Profile of Head Injuries: Prehospital Care, Diagnosis, and Severity in an Ethiopian Tertiary Hospital

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BACKGROUND: **Consistent data on head injury is lacking especially in the low- and middle-income countries. Our study tries to characterize patients with head injury at the emergency department of one of the few tertiary public hospitals giving neurosurgical care in the country.**

METHODS: **A retrospective cross-sectional study was performed from May 2015 to October 2015 in one of the neurosurgical teaching hospitals, Black Lion Specialized Hospital. All adult patients with head injury who visited the emergency department during the study period were included. Data on patients' sociodemographic, mechanism of trauma, clinical presentation, imaging findings, and presence of polytrauma were collected by a pretested questionnaire. The source of data was emergency department logbooks and patient charts.**

RESULTS: **A total of 390 patients with head injury who visited the emergency department were included during the study period. There were 335 males (85.9%) and 55 females (14.1%) with the mean age (standard deviation) of 35.4 (15.6) years. Majority of patients came by taxi constituting 149 (38.2%) of all patients, whereas 147 patients (37.7%) used ambulance. Of 147 patients brought by ambulances, 133 (90.4%) were referred from other hospitals. The majority, 26 (45.6%), of patients who came directly to the emergency department used taxis. It is shown that the mode of arrival and origin of arrival are significantly related, $P = 0.000$. Mortality of severe head injury at the emergency department was 50.8%.**

CONCLUSIONS: **Prehospital care coverage was low and ambulances were used mainly for interhospital transfers. Mortality of severe head injury at the emergency department is high and significantly associated with preventable causes like vital sign derangement.**

INTRODUCTION

Trauma has become an emerging challenge in the low- and middle-income countries (LMICs). These are countries with the lowest gross national income as defined by the World Bank.[1] It is estimated that approximately 89% of all trauma-associated deaths occur in this region according to the Global Burden of Disease report of 2010.Trauma-related deaths accounted for 12% of all deaths in LMICs as compared with the 6% in high-income countries.[2] The impact of injury can be more significant than this in some African countries such as South Africa where injury comes second as a cause of death and disability-adjusted life years.[3] Trauma is expected to increase in the future, and injuries from road traffic accidents (RTAs) are projected to be the fifth leading cause of death worldwide.[4]

Half of trauma deaths are caused by head injury.[5] It also contributes a significant share to the disability-adjusted life years. Head injury mostly affects the productive age group of a population, that is, the younger age group.[6] Despite the significance of the problem, consistent data on head injury are lacking especially in the LMICs.[7] This deficiency is witnessed

Key words
- Head injury
- Interhospital transfer
- Mortality
- Prehospital care
- Resource limited setup
- Vital signs

Abbreviations and Acronyms
AEDH: Acute epidural hematoma
DSF: Depressed skull fractures
LMICs: Low- and middle-income countries
RTA: Road traffic accident

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both in the prehospital and hospital setup, leading to the underestimation of the burden of the problem in these areas.

In Africa, there is scanty information, if any, on the mortality and morbidity of head injury.[8] The Global Burden of Disease 1996 survey showed that 62% of all head injuries are due to RTA with the highest share coming from Sub-Saharan Africa and Latin America.[9] Country-specific data on the prevalence and incidence of head injury in Africa are still deficient.

Head injury was found to be the commonest cause of death in the emergency department of one of the very few tertiary hospitals giving neurosurgical services in Ethiopia.[10] Likewise, a Nigerian study showed head injury to be the commonest cause of mortality in the injured population.[11] Moreover, head injury is the commonest cause for emergency visits in Ethiopia after post-traumatic fractures.[12]

In the face of the poorly developed prehospital care and the very few hospitals giving neurosurgical services in the country, head injury poses a big challenge.[13] Delays in the care of patients with severe head injury lead to worse outcomes both in terms of survival and functional status.[14] The problem is compounded by the very few number of hospitals providing neurosurgical services in the entire country. This has created even more delays to the optimum care that the patients can get in the country.

Our study tries to characterize patients with head injury at the emergency department of one of the few tertiary public hospitals giving neurotrauma care for the entire country with a population of 106 million. We believe that this study highlights the characteristics of patients with head injury in terms of their referral patterns, prehospital care, clinical presentation, and severity in Ethiopia.

PATIENTS AND METHODS

This is a retrospective cross-sectional study performed from May 2015 to October 2015 in one of the neurosurgical teaching hospitals, Black Lion Specialized Hospital. This is the biggest tertiary public hospital giving neurosurgical services for the majority of the Ethiopian population and the first hospital giving neurosurgical services in the country. Moreover, it is a university hospital where the first neurosurgical training program was started in 2006 in the country.

Black Lion Specialized Hospital provides 24-hour emergency neurosurgical services. Patients from all over the country are referred to the hospital as it is one of the very few places having comprehensive trauma care including ICU setup and neurosurgical operating room with a better facility. Moreover, the cost of treatment is very low, making health expenses affordable for the poor.

All adult patients with head injury who visited the emergency department during the study period were included. Data on patients' socioeconomic status, mechanism of trauma, clinical presentation, imaging findings, and presence of polytrauma were collected by a pretested questionnaire. The source of data was emergency department logbooks and patient charts.

Collected data were entered using SPSS 21.0 software and analyzed. The χ^2 test was used to assess the association between 2 variables.

RESULTS

Demographics

A total of 390 patients with head injury who visited the emergency department were included during the study period. There were 335 males (85.9%) and 55 females (14.1%). Their mean age (standard deviation) was 35.4 (15.6) years. The mean age of male patients was 34.5 years, whereas that of female patients was 41 years with a significant difference between the 2 sexes ($P = 0.004$) (Table 1).

Of all patients, there were 164 (42%) from Addis Ababa, whereas the remaining 221 patients (56.6%) were from outside of the capital, Addis Ababa. There were 5 patients (1.3%) whose address was missing. Of the 372 patients with recorded origin of referral, 299 (80%) were referred from district hospitals, whereas 59 (15.9%) came directly to the emergency department without any referral. Fourteen patients (3.8%) were referred from nearby health centers found around the scene of the accident (Table 1).

Mode of Transportation to the Hospital

Patients were brought to the hospital by various means of transportation. Mode of transportation to the hospital was recorded for 354 of the patients. Majority of patients came by taxi constituting 149 (42.1%) of all patients, whereas 147 patients (41.5%) used ambulance, 35 patients (10%) used private car, and 15 patients (4.2%) came walking. Six (1.7%) of the patients were brought by police car, whereas 2 patients (0.6%) presented carried by attendants (Table 2).

Most patients who were referred from hospitals came by ambulances followed by taxis. Of the 270 patients referred from other

Table 1. Sociodemographic and Origin of Referral of Patients with Head Injury During the Study Period (May 2015 to October 2015)

	N (%)
Male	335 (85.9)
Female	55 (14.1)
Mean age (years) $P = 0.004$	
Male	34.5
Female	41.0
Trauma mechanism $P = 0.000$	
Assault	33.2
RTA	35.7
Fall	42.3
Origin of referral	372
District hospitals	299 (80)
Brought directly to the emergency department	59 (15.9)
Health centers	14 (3.8)

RTA, road traffic accident.

Table 2. Mode of Arrival and Origin of Referral of Study Subjects During the Study Period (May 2015 to October 2015)

	Mode of Arrival						
	Ambulance	Taxi	Private Car	Police Car	Walking	Carried by Attendants	Total
Origin of referral							
Hospital	133 (49.3%)	110 (40.7%)	21 (7.8%)	—	5 (1.9%)	1 (0.4%)	270
Health center	3 (23.1%)	4 (30.8%)	4 (30.8%)	2 (15.4%)	—	—	13
Came directly without referral	10 (17.5%)	26 (45.6%)	8 (14.1%)	3 (5.3%)	9 (15.8%)	1 (1.8%)	57

hospitals with recorded data on their mode of arrival, 133 (49.3%) were brought by ambulances. Taxis were the next common mode of transportation from other hospitals with 110 patients (40.7%) brought by taxis.

Ambulance was used mostly for those patients who were referred from district hospitals. Among a total of 147 patients who were brought by ambulances, 133 (90.5%) were referred from other hospitals. The majority, 26 of 57 patients (45.6%) with recorded data, of patients who came directly to the emergency department used taxis. The mode of arrival and origin of referral are significantly associated ($P = 0.000$).

Prehospital care was assessed for 54 patients who came directly to the emergency department. The remaining patients were referred from hospitals and health centers. Only 4 (7.4%) of those patients who came directly to the emergency department had prehospital care, whereas the others did not get any prehospital care.

Mechanism of Injury

Mechanism of injury was recorded for 329 patients. The commonest mechanism of injury overall was assault by a stick comprising 124 of the 329 patients (37.7%). RTAs were the cause of head injury in 103 patients (31.3%), whereas 64 patients (19.5%) sustained fall accident. Among victims of RTAs, 46 (44.7%) were pedestrians, whereas 24 (23.3%) were car occupants (Table 3).

The commonest mechanism of trauma in the capital, Addis Ababa, was RTA accounting for 43 patients (30.7%) followed by fall accidents accounting for 41 (29.3%) and stick injuries accounting for 40 patients (28.6%). Stick injury was the commonest cause of injury in the district regions out of Addis with a total of 84 of 189 patients (44.4%) (Table 4).

The mean age of the victims in the different trauma mechanisms showed a significant difference ($P = 0.000$) (Table 1). Post hoc analysis showed that fall accident victims are older than RTA and assault victims.

Table 3. Mechanism of Injury of Study Subjects During the Study Period (May 2015 to October 2015)

Mechanism of Injury	N (%)
Road traffic accident (RTA)	103 (31.3)
Pedestrians	46 (44.7)
Car occupants	24 (23.3)
Tricycle occupant	8 (7.8)
Motor cycle driver	4 (7.8)
Pushed by motorcycle	2 (1.9)
RTA with unregistered mechanism	19 (18.4)
Fall accident	64 (19.5)
Penetrating head injury (gunshot, stab)	9 (2.7)
Stick injury	124 (37.7)
Stone	29 (8.8)
Total	329

Clinical Status on Arrival

Vital signs of patients were assessed in relation to their mode of arrival. Of 144 patients who came by ambulance and with recorded vital signs, 50 (34.7%) had either low blood pressure (28) or low oxygen saturation level (22). Among the 141 patients with a recorded blood pressure who used taxis, 23 (16%) had low blood pressure, whereas 14 of 135 patients (10.4%) with a recorded saturation level had a low oxygen level.

Mode of arrival to the hospital and oxygen saturation status of patients was not significantly associated ($P = 0.234$). Among patients who were brought from district hospitals, 269 had recorded blood pressure and oxygen saturation levels. The number of patients with low blood pressure was 39 (14.5%), whereas that with a

Table 4. Mechanism of Injury in the Different Regions During the Study Period (May 2015 to October 2015)

	Addis Ababa, N (%)	Other Regions, N (%)
Mechanism of injury		
Road traffic accident	43 (30.7)	60 (31.7)
Falls	41 (29.3)	23 (12.2)
Assault with stick	40 (28.6)	84 (44.4)
Assault with stone	13 (9.3)	16 (8.5)
Assault stab	3 (2.1)	5 (2.6)
Gunshot	—	1 (0.5)

low saturation level was 27 (10%). Both low blood pressure and oxygen saturation level were recorded in 6 patients (2.2%).

Severity of Head Injury

Recorded data on the severity of head injury was retrieved for 369 patients. Of these patients, 247 (63.3%) had mild head injury (Glasgow Coma Scale [GCS] = 14 and 15), 65 (16.7%) had moderate head injury (GCS = 9–13), and the remaining 57 (14.6%) had severe head injury. Among the mechanisms of trauma, falls had the highest proportion of severe head injury with 14 of 61 patients (23%) followed by RTA with 19 of 101 patients (18.8%) having severe head injury. This showed a significant association of the mechanism of trauma with severity of head injury (P = 0.016). The mean GCS of patients showed a significant difference among the different trauma mechanisms (P = 0.002). The mean GCS of RTA victims was 12.1, whereas that of assault was 13.4 (Table 5).

Ambulance was used in 32 (62.7%) and taxis in 10 (19.6%) of the total 51 patients with severe head injury with recorded mode of transportation to the hospital. Transportation mode was associated with head injury severity at admission to the emergency department (P = 0.00) (Table 6).

The total number of patients with severe head injury with a low oxygen saturation level was 22 (40.7%) from a total of 54 patients with a recorded oxygen saturation level, whereas low blood pressure was measured in 15 of 55 patients (27.3%) with documented blood pressure. Severity of head injury was significantly associated with the oxygen saturation level (P = 0.000) and the blood pressure (P = 0.015) of patients with head injury at presentation to the emergency department.

Polytrauma and Head Injury

Twenty-three of the 390 patients (6%) had polytrauma. Long bone fractures were the commonest concomitant injuries present in 11 patients followed by chest and spine injuries with 8 and 4 patients, respectively.

Table 5. Mean GCS Difference Among Different Trauma Mechanisms (May 2015 to October 2015)

Trauma Mechanism (Mean GCS)	Trauma Mechanism	Mean Difference	Sig.	95% Confidence Interval	
				Lower Bound	Upper Bound
RTA (12.06)	Assault	−1.308*	0.006	−2.30	−0.32
	Fall	−0.055	0.995	−1.38	1.26
Assault (13.37)	RTA	1.308*	0.006	0.32	2.30
	Fall	1.252*	0.036	0.07	2.44
Fall (12.11)	RTA	0.055	0.995	−1.26	1.38
	Assault	−1.252*	0.036	−2.44	−0.07

GCS, Glasgow Coma Scale; RTA, road traffic accident.
*The mean difference is significant at the 0.05 level.

Table 6. Mode of transportation to the Hospital Among Patients with Head Injury with Different severity During the Study Period (P = 0.000)

Transportation Mode	Head Injury Severity		
	Severe (%)	Moderate (%)	Mild (%)
Ambulance	32 (62.7)	35 (59.3)	74 (33.2)
Taxi	10 (19.6)	20 (33.9)	108 (48.4)
Heavy track	—	1 (1.7)	1 (0.4)
Private car	7 (13.7)	3 (5.1)	22 (9.9)
Police car	2 (3.9)	—	3 (1.3)
Walking	—	—	13 (5.8)
Carried by attendants	—	—	2 (0.9)
Total	51	59	223

Imaging Findings

Computed tomography (CT) findings for 320 patients were retrieved from the patient charts (Table 7). The CT findings were recorded based on the main finding on which the patients' treatment plans were made.

The commonest finding was depressed skull vault fractures (DSFs). Ninety-four patients (29.4%) had DSFs, whereas 51 (15.9%) had acute epidural hematoma (AEDH). Chronic subdural hematoma accounted for 42 patients (13.1%). There were 12 patients (3.8%) with acute subdural hematoma. There were 38 patients (11.9%) with contusions. Basal skull fracture was identified in 24 patients (7.5%), whereas 10 patients (3.1%) had linear fracture. Normal CT result was found in 49 (15.3%) of all patients.

The commonest cause for DSFs and AEDH was stick injury. Among 81 patients with DSF and known mechanism of injury, 31 (38.3%) sustained stick injury, whereas 24 of 44 patients (54.5%)

Table 7. CT Findings of Patients with Head Injury During the Study Period (May 2015 to October 2015)

CT Finding	N = 320 (%)
Depressed skull fractures	94 (29.4)
Linear skull vault fractures	10 (3.1)
Basal skull fractures	24 (7.5)
Acute epidural hematoma	51 (15.9)
Contusions	38 (11.9)
Acute subdural hematoma	12 (3.8)
Subacute/chronic subdural hematoma	42 (13.1)
Normal	49 (15.3)

CT, computed tomography.

with AEDH sustained stick injury. The mechanism of injury is shown to be significantly associated with CT findings of head injury ($P = 0.000$).

Patient Dispositions

Disposition of patients was recorded for a total of 376 patients. Ninety-two (24.5%) of the 376 patients were admitted, whereas 23 patients (6.1%) were referred because of lack of bed in the hospital. Thirty-five (9.3%) of the patients died at the emergency department, whereas 226 (60%) of the 370 patients were discharged with a follow-up appointment.

Mortality in the Emergency Department

A total of 35 patients died at the emergency department with the mortality rate of 9.3% among the 376 patients with a recorded disposition. There were 29 deaths (50.8%) at the emergency department among the 57 patients with severe head injury, whereas there were 4 patients (6.2%) who died among the 65 patients with moderate head injury. It was shown that low blood pressure and mortality are significantly associated ($P = 0.004$). Among 45 patients with a low oxygen and recorded mortality, 13 (28.9%) died showing a significant association between mortality and low oxygen level ($P = 0.00$).

Among 31 mortalities with recorded origin of referral, 28 (90%) were referred from district hospitals. Even though the mortality of transfers from district hospitals was high, there was no significant association between the origin of referral and mortality ($P = 0.38$).

DISCUSSION

This study highlights the prehospital and emergency care of patients with head injury in Ethiopia. Our results showed significant delay in definitive neurosurgical treatment of patients with head injury because the majority of head injury victims were referred from district hospitals where they stayed without any neurosurgical care. This finding goes in line with another study from Nigeria where most patients with head injury presented were referred from other district hospitals.[15] Mortality was high among the interhospital transfers even though there is no statistically significant association. A study performed in the effect of direct and indirect transfer of trauma patients to a specialty care in Sub-Saharan Africa showed less mortality in those patients with direct transfers.[16]

Our study showed that the prehospital care coverage was low. Majority of the patients coming directly to the hospital had no prehospital care. A study performed in the same hospital reported a similar finding depicting a very small prehospital care coverage.[13] The commonest mode of transportation was taxi followed by ambulances. Our observations show that taxis are easily accessible in close proximity to where accidents occur and hence are the commonest mode of transportation. Ambulances were mainly used for interhospital transfers. This finding is in concordance with a previous study that showed that ambulances were commonly used for interhospital transfers and mainly for pregnancy-related rather than trauma-related emergencies.[17]

We discovered that vital sign derangement with low blood pressure was often seen in patients who came by ambulance (19.4%). This illustrates the presence of inadequate prehospital care and paramedics training is lacking even though ambulance transportation was available. Ambulances are solely used for transportation purpose. They are not equipped with trained paramedics, life support, and monitoring instruments. Patients are usually not attended by health professionals and the ambulances lack basic life support equipment.

The blood pressure pattern was shown to be significantly associated with mortality in the emergency department. Hence, early correction of vital sign derangements has to be a crucial component of emergency management of patients with head injury. A Colombian study showed a significant decrease in mortality and an increase in discharge GCS of patients with head injury after introducing a standardized protocol for resuscitation of patients.[18]

Interestingly, the results of the study showed the common mechanisms of injury varied based on the geographical distribution of patients. RTAs are the leading causes of injury in the capital, Addis Ababa, followed by falls and assaults by stick. The commonest cause of head injury outside of Addis was assaults by stick. Wooden sticks are usually used in rural areas as a self-defense weapon and many use it in domestic violence (Figure 1).

These findings match with other African studies that showed violence to be the commonest cause of head injury in the rural setup.[8,19] The studies however did not show the types of violence.

The mechanism of injury and severity were shown to have a statistically significant association with RTAs causing most of the severe head injuries followed by fall accidents. A previous study from Addis Ababa showed falls to be the commonest cause of injuries followed by RTAs, whereas RTAs account for most of injury-related admissions.[20] The study however did not stratify patients based on their diagnoses. Thus, we could not know the commonest causes of head injury.

DSF was the commonest diagnosis in our patient population followed by AEDH. AEDH is relatively common in Ethiopia—a common finding in other African large cities as well as Cambodia.[19,21] It is also shown that the mechanism of injury and CT findings are significantly associated with stick injury being the commonest cause for DSFs and AEDH.

The overall mortality rate for head injuries at the emergency department was 9.2%, which is similar to a Ugandan study.[22] The mortality rate for severe head injury was 50.8%. Mortality of

Figure 1. A farmer holding a stick in the rural area of Ethiopia. (Photograph taken from http://tsehainy.com/2142.)

patients with severe head injury in our setup was very high compared with a resource-rich setting such as Switzerland that had a reported mortality rate of 26.4%.[23] Studies from Tanzania and Cameroon showed a relatively higher mortality rate of patients with severe head injury compared with ours.[24,25] Vital sign derangement such as low blood pressure is shown to be associated with higher mortality. These findings are similar to a study performed in Africa.[8]

This study identified potential opportunities to improve the prevention and early management of head injury in a resource-limited setting. It is shown that the mechanism of injury varies geographically with RTAs common in the cities and assaults in the rural area. This gives a hint how to tailor our prevention mechanisms based on the epidemiology.

Prehospital care was also shown to be inadequate with suboptimal vital sign management in the ambulances. This gives a substantial feedback to improve our prehospital care because mortality was related to vital sign derangements. Ambulances should be equipped with well-trained paramedics team and emergency medical equipment. Primary trauma care training given to paramedics in Iraq showed a significant improvement in mortality rates.[26]

Because taxis were also commonly used for transportation to the hospital, it will be worthwhile to train taxi drivers how to handle patients with trauma and life-threatening conditions. This low-cost strategy of emergency medical training for taxi drivers as first responders was shown to be effective in Ghana.[27]

The in-hospital emergency treatment of patients with head injury has its own challenges. Even though there is in-house CT scan in the hospital, it is usually difficult to get emergency CT scan in a timely manner, contributing to the treatment delay. Moreover, ICU beds are very scarce. The total number of ICU beds in the hospital is 12, which should be shared among all critical patients needing ICU treatment. Hence, it is usually difficult to admit all patients with severe head injury to the ICU, making treatment of these patients very difficult.

Easy and timely access of CT scans for patients with head injury should be improved. Further studies should be performed to quantify the time delay to CT scans, and specific measures to shorten time delay should be taken. The capacity of the critical care for patients with neurotrauma should also be expanded. This allows optimal care for patients with severe head injury.

The study has limitations. One of the major limitations is its retrospective nature and the presence of some missed data. For instance, it was difficult to retrieve data about the time delay between trauma and presentation to the hospital. This could have given us very important information on the impact of delay to treatment on the outcome of patients with head injury. Otherwise, the study gives a panoramic view of head injury with its severity, diagnosis, and referral practices.

CONCLUSIONS

Head injury preventive measures should be undertaken to reduce RTAs, assaults, and fall accidents. This should be tailored according to the epidemiologic distribution of causes of head injury in the country.

Prehospital care in Ethiopia should be improved. Mortality from severe head injury at the emergency department is high and significantly associated with preventable causes like vital sign derangement.

This study, moreover, opens an opportunity to perform further studies to see the effect of the triage and referral system of head injuries on their outcome.

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