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The effect of anatomic location of injury on mortality risk in a resource-poor setting

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ABSTRACT

Introduction: Injury is a significant cause of death, with approximately 4.7 million people mortalities each year. By 2030, injury is predicted to be among the top 20 causes of death worldwide. We sought to characterize and compare the mortality probability in trauma patients in a resource-poor setting based on anatomic location of injury.
Methods: We performed a retrospective analysis of prospectively collected data using the trauma database at Kamuzu Central Hospital (KCH) in Lilongwe, Malawi. We included all adult trauma patients (≥16years) admitted between 2011 and 2015. We stratified patients according to anatomic location of injury, and used descriptive statistics to compare characteristics and management of each group. Bivariate analysis by mortality was done to determine covariates for our adjusted model. A Cox proportional hazard model was performed, using upper extremity injury as the baseline comparator. Descriptive statistics were used to describe the trend in incidence and mortality of head and spine injuries over five years.
Results: Of the 76,984 trauma patients who presented to KCH from 2011 to 2015, 49,126 (63.8%) were adults, and 8569 (17.4%) were admitted. The most common injury was to the head or spine, seen in 3712 patients (43.6%). The highest unadjusted hazard ratio for mortality was in head and spine injury patients, at 3.685 (95% CI = 2.50–5.44), which increased to 4.501 (95% CI = 2.78–7.30) when adjusted for age, sex, injury severity, transfer status, injury mechanism, and surgical intervention. Abdominal trauma had the second highest adjusted hazard of mortality, at 3.62 (95% CI = 1.92–6.84) followed by thoracic trauma (HR = 1.3621, 95% CI = 0.49–3.56).
Conclusion: In our setting, head or spine injury significantly increases the hazard of mortality significantly compared to all other anatomic injury locations. The prioritization of timely operative and non-operative head injury management is imperative. The development of head injury units may help attenuate trauma- related mortality in resource poor settings.

Introduction

Injury is a significant cause of mortality worldwide, accounting for 10% of annual deaths globally, with millions more disabled [1,2]. In 2015, injuries caused 4.7 million deaths [2] and 247 million disability adjusted life years (DALYs) [1]. The three leading global causes of injury related deaths are road traffic crashes, suicide, and homicide, which currently rank as the 9th, 16th and 22nd global leading causes of death, respectively. All are predicted to rise in rank compared to other causes of death, placing all three of these among the top 20 leading causes of death in the world by 2030 [3]. An estimated 90% of trauma-related deaths and DALYs occur in low and middle income countries (LMIC) [4].

Trauma in sub-Saharan Africa (SSA) is often a result of road traffic crashes, assaults, or falls. Primary prevention of these types of injuries is an important aspect of the public health approach to decreasing morbidity and mortality [5]. Secondary prevention of injury-related morbidity and mortality should focus on

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strategically optimizing care of these patients. In a setting with limited resources, we must understand the most significant drivers of mortality in order to prioritize targeted interventions. Morbidity and mortality associated with trauma is driven in part by injury mechanism, and in part by the anatomic location of injuries [6].

Management priorities and risk of mortality vary greatly based on the anatomic location of injury. Clearly, injuries that affect airway and breathing, including head and neck injuries, as well as thoracic trauma, should take priority, as their impact on survival is more time-sensitive [7]. These injuries should therefore be given first priority during initial resuscitation. Because of the critical nature of these injuries, both head and chest injuries have been shown to be associated with significant mortality. Injury to the central nervous system is estimated to be the most common cause of trauma-related death [8], responsible for one-third to one-half of all trauma related mortality [9], while reports of thoracic trauma in SSA estimate that up to 15% of patients with blunt injury to the chest die before or within an hour of reaching the hospital [10]. Abdominal trauma in this setting also represents a significant cause of mortality, presenting a risk of internal hemorrhage or hollow viscous injury [11] that can be difficult to address with limited operative resources and blood banking.

Due to the significance of injury as a global public health concern, we aimed to characterize trauma mortality, and ascertain the hazard of mortality associated with anatomic location of injury in our setting at Kamuzu Central Hospital, Malawi. We believe that this will help inform trauma care in a resource-poor setting. Based on existing literature on the most common causes of death following trauma [8,9], we hypothesized that injury to the central nervous system would confer an increased risk for mortality, after adjusting for significant covariates, when compared to injuries in other anatomical locations.

Materials and methods

We performed a retrospective analysis of a prospectively collected dataset utilizing the trauma registry at Kamuzu Central Hospital, in Lilongwe, Malawi from 2011 to 2015. We included admitted adults ($\geq$16 years), and excluded patients who were treated as outpatients or were brought in dead. Children were excluded in this analysis as the pattern of trauma tends to be different in the pediatric population. Characteristics of the KCH trauma surveillance registry have been previously described [12].

Setting

KCH is a 1000-bed tertiary care center with a catchment area of 6 million people in Lilongwe, Malawi. Ultrasounds, x-rays, and computerized tomography (CT) scans, as well as limited laboratory investigations and a blood bank, are available. Both radiology and laboratory assets are subject to personnel, electricity and supply availability, and are therefore not always fully functional.

Teams of interns, general surgery residents, and consultant general surgeons manage most trauma patients at KCH. One neurosurgeon, one pediatric surgeon, and one urologist are on staff. Several consultant orthopedic surgeons work with a team of clinical officers to manage orthopedic injuries. Clinical officers are licensed medical practitioners with a relatively shortened training time that make up a large proportion of the healthcare workforce in Malawi [13]. All anesthesiologists are also clinical officers. KCH has a high-dependency, or step-down, unit equipped with electronic monitoring, and a lower nurse to patient ratio, as well as a five-bed intensive care unit with ventilator capability, staffed by nurses and clinical officers.

Up to three injuries per patient are recorded in the database, described by type (for example, contusion, laceration, fracture, etc), and by anatomic location. The patient's most severe injury, as judged by the evaluating clinician, is designated as Injury 1, followed by the second- and third-most severe injuries, if applicable. We stratified the patients based on the anatomic location of Injury 1, into head/spine, chest, abdomen, upper extremity, or lower extremity/pelvis. Head/spine patients had their most severe injury to the head, neck, back, spine, or face.

We performed descriptive statistics based on the anatomic location of the patient's most severe injury. Statistical significance of differences between groups was assessed using Pearson's chi-square test for categorical variables, and ANOVA for continuous variables. We performed bivariate analysis based on mortality to identify covariates that were significantly associated with increased mortality. We then constructed a Cox proportional hazards model. We selected upper extremity injury as the reference group, expecting these injuries to confer the lowest hazard of mortality. We adjusted the model for age, sex, injury severity, transfer status, injury mechanism, and surgical intervention based on variables that were significant on bivariate analysis. Injury severity was established using the Revised Trauma Score (RTS), which includes the Glasgow Coma Score (GCS), systolic blood pressure, and respiratory rate. Adjusted hazard ratios were used to calculate the

Table 1
Characteristics of Patients and Trauma by Anatomic Injury Location.

	Head or Spine	Chest	Abdomen	Upper Extremity	Lower Extremity/Pelvis
Number of patients (Total = 8569)	(3712 [43.6%])	(403 [4.7%])	(507 [6.0%])	(1329 [15.6%])	(2564 [30.1%])
Age (8530 [99.5%]) (years)	33.5	36.1	31.3	34.4	40.5
Male Sex (8564 [99.9%])	3152 (85.0%)	333 (82.6%)	415 (81.9%)	1053 (79.2%)	1891 (73.8%)
Setting of Injury (8507 [99.3%])					
Home	723 (19.6%)	104 (26.3%)	126 (25.1%)	358 (27.1%)	765 (30.0%)
Work	201 (5.5%)	22 (6.3%)	33 (6.6%)	134 (10.2%)	163 (6.4%)
Road/Street	2380 (64.6%)	223 (56.3%)	249 (49.6%)	657 (49.8%)	1281 (50.3%)
Public Space	231 (6.3%)	25 (6.3%)	51 (10.2%)	75 (5.7%)	97 (3.8%)
Other	231 (6.3%)	22 (6.3%)	43 (8.6%)	95 (7.3%)	243 (9.5%)
Mechanism of Injury (8527 [99.7%])					
Pedestrian in RTA	484 (13.1%)	36 (9.0%)	41 (8.1%)	88 (6.6%)	368 (14.5%)
Driver/passenger in RTA	1230 (33.3%)	134 (33.5%)	128 (25.3%)	387 (14.8%)	729 (28.6%)
Fall	230 (6.2%)	26 (6.5%)	39 (7.7%)	206 (15.6%)	736 (28.9%)
Assault	1429 (38.7%)	143 (35.8%)	212 (41.9%)	365 (27.6%)	306 (12.0%)
Other	323 (8.7%)	61 (15.3%)	86 (17.0%)	279 (21.1%)	407 (16.0%)
Presented within 4 h of injury (6973 [81.4%])	1774 (58.1%)	206 (60.1%)	194 (45.9%)	520 (47.3%)	852 (41.5%)
Alcohol Involved? (8549 [99.8%])	443 (12.0%)	42 (10.5%)	67 (13.2%)	97 (11.9%)	164 (6.4%)
Transfer from outside hospital? (8490 [99.1%])	1395 (37.7%)	152 (37.8%)	252 (49.8%)	546 (41.2%)	1183 (46.3%)