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Original article

A cohort of pediatric injury patients from a hospital-based trauma registry in Northern Tanzania

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ABSTRACT

Introduction: Pediatric injuries in low- and middle-income countries are a leading cause of morbidity and mortality worldwide. Implementing hospital-based trauma registries can reduce the knowledge gap in both hospital care and patient outcomes and lead to quality improvement initiatives. The goal of this study was to create a pediatric trauma registry to provide insight into the epidemiology, outcomes, and factors associated with poor outcomes in injured children.

Methods: This was a prospective observational study in which a pediatric trauma registry was implemented at a large zonal referral hospital in Northern Tanzania. Data included demographics, hospital-based care, and outcomes including morbidity and mortality. Data were input into REDCap© and analyzed using ANOVA and Chi-squared tests in SAS(Version 9.4)©.

Results: 365 patients were enrolled in the registry from November 2020 to October 2021. The majority were males (n=240, 65.8%). Most were children 0–5 years (41.7%, n=152), 34.5% (n=126) were 6–11 years, and 23.8% (n=87) were 12–17 years. The leading causes of pediatric injuries were falls (n=137, 37.5%) and road traffic injuries (n=125, 34.5%). The mortality rate was 8.2% (**n=30**). Of the in-hospital deaths, 43.3% were children with burn injuries who also had a higher odds of mortality than children with other injuries (OR 8.72, $p<0.001$). The factors associated with in-hospital mortality and morbidity were vital sign abnormalities, burn severity, abnormal Glasgow Coma Score, and ICU admission.

Conclusion: The mortality rate of injured children in our cohort was high, especially in children with burn injuries. In order to reduce morbidity and mortality, interventions should be prioritized that focus on pediatric injured patients that present with abnormal vital signs, altered mental status, and severe burns. These findings highlight the need for health system capacity building to improve outcomes of pediatric injury patients in Northern Tanzania.

African Relevance

- More than 95% of pediatric injury-related deaths occur in low- and middle-income countries, with children in sub-Saharan Africa (SSA) disproportionately affected. Beyond mortality, tens of millions of children sustain injuries each year that result in long-term disability and lost economic vitality in SSA.
- The burden of injuries in children in SSA is a significant public health problem that deserves urgent attention.
- Improving outcomes for injured pediatric patients requires robust data, and hospital-based trauma registries provide a standardized way to facilitate injury surveillance, measure outcomes, and track changes in trauma system performance over time.
- Trauma registries are both possible and useful in SSA, and their successful implementation is well documented.

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- We present a cohort of pediatric injury patients enrolled in a prospective pediatric trauma registry at a zonal referral hospital in Northern Tanzania. We hope that by describing the landscape of pediatric injuries in this setting, we can identify and establish interventions to improve the care of pediatric injured patients in this community.

Introduction

Injuries are a leading cause of morbidity and mortality in children worldwide [1]. More than 95% of pediatric injury-related deaths occur in low-and middle-income countries [LMICs), with children in sub-Saharan Africa disproportionally affected [1]. Beyond mortality, tens of millions of children sustain injuries each year that result in long-term disability and lost economic vitality in LMICs [2]. Thus, the burden of injuries in children in LMICs is a significant public health problem that deserves urgent attention [1,3]. Despite this, funding and subsequent research on pediatric injury in LMICs remains low compared to communicable diseases [4–6].

Improving outcomes for injured pediatric patients requires robust data. Hospital-based trauma registries provide a standardized way to facilitate injury surveillance, measure outcomes, and track changes in trauma system performance over time [7]. Trauma registries are both possible and useful in sub-Saharan Africa, and their successful implementation in LMICs is well documented [1, 8–11]. Trauma registries are an efficient way to organize patient data to determine what areas need to be improved, and thus can lead to important quality improvement initiatives that have the potential to impact injury morbidity and mortality [10]. While injury registries for adult populations have become common [11], injury registries specific to children are rarer, and the literature on pediatric trauma epidemiology in LMICs is limited [12].

In this manuscript, we present a cohort of pediatric injury patients enrolled in a prospective pediatric trauma registry at a zonal referral hospital in Northern Tanzania. The goal of the study is to describe the epidemiology, clinical presentation, and hospital outcomes of these pediatric injury patients, and to examine clinical factors associated with both morbidity at discharge and in-hospital mortality. We hope that by describing the landscape of pediatric injuries in this setting, we can identify and establish interventions to improve the care of pediatric injured patients in this community.

Methods

Ethical approvals

This study was approved by the Tanzanian National Institute for Medical Research, Kilimanjaro Christian Medical University College Institutional Review Board, and the University of Utah Institutional Review Board.

Study design

This was a prospective observational study using a pediatric trauma registry that was implemented at Kilimanjaro Christian Medical Centre (KCMC) in Moshi, Tanzania. For the current manuscript, we analyzed registry data collected between November 2020 and October 2021, which included 365 unique patients.

Study setting

KCMC is a zonal referral hospital located in Kilimanjaro region that serves the Northern zone of Tanzania. The Emergency Medical Department (EMD) sees approximately 1400–1700 pediatric patients per year. The pediatric trauma registry was established at KCMC in November 2020. It is currently ongoing with prospective consecutive enrollment of all patients less than 18 years of age presenting to KCMC Emergency Department for treatment of an injury.

Study population

The KCMC pediatric trauma registry was developed in order to define areas for quality improvement in the care of pediatric trauma patients. Registry inclusion criteria included patients less than 18 years old seeking care for any injury that occurred in the last month who survived to evaluation in the EMD. Registry exclusion criteria included patients who presented with injuries that occurred greater than one month prior to presentation or who presented for follow-up care. Patients with missing outcome data were excluded (n=10).

We defined injuries according to the World Health Organization as caused by acute exposure to physical agents such as mechanical energy, heat, electricity, chemicals, and ionizing radiation interacting with the body in amounts that exceed the threshold of human tolerance.[13] Our study population had injury types including fractures, burns, lacerations, traumatic brain injuries, ingestions/poisonings, animal envenomation, road traffic injuries, falls, drownings, penetrating trauma, non-accidental trauma, and others.

Data collection

The registry data were collected over 60 h per week, 6 days a week, by two trained Tanzanian research assistants. Data were collected by direct observation of patient care. For children who arrived to the EMD outside of data collection time periods, enrollment occurred the next day if the patient was still in the hospital. If the child was discharged from the EMD, then these patients were missed. Patients were not consented as this was a standard healthcare quality improvement process, and the registry was observational and did not affect patient care. As such, consent was implied in the consent to treatment. Research assistants followed patients through their hospital course, collecting care information and discharge information. Data were recorded on tablets in REDCap©,[14] and quality of all entries was reviewed by the PI (EMK). Completeness and quality of this data were ensured by two full-time trained research assistants who observed patient care, assisted with gathering vital signs, and obtained data from the medical records. Research assistants both had prior research experience, had two weeks of additional training on data collection, and participated in weekly calls and meetings with the research team to allow for data collection and quality challenges to be addressed.

Variables

Data collected included patient demographics, acute presentation information, hospital-based care, and outcomes including in-hospital mortality and morbidity (Table 1). Initial vital signs were recorded. Age-specific vital sign abnormalities were defined as in Table 2. For Glasgow Coma Score (GCS), a score of 15 was defined as normal and a score of <15 as abnormal. For burn severity, burns were classified as “mild” for body-surface area <10% burned, “moderate” for body-surface area 10–19% burned, and “severe” for body-surface area ≥20% burned [15].

The outcome data collected were in-hospital mortality and two measures of morbidity of the injury. Two morbidity instruments were used because they represent two different ways of measuring morbidity. The Glasgow Outcome Score-Extended Pediatrics (GOS-E Peds) is an external assessment in which the researcher determines the patient’s capacity after asking the caregiver a number of questions about level of functioning. The GOS-E Peds is an 8 item instrument designed to measure outcomes in children after traumatic brain injury [16]. It has also been used to assess outcomes in other trauma populations as it can be administered by a caregiver on behalf of their child, it encompasses most domains from the World Health Organization’s International Classification of Functioning, Disability and Health, [17] and it has been shown to be responsive to change in the non-head injured population [18]. It is recommended for use by trauma registries for

Table 1
Variables collected in pediatric trauma registry during hospital stay and at discharge.

Acute presentation	Mechanism of injury
	Mode of transportation to hospital
	Patient demographics
Hospital-based care	Patient education
	Treatment
	Procedures
	Complications
	Length of hospital stay
Outcomes	Mortality
	Two measures of morbidity:
	1. GOS-E Peds(16):
	Consciousness
	Independence in the home
	Independence outside the home
	School/work
	Social and leisure activities
	Family and friendships
	Return to normal life
	2. Patient Specific Functional Scale(22):
	Ability to perform 3-5 patient specific activities on scale of 0-10

Table 2
Age-specific vital sign abnormalities.

Variable	Age	Abnormal Vital Sign
Hypotension	0-28 days	Systolic blood pressure <60 mmHg
	1-12 months	Systolic blood pressure <70 mmHg
	1-10 years	Systolic blood pressure <(70 + (age in years x2)) mmHg
	>10 years	Systolic blood pressure <90 mmHg
Hypoxemia	All ages	Pulse oxygenation <90%
Tachycardia	0-3 months	Heart rate >205 beats per minute
	3 months-2 years	Heart rate >190 beats per minute
	2–10 years	Heart rate >140 beats per minute
	>10 years	Heart rate >100 beats per minute

monitoring functional outcomes [18]. For the purposes of our analysis, we dichotomized the score with a score of 1-2 representing "good recovery" and a score greater than 2 representing a "poor recovery" [19]. Dichotomization is the most widely used approach to analysis of the GOS-E [20].

The Patient-Specific Functional Scale (PSFS) is a personalized assessment of return to optimal patient function. It is a patient or parent-reported outcome measure in which patients or parents give scores from 0 to 10 to their ability to perform 3–5 activities depending on their level of functioning [21]. Lower scores indicate greater disability. It has been shown to be valid in cross-cultural settings and can be used to measure change in outcomes in a wide range of conditions [22–24]. It is a different way to measure morbidity than the GOS-E Peds as it is a unique way of patient or parent assessment that is more geared to personalized outcomes and goals.

Statistical methods

We summarized patient demographics, acute presentation information, hospital-based care, and outcomes overall, and by in-hospital mortality and morbidity, using descriptive statistics for all pediatric injury patients. Continuous data were represented as means with standard deviation, while nominal data were represented as frequencies and percentages. Differences in these statistics by mortality and morbidity were assessed using analysis of variance (ANOVA) or Chi-squared tests as appropriate. We estimated odds ratios and 95% confidence intervals for in-hospital mortality using logistic regression. All analyses were performed in SAS (Version 9.4)©, and figures were made in R using ggplot2.

Results

Patient demographics

A total of 365 patients were enrolled in the registry from November 2020 to October 2021. The demographics of the patient population are described in Table 3.

Mechanisms of injury

348 injuries were unintentional while 16 were intentional (including non-accidental trauma and interpersonal violence). The leading causes of pediatric injuries were falls (n=137, 37.5%) and road traffic injuries (n=125, 34.5%) (Fig. 1).

Mortality

There were 30 in-hospital deaths, representing a mortality rate of 8.2%. In children under 5, mortality was 9.2% (n=14). Children with burn injuries accounted for 43.3% of the in-hospital deaths, and these children had a higher odds of mortality compared to children with other injuries (OR 8.72, $p<0.001$) (Fig. 1; Table 3). Further, burn severity was associated with increased risk of mortality, as 70.6% of those who had a severe burn died.

Clinical factors associated with in-hospital mortality

The factors associated with in-hospital mortality were tachycardia, hypoxemia, hypotension, abnormal GCS, ICU admission, and not having

Table 3
Demographics.

Characteristic	Overall	In Hospital Mortality (n = 30)	Discharge Alive (n = 335)	P value	Poor Recovery[a] (n = 173)	Good Recovery[a] (n = 192)	P value
Sex, N (%)							
Male	240 (65.8%)	18 (60.0%)	222 (66.3%)	0.488	111 (64.2%)	129 (67.2%)	0.543
Female	125 (34.2%)	12 (40.0%)	113 (33.7%)		62 (35.8%)	63 (32.8%)	
Age, years, mean (SD)	7.4 (5.0)	6.3 (5.0)	7.5 (5.0)	0.233	8.2 (4.9)	6.6 (5.0)	0.003
Age Group, N (%)							
Infant (0-1 year)	43 (11.8%)	7 (23.3%)	36 (10.7%)	0.215	18 (10.4%)	25 (13.0%)	0.002
Toddler (2-3 years)	58 (15.9%)	5 (16.7%)	53 (15.8%)		16 (9.2%)	42 (21.9%)	
Preschool (4-5 years)	51 (14.0%)	2 (6.7%)	49 (14.6%)		19 (11.0%)	32 (16.7%)	
Child (6–11 years)	126 (34.5%)	10 (33.3%)	116 (34.6%)		74 (42.8%)	52 (27.1%)	
Preteen (12–14 years)	47 (12.9%)	5 (16.7%)	42 (12.5%)		24 (13.9%)	23 (12.0%)	
Teen (15–17 years)	40 (11.0%)	1 (3.3%)	39 (11.6%)		22 (12.7%)	18 (9.4%)	
Where patient lives, N (%)							
Moshi Urban District	106 (29.0%)	3 (10.0%)	103 (30.7%)	0.041	48 (27.7%)	58 (30.2%)	0.869
Moshi Rural District	113 (31.0%)	10 (33.3%)	103 (30.7%)		55 (31.8%)	58 (30.2%)	
Other	146 (40.0%)	17 (56.7%)	129 (38.5%)		70 (40.5%)	76 (39.6%)	
Patient lives with, N (%)							
single parent	83 (22.8%)	9 (30.0%)	74 (22.2%)	< 0.001	45 (26.2%)	38 (19.8%)	0.113
both parents	219 (60.2%)	15 (50.0%)	204 (61.1%)		94 (54.7%)	125 (65.1%)	
grandparent/aunt/uncle	60 (16.5%)	4 (13.3%)	56 (16.8%)		31 (18.0%)	29 (15.1%)	
Other	2 (0.5%)	2 (6.7%)	0 (0.0%)		2 (1.2%)	0 (0.0%)	
Number of children living in the home, N (%)							
1 (patient)	58 (15.9%)	6 (20.0%)	52 (15.6%)	0.446	28 (16.3%)	30 (15.6%)	0.190
2-3	200 (54.9%)	14 (46.7%)	186 (55.7%)		94 (54.7%)	106 (55.2%)	
4-5	83 (22.8%)	7 (23.3%)	76 (22.8%)		38 (22.1%)	45 (23.4%)	
6-7	16 (4.4%)	3 (10.0%)	13 (3.9%)		11 (6.4%)	5 (2.6%)	
>7	7 (1.9%)	0 (0.0%)	7 (2.1%)		1 (0.6%)	6 (3.1%)	

[a] As measured by the GOS-E Peds

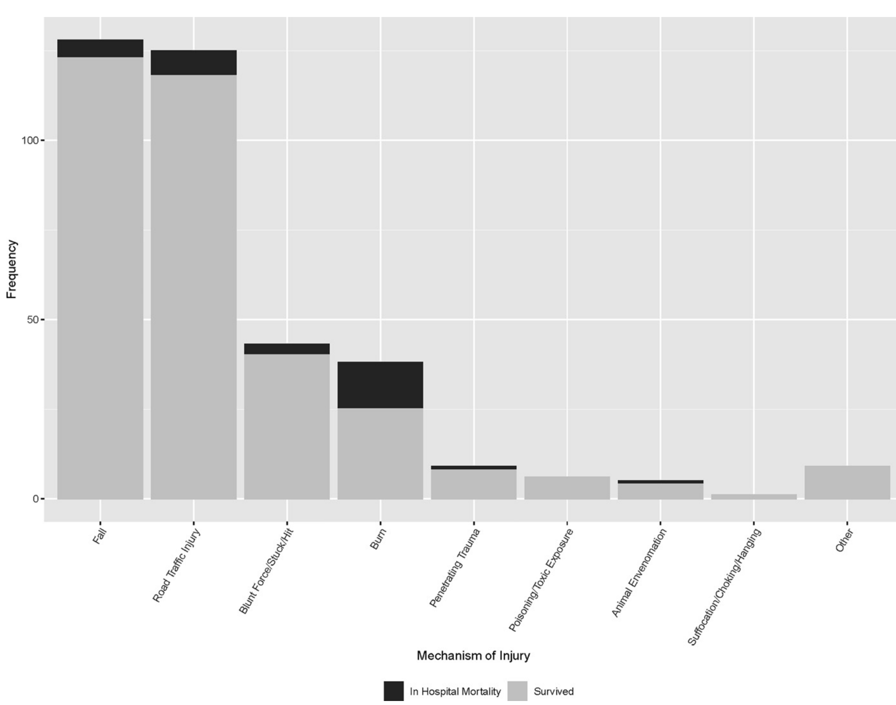

Fig. 1. Mechanisms of Injury in Pediatric Trauma Registry in Northern Tanzania from November 2020 to October 2021.

surgery (Table 4). Pediatric injury patients who were tachycardic had a 4.70 (95% CI: 1.97–11.23) higher odds of dying than those that had normal heart rate, while those with hypoxia had a 10.43 (95% CI: 3.61–30.18) higher odds of dying that those with normal oxygen saturations. Pediatric injury patients with an abnormal GCS score had a 9.14 (95% CI: 4.06–20.55) higher odds of dying than those who had a normal GCS score.

Morbidity

In our cohort, 192 (52.6%) patients had GOS-E Peds scores of 1 or 2, indicating good recovery at hospital discharge. 173 (47.4%) had GOS-E Peds scores of 3–8 at discharge, indicating poor recovery. The average PSFS in our cohort at hospital discharge was 3.78 (SD=3.41) on a 0-10 point scale. **Lower scores indicate greater disability.**

Table 4
Factors associated with in-hospital mortality.

Characteristic, N (%)	Overall	In-Hospital Mortality (n = 30)	Discharge Alive (n = 335)	*P* value	Odds Ratio (95% CI)
Mechanism of injury					
Fall	137 (37.5%)	7 (23.3%)	130 (38.8%)	0.094	0.48 (0.20–1.15)
Burn	40 (11.0%)	13 (43.3%)	27 (8.1%)	< 0.001	8.72 (3.83–19.85)
Road traffic injury	125 (34.2%)	7 (23.3%)	118 (35.2%)	0.189	0.56 (0.23–1.34)
Other	65 (17.8%)	3 (10.0%)	62 (18.5%)	0.243	0.49 (0.14–1.66)
Vital Sign Abnormality					
Tachycardia	37 (10.1%)	9 (30.0%)	28 (8.4%)	< 0.001	4.70 (1.97–11.23)
Hypoxemic	17 (4.8%)	7 (25.0%)	10 (3.1%)	< 0.001	10.43 (3.61–30.18)
Hypotension	5 (1.5%)	3 (11.5%)	2 (0.7%)	< 0.001	*
Traumatic Brain Injury	134 (36.7%)	10 (33.3%)	124 (37.0%)	0.689	0.85 (0.39–1.88)
Burn Severity					
Not Burned	321 (87.9%)	17 (56.7%)	304 (90.7%)	< 0.001	*
1. Mild Burn (<10% BSA)	16 (4.4%)	0 (0.0%)	16 (4.8%)		
2. Moderate Burn (10-19% BSA)	11 (3.0%)	1 (3.3%)	10 (3.0%)		
3. Severe Burn (>=20% BSA)	17 (4.7%)	12 (40.0%)	5 (1.5%)		
Length Of Stay, days					
<7 days	246 (68.3%)	25 (83.3%)	221 (67.0%)	0.065	2.47 (0.92–6.62)
7 or more days	114 (31.7%)	5 (16.7%)	109 (33.0%)		
ICU Admission	34 (9.3%)	22 (73.3%)	12 (3.6%)	< 0.001	80.26 (28.09–229.35)
Had Surgery	144 (39.5%)	5 (16.7%)	139 (41.5%)	0.008	0.28 (0.11–0.75)
CT findings					
Normal	34 (9.3%)	2 (6.7%)	32 (9.6%)	0.861	*
Abnormal	99 (27.1%)	8 (26.7%)	91 (27.2%)		
Not done	232 (63.6%)	20 (66.7%)	212 (63.3%)		
Glasgow Coma Score					
<15	49 (13.9%)	15 (51.7%)	34 (10.5%)	< 0.001	9.14 (4.06–20.55)
15	304 (86.1%)	14 (48.3%)	290 (89.5%)		

*Odds ratio not estimated due to low sample size

Clinical factors associated with morbidity

Factors associated with increased morbidity as measured by a poor GOS-E Peds score [3–8] at discharge were hypotension, burn severity, abnormal GCS score, ICU admission, and length of stay >=7 days (Table 5). Patients that had hypotension were more likely to have poor GOS-E Peds scores than normotensive patients (p=0.02). Patients with severe burns had poorer outcomes than those with no, mild or moderate burns (p=0.02). Patients with an abnormal GCS score (<15) were more likely to have poorer outcomes measured with the GOS-E Peds (p=0.02). Patients admitted to the ICU were more likely to have poorer outcomes measured by the GOS-E Peds score than those not admitted to the ICU (p<0.001). Patients with length of stay >=7 days had poorer outcomes as measured by the GOS-E Peds score (p=0.01).

Factors associated with increased morbidity as measured by a lower PSFS at discharge were road traffic injury as mechanism of injury, severe burn, had surgery, and hospital length of stay >= 7 days. PSFS differed by severity of burns (p=0.03). Patients that had surgery had a lower PSFS and thus poorer outcomes than those that did not need surgery (p<0.001). Patients that had a hospital length of stay >=7 days had a lower PSFS and poorer outcomes than those who stayed <7 days (p<0.001).

Discussion

We present a cohort from a pediatric trauma registry that provides insight into the epidemiology and outcomes of injured children that presented to a zonal referral hospital in Northern Tanzania. Although data from adult trauma registries in LMICs are well documented, registries specific to pediatric injured children are very limited in the literature. Thus, our study provides key insight into the epidemiology of injuries unique to children in LMICs and helps to identify areas in which interventions can be developed to both prevent and build healthcare capacity to improve the outcomes of injured children.

This cohort of injured children included more males than females, and the most common mechanisms of injury were road traffic injuries and falls. This is supported by many adult and one pediatric trauma registry study in LMICs that have found that young, male, road traffic injured and fall patients represent a large proportion of the trauma burden [8,25–29]. Examining the epidemiology of injured patients through a hospital-based registry allows for the identification of priority areas for the development of trauma quality improvement interventions and prevention campaigns [27]. Thus, our findings highlight the need to develop prevention initiatives targeting children at risk for falls and road traffic injuries. For falls, prevention needs include improved availability and use of safety and protective equipment, education programs, and increased supervision around fall hazards [30]. For road traffic injuries, prevention priorities specific to pediatric populations include the use of child restraint systems, increased helmet usage, and improved road infrastructure for pedestrians [30,31]. In this region specifically, child restraint systems and helmets are not widely used, representing an area for targeted improvement.

The mortality rate of injured children in our cohort was considerably high at 8.2%. In other pediatric registry studies, mortality rates ranged from 0.3% to 7.0% [3,9,12,29,32]. More specifically, a multi-site study at 10 centers in LMICs found an overall mortality rate of 0.8% for admitted pediatric injured patients [12]. One potential explanation for this lower mortality rate is the fact that this study enrolled patients admitted to the trauma service, whereas in our study we enrolled all pediatric trauma patients presenting to the EMD. It is possible that the multi-site study missed some children who presented to the EMD and died before admission, thus resulting in a lower than actual mortality rate. However, it is also possible that this study missed some minor trauma patients seen in the EMD and discharged home rather than being admitted to the trauma service, thus potentially resulting in a higher mortality rate than actual. Thus, it is not possible to know the exact impact only including admitted children has on the true mortality rate of pediatric trauma in the regions of the study. Potentially a more direct comparison to our study, a multi-site study in Rwanda showed an in-hospital mortality rate of 4.8% for pediatric trauma patients enrolled in the EMD, which is closer yet still below the mortality rate found in our cohort [29]. The high mortality rate found in our cohort shows that pediatric

Table 5
Factors associated with morbidity as measured by GOS-E Peds and PSFS.

Characteristic, N (%)	Poor Recovery* (n = 173, **47.4%**)	Good Recovery* (n = 192, **52.6%**)	*P* value	Average PSFS at discharge (0-10)	*P* Value
Mechanism of injury = Fall					
No	114 (65.9%)	114 (59.4%)	0.199	4.0 (3.5)	0.117
Yes	59 (34.1%)	78 (40.6%)		3.4 (3.2)	
Mechanism of injury = Burn					
No	149 (86.1%)	176 (91.7%)	0.091	3.7 (3.4)	0.030
Yes	24 (13.9%)	16 (8.3%)		5.1 (3.7)	
Mechanism of injury = RTI					
No	105 (60.7%)	135 (70.3%)	0.053	4.1 (3.5)	0.020
Yes	68 (39.3%)	57 (29.7%)		3.2 (3.2)	
Mechanism of injury = Other					
No	151 (87.3%)	149 (77.6%)	0.016	3.5 (3.3)	0.001
Yes	22 (12.7%)	43 (22.4%)		5.1 (3.7)	
Tachycardia					
No	151 (87.3%)	177 (92.2%)	0.121	3.9 (3.4)	0.109
Yes	22 (12.7%)	15 (7.8%)		2.8 (3.0)	
Hypoxemic					
No	155 (93.9%)	179 (96.2%)	0.317	3.8 (3.4)	0.738
Yes	10 (6.1%)	7 (3.8%)		4.2 (3.9)	
Hypotension					
No	158 (96.9%)	169 (100.0%)	0.022	3.6 (3.3)	0.272
Yes	5 (3.1%)	0 (0.0%)		1.0 (1.4)	
Traumatic Brain Injury					
No	116 (67.1%)	115 (59.9%)	0.157	3.5 (3.3)	0.044
Yes	57 (32.9%)	77 (40.1%)		4.3 (3.5)	
Burn Severity					
Not Burned	149 (86.1%)	172 (89.6%)	0.017	3.7 (3.4)	0.034
Mild Burn (<10% BSA)	5 (2.9%)	11 (5.7%)		5.0 (4.0)	
Moderate Burn (10-19% BSA)	5 (2.9%)	6 (3.1%)		6.3 (3.7)	
Severe Burn (>=20% BSA)	14 (8.1%)	3 (1.6%)		2.4 (1.6)	
Length Of Stay, days					
<7 days	105 (61.8%)	141 (74.2%)	0.011	4.3 (3.5)	< 0.001
7 or more days	65 (38.2%)	49 (25.8%)		2.8 (3.0)	
ICU Admission					
No	144 (83.2%)	187 (97.4%)	< 0.001	3.8 (3.4)	0.470
Yes	29 (16.8%)	5 (2.6%)		3.1 (3.3)	
Had Surgery					
No	98 (56.6%)	123 (64.1%)	0.148	4.5 (3.6)	< 0.001
Yes	75 (43.4%)	69 (35.9%)		2.8 (2.8)	
CT findings					
Normal	17 (9.8%)	17 (8.9%)	0.508	4.3 (3.7)	0.518
Abnormal	42 (24.3%)	57 (29.7%)		3.9 (3.4)	
Not done	114 (65.9%)	118 (61.5%)		3.6 (3.4)	
Glasgow Coma Score					
<15	31 (18.5%)	18 (9.7%)	0.018	3.8 (3.5)	0.983
15	137 (81.5%)	167 (90.3%)		3.8 (3.4)	

*As measured by the GOS-E Peds

injuries should be a high priority area for interventions targeting child health in Northern Tanzania.

Burn injuries were common in this cohort and had a high mortality. In children with severe burn injuries, they were both more likely to die and have increased morbidity. These findings are supported by other studies in SSA that demonstrated that burns are common in the pediatric population and have relatively high mortality [27,33,34]. A literature review on burns in SSA found that children were affected disproportionately, with >80% of those burned <10 years old. A systematic review on prevention of burn injuries in LMICs found that education-based initiatives show favorable outcomes, but that outcomes research is lacking [35]. Further, little has been published about the management of burn injuries in LMICs [36]. Thus, this is a common problem in children and further studies need to be done on ways to both prevent burn injuries and also improve outcomes for burn injured pediatric patients.

Clinical factors associated with poor outcomes included vital sign abnormalities, severe burns, abnormal mental status, and need for ICU admission. We chose to focus on clinical factors in order to help assist us to create a care process guideline. Our findings are supported by other studies in adult trauma patients at KCMC, including a study on adults with abdominal trauma that found that patients with hypotension had higher odds of mortality, and a study in TBI patients that found that hypotension and hypoxemia predicted mortality [37,38]. Regarding mental status as a predictor of poor outcomes, our finding is supported by studies in Kenya and Malawi that found that presenting with abnormal mental status predicted mortality [27,39]. The aforementioned studies were all mainly in adults, with only one including a small number of children as young as nine years old [39]. We found only one study on predictors of mortality in pediatric injured patients in an upper middle-income country, and none in a low-income country [40]. This study examined systolic blood pressure and base excess in predicting clinical outcomes, and found that systolic blood pressure is a late marker of mortality. The authors suggest the use of base excess in conjunction with blood pressure as a more useful means of identifying shock [40]. Unfortunately base excess is not available in our clinical registry at this time. Nevertheless, knowing the predictors of poor outcomes can enable the creation of a care process guideline in order to identify and more closely monitor pediatric injured patients who have these findings on clinical presentation to KCMC and other hospitals in similar low-resource settings.

This study has limitations. This is a prospective pediatric injury registry where data is collected by research assistants. There is some missing data such as vital signs that were not taken at the time of arrival to the KCMC EMD. To mitigate this, we trained our research assistants to take the vital signs of patients whenever they enrolled them in the EMD. In addition, this registry is hospital-based, and thus we are not capturing data prior to hospital care including those who do not survive to presentation at KCMC, which introduces a survivorship sampling bias. Thus, the true burden of pediatric injury at the community level may not be known since we are missing those who die before arrival to KCMC. Further, the design of this registry allows for measurement of in-hospital outcomes. Therefore, we are unable to determine long-term outcomes and disability.

Conclusion

The mortality and morbidity rates of injured children in our cohort was considerably high, especially in children with burn injuries. Clinical factors associated with poor outcomes including vital sign abnormalities, severe burns, and abnormal mental status, allow for prioritizing interventions in injured children with these presentations. These findings highlight the need to implement strategies to both prevent and improve outcomes of pediatric injury patients in Northern Tanzania.

Dissemination of results

Results from this study were shared with staff members at the data collection site through a Grand Rounds presentation. In addition, results from this study were shared with the local scientific community through an oral presentation at the Non-Communicable Diseases Conference in Arusha, Tanzania in November 2021.

Authors' Contribution

Authors contributed as follows to the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content: EK contributed 30%; CS contributed 15%; FS, BM, GN, and IA contributed 10% each; and CT, NF, and MW contributed 5% each. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

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Declaration of Competing Interest

The authors declared no conflicts of interest.

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