Original Research

The Clinical Outcomes of Patients with Head Injuries at a Resource-Limited Secondary-Level Hospital in Eastern Province, Zambia

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Abstract

Background

Traumatic brain injury (TBI) is a leading cause of morbidity and mortality worldwide. TBI disproportionately affects low- and middle-income countries (LMICs). Evidence describing the clinical outcomes of head injuries in rural Zambia remains limited. The objective of this study is to describe the epidemiology and clinical outcomes of patients with head injuries treated at a secondary-level referral hospital in Eastern Province, Zambia.

Methods

We conducted a retrospective cohort study of patients treated for head injuries at St. Francis Mission Hospital between 2019 and 2021. Data on demographics, injury characteristics, diagnostic investigations, management, and outcomes were extracted from hospital records.

Results

A total of 567 patients with head injuries was included. The mean age was 29.4 years and 88.5% (502/567) were male. Road traffic accidents accounted for 60.0% (340/567) of injuries, with motorcycles 41.2% (140/340) and bicycles 22.4% (76/340) contributing most. The majority of patients presented with mild TBI (88.9% [504/567]), while 5.3% (30/567) had moderate TBI, and 5.8% (33/567) had severe TBI. Computed tomography (CT) imaging was performed in 6.2% (35/567) of patients. A total of 13.8% (78/567) underwent surgical management. A total of 3.7% (21/567) required intensive care unit (ICU) admission, of which 61.9% (13/21) died. The overall mortality rate was 4.1% (23/567).

Conclusions

Head injuries in Eastern Zambia predominantly affect male motorcycle and bicycle road users within the working-age population. Although overall mortality was only 4.1%, mortality among patients requiring ICU care was 61.9%. Strengthening neurocritical care capacity and supporting task-sharing initiatives between general surgeons and neurosurgical teams may improve outcomes in resource-limited settings.

Introduction

Traumatic brain injury (TBI) is a major global health problem and one of the leading causes of death and disability worldwide.[1] Road traffic accidents (RTAs) rank among the leading causes of death and disability, particularly affecting individuals aged 5–29 years.[2] More than half of RTA-related deaths involve vulnerable road users, includ-

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ing pedestrians, cyclists, and motorcyclists.[2,3] Over 90% of these deaths occur in low- and middle-income countries (LMICs), where limited resources, delayed access to care, and inadequate trauma systems contribute to poorer outcomes.[2]

TBI resulting from RTAs is a major contributor to morbidity and mortality among young populations in LMICs.[4] Patients with TBI often require timely diagnosis, neurosurgical assessment, critical care support, and rehabilitation services. Delays in the diagnosis and treatment can result in preventable mortality and long-term disability.

Early detection of intracranial injuries through computed tomography (CT) imaging and timely surgical intervention, when indicated, are important components of modern TBI management.[5]Access to these services remains limited in many resource-constrained settings.

Sub-Saharan African countries face substantial challenges in delivering comprehensive neurotrauma care.[6] Challenges include shortages of neurosurgeons, limited access to advanced imaging, inadequate neurocritical care services, and underdeveloped referral systems.[6] Consequently, many patients with head injuries are managed in district and secondary-level hospitals by non-neurosurgical clinicians.[7] Understanding outcomes in these settings is essential for informing health system strengthening efforts and improving trauma care delivery.

Although efforts have been made to strengthen surgical services through policy such as development of the National Surgical, Obstetric and Anesthesia Plan (NSOAP),[8] access to specialist neurosurgical care remains concentrated in tertiary centers.

Despite the growing burden of neurotrauma in Zambia, there is limited published evidence describing the characteristics, management, and outcomes of patients with head injuries treated outside specialist neurosurgical centers. This study aims to describe the epidemiology and clinical outcomes of head injury patients treated at a secondary-level hospital in Eastern Zambia. Understanding these outcomes may help identify gaps in care and inform future strategies to strengthen neurotrauma services in similar resource-limited settings.

Methods

Study design

We conducted a retrospective cohort study of head injury patients treated at St. Francis Mission Hospital between 2019 and 2021. This period was selected because hospital records were most complete and consistently archived, allowing reliable extraction of clinical and outcome data. Earlier records were excluded due to incomplete documentation and inconsistencies that would have compromised data quality.

Study area

Zambia's health system comprises three levels with 1956 health facilities: (1) the district level includes 1926 health posts, health centers, and district hospitals which provide Primary Health Care services; (2) the secondary level consists of 24 general/secondary referral hospitals providing curative care in internal medicine, pediatrics, obstetrics, gynecology, and general surgery; and (3) the tertiary level is comprised of 6 central hospitals providing specialized and sub-specialized care. St. Francis Mission Hospital is a secondary-level facility located in Katete District, Eastern Province. During the study period, CT imaging was not available on site, and the nearest facility with CT services was located approximately 85.9 km away in Chipata, the provincial capital.

Study population and data collection

All patients with head injuries presenting during the study period were included. Data were extracted retrospectively from medical records using a structured data extraction tool. Patients were identified through hospital registers using admission numbers and archive codes.

Variables collected included demographics (age, sex), clinical presentation, mechanisms of injury, severity of TBI, diagnostic investigations (CT imaging), treatments (surgical or non-surgical) and outcomes (survival or death). Surgical intervention was based on clinical assessment and CT imaging findings, including the presence of lacerations, depressed skull fractures, or intracranial lesions requiring operative management. Although formal intensive care unit (ICU) admission criteria were not established, patients admitted to the ICU were typically those who required post-operative care or mechanical ventilation. TBI severity was classified using the Glasgow Coma Scale (GCS): mild (13–15), moderate (9–12), and severe (3–8). Age groups were defined as early childhood (<5 years), school-going (5–14 years), early adulthood/active workforce (15–44 years), late adulthood (45–59 years), and elderly (>60 years).

Data analysis

Data were entered, cleaned, and analyzed using Stata version 18 (StataCorp LLC, College Station, TX, USA). Continuous variables were summarized using means or medians depending on distribution, while categorical variables were summarized as frequencies and percentages. Bivariate analysis was performed to assess associations between independent variables and the outcome (survival). Chi-square or Fisher's exact tests were used for categorical variables. Variables were selected for inclusion in the multivariable logistic regression model based on clinical relevance and results from bivariate analysis. Multivariable logistic regression was used to identify independent predictors of outcome, and results were reported as crude odds ratios (COR) and adjusted odds ratios (AOR) with 95% confidence intervals. Statistical significance was set at $P < .05$. Missing data were assessed prior to analysis, and a complete-case analysis approach was applied, whereby records with missing key outcome or exposure variables were excluded from regression analyses.

Results

Patient characteristics

A total of 567 patients with head injuries were included in the study. The mean age was 29.4 years (range: 2 months to 99 years), with most patients aged 15–44 years (69.1% [392/567]). Males accounted for 88.5% (502/567) of cases. RTAs were the leading mechanism of injury, accounting for 60.0% (340/567) of cases. Among RTAs, motorcycle-related injuries were the most common 41.2% (140/340), followed by bicycle-related injuries 22.4% (76/340) and motor vehicle-related injuries 20.0% (68/340). On admission, most patients had mild TBI 88.9% (504/567), while 5.3% (30/567) had moderate TBI and 5.8% (33/567) had severe TBI. Associated extracranial injuries were present in 3.0% (17/567) patients and were exclusively musculoskeletal. The largest proportion of patients presented during the cool dry season 45.9% (260/567). The mean length of hospital stay was 3.1 ± 4.4 days and the overall mortality rate was 4.1% (23/567). (Table 1)

Clinical management and outcomes

The majority of patients were managed conservatively (86.2% [489/567]), while 13.8% (78/567) underwent surgical intervention. Surgical debridement was the most frequently performed procedure (78.2% [61/78]), followed by burr hole surgery (15.4% [12/78]), bone elevation with wound closure (3.8% [3/78]), and craniotomy (2.6% [2/78]). All operations were performed by general surgeons.

CT imaging was performed in 6.2% (35/567) of patients, revealing subdural hematoma in 42.9% (15/35), epidural hematoma in 28.6% (10/35), cerebral contusions in 20.0% (7/35) and skull fractures in 8.6% (3/35). (Table 1)

ICU admission was required for 21 patients (3.7%). The indications for ICU admission included severe TBI and neurological deterioration requiring airway protection. Overall, 13 of the 21 patients died, while 38.1% (8/21) survived. All 6 patients who required postoperative intubation died. The mean ICU stay was 3.3 ± 4.8 days, and the mean duration of mechanical ventilation among intubated patients was 2.3 ± 1.9 days. (Table 1)

Factors associated with mortality

Survival was higher among patients injured during the cool and dry (253/260; 97.3%) and rainy (191/197; 97%) seasons compared to the hot season (100/110; 90.9%) (P = .01). (Table 2) Patients who underwent CT imaging also had higher mortality rates than those who did not. (Table 3)

Antiepileptics, ICU admission, and patient intubation were all significantly associated with mortality (all $p < 0.01$) (Table 4)

In univariate analyses, mortality was significantly associated with TBI severity, season of presentation, CT imaging and ICU admission. (Table 5)

In multivariable logistic regression analysis, severe TBI was the strongest independent predictor of mortality. Compared with patients with mild TBI, those with severe TBI had significantly higher odds of death (AOR 69.9, 95% CI 4.7–1029.8; P <.01). ICU admission (AOR 13.4, 95% CI 1.1–157.8; P =.04) and anticonvulsant use (AOR 11.9, 95% CI 1.5–91.9; P = .02) were also independently associated with increased odds of mortality. (Table 5)

Discussion

This study demonstrates that in a secondary-level hospital in rural Zambia, head injuries are predominantly mild and affect young male road users. RTAs, particularly involving motorcycles and bicycles, were the principal mechanism of injury. While overall mortality was low, outcomes among patients requiring intensive care were poor. ICU mortality exceeded 60%, highlighting a critical gap in neurocritical care capacity at district level.[9]

The predominance of young adult males among head injury patients is consistent with reports from other LMICs.[4] The socioeconomic implications are considerable as injuries affecting this group may result in loss of income, increased dependency, and long-term consequences for affected households. The high proportion of motorcycle and bicycle-related injuries observed in this study likely reflects the widespread use of these modes of transport in Eastern Zambia. These findings reinforce the importance of targeted injury prevention strategies, including enforcement of traffic regulations, promotion of helmet use, and improvements in transport infrastructure. The predominance of mild TBI likely reflects prehospital mortality bias, as patients with devastating injuries may not survive to reach hospital care. This highlights a well-described limitation of hospital-based trauma surveillance in low-resource settings, where the true burden of severe TBI is likely underestimated.[9]

Only 6.2% of patients underwent CT imaging, reflecting the limited availability and accessibility of advanced diagnostic services during the study period. Its use was largely restricted to patients with more severe clinical presentations. Mortality was therefore higher among patients who underwent CT scanning, likely reflecting greater injury severity rather than any adverse effect of imaging itself. Limited access to CT may delay diagnosis of surgically significant intracranial lesions and may contribute to poorer outcomes among patients with severe injuries. Expanding access to diagnostic imaging therefore remains an important priority for strengthening trauma care services in rural

Table 1. Demographic and clinical characteristics

Variables	Frequency	Percentage (%)
Age (years)		
0–5	27	4.8
6–14	73	12.9
15–44	392	69.1
45–59	51	9
≥60	24	4.2
Sex		
Male	502	88.5
Female	65	11.5
Admission GCS		
Mild TBI (GCS: 13–15)	504	88.9
Moderate TBI (GCS: 9–12)	30	5.3
Severe TBI (GCS: 3–8)	33	5.8
Length of hospital stay (days), *mean ± SD*	3.1	± 4.4
Season of presentation		
Cool and dry	260	45.9
Hot and dry	110	19.4
Wet and rainy	197	34.7
Mechanism of injury		
Assault	194	34.2
Fall from height	33	5.8
Road traffic accident	340	60
Causes of RTA		
Motorcycle	140	41.2
Bicycle	76	22.4
Car	68	20
Oxcart	43	12.6
Truck	13	3.8
Extracranial injuries Musculoskeletal	17	3.0
Diagnostics		
CT scan	35	6.2
Diagnosis		
Haemorrhagic contusions	7	20
Epidural hematoma	10	28.6
Subdural hematoma	15	42.9
Skull fracture	3	8.6
Treatment		
Surgical	78	13.8
Non-surgical	488	86.2
Types of surgical procedures		
Burrholes and drainage	12	15.8
Craniotomy	2	2.6
Bone elevation and closure	3	3.8
Debridement and suturing	61	78.2
Treatment outcomes		
Admitted to ICU	21	3.7
Patient intubated	6	1.1
Length of ICU stay (days), *mean ± SD*	3.3	±4.8
Duration of intubation (days), *mean ± SD*	2.3	±1.9
Survival outcome		
Survived	544	95.9
Death	23	4.1

Zambia. Similarly, the association between anticonvulsant use and mortality likely represents confounding by indication, as these agents were preferentially administered to patients with severe injury or seizure risk. This finding does

Table 2. Association between demographic and clinical characteristics with survival outcome

Variables	Total	Survival outcome, *n* (%)		*P* value
		Survived	Death	
Age (years)				0.521
0–5	27 (4.8)	27 (100)	0	
6–14	73 (12.9)	69 (94.5)	4 (5.5)	
15–44	392 (69.1)	376 (95.9)	16 (4.1)	
45–59	51 (9)	50 (98)	1 (2)	
≥60	24 (4.2)	22 (91.7)	2 (8.3)	
Sex				0.095*
Male	502 (88.5)	479 (95.4)	23 (4.6)	
Female	65 (11.5)	65 (100)	0	
Admission GCS				**0.001**
Mild TBI	504 (88.9)	502 (99.6)	2 (0.4)	
Moderate TBI	30 (5.3)	23 (76.7)	7 (23.3)	
Severe TBI	33 (5.8)	19 (57.6)	14 (42.4)	
Season of head injury				**0.012**
Cool and dry	260 (45.9)	253 (97.3)	7 (2.7)	
Hot and dry	110 (19.4)	100 (90.9)	10 (9.1)	
Wet and rainy	197 (34.7)	191 (97)	6 (3)	
Mechanism of injury				0.268
Assault	194 (34.2)	188 (96.9)	6 (3.1)	
Fall from height	33 (5.8)	33 (100)	0	
Road traffic accident	340 (60)	323 (95)	17 (5)	

* Fishers exact test

Table 3. Association between diagnostic profile and survival outcome

Variables	Total	Survival outcome, *n* (%)		*P* value
		Survived	Death	
CT scan performed				**0.001**
Yes	35 (6.2)	23 (65.7)	12 (34.3)	
No	532 (93.8)	521 (97.9)	11 (2.1)	
Epidural hematoma				0.058*
Yes	10 (1.8)	8 (80)	2 (20)	
No	557 (98.2)	536 (96.2)	21 (3.8)	
Subdural hematoma				**0.001**
Yes	15 (2.6)	10 (66.7)	5 (33.3)	
No	552 (97.4)	534 (96.7)	18 (3.3)	
Cerebral contusions				**0.002***
Yes	7 (1.2)	4 (57.1)	3 (42.9)	
No	560 (98.8)	540 (96.4)	20 (3.6)	

* Fishers exact test

not imply harm from treatment but instead highlights the severity gradient within the treated population.

The overall mortality rate of 4.1% was lower than that reported in many studies from Sub-Saharan Africa.[10-15] While this finding may reflect the predominance of mild injuries in our cohort, ICU mortality was 61.9%. However, this finding should be interpreted cautiously. The retrospective nature of the study prevented reliable determination of specific causes of death, making it difficult to distinguish mortality directly attributable to TBI from those related to in-hospital complications. Multivariable analysis identified severe TBI and ICU admission as strong predic-

Table 4. Association between treatment profile and survival outcome

Variables	Total	Survival outcome, *n* (%)		*P* value
		Survived	Death	
Treatment modality				
Surgical	78 (13.8)	73 (93.6)	5 (6.4)	0.23*
Non-surgical	489 (86.2)	471 (96.3)	18 (3.7)	
Antiepileptics/anticonvulsants				
Yes	28 (4.9)	16 (57.1)	12 (42.9)	**<0.01**
No	539 (95.1)	528 (98)	11 (2)	
Admitted to ICU				
Yes	21 (3.7)	8 (38.1)	13 (61.9)	**<0.01**
No	546 (96.3)	536 (98.2)	10 (1.8)	
Patient intubated				
Yes	6 (1.1)	0	6 (100)	**<0.01**
No	561 (98.9)	544 (97)	17 (3)	

* Fishers exact test

tors of death, underscoring the vulnerability of critically ill patients. These findings suggest that, although secondary-level hospitals may achieve favorable outcomes for mild injuries, significant challenges remain in the management of severely injured patients.

Similar challenges have been reported across LMICs, where shortages of trained personnel, monitoring equipment, and standardized neurocritical care protocols contribute to poorer outcomes compared with high-income settings.[11,16] Sustainable approaches such as targeted workforce training, telemedicine support, and context-appropriate critical care protocols may represent feasible strategies for improving outcomes in resource-constrained environments.[17]

Our findings also have implications for workforce planning and service delivery. During the study period, all neurosurgical procedures were performed by general surgeons because specialist neurosurgical services were unavailable locally. This reflects the reality of trauma care delivery in many parts of Zambia and other LMICs. Strengthening task-sharing models through structured collaboration between general surgeons and neurosurgical specialists, supported by referral networks and teleconsultation where available, may help bridge existing service gaps and improve access to timely care.[7] Such approaches align with broader national efforts to strengthen surgical systems and expand access to essential specialist services.

Overall, this study demonstrates that secondary-level hospitals play a critical role in the management of head injuries in Zambia. While most patients with mild TBI achieved favorable outcomes, deficiencies in access to CT imaging, neurocritical care services, and specialist neurosurgical support remain important barriers to optimal care for patients with severe injuries. Addressing these gaps through improved diagnostic capacity, strengthened referral pathways, enhanced neurocritical care services, and expanded task-sharing arrangements may contribute to improved outcomes in similar resource-limited settings.

Study Limitations

This study has several limitations. As a single-center retrospective study, its findings may not be generalizable to all health care facilities in Zambia. The retrospective design limited the availability and completeness of clinical information, including indications for surgery, timing of interventions, and long-term patient outcomes. The absence of standardized trauma registries also introduced challenges related to missing and inconsistently documented data. Furthermore, outcomes were limited to survival or death at discharge, preventing assessment of functional recovery and quality of life among survivors. The multivariable logistic regression model may have been affected by sparse data in certain exposure categories, particularly among patients with severe TBI and those requiring intensive care. This resulted in wide confidence intervals and potential model instability. Due to the retrospective design and limited number of outcome events, the adjusted estimates should therefore be interpreted with caution and as exploratory rather than definitive causal effects. Additionally, mortality outcomes should be interpreted with caution, as cause-specific mortality data were not consistently available. Future prospective studies should incorporate detailed clinical variables, time-to-treatment measures, and long-term follow-up assessments to provide a more comprehensive understanding of TBI outcomes in Zambia.

Conclusion and Recommendations

This study, conducted in a rural resource-limited setting, found that head injuries predominantly affect motorcycle and bicycle users within working-age population. RTAs remain the principal cause of injury, with most patients

Table 5. Logistic regression analysis for factors associated with TBI outcome

Independent variables	Univariate logistic regression			Multivariate logistic regression		
	P value	COR	95% CI of COR	*P value*	AOR	95% CI of AOR
Age (years)						
0–5	0.998	-	-	0.996	-	-
6–14	0.617	0.6	0.1–3.7	0.518	0.3	0.005–15
15–44	0.331	0.5	0.1–2.2	0.689	0.5	0.02–13.7
45–59	0.226	0.2	0.02–2.6	0.564	0.3	0.003–23.4
≥60	Ref					
Admission GCS						
Mild TBI	Ref					
Moderate TBI	**0.001**	76.4	15–388.4	**0.005**	31	2.8–338.5
Severe TBI	**0.001**	185	39.2–872.1	**0.002**	69.9	4.7–1029.8
Season of brain injury						
Cool and dry	Ref					
Hot and dry	**0.011**	3.6	1.3–9.8	0.271	4.1	0.3–49.7
Wet and rainy	0.822	1.1	0.4–3.4	0.397	2.6	0.3–25
CT scan performed						
Yes	**0.001**	24.7	9.9–61.9	0.705	0.5	0.02–16.3
No	Ref					
Subdural hematoma						
Yes	**0.001**	14.8	4.6–47.9	0.444	3.9	0.1–129.8
No	Ref					
Cerebral hematoma						
Yes	**0.001**	20.3	4.2–96.6	0.978	0.9	0.02–43.5
No	Ref					
Antiepileptics/anticonvulsants						
Yes	**0.001**	36	13.8–93.8	**0.018**	11.9	1.5–91.9
No	Ref					
Admitted to ICU						
Yes	**0.001**	87.1	29.6–256.6	**0.039**	13.4	1.1–157.8
No	Ref					

COR: Crude Odd Ratio; AOR: Adjusted Odd Ratio; CI: Confidence Interval

presenting with mild TBI. Although overall mortality was relatively low (4.1%), outcomes among critically ill patients were poor. Limited access to CT imaging and the absence of specialist neurosurgical services highlight important gaps in neurotrauma care.

Strengthening neurocritical care capacity, improving access to diagnostic imaging, and enhancing referral pathways should be prioritized to improve outcomes for patients with severe head injuries. Given the limited availability of neurosurgeons outside tertiary centers, strengthening task-sharing models through structured collaboration between general surgeons and neurosurgical services may represent a practical strategy for improving care in resource-constrained settings. Preventive interventions aimed at reducing road traffic injuries, including road safety education, helmet use promotion, and improvements in transport infrastructure, are also essential. Future prospective studies should evaluate functional outcomes, quality of life, and time-to-treatment measures to better understand the long-term impact of TBI in Zambia.

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Ethical Approval

This study received ethical approval from COSECSA (Ref. No. COSECSA/REC/2022/07), University of Zambia Biomedical Research Ethics committee (UNZABREC) (Ref No. 3306-2022) and the National Health Research Authority (NHRA) (**Ref No: NHRA0000012/20/12/2022)**. Permission to access data was obtained from the St. Francis Mission Hospital Management.

Informed Consent

The requirement for informed consent was waived by the ethics committee because this was a retrospective study using routinely collected, de-identified data.

Data Availability

Data described in the manuscript, code book, and analytic code will be made available upon request pending application and approval.

Conflict of Interest

The authors declare no competing interests.

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