (n=93)	10	(11)	13	(19)	0.26
Died in hospital (n=101), n (%)	5	(8.5)	4	(9.5)	>0.99
Total hospital bill (Ksh), (n=75)	57,928	(97,305)	34,819	(73,712)	0.68

Key: *All data presented are median (IQR) unless otherwise noted, and p-values are for the rank sum test due to skewed data; **Single Result; Secondary outcomes*

Thus, our study is the first to do this in the African setting. However, the study had several limitations. The use of E-FAST did not significantly change the composite primary outcomes, which were the performance of, or time taken to initiate blood transfusion, place a chest tube or go to the operating theatre. Several factors may have impacted this result. First, the study was likely underpowered to detect these changes. This is because only 9 patients in the "usual care" group and 8 patients in the "E-FAST" group reached the composite outcome.

Secondly, aspects of the primary outcome may have been impacted by factors such as the lack of treatment therapies for blood products or workforce constraints, such as a shortage of surgeons available for operative care.

While E-FAST use does not resolve broader systemic barriers in trauma care, future research should examine their influence on care delivery and POCUS interpretation, as these factors were beyond the scope of this study. Notably, this was the first time E-FAST was integrated into trauma care at KNH A&E, with support from A&E, radiology, and surgical leadership. A&E staff conducted E-FAST exams, with radiology confirming positive or unclear results before surgical consultation. The absence of surgical teams during examinations and the lack of a standardised protocol for responding to E-FAST findings may have introduced variability in management decisions. A larger sample size and standardised approach may improve future evaluations. Ongoing collaboration among clinical leaders will be key for future improvements.

Conclusion

The use of the E-FAST exam at triage in blunt trauma victims did not demonstrate a significant clinical impact in regard to surgical intervention or transfusion of blood products. However, there was improved time to IVF resuscitation. Primary outcomes could have been impacted by resource limitations, for example, lack of blood products, and/or a small sample size.

Recommendations

E-FAST in KNH triage does not appear to be the ideal setting and we recommend further study to determine where and how this technology could best enhance patient care at KNH.

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