ORIGINAL RESEARCH

Review of a large trauma registry in Addis Ababa, Ethiopia: Insights into prehospital care and provider training for trauma quality improvement

Nichole Starr[1], Mengistu Ayehu[2], Alex Zhuang[3], Habtamu Tamiru Minalu[2], Genet Kifle Alemu[2], Samuel Fisseha[2], Sisay Chekol[2], Aklile Habtemariam Kassa[2], Makida Hadis[2], Biruh Alemtsehay[2], Minale Mengiste[2], Ashenafi Kenefi[2]

[1]Department of Surgery, University of California, San Francisco, San Francisco, CA, USA
[2]ALERT Trauma Center, Addis Ababa, Ethiopia
[3]Boston University School of Medicine, Boston, MA, USA

Correspondence: Dr Nichole Starr (nichole.starr@ucsf.edu)

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Abstract

Background

Injury is a major cause of death and disability in Ethiopia. ALERT Trauma Center in Addis Ababa, among only 3 designated trauma centres in the country, has employed a basic trauma registry since its inception in 2016; however, these data had not been utilized. In joint efforts with the Federal Ministry of Health, we aimed to understand patient injury characteristics and predictors of mortality to inform priorities in resource and training investments.

Methods

Data from 12 816 consecutive patients in the first 3 years of the trauma registry were reviewed retrospectively. MEWS (Modified Early Warning Score) was used at triage to indicate injury severity ('red', critically injured; 'green', minor injury). Physiologic data for calculating injury severity scores and in-hospital intervention data were not available. Triage groups were compared, and multivariate logistic regression analysis was conducted to determine predictors of death in the emergency department.

Results

Most patients presented with minor injuries, with 64.7% triaged as 'yellow' and 16.4% triaged as 'green'. Most patients (75.9%) were also referred in from another facility. Of those who were critically injured, only 31.0% arrived by ambulance. Most injuries were soft-tissue injuries (51.1%) and fractures (23.0%). Most 'red' patients had sustained head injuries (62.7%). Arrival by ambulance (odds ratio, 2.20; P=0.017) and head injury (odds ratio, 3.11; P<0.001) were independent predictors of death in the emergency department.

Conclusions

This study of injured patients presenting to an Ethiopian trauma centre is among the largest to date, highlighting the need for more accessible and streamlined prehospital trauma care. Opportunities for improvement include staff training in initial trauma management and implementation of a more comprehensive trauma registry containing physiologic, intervention, and outcomes data to support a robust quality improvement programme. Efforts by the Federal Ministry of Health are ongoing to support these improvements in care.

Keywords: trauma registry, quality improvement, patient outcomes, Ethiopia

Introduction

In 2009, the World Health Organization (WHO) and several international surgical societies published a collection of guidelines for improving the quality and efficacy of trauma care globally. This joint effort was made in response to the more than 5 million people who lose their lives to injury-related deaths each year, 90% of which occur in low- and middle-income countries.[1] Among the recommendations, the report emphasized the importance of assessing the quality of trauma care in hospitals with tools such as trauma

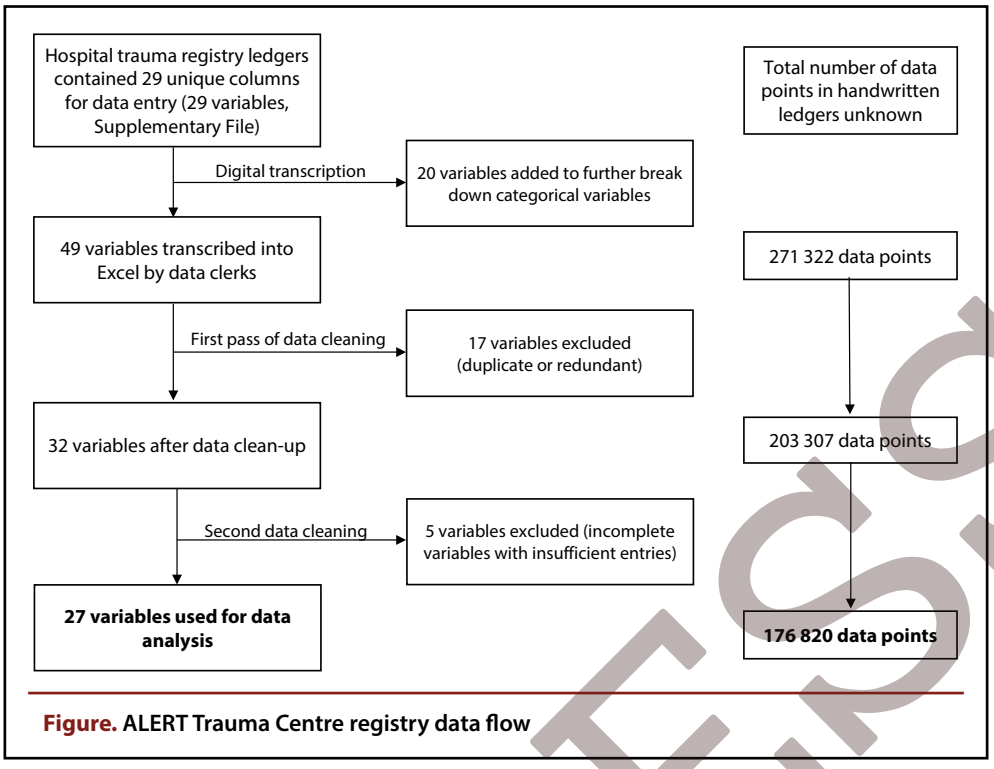

Figure. ALERT Trauma Centre registry data flow

registries.[2] Trauma registries are an important component of programmes designed to improve trauma care and reduce mortality in both high- and low-income environments.[3] While trauma registries are common in high-resource settings, their use is varied in countries with constrained resources and less-developed trauma systems. Despite this, many registries have been implemented in low-income settings, including in sub-Saharan Africa, in an effort to improve trauma care.[4]-[7] Many of these programmes use trauma registries to identify and review preventable deaths from trauma and address gaps in specific trauma care processes.[8]

Injury remains a prevalent cause of death and disability in Ethiopia.[9] While several studies have characterized the volume and types of injuries seen at hospitals across Ethiopia,[10]-[13] particularly noting the high volume of road traffic crashes contributing to trauma volumes,[14] permanently established trauma registries outside of short-term studies remain rare.[15] The Ethiopian Ministry of Health has implemented a basic standardized trauma registry throughout major hospitals in Ethiopia. ALERT Hospital Trauma Center in Addis Ababa is currently among only 3 designated trauma centres in the country and has been maintaining this basic trauma registry, which includes patients presenting to the trauma unit, since 2016.

While this trauma registry has existed for several years, its data have never been analysed or used to guide future priority settings. This study aimed to examine 3 years of trauma registry data to describe the patterns of injury and the demographics of patients presenting to ALERT Trauma Center, identify priority areas for local trauma system improvement, and inform future implementation of a more comprehensive, standardized, and accessible registry.

Methods

Study setting and ethical approval

ALERT Hospital is a tertiary care hospital in Addis Ababa, the capital city of Ethiopia. It serves a population of approximately 3.5 million and has 20 emergency department (ED) beds, 38 inpatient trauma ward beds, and 10 critical-care beds. The hospital has 10 operating theatres, 3 of which are exclusively dedicated to trauma care.

ALERT Hospital Trauma Center was inaugurated in 2015 as 1 of 3 dedicated trauma centres in the country. The hospital began a basic trauma registry in 2016 by entering the data of all patients who presented to the trauma ED—a separate building from the medical ED—into a registry book. Data were then later transcribed into the hospital's electronic database (Supplementary File). Armauer Hansen Research Institute, ALERT Hospital's ethical review board, approved the study (protocol number PO/24/19).

Study design

This was a retrospective review of a basic trauma registry at a trauma centre in Addis Ababa, Ethiopia. The database was maintained by hospital personnel in Excel (Microsoft Corp. Redmond, WA, USA) and was deidentified before analysis for study purposes. After ethical approval was obtained from the hospital's institutional review board, the deidentified database was delivered to study personnel for cleaning and analysis. All entries in the database for the consecutive 3 years since its inception were included in the original dataset. The registry was developed by Ethiopia's Ministry of Health and contains information on patient demographics, course of care (mode of arrival, referral status, triage category, time to triage, and disposition after triage), diagnostic information (mechanism of injury and diagnosis), and ED outcomes

Table 1. Modified Early Warning Score (MEWS)

Score	0	1	2	3
Mobility	Walking	With help	Stretcher	
Heart rate	51-100	41-50 or 101-110	≤40 or 111-129	>130
Respiratory rate	9-14	15-20	≤8 or 21-29	>30
Oxygen saturation	≥94%	90-94%	≤90%[a]	
Temperature	35.1-37.2	37.3-37.9	≤35.0 or ≥38.5	
CNS/AVPU	Alert	Respond to voice	Respond to pain or confused	Unresponsive
Systolic blood pressure	101-199	81-100	71-80 or ≥200	≤70
Trauma	No	Yes		
Pain score	No pain	1-3 out of 10	4-7 out of 10	≥7 out of 10

MEWS categories[b]			
Red	**Orange**	**Yellow**	**Green**
MEWS ≥7	MEWS 5-6	MEWS 3-4	MEWS 3-4
- OR -	- OR -	- AND -	- OR -
Chest pain		Hgb < 8	Haemoglobin <10 g/dL
Current seizure	Postictal state	Previous bleeding	
Blood sugar <45 mg/dL		Haematemesis	
Aggressive	Aggressive	Haemoptysis	

[a]Not for CO poisoning; [b]Black = Dead on arrival

(duration of ED stay, disposition status from ED). No information after ED departure was included in the registry, and aside from the initial triage category, which accounts both for injury mechanisms and initial vital signs, no other physiologic or intervention data were included.

Missing data and excluded variables

The Excel format of the registry had duplicate or redundant variables (17 total) that were excluded and an additional 5 variables with such little data that they were also excluded from the analysis, leaving the database with 27 variables in the final analysis (Figure). Most patients (n=12 776, 99.7%) were missing information on the mechanism of injury, which was ultimately excluded from the analysis. While 2 364 patient records referred to injuries sustained in road traffic crashes, only 287 (12.1%) contained any information on the type of vehicle involved. Patient records with missing data were included in this available-case analysis and categorized as 'Unknown'. For brevity, these missing data are not itemized in the tables; however, percentages were calculated using the total counts of the respective variables, including the 'Unknown' data, as denominators.

Data cleaning and analysis

All patients recorded in the trauma registry between September 2016 and March 2019 were included in this study. The dataset was cleaned using Excel, version 16.39. Data cleaning involved converting dates from the Ethiopian calendar to the Gregorian calendar as well as correcting errors and typos from the initial data entry. In the event of an unclear entry, data clerks and hospital staff were consulted, and uninterpretable entries were discarded. Data were analysed using Stata 16.1 (StataCorp, College Station, TX, USA).

Patients were stratified by injury severity based on their vital signs and diagnoses upon triage. Each patient was first assigned a MEWS (Modified Early Warning Score, a scoring index intended to identify patients at increased risk of clinical deterioration and death, which has been validated for medical and surgical patients).[16],[17] Triage categories were organized by colour, with 'red' as the most critical category, followed by 'orange', 'yellow', and 'green' in descending order of severity and urgency; 'black' signified patients who were dead on arrival (Table 1, Table 2).

Each diagnosis entry was assigned a standardized Abbreviated Injury Score body region code. These were further

Table 2. Overall characteristics (N=12 816)

Median age, years (IQR)	27 (21-36)	**Road traffic crash**	2364 (18.4)
Sex		**Road user type (n=2364)**	
Male	9568 (74.7)	Pedestrian	1861 (78.7)
Female	3201 (25.0)	Motorcyclist	74 (3.1)
Patient residence		Vehicle occupant	429 (18.1)
Addis Ababa	9388 (73.3)	**Pedestrian struck by vehicle type (n=1861)**	
Amhara	475 (3.7)	Three-wheeled vehicle	84 (4.5)
Harar	14 (0.1)	Minibus	58 (3.1)
Oromia	1322 (10.3)	Taxi	49 (2.6)
SSNPR	274 (2.1)	Motorcycle	26 (1.4)
Tigray	38 (0.3)	Heavy truck	25 (1.3)
Mode of presentation to hospital		Private car	24 (1.3)
Ambulance	1329 (10.4)	Bicycle	6 (0.3)
Taxi	3299 (25.7)	**Injury location by AIS body region**	
Self-presentation (walk-up)	4039 (31.5)	Head	1381 (10.8)
Interfacility referral	2878 (22.5)	Face	264 (2.1)
Private vehicle	727 (5.7)	Thorax	339 (2.6)
Police	35 (0.3)	Abdomen	101 (0.8)
Assisted	113 (0.9)	Spine	188 (1.5)
Referral from other facility	9725 (75.9)	Upper extremity	994 (7.8)
Referring facility (n=9725)		Lower extremity	926 (7.2)
Health centre	4675 (48.1)	**Patient disposition from ED**	
Different hospital	1561 (16.1)	Stabilized and discharged from ED	8332 (65.0)
Triage category		Admitted	1567 (12.2)
Red	480 (3.7)	Direct to operating theatre	156 (1.2)
Orange	1481 (11.6)	Referred out	215 (1.7)
Yellow	8293 (64.7)	Died in ED	57 (0.4)
Green	2099 (16.4)		
Black	41 (0.3)		
Disposition after triage			
Resuscitation area	4291 (33.5)		
Operating theatre/procedure room	2188 (17.1)		
ED exam room	759 (5.9)		
Waiting area	4187 (32.7)		
Dead on arrival	21 (0.2)		

Values are n (%) unless otherwise indicated. Patient records with missing data were included in this available-case analysis and categorized as 'Unknown'. For brevity, 'Unknown' data and categories with low tallies are not listed here. Percentages were calculated using the total counts of the respective variables, including the 'Unknown' data, as denominators.

AIS, Abbreviated Injury Scale; ED, emergency department; IQR, interquartile range; SSNPR, Southern Nations, Nationalities, and Peoples' Region

Table 3. Demographics and injuries by triage category (N=12 816)

Variable	Triage category				*P* value
	Red (n=480)	Orange (n=1481)	Yellow (n=8293)	Green (n=2099)	
Median age, years (IQR)	28 (23-38)	28 (22-38)	27 (21-35)	27 (20-35)	<0.001
Sex					
Male	389 (81.2)	1199 (81.1)	6173 (74.5)	1484 (70.9)	<0.001
Female	90 (18.8)	280 (18.9)	2108 (25.5)	609 (29.1)	
Patient residence					
Inside Addis Ababa	253 (52.7)	968 (65.4)	6193 (74.7)	1674 (79.6)	<0.001
Outside Addis Ababa	130 (27.0)	321 (21.7)	1342 (16.2)	270 (12.9)	
Mode of presentation to hospital					
Ambulance	149 (31.0)	308 (20.8)	772 (9.3)	87 (4.2)	
Taxi	69 (14.4)	250 (16.9)	2404 (29.0)	546 (26.0)	
Self-presentation (walk-up)	90 (18.6)	344 (23.2)	2545 (30.7)	946 (45.1)	
Interfacility referral	139 (29.0)	452 (30.5)	1839 (22.2)	345 (16.4)	<0.001
Private vehicle	21 (4.4)	84 (5.7)	504 (6.1)	112 (5.3)	
Police	0 (0.0)	8 (0.5)	18 (0.2)	7 (0.3)	
Assisted	2 (0.4)	9 (0.6)	84 (1.0)	13 (0.6)	
Referral from other facility	399 (83.1)	1173 (79.2)	6482 (78.2)	1493 (71.1)	<0.001

Continued

sorted into injury categories within specific body regions: head, face, thorax, abdomen, spine, upper extremity, lower extremity, and body region not otherwise specified.

Descriptive and summary statistic tables were generated using patient demographic, injury, and hospital course information. Comparative analyses included using chi-squared or Kruskal–Wallis tests of significance, as appropriate, to analyse differences between groups. Univariate and multivariate analyses were also conducted to determine predictors of death in the ED.

Results

A total of 12 816 records from the trauma registry were identified and reviewed for this study. Of the 12 816 patients included, the median age was 27±15 years, and 9568 patients (74.7%) were male (Table 2). Most patients lived in Addis Ababa (n=9388, 73.3%); the second most common region of residence was Oromia (n=1322, 10.3%), which surrounds Addis Ababa. Most patients self-presented (walked up) to the ED (n=4039; 31.5%); 3299 (25.7%) arrived by taxi, while 1329 (10.4%) arrived by ambulance. Most patients were referred to ALERT from an outside facility (n=9725, 75.9%); 215 patients (1.7%) were referred out to other facilities afterwards. Approximately half of the patients (n=4675, 48.1%) were referred in from a health centre, while others were referred from another secondary or tertiary hospital (n=1561, 16.1%).

Triage category, injuries, and disposition after triage

Most patients were triaged into the 'yellow' triage category (n=8293, 64.7%), while 480 patients (3.7%) were classified as 'red' (Table 2). After initial triage, about one-third of patients were transferred to the resuscitation area (n=4291, 33.5%), and another one-third went back to the waiting area (n=4187, 32.7%). The rest of the patients either went directly to the operating theatre or procedure room (n=2188, 17.1%) or an unmonitored ED examination room (n=759, 5.9%). Eighteen per cent of patients (n=2364) were involved in road traffic crashes; of these, most were pedestrians (n=1861, 78.7%). Most patients (n=8332, 65.0%) were stabilized and discharged from the ED; 1567 (12.2%) were admitted to the hospital, and 57 patients (0.4%) died in the ED.

Demographics, injuries, and outcomes by triage category

Of the most severely injured 'red' patients (n=480), 149 (31.0%) presented via ambulance, compared with 87 'green' patients (4.2%) (Table 3). Ninety 'red' patients (18.6%) and 946 'green' patients (45.1%) presented themselves without vehicular assistance. There were 155 'red' patients (32.3%) sent to the operating theatre or procedure room after triage; 119 (24.8%) returned to the waiting area, and 95 (19.8%)

Table 3. Continued

Variable	Triage category				*P* value
	Red (n=480)	Orange (n=1481)	Yellow (n=8293)	Green (n=2099)	
Referring facility					
Health centre	141 (29.4)	502 (33.9)	3189 (38.5)	767 (36.5)	<0.001
Other hospital	163 (34.0)	323 (21.8)	926 (11.2)	113 (5.4)	
Disposition after triage					
Resuscitation area	95 (19.8)	316 (21.3)	2865 (34.5)	895 (42.6)	
Operating theatre/procedure room	155 (32.3)	515 (34.8)	1320 (15.9)	154 (7.3)	<0.001
ED exam room	26 (5.4)	78 (5.3)	579 (7.0)	67 (3.2)	
Waiting area	119 (24.8)	371 (25.1)	2812 (33.9)	840 (40.0)	
Road traffic crash	143 (29.8)	361 (24.4)	1531 (18.5)	294 (14.0)	<0.001
Road user type					
Pedestrian	121 (84.6)	295 (81.7)	1195 (78.1)	220 (74.8)	0.057
Motorcyclist	3 (2.1)	17 (4.7)	45 (2.9)	8 (2.7)	
Vehicle occupant	19 (13.3)	49 (13.6)	291 (19.0)	66 (22.4)	
Patient disposition from ED					
Stabilized and discharged from ED	140 (9.2)	595 (40.2)	5765 (69.5)	1665 (79.3)	
Admitted	151 (31.5)	484 (32.7)	805 (9.7)	89 (4.2)	<0.001
Direct to operating theatre	30 (6.3)	46 (3.1)	72 (0.9)	5 (0.2)	
Referred out	20 (4.2)	41 (2.8)	119 (1.4)	31 (1.5)	
Died in ED	22 (4.6)	5 (0.3)	15 (0.2)	12 (0.6)	

Values are n (%) unless otherwise indicated. Patient records with missing data were included in this available-case analysis and categorized as 'Unknown'. For brevity, missing data and categories with low tallies are not listed here. Percentages were calculated using the total counts of the respective variables, including the 'Unknown' data, as denominators.

ED, emergency department; IQR, interquartile range

were sent to the resuscitation area. These proportions were reflected similarly in the breakdown of 'orange' patients' dispositions after triage, with 515 (34.8%) going to the operating theatre or procedure room, 371 (25.1%) to the waiting area, and 316 (21.3%) to the resuscitation area.

Soft-tissue injuries (n=5647, 52.1%) and fractures/dislocations (n=2489, 23.0%) were the most common injuries (Table 4). 'Red' patients were most likely to present with head injuries (n=253, 62.7%), such as traumatic brain injuries and intracranial bleeds, while 'green' patients were most likely to present with soft-tissue injuries (n=1310, 89.0%) (Table 3). The majority of upper (82.8%) and lower (88.3%) extremity injuries were fractures/dislocations, most of which were assigned to the 'yellow' triage category. While many of the differences between variables by triage category reached statistical significance, it is beyond the scope of this article to explore detailed statistical differences between individual triage category groups.

Most 'green' patients (n=1665, 79.3%) were stabilized and discharged from the ED, 89 (4.2%) were admitted, and 12 (0.6%) died in the ED (Table 3). Meanwhile, 140 'red' patients (29.2%) were stabilized and discharged, 151 (31.5%) were admitted, and 22 (4.6%) died in the ED.

Predictors of ED mortality

Multivariate logistic regression analysis—controlling for age, gender, and triage severity category—indicated that residence in Addis Ababa (odds ratio [OR], 0.52; *P*=0.049) and interfacility transfer (OR, 0.17; *P*=0.001) were associated with lower odds of death in the ED (Table 5). Patients who arrived by ambulance (OR, 2.20; *P*=0.017) and had sustained head injuries (OR, 3.11, *P*<0.001) had increased odds of death in the ED.

Discussion

This study represents the largest population of injured patients studied in Ethiopia to date. Analysis of the first 3 years

Table 4. Injury types overall and by triage category

Factor	Total (N=12 816)	Triage category				*P* value
		Red (n=480)	Orange (n=1481)	Yellow (n=8293)	Green (n=2099)	
Injury by AIS Head	1381 (10.8)	253 (52.7)	345 (23.3)	687 (8.3)	75 (3.6)	<0.001
Head injury NOS	15 (1.1)	2 (0.8)	3 (0.9)	8 (1.2)	2 (2.7)	
Skull fracture	208 (15.1)	9 (3.6)	40 (11.6)	138 (20.1)	18 (24.0)	
Mild TBI	571 (41.3)	42 (16.6)	145 (42.0)	350 (50.9)	30 (40.0)	
Moderate TBI	291 (21.1)	79 (31.2)	97 (28.1)	93 (13.5)	17 (22.7)	
Severe TBI	112 (8.1)	92 (36.4)	12 (3.5)	4 (0.6)	1 (1.3)	
Intracranial bleed	163 (11.8)	29 (11.5)	45 (13.0)	79 (11.5)	4 (5.3)	
Scalp laceration	21 (1.5)	–	3 (0.9)	15 (2.2)	3 (4.0)	
Injury by AIS Face	264 (2.1)	2 (0.4)	31 (2.1)	181 (2.2)	44 (2.1)	0.52
Ophthalmic injury	18 (6.8)	–	–	16 (8.8)	2 (4.5)	
Oral/dental injury	41 (15.5)	–	4 (12.9)	30 (16.6)	7 (15.9)	
Facial laceration	51 (19.3)	–	5 (16.1)	33 (18.2)	10 (22.7)	
Facial fracture	154 (58.3)	2 (100.0)	22 (71.0)	102 (56.4)	25 (56.8)	
Injury by AIS Thorax	339 (2.6)	14 (2.9)	42 (2.8)	247 (3.0)	29 (1.4)	<0.001
Thoracic trauma NOS	4 (1.2)	1 (7.1)	1 (2.4)	2 (0.8)	–	
Blunt thoracic trauma	79 (23.3)	3 (21.4)	6 (14.3)	60 (24.3)	9 (31.0)	
Penetrating thoracic trauma	22 (6.5)	2 (14.3)	6 (14.3)	13 (5.3)	1 (3.4)	
Haemothorax	35 (10.3)	3 (21.4)	12 (28.6)	18 (7.3)	2 (6.9)	
Rib fracture	96 (28.3)	5 (35.7)	10 (23.8)	71 (28.7)	5 (17.2)	
Clavicle fracture	91 (26.8)	–	4 (9.5)	75 (30.4)	11 (37.9)	
Scapular fracture	12 (3.5)	–	3 (7.1)	8 (3.2)	1 (3.4)	
Injury by AIS Abdomen	101 (0.8)	10 (2.1)	22 (1.5)	57 (0.7)	11 (0.5)	0.12
Abdominal trauma NOS	9 (8.9)	1 (10.0)	3 (13.6)	3 (5.3)	2 (18.2)	
Blunt abdominal trauma	68 (67.3)	6 (60.0)	9 (40.9)	44 (77.2)	8 (72.7)	
Penetrating abdominal trauma	24 (23.8)	3 (30.0)	10 (45.5)	10 (17.5)	1 (9.1)	

Continued

of the ALERT Trauma Center trauma registry reveals several important issues in the functioning of the trauma centre as well as the trauma response system in Addis Ababa and may be used to highlight areas of potential improvement.

Prehospital care and initial patient triage

The small proportion of critically injured patients arriving by ambulance highlights gaps in the prehospital care system and elucidates opportunities for more robust ambulance services and communication networks to expedite patient transport. A recent large-scale study conducted in Malawi revealed similar problems with long transport times for patients with serious injuries and highlighted the importance of improved emergency medical services.[18] Similarly, a study conducted in Nigeria highlighted a high proportion of patients being transported to trauma centres by laypersons with long transport times.[19] The pattern of a high proportion of road traffic accidents and intracranial injuries among those seriously injured was also seen in a recent study in Tanzania that used data from the WHO model trauma registry.[20] For seriously injured patients with head injuries, rapid transport to trauma centres with the highest level of care provides the best opportunity for survival. In this setting, a potential opportunity for improvement could be greater access to ambulance services for critically injured patients to receive immediate care during rapid transport to a trauma centre.

Table 4. ***Continued***

Factor	Total (N=12 816)	Triage category				*P* value
		Red (n=480)	Orange (n=1481)	Yellow (n=8293)	Green (n=2099)	
Injury by AIS Spine	188 (1.5)	8 (1.7)	59 (4.0)	109 (1.3)	8 (0.4)	<0.001
Lumbar spine fracture	16 (8.5)	–	6 (10.2)	8 (7.3)	2 (25.0)	
Thoracic spine fracture	1 (0.5)	–	–	–	–	
Cervical spine fracture	36 (19.1)	3 (37.5)	8 (13.6)	24 (22.0)	–	
Spinal cord injury	135 (71.8)	5 (62.5)	45 (76.3)	77 (70.6)	6 (75.0)	
Injury by AIS Upper Extremity	994 (7.8)	8 (1.7)	62 (4.2)	764 (9.2)	148 (7.1)	0.087
Injury NOS	103 (10.4)	4 (50.0)	8 (12.9)	76 (9.9)	15 (10.1)	
Fracture/dislocation	823 (82.8)	4 (50.0)	50 (80.6)	632 (82.7)	125 (84.5)	
Soft tissue injury/infection	46 (4.6)	–	3 (4.8)	36 (4.7)	7 (4.7)	
Amputation	22 (2.2)	–	1 (1.6)	20 (2.6)	1 (0.7)	
Injury by AIS Lower Extremity	926 (7.2)	21 (4.4)	181 (12.2)	655 (7.9)	61 (2.9)	<0.001
Injury NOS	11 (1.2)	0 (0.0)	2 (1.1)	8 (1.2)	1 (1.6)	
Fracture/dislocation	818 (88.3)	16 (76.2)	158 (87.3)	583 (89.0)	53 (86.9)	
Soft tissue injury/infection	7 (0.8)	–	–	5 (0.8)	2 (3.3)	
Amputation	1 (0.1)	1 (4.8)	–	–	–	
Sprain	18 (1.9)	–	1 (0.6)	15 (2.3)	2 (3.3)	
Pelvic trauma NOS	1 (0.1)	–	–	1 (0.2)	–	
Pelvic fracture	67 (7.2)	4 (19.0)	20 (11.0)	40 (6.1)	3 (4.9)	
Genital trauma	3 (0.3)	–	–	3 (0.5)	–	
Injury by Body Region NOS	6612 (61.6)	86 (17.9)	449 (30.3)	4491 (54.2)	1472 (70.1)	<0.001
Soft-tissue injury	5584 (84.5)	42 (48.8)	323 (71.9)	3812 (84.9)	1310 (89.0)	
Burn	219 (3.3)	10 (11.6)	28 (6.2)	129 (2.9)	46 (3.1)	

Values other than *P* values are n (%).

AIS, Abbreviated Injury Scale; NOS, not otherwise specified; TBI, traumatic brain injury

While critically injured patients should be prioritized to receive ambulance transport to trauma centres, low-acuity patients can safely be treated at lower levels of care. The high number of soft-tissue injuries and low-acuity patients treated at ALERT creates difficulties in patient flow, rapid triage, and treatment at this designated trauma centre, which is among just a few in Ethiopia. Many of these minor injuries could likely be treated at lower levels of care, freeing space at the trauma centre to manage more complex injuries, but they need to be managed through an improved prehospital triage process to ensure that the correct mix of patients is optimized at each level of care. Currently, the Federal Ministry of Health is developing a centralized ambulance dispatch call centre for Addis Ababa and constructing ambulance 'hubs' distributed throughout the city for a more coordinated and timely prehospital response. The Ministry of Transport has also supported several training events for drivers to receive basic first-responder training for road traffic accidents. The results from this study provide convincing support for this service expansion.

ED triage and resuscitation

Overall, the ED mortality rate was low at 0.5%. However, 12 patients (0.6%) triaged as 'green' died in the ED. In these instances, it is likely that either serious injuries were missed or these patients were triaged inappropriately. In such circumstances, a death audit could be performed to identify the exact details related to these patients' presentations, and a trauma quality improvement committee could conduct a preventable death review to ascertain potential systemic issues and improve future patient care. Furthermore, the disposition after triage also points to potential workflow ineffi-

Table 5. Univariate and multivariate predictors of death in emergency department

Variable	Univariate logistic regression			Multivariate logistic regression		
	OR	95% CI	*P* value	OR	95% CI	*P* value
Age, years	1.01	0.99-1.03	0.206			
Male sex	0.71	0.37-1.37	0.310			
Triage category						
Red	18.83	10.89-32.54	<0.001			
Orange	0.76	0.30-1.92	0.568			
Yellow	0.19	0.10-0.34	<0.001			
Green	1.29	0.68-2.45	0.434			
Referred from hospital	1.75	0.86-3.56	0.125			
Patient resides in Addis Ababa	0.43	0.23-0.81	0.008	0.52	0.27-1.00	0.049
Arrival by						
Ambulance	3.12	1.70-5.72	<0.001	2.20	1.15-4.19	0.017
Taxi	1.20	0.66-2.17	0.548			
Self	0.59	0.32-1.08	0.087			
Interfacility	0.21	0.08-0.59	0.003	0.17	0.06-0.48	0.001
Primary injury location						
Head	5.17	3.01-8.89	<0.001	3.11	1.73-5.59	<0.001
Face	1.76	0.43-7.26	0.435			
Thorax	1.00	–				
Abdomen	1.00	–				
Spine	2.84	0.68-11.75	0.151			
Upper extremity	0.46	0.11-1.88	0.279			
Lower extremity	0.50	0.12-2.06	0.338			
Soft tissue NOS	0.58	0.34-0.98	0.043	0.82	0.47-1.43	0.485

CI, confidence interval; NOS, not otherwise specified; OR, odds ratio

ciencies, with nearly half of 'green' patients being sent to the resuscitation area, which is typically intended for more critically injured patients. Conversely, about a third of critically ill patients were sent to the waiting room after triage, emphasizing the need for staff trauma training and restructuring of triage systems so that patients are immediately allocated to the appropriate level of care on arrival.

Health centre referrals

The large number of referrals from health centres is also related to the organization of prehospital transport and referral structures. Contrary to the expectation of referrals for clinical care, many patients—particularly those with low triage acuity—were reportedly transferred for the completion of medicolegal documentation, which can only be performed by physicians. While data regarding the reason for referral were not specifically documented in the registry, the frequent patient presentation from health centres for medicolegal documentation is well known among Ethiopian physicians. The burden of this documentation being transferred to treating physicians at trauma centres can distract from the time dedicated to clinical service provision for more severely injured patients. Further research on the reasons for trauma centre referral and the medicolegal documentation process may help identify possible opportunities for improvement. While the ambulance dispatch system may help address some of these inappropriate referrals, education is needed at the health centre level. Additionally, deploying more general physicians at health centres could alleviate the burden of injury documentation being performed at trauma centres. A more widely implemented trauma intake form that can serve as a medicolegal document nationwide would be another potential solution.

Expansion of trauma registry data

An integrated and comprehensive trauma registry is necessary to optimize the use of injury data in quality improvement efforts at the facility level and beyond. However, this has been difficult to implement and maintain at the hospital level thus far. A study of injured patients at Yekatit 12 Hospital and Tikur Anbessa Hospital in Addis Ababa revealed a high prevalence of trauma and poor outcomes for severely injured trauma patients. It highlighted the need for trauma registries to enhance the monitoring of patient care and outcomes in trauma.[21] Following this recommendation, such registries were established, leading to the collection of higher-quality data.[22] Similarly, in Mekele, Ethiopia, a retrospective study found a high prevalence of traumatic injuries in EDs, primarily from interpersonal violence, falls, and road traffic accidents; it also called for the implementation of a trauma registry for higher-quality data.[23] One study including patients from 2 referral hospitals in Addis Ababa found a mortality rate that was higher than the rate predicted using Injury Severity Score data,[21] highlighting the importance of not only cataloguing injury data with comprehensive registries but also identifying opportunities for trauma quality and outcome improvement initiatives. As a next step at ALERT Trauma Center, a more detailed trauma registry with information on physiologic data and interventions will be implemented, and staff will be trained to improve data completeness. This registry, using the WHO Trauma Intake form and standardized WHO trauma registry, will allow for injury scoring and more detail on ED and hospital interventions, as well as inpatient complications and discharge outcomes, all of which are essential for understanding current practices and identifying improvements at the hospital level. This more comprehensive registry will inform a facility-based quality improvement programme as part of a national initiative to strengthen trauma care in Ethiopia. A similar process has been undertaken in Tanzania, lessons from which may pave the way for implementation in Ethiopia.[24]

Limitations

Data incompleteness posed a significant limitation in the evaluation of this trauma registry. The retrospective nature of this study made real-time improvement of data quality impossible, and as data clerks recorded entries by hand, this method produced a significant number of errors and missing information in the registry. Although the clerks were trained in data collection protocols, they were not able to consistently capture pertinent information. For example, date and time entry formats were not standardized, and many words were incorrectly transcribed from the registry book into the electronic database. These errors in data transcription and entry underscore the need for an electronic data capture mechanism. Also, the available-case approach to analysing datasets with missing entries can introduce bias; however, in our analysis, the likelihood of such bias was minimal because the causes of missing data were unlikely to have been systematic or associated with outcomes. Furthermore, physiologic data necessary to calculate injury severity scores and interventions performed in the ED were not included in this registry. It is difficult to target and prioritize areas for improvement without this more granular understanding of care provided at the patient level. Additionally, the causes and timing of patient deaths were not available in the registry; therefore, it is difficult to infer detailed interventions that may have had the highest impact for these patients. This registry has been modified, and at present, a more comprehensive trauma registry is being used at ALERT Hospital, following the WHO Trauma Intake format.

Studies on trauma registry implementation in low- and middle-income countries demonstrate an enormous range of form completion rates, ranging from 21% to 90%.[25]-[27] One study conducted in Ethiopia at Tikur Anbessa Hospital characterized the successes and challenges of the implementation of a standardized trauma registry form, noting that the data capture rate was low and that lack of training and supervision were key challenges to form completion.[28] Furthermore, it was difficult to evaluate the types and quality of in-hospital services provided, as our registry did not contain such information. Patient charts also commonly do not document all ED interventions or procedures. A more comprehensive registry, which is now being implemented, is essential to capture more information regarding in-hospital trauma care. Ideally, this would be integrated with the medical record to avoid duplication of data collection and overburdening staff with the clerical tasks of registry data collection.

Conclusions

Many sub-Saharan nations have underdeveloped trauma systems,[29] including Ethiopia, which is currently pursuing nationwide efforts to improve the care of injured patients. The findings of our pilot trauma registry study offer important insights into the volume and type of trauma seen at 1 of the 3 major trauma centres in Ethiopia. They also shed light on the essential improvements required in the coordination of trauma care services, including prehospital transport, triage, and resuscitation practices. As part of a collaboration with the Federal Ministry of Health and the WHO, a more comprehensive trauma registry is being implemented at 7 newly designated trauma hospitals in Ethiopia. Prehospital services are also being expanded, and the training of prehospital providers is being enhanced in Addis Ababa. Through the dedicated efforts of clinicians and public health practitioners in Ethiopia, the key learning points from this study and others will help inform improvements in the care of injured patients nationwide.

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