Open Journal of Surgery
ISSN: 2639-3611
Volume 3, Issue 2, 2020, PP: 01-09

Head Injury as a Risk Factor for Inpatient Mortality Among Fall Patients in Malawi

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Abstract

Introduction: *Falls result in 700,000 deaths annually, with a high burden occurring in low- and middle-income countries (LMICs). Identifying patient risk factors associated with mortality following falls in a resource poor setting can help guide pre- and in-hospital care. This study aimed to identify factors associated with inpatient mortality and length of stay among fall patients in Malawi.*

Methods: *This was a retrospective cohort study of prospectively collective data on all patients admitted between January 2012 and December 2015 to Malawi's Kamuzu Central Hospital (KCH) who were injured by falling. Bivariate analysis evaluated the effect of potential risk factors on inpatient mortality. Multivariable logistic regression assessed the direct effect of potential risk factors on length of stay. Factors assessed included age, sex, most severely injured body part, fall height, alcohol use, transfer status, and surgical interventions.*

Results: *Of the 2,572 patients admitted after a fall, 17 (1%) died. Patients who died in hospital were older (median 41 years, IQR 25-49) compared to those discharged alive (median 11 years, IQR 6-28), p=0.001. Head injury was associated with mortality in 6 (35%) of patients who died compared to 206 (8%) of patients discharged alive (p<0.001). After adjustment, older patients had longer lengths of stay, as did patients with abdominal/pelvis injuries or lower extremity injuries.*

Conclusions: *Patients with head injuries from falls are at higher risk of mortality compared to patients with other anatomic injury locations. This knowledge can be used to identify fall patients who may benefit from triage to a higher level of care in resource-poor settings.*

Keywords: *Trauma; Falls; Traumatic Brain Injury; Sub-Saharan Africa; inpatient mortality; Malawi*

Introduction

Falls are a leading cause of unintentional injury and account for a majority of the disability after injury worldwide. (1-3) Falls result in 35 million disability-adjusted life-years (DALYs) and 700,000 deaths annually, with most of this disability occurring in low- and middle-income countries (LMICs.)(4, 5) The mortality rate is highest in Southeast Asia and Africa and is increasing.(5, 6) Poor infrastructure in LMICs increases risk for falls, while the lack of health care resources result in high rates of persistent disability and mortality after fall-related injuries. Other studies in LMICs have identified several risk factors for falls, including female sex, older age, and presence of chronic medical conditions.(2, 4, 7-9) However, there is a paucity of research on inpatient mortality following falls in LMICs, especially in sub-Saharan Africa.(10-12)

Effective treatment strategies to reduce the burden of fall-related morbidity and mortality in LMICs depend on clearly understanding the injury and patient characteristics associated with poor outcomes in these resource-limited settings. While older age has been associated with a higher risk of mortality from falls in LMICs, few other risk factors have been identified.(13, 14) Therefore, we sought to determine the injury characteristics and inpatient risk factors for length of stay (LOS) and mortality following falls in patients presenting to an urban tertiary care hospital in Lilongwe, Malawi. We hypothesized that injury pattern, age, and fall height would be associated with mortality following falls in Malawi.

Materials and Methods

This study is a retrospective cohort study that analyzes prospectively collected trauma surveillance data on all trauma patients admitted with injuries following falls to Kamuzu Central Hospital (KCH), Lilongwe, Malawi between January 2012 and December 2015. KCH is one of Malawi's largest hospitals and busiest trauma centers with 900 adult surgical beds, 5 surgical wards, and a dedicated burn center. It serves a population of 6 million people from the country's capital and central region, and approximately 15,000 trauma patients are evaluated there annually. Fall-related injuries are one of the most common injury mechanisms seen at KCH.

Eligibility criteria included all patients admitted during the time period who had a fall as a mechanism of injury. Trauma registry clerks collect data on trauma patients 24 hours a day, 7 days a week, and upload the data into the trauma registry. Data points include patient demographics, including age, sex, occupation, co-morbid conditions, mechanism of injury, primary anatomic location of injury, length of stay, and inpatient mortality. Primary injury locations are classified as head, spine, chest, abdomen/pelvis, lower extremity, and upper extremity. Injury settings, alcohol use, and fall height are patient or family reported. Patient surgeries and procedures include chest tube placement, burr hole, laparotomy, skin grafting, external fixation, orthopedic surgery, amputation, laceration repair, and wound debridement. Injury severity was difficult to assess using standard Revised Trauma Score, Kampala Trauma Score, or Malawi Trauma Score given missing variables.

All patients admitted to KCH with traumatic injury due to a fall during this study period were eligible for inclusion. The primary outcome of interest was inpatient mortality and secondary outcome of interest was LOS, in days. LOS was treated as both dichotomous (<3 days [lowest quartile] vs. ≥3 days [upper three quartiles]) and as a continuous, linear variable. Patient demographics and injury characteristics, stratified by discharge disposition (alive vs. dead) and by LOS (dichotomized) were compared using Fisher's exact and Wilcoxon-Mann-Whitney tests, where appropriate. A p-value <0.05 was considered statistically significant. When assessing LOS, only patients discharged alive were included.

Multivariable linear regression was used to assess the association between patient demographics and fall characteristics on average LOS. Due to the low incidence of inpatient mortality (n=17, 1%), we were unable to perform adjusted analyses on this outcome.

All analyses were performed using SAS 9.4 (SAS Inc., Cary, NC). In compliance with the necessity for ethical approval, the Malawi National Health Science Research Council and the University of North Carolina IRB committees approved this study.

Results

Between 2012 and 2015, 62,238 patients were evaluated for injuries at KCH. Of these 17,988 (29%) presented after a fall, making falls the most common injury mechanism, with road traffic collisions accounting for 26% and assaults 24% of injuries. Of the patients who fell, 15,398 (86%) were treated and sent home, 8(0.1%) patients were brought in dead or died before admission, and 2,572 (14%) were admitted; 10 patients were missing admission status. Almost all patients (n=17,934, >99%) were classified as alert at their initial neurological assessment. Median fall height was 0 meters (IQR 0-1, range 0-50.) Even among admitted patients, 80% had fallen between 0 and 1 meters. The majority of falls patients were males: 10,057 (65%) of those treated and sent home and 2,572 (68%) of those admitted. Differences between those admitted and those sent home were consistent among children (0-19 years old) and adults (≥20 years old). (Table 1) Primary upper extremity injuries were more common among those sent home (7,546, 49% vs 939, 36%), while lower extremity injuries were more common among those admitted (1,085, 42% vs 4,093, 27%.) The most common injury setting was the home for both patients sent home

(10,795, 70%) and those admitted (1,761, 69%.) The injuries were evenly distributed throughout the seasons for all patients. Alcohol use was reported in 278 (2%) of patients following a fall. Among admitted patients, 1,462 (57%) were transferred to KCH from another facility compared to 2,595 (17%) of patients who were discharged from the Emergency Department (ED.) (Table 1)

Table1. *Patient demographics and injury characteristics among patients who were treated at KCH between 2012 and 2015 for fall injuries.*

	Discharged from ED[a,b] 15,398 (86%)	**Admitted[a] 2,572 (14%)**
Male, n (%)	10,057 (65)	1,752 (68)
Age, in years, n (%)		
0-9 years old	5,387 (45)	931 (44)
10-19 years old	2,785 (23)	504 (24)
20-29 years old	1,618 (14)	161 (8)
30-39 years old	1,026 (9)	132 (6)
40-49 years old	501 (4)	95 (5)
50-59 years old	307 (3)	74 (4)
60-69 years old	199 (2)	101 (5)
70-79 years old	85 (1)	75 (4)
≥80 years old	30 (<1)	40 (2)
Primary injury location, n (%)		
Head	1,701 (11)	228 (9)
Spine	421 (3)	90 (4)
Chest	1,182 (8)	69 (3)
Abdomen/Pelvis	428 (3)	161 (6)
Upper extremity	7,546 (49)	939 (36)
Lower extremity	4,093 (27)	1,085 (42)
Injury setting, n (%)		
Home	10,795 (70)	1,761 (69)
Work	950 (6)	115 (4)
Road/street	966 (6)	207 (8)
School	951 (6)	120 (5)
Farm	84 (1)	75 (3)
Sport/recreation venue	1,160 (8)	161 (6)
Public space	371 (2)	81 (3)
Lake/river	71 (<1)	38 (1)
Field/forest	22 (<1)	9 (<1)
Other	1 (<1)	0 (0)
Season, n (%)		
Winter	4,086 (27)	658 (25)
Spring	4,177 (27)	666 (26)
Summer	3,543 (23)	592 (23)
Fall	3,592 (23)	666 (26)
Alcohol-related, n (%)	234 (2)	44 (2)
Fall height, n (%)		
0 meter	9,699 (65)	1,269 (51)
1 meter	3,574 (24)	723 (29)
2 meters	751 (5)	167 (7)
3 meters	348 (2)	84 (3)
4 meters	319 (2)	112 (5)
≥5 meters	285 (2)	135 (5)
Transfer from outside facility, n (%)	2,595 (17)	1,462 (57)

Abbreviations:

[a] 8 patients were brought in dead or died before admission and were excluded

[b] Emergency Department

Of the 2,572 patients who were admitted, 17 (1%) died during their hospitalization, 2,436 (97%) were discharged alive, 4 were transferred (<1%), and 64 (3%) absconded; 51 patients were missing discharge status. Table 2 includes patient and injury differences across those who died and those who were discharged alive. Thirteen (76%) of the patients who died were male, compared to 1,660 (68%) of the patients who were discharged, p=0.61. Patients who died were older than those who were discharged, with a median age of 45 (IQR 25-49) compared to 11 (IQR 6-28), p<0.001, respectively. Surgical procedures were equivalent among those who died and those who survived. No patients required burr holes. Patients with head injuries were more likely to die (6, 35% vs 206, 8%, p<0.0001), while upper extremity injuries were protective (1, 6% among patients who died vs 892, 37% among discharged patients, p=0.009). (Table 2)

Table2. *Patient demographics and injury characteristics, stratified by discharge disposition.*

	In Hospital Mortality 17 (1%)	Discharged Alive 2,436 (99%)	p-value
Male, n (%)	13 (76)	1,660 (68)	0.61
Age, in years, median (IQR)	41 (25 – 49)	11 (6 – 28)	**0.001**
Primary injury location, n (%)			
Head	6 (35)	206 (8)	**<0.0001**
Spine	2 (12)	82 (3)	0.11
Chest	0 (0)	64 (3)	0.99
Abdomen/Pelvis	2 (12)	148 (6)	0.28
Upper extremity	1 (6)	892 (37)	**0.009**
Lower extremity	6 (35)	1,044 (43)	0.63
Alcohol-related, n (%)	2 (12)	39 (2)	**0.03**
Fall height, meters, n (%)			
0 (ground-level fall)	9 (53)	1,211 (51)	0.99
1	3 (18)	680 (29)	0.42
≥2	5 (29)	468 (20)	0.36
Transfer from outside facility, n (%)	10 (59)	1,385 (57)	0.99
Any surgery, n (%)	4 (24)	392 (20)	0.76
Abbreviations: IQR, interquartile range;			

Median length of stay was 7 days (IQR 3 – 21, range 0 – 186 days). Bivariate analysis showed that patients with a LOS less than 3 days were more likely to have head (80, 13% vs 126, 7%, p<0.0001), spine (32, 5% vs 50, 3%, p=0.003), chest (23, 4% vs 41, 2%, p=0.04) and upper extremity injuries (301, 51% vs 591, 32%, p<0.0001.) Patients with lower extremity injuries had longer LOS (919, 50% for ≥ 3 days vs 125, 21% for < 3 days.) Transfer patients also had longer lengths of stay (1,085, 59% for ≥ 3days vs 300, 51% for < 3 days.) No other variables were significant. (Table 3)

Table3. *Patient demographics and injury characteristics among patients discharged alive, stratified by length of stay*

	LOS <3 days 594 (24%)	LOS ≥3 days 1,842 (76%)	p-value
Male, n (%)	423 (71)	1,237 (67)	0.07
Age, in years, median (IQR)	10 (6 – 25)	11 (6 – 29)	0.40
Primary injury location, n (%)			
Head	80 (13)	126 (7)	**<0.0001**
Spine	32 (5)	50 (3)	**0.003**
Chest	23 (4)	41 (2)	**0.04**
Abdomen/Pelvis	33 (6)	115 (6)	0.62
Upper extremity	301 (51)	591 (32)	**<0.0001**
Lower extremity	125 (21)	919 (50)	**<0.0001**
Alcohol-related, n (%)	11 (2)	29 (2)	0.57
Fall height, meters, n (%)			
0 (ground-level fall)	307 (53)	904 (51)	0.27
1	158 (27)	522 (29)	0.43
≥2	110 (19)	358 (20)	0.67
Transfer from outside facility, n (%)	300 (51)	1,085 (59)	**0.0005**
Any surgery, n (%)	111 (19)	381 (21)	0.32
Abbreviations: IQR, interquartile range			

Multivariable linear regression demonstrated that of patients discharged alive, patients older than 60 years of age had longer LOS (Change in estimate (CIE) 5.99, 95%CI 2.22-9.76, p=0.002 for patients 60-69 years old and CIE 10.70, 95%CI 6.63-14.77, p<0.0001 for patients 70-79 years old.) Patients with abdominal and pelvic injuries had longer LOS (CIE 4.69, 95%CI 1.92-7.46, p= 0.0009), as did patients with lower extremity injuries (CIE 13.14, 95%CI 11.69-14.60, p<0.0001) and patients transferred from an outside facility (CIE 1.55, 95%CI 0.30-2.80, p=0.02.) (Table 4)

Table4. *Adjusted association of patient demographics and injury characteristics on average length of stay, among patients discharged alive*

	CIE (95% CI)	p-value
Male	-0.50 (-1.84, 0.84)	0.47
Age, in years		
0-9 years old	1.14 (-1.54, 3.83)	0.40
10-19 years old	0.82 (-2.00, 3.65)	0.57
20-29 years old	-0.14 (-3.46, 3.19)	0.94
30-39 years old	ref	–
40-49 years old	2.89 (-0.88, 6.65)	0.13
50-59 years old	2.45 (-1.79, 6.70)	0.26
60-69 years old	5.99 (2.22, 9.76)	**0.002**
70-79 years old	10.70 (6.63, 14.77)	**<0.0001**
≥80 years old	9.91 (4.75, 15.07)	**0.0002**
Primary injury location		
Head	0.59 (-1.87, 3.07)	0.64
Spine	1.59 (-1.94, 5.12)	0.38
Chest	-2.28 (-.607, 1.52)	0.24
Abdomen/Pelvis	4.69 (1.92, 7.46)	**0.0009**
Upper extremity	ref	–
Lower extremity	13.14 (11.69, 14.60)	**<0.0001**
Alcohol-related	-1.70 (-6.30, 2.91)	0.47
Fall height, meters		
0 (ground-level fall)	ref	–
1	0.44 (-0.97, 1.85)	0.54
≥2	1.47 (-0.25, 3.19)	0.09
Transfer from outside facility	1.55 (0.30, 2.80)	**0.02**
Any surgery	1.12 (-0.35, 2.60)	0.14
Abbreviations: CIE, change in estimate; CI, confidence interval		

Discussion

Falls are a leading cause of traumatic injury in Sub-Saharan Africa.(8, 12, 15, 16) Although the mortality was relatively low for the fall patients in this study, falls were the most common injury mechanism treated at KCH. Thus, it is essential to identify the characteristics associated with fall-related mortality to improve overall trauma morbidity and mortality in the region. One study in Cape Town showed that falls make up 45% of unreported fatalities, signifying that the burden of disease may actually be higher.(17) Admitted patient with head injuries after falls and older patients were at risk for mortality, while patients admitted with upper extremity injuries had fewer deaths. Older patients, transfer patients, and patients with abdominal/pelvic or lower extremity injuries had longer lengths of stay.

The World Health Organization (WHO) cites female sex, rural location of injury, presence of multiple chronic conditions, and poor cognitive function as risk factors for more severe injury and disability in patients who fall in LMICs.(2) Studies in HICs have demonstrated an association between older age and mortality.(8, 18, 19) In this study, patients overall were young however we did note an association between mortality and age, as well as an association between patients older than age 60 and length of stay. The young age in this population was driven by the inclusion of children.

Some studies in LMICs have shown that falls are most common in the workplace and in rural farming settings.

(5, 20, 21) Interestingly, the majority of patients and families in this Malawian trauma population reported that the falls occurred at home. The reasons for this difference may be secondary to the inclusion of paediatric patients in this study. Fall height was not associated with mortality or LOS, likely because the vast majority of patients had falls of 1 meter or less.

While very few studies have specifically evaluated risk factors for mortality among fall patients in LMICs, head injuries have previously been reported to be common after falls, as we found in this study. Small studies in South Africa, Botswana, and Uganda have demonstrated a link between falls and traumatic brain injury in paediatric and adult patients.(22-25) A study in Gambia at two major trauma centers found that elderly patients who fall and have brain injuries have the highest odds for disability at the time of discharge.(26) Another study of injury-related mortality in Sub-Saharan Africa found patients who suffered head trauma from falls were more likely to die as a result of their injury.(18) The majority of data about fall-related mortality comes from studies in HICs. Among elderly patients, male sex, head injuries, and hip injuries have been associated with fall mortality in Austria, Slovakia, and the United States.(13, 14, 27) Recently, a study of elderly patients in the United States also demonstrated post-fall mortality was associated with head injury, increasing age, high injury severity score, low Glasgow Coma Scale, Intensive Care Unit admission, and anaemia.(18) Mortality after falls appears to be increasing annually in HIC as well as LMICs, which may be secondary to a larger aging population.(28, 29)

This study adds to the growing body of knowledge that highlight the lethality associated with head injury in the Malawian trauma population. Previous analyses of the KCH trauma registry revealed a stark prognosis for head injury patients at this tertiary referral center.(30-35) We have noted this association between head injury and mortality among the paediatric KCH population in pre-hospital trauma deaths, in mortality following road traffic accidents, and among children suffering from intentional injuries.(30, 31, 35) In the adult KCH population, head injury is the anatomic location of injury most associated with death in the prehospital trauma setting and following trauma in all injury mechanisms.(32, 34) Overall, the mortality rate is 31% for all Traumatic Brain Injury (TBI) patients at KCH.(33) While this is comparable to large randomized trials of patients with moderate and severe brain injuries in HICs, GCS <=12, which range from 20-44%, the KCH mortality rates include a majority of patients with minor traumatic brain injuries.(36)

Resources are essential to care for head injury patients and transition them out of the hospital. The challenges at KCH are faced by many hospitals in LMICs, including limited availability of ventilators and neurosurgeons, lack of equipment (CT scans and external ventricular drains) or staff to monitor severely head injured patients, and lack of a dedicated neurosurgical intensive care unit. Even the ability to monitor changes in GCS closely is inadequate because nursing to patient ratios approach 40:1 on most surgical wards. Currently KCH has 4 surgical intensive care unit beds, no dedicated paediatric intensive care unit beds and 4 ventilators. Neurosurgical assessment and interventions are limited as there is only one neurosurgeon intermittently available, and two clinical officers that perform some neurosurgical procedures. The only CT scanner at KCH frequently does not work, and KCH does not have a MRI scanner, thus diagnosis is mostly clinical. No invasive intra-cranial pressure monitoring is available.

The management of trauma brain injuries at KCH has been shaped by the limited resources. These local standards frequently differ from TBI management in HICs, and include exploratory Burr holes in severe TBI with a localizing exam. None of the fall patients in this trauma cohort received Burr holes. The ones who may have benefited from a Burr hole or decompressive craniotomy were likely not identified due to lack of monitoring and resources. Given missing data on GCS and cause of mortality, whether the patients who died would have benefited from surgical intervention is unclear. In prior studies, mortality among 241 TBI patients undergoing Burr holes at KCH was 6.8% compared to 43.9% in those not undergoing Burr hole (OR 12.0, $p<0.0001$). (37) Other studies in India, Thailand, Benin and American Samoa have demonstrated similar benefits to exploratory Burr holes in the resource poor setting.(38-41)

In addition to exploratory Burr holes, standardized TBI protocols may help. One study in Columbia showed a decrease in mortality, increased discharge GCS, and increased use of emergency department interventions after developing a standardized trauma protocol for

TBI patients.(42) A TBI protocol at KCH would be a feasible and economical intervention. The increased mortality among head injured fall patients reinforces a recurring theme of increased mortality from head trauma in this trauma population and underscores this point: in order to reduce trauma mortality at KCH, the triage and management of TBI patients must be a top priority.

This study has several limitations. First, the findings at KCH may not be generalizable to the rest of the country, region, or other LMICs. Missing data limited the ability to grade both overall injury severity and the severity of TBI. GCS was missing in 38% of our cohort. Similarly, over 75% of patients were missing initial respiratory rate and/or systolic blood pressure so injury severity trauma scores could not be calculated. Many patients in Malawi also rarely visit a physician, thus the presence of comorbid conditions and their contribution to mortality is also unknown. Due to the low incidence of mortality, multivariable modelling could not be performed, limiting our ability to account for confounders. Data about cause of death were not available. The trauma registry does not include discharge functional status and has no post-discharge follow-up, so longer term mortality and disability related to falls are not available. Future studies of long-term outcomes, including both mortality and disability related to falls in LMICs are needed. Falls may make up a significant proportion of unreported fatalities in the prehospital setting, introducing selection bias.

Conclusion

In this study at KCH in Malawi, inpatient mortality following a fall mechanism of injury was 1%, with the majority of death attributable to head injury. Older age was a risk factor as well. This information is critical in a low-resource setting to assist clinicians in triaging at-risk head injury patients. Limited resources available should be directed towards treatment and management of the trauma head injury population, with potential interventions such as such as exploratory burr holes, TBI trauma protocols, and less resource intensive ways to monitor GCS changes in TBI patients. Further studies are needed to determine effective and financially feasible methods to reducing mortality in the resource poor setting. Among fall patients, further studies are needed to evaluate disability and morbidity.

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Citation: **Trista D. Reid, Avital Yohann, Paula D. Strassle, et al.** *Head Injury as a Risk Factor for Inpatient Mortality Among Fall Patients in Malawi. Open Journal of Surgery. 2020; 3(2): 01-09.*