Patient Related Outcome Measures

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ORIGINAL RESEARCH

Incidence and Predictors of Mortality Among Patients with Traumatic Brain Injury at University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia: A Retrospective Follow-Up Study

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Background: Traumatic brain injury is a major list of health and socioeconomic problems especially in low- and middle-income countries which influences productive age groups. Differences in patient characteristics, socioeconomic status, intensive care unit admission thresholds, health-care systems, and the availability of varying numbers of intensive care unit (ICU) beds among hospitals had shown to be the causes for the variation on the incidence in mortality following traumatic brain injury across different continents. The aim of this study was to assess the incidence and predictors of mortality among patients with traumatic brain injury at University of Gondar Comprehensive Specialized Hospital.

Methods: A retrospective follow-up study was conducted based on chart review and selected patient charts admitted from January, 2017 to January, 2022. Participants in the study were chosen using a simple random sample procedure that was computer generated. Data was entered with epi-data version 4.6 and analyzed using SPSS version 26. Both bivariate and multivariate logistic regression analyses were used, and in multivariate logistic regression analysis, P-value <0.05 with 95% CI was considered statistically significant.

Results: The magnitude of mortality was 28.8%. Most of the injuries were caused by assault followed by road traffic accident (RTA). About 30% of the subjects presented with severe head injuries and epidural hematoma (EDH) followed by skull fracture were the most common diagnoses on admission. The independent predictors of mortality were male sex (AOR: 6.12, CI: 1.82, 20.5), severe class injury with Glasco coma scale (GCS <9) (AOR: 5.96, CI: 2.07, 17.12), intraoperative hypoxia episode (AOR: 10.5, CI: 2.6–42.1), hyperthermia (AOR: 25, CI: 5.54, 115.16), lack of pre-hospital care (AOR: 2.64 CI: 1.6–4.2), abnormal appearance on both eyes (AOR: 13.4, CI: 5.1–34.6), in-hospital hypoxia episode and having extra-cranial concomitant injury were positively associated with mortality, while on admission, systolic blood pressure (SBP) of 100–149 (AOR: 0.086, CI: 0.016–0.46) was negatively associated with mortality.

Conclusion: The overall mortality rate was considerably high. As a result, traumatic brain injury management should be focused on modifiable factors that increase patient mortality, such as on-admission hypotension, a lack of pre-hospital care, post-operative complications, an intraoperative hypoxia episode, and hyperthermia.

Keywords: head injury, mortality, trauma, injury

Introduction

Traumatic brain injury (TBI) is any change in mental or physical functioning as a result of a blow to the head. It can be mild, moderate and severe traumatic brain injury. Falling down accidents (FDA) and road traffic injuries (RTI) are the leading causes of TBI among all age groups, respectively.[1,2] It is a major list of health and socioeconomic problems that has been dubbed a silent epidemic.[3] The World Health Organization (WHO) estimates that more than 10 million people worldwide suffer TBI each year resulting in death or severe disability.[4] Among all trauma-related injuries, brain injuries are considered the greatest contributor to death and disability globally.[5] The incidence of estimated TBI in sub-

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Saharan Africa is 801 per 100,000.[6,7] The TBI is particularly frequent in younger people,[4] and Ethiopia has more than 70 million citizens younger than 30 years of age.[8] The prevalence of TBI in Ethiopia is reported as 29–40%[9–11] and a study done at the University of Gondar Specialized Hospital showed that the prevalence of TBI was reported as 40.5%.[11] Differences in patient characteristics, socioeconomic status, ICU admission thresholds, health-care systems, and the availability of varying numbers of ICU beds among hospitals had shown to be the causes for the variation across different continents.[12]

Studies done in Africa have shown that death rates from head injuries range from 4.2% to 35%.[13–16] The prevalence of death as a result of TBI was 12.8% and 16.9%.[17,18] Besides, the fatality rate of THI relative to total injured patients had found 22.6% and 30.7%.[16,19] The mortality rates of THI in Ethiopia (Addis Ababa, Hawassa, and Bahir Dar) were 10.3%, 12.7%, and 25.3%, respectively.[20–22]

Absence of pre-hospital care, having extra-cranial damage, lack of neurosurgical intervention, increased age, lower GCS on admission, pupil abnormalities were predictive factors for higher mortality in TBI patients.[21,23–31] Dysautonomia manifested by vital sign variability tend to have poorer outcomes.[18] Hypotension/hypoxia, patients with SBP higher than 149 mmHg or lower than 90 mmHg, on admission arterial oxygen saturation levels lower than 90%, respiratory rate <8 and above 20 breath per minute were recognized as significant variables associated with adverse outcomes following TBI.[18,27,32–34,34] Blood loss of >1000 mL, hospital arrival time delays above 24 hours, providing mechanical ventilation for severe TBI and Hypoglycemia were also found to be the predictors of mortality after TBI.[21,35–38]

Despite the fact of variable magnitude of mortality, there were no studies on the outcome of TBI at the University of Gondar compressive specialized hospital. The aim of this study was to assess the incidence and predictors of mortality among patients with traumatic brain injury at the University of Gondar Comprehensive Specialized Hospital.

Method

Study Design and Period

A retrospective follow-up study was conducted at the University of Gondar Comprehensive Specialized Hospital, Northwest Ethiopia, by reviewing charts of brain injury patients who got care from January 30/2017 to January 30/2022.

Study Area

The study was conducted at the University of Gondar Comprehensive Specialized Hospital, North West Ethiopia. University of Gondar Comprehensive Specialized Hospital is located in the Central Gondar administrative zone, Amhara National Regional state, which is about 750 km northwest of Addis Ababa, the capital city of Ethiopia. It serves more than five million people in the Central Gondar zone and the people of the neighboring zones. It has more than 500 beds and delivers both basic and cutting-edge services at its various units. Trauma sufferers are initially assessed and given resuscitation in the emergency room. In one major theater complex and two minor surgery facilities, the hospital offers general surgical services. In terms of emergency response, the hospital offers trauma care for 24 hours.

Source Population

All adult traumatic brain injury patients who got surgical, intensive and/or supportive care at the University of Gondar Comprehensive Specialized Hospital.

Study Population

All adult traumatic brain injury patients who got surgical, intensive and/or supportive care at the University of Gondar Comprehensive Specialized Hospital from January 30/2017 to January 30/2022.

Inclusion and Exclusion Criteria

Inclusion Criteria

All adult traumatic brain injury patients who got surgical, intensive and/or supportive care at the University of Gondar Comprehensive Specialized Hospital during the study period were included.

Exclusion Criteria

Patients who had pre-existing comorbidity (DM, HTN, asthma, and epilepsy), refused care, and referred to other care center were excluded.

Variables

Independent Variable

Socio-demographic data (age, sex, residence)

Cause of injury (assaults, road traffic injury, fall, pedestrian)

Pre-hospital characteristics (pre-hospital management, time from injury to arrival, concomitant injury)

Clinical characteristics at admission to hospital (GCS, heart rate, respiratory rate, systolic blood pressure, oxygen saturation, pupillary response, number of eye abnormality)

Clinical characteristic during hospital treatment (surgical, post-surgical complications, ICU treatment, mechanical ventilation, systemic hypotension, systemic hypoxia, electrolyte disturbance, hyperthermia)

Dependent Variables

Mortality from traumatic brain injury

Operational Definition

Hypoxia episode: two or more record of pulse oximeter oxygen saturation value <90%.[21]

Hypotension episode: systolic blood pressure value <90 mmHg measured at any time point during hospitalization, including the hospital arrival value.[18]

Hyperthermia: body temperature ≥38°C during hospitalization.[39]

Pre-hospital management: any documented intervention from the referral paper and/or documented history by the primary clinician.[40]

Post-operative complication: Adverse events such as pneumonia, meningitis, wound infection, postoperative wound dehiscence, reoperation occur as a consequence of tissue injury due to surgery or anesthesia, following Surgery and Anesthesia.[41]

Unfavorable outcome: is the mortality/death following TBI.

Sample Size and Sampling Procedure

Sample Size Determination

The actual sample size for the study was determined by using single population proportion formula, by taking the magnitude of mortality from a study from Addis Ababa, Ethiopia, case-specific mortality for severe associated ASDH reported 54.1%.[35]

Formula for single population proportion, $n = (Z\alpha/2)^2\rho(1-\rho)/(\varepsilon)^2$

Where n = Initial estimated sample size

Z = Confidence level (alpha, α); α=95%; $Z\alpha/2 = 1.96$

ρ = proportion; $\rho = 0.541$, from previous study

ε= marginal error;$\varepsilon = 5\%$.

$$\mathrm{n} = \frac{(1.96)^2 * 0.541(1-0.541)}{(0.05)^2}$$

$$\mathrm{n} = 381.57 \approx 382$$

By adding 10% (39 patient charts) non-response rate; the final sample size was 421.

Sampling Procedures

The participant's data files having the diagnosis of TBI on the emergency and/or operation room registration books have been listed by their registration ID number. Then after obtaining the list, the medical record numbers of the patients were entered into Microsoft Excel 2010 and the sampling frame was prepared based on random numbers. Study participants were selected using a computer-generated simple random sampling method from the sampling frame of 4803 patients' chart by medical record numbers to obtain a sample of 464 (43 for pretest and 421 for main study) (Figure 1).

Data Collection Procedure and Data Quality Control

Data Collection Procedure

A semi-structured questionnaire was prepared by the principal investigator for all patients who fulfill the inclusion criteria. The data was extracted from the patient's record (log book), patient history chart, anesthesia record sheet and operation notes using a data extraction tool for the occurrence of the event.

The question list contained demographic characteristics of patients, injury characteristics, clinical findings, vital signs on admission, length of hospital stay, surgical intervention, amount of blood loss and transfusion, perioperative vital sign conditions, and body temperature value (Annex I).

Data Quality Control

A pre-test of the data collection tool has been done on 10% (43 patient charts) of participants and pre-tested respondents who have complete and/or accepted range study variables were also included in the main study. After the pre-test, the questionnaire was modified by excluding those variables that were not feasible to access.

The collected data has been checked for completeness, accuracy, and clarity by the principal investigator. Training was given to a data collector for half a day on how to use the data collection tools and how to collect data from a patient's record. Finally, prior to analysis, data were cleaned up and cross-checked.

Data Processing and Analysis Procedures

After completion of data collection, the data was coded, entered, and cleaned for errors using Epi-data software (version 4.6). Then, the data was exported into SPSS (version 26) for analysis. The normality of data was tested by using the Shapiro–Wilk normality test. Non-normally distributed data were presented as median ± IQR, and categorical data as count and percentage. Before computing logistic regression, a cross-tabulation was performed to identify whether the variables fulfilled the assumption for bivariate logistic regression. In the bivariate regression, predictor variables with a p-value of <0.2 were fitted

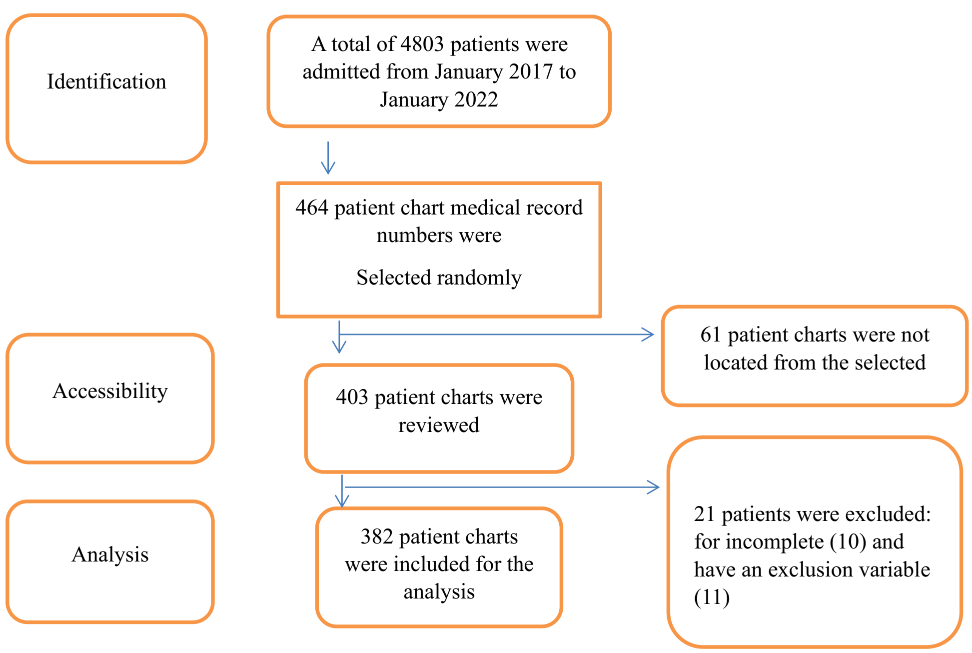

Figure 1 Diagram illustrating data collection procedure among traumatic brain injury patients admitted to University of Gondar Comprehensive Specialized Hospital from January 2017 to January 2022.

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for multivariate logistic regression. The model fitness was checked by using Hosmer and Lemeshow's goodness-of-fit test. In multivariate logistic regression, p-value < 0.05 at 95% CI has been considered as statistically significant.

Result

Socio-Demographic Characteristics

Out of 421 patient charts, a total of 382 having complete data were included in this study, with a response rate of 90.7%. Most of the study participants were males, with a male-to-female ratio of 6.6:1. The most affected age group (79%) was those ranging from 19 to 40 years old, and admission from rural residences accounted for 81.2% of study participants (Table 1).

Pattern of Admission of TBI Patients

The most common cause of TBI on admission was assault, with 222 (58.1%) cases. The other causes were RTA, FDI and pedestrian, respectively (Table 2).

Computed tomography scans were obtained for 231 (60.5%) patients. The most common diagnosis seen was epidural hematoma 77 (33.3%), followed by skull fractures 71 (18.6%). Concerning TBI severity, about 30% of the subjects presented with severe TBI (Table 3).

About half 190 (49.7%) of patients had received pre-hospital management. Time from injury to arrival has been ≤24 hour in 229 (59.94%) of the patient. The majority of the study subjects 161 (42.15%) presented with blunt brain injury cases were presented with associated extra-cranial injuries (Table 4).

About 96 (25.1%) of individuals exposed to hypoxia (SPO_2 <90%) (Table 5). About 122 (31.9%) of patients were admitted to ICU and 85 (22.3%) of them had received mechanical ventilation. Around 135 (35.3%) patients were having electrolyte disturbance (Table 6).

Table 1 Socio-Demographic Characteristics of Traumatic Brain Injury Patients Admitted to University of Gondar Comprehensive Specialized Hospital from January 2017 to January 2022, Gondar, Northwest Ethiopia

Variable	Category	Frequency	Percent
Age	19–40	302	79.1
	41–64	68	17.8
	65^{+}	12	3.1
Sex	Male	332	86.9
	Female	50	13.1
Residence	Rural	310	81.2
	Urban	72	18.8

Table 2 Cause of Injury with Mortality from Traumatic Brain Injury at UOGCSH from 2017 to 2022

Variables	Category	Outcome		Total
		Not died N (%)	Died N (%)	N (%)
Cause of injury	RTA	54 (67.5)	26 (32.5)	80 (20.9)
	FDI	33 (63.5)	19 (36.5)	52 (13.6)
	Assault	162 (73)	60 (27)	222 (58.1)
	Pedestrian	23 (82.1)	5 (17.9)	28 (7.3)

Table 3 The Severity of TBI and Its Diagnosis by Computed Tomography Scans Among Patients Admitted to UOGCSH from January 2017 to January 2022, Gondar, Northwest Ethiopia

Variables	Category	Frequency	Percentage
Diagnosis by CT scan	Epidural hematoma	77	33.5
	Skull fractures	71	18.6
	Subdural hematomas	18	4.7
	Contusion	12	3.1
	Intracerebral hemorrhage	6	1.6
	Others	47	12.3
Severity of TBI	Mild	178	46.6
	Moderate	89	23.3
	Sever	115	30.1

Table 4 On Admission Injury Characteristics of Traumatic Brain Injury Patients Admitted to UOGCSH from January 2017 to January 2022, Gondar, Northwest Ethiopia

Variable	Category	Frequency	Percent
Pre-hospital management	Yes	190	49.7
	No	192	50.3
Time from injury to arrival	≤24	229	59.94
	> 24	153	40.05
Concomitant injury	Yes	161	42.15
	No	221	57.85

Magnitude of Mortality from TBI

The incidence of mortality from traumatic brain injury was 28.8% (CI = 27.3–29.7). About 272 (71.2%) of patients were discharged from the hospital with median ± IQR of 5 ± 2–12.

Factors Affecting Patient's Mortality

Bivariate logistic regression analysis showed that sex, having concomitant extra-cranial injury, lack of pre-hospital management, patients' condition at presentation (SBP, HR, SpO2, abnormal pupillary reaction), GCS at presentation, having operative management, post-operative complication, hypotension episode during hospitalization, intraoperative hypoxia episode, blood loss above 1000 mL, in-hospital hypoxia episode, in-hospital hypotension episode, and hyperthermia during hospital stay were found to be statistically significant at 95% CI.

When these variables were tested at multivariate logistic regression, being male, having concomitant extra-cranial injury, lack of pre-hospital management, patients' condition at presentation SBP, low GCS level, number of abnormal pupils, intraoperative hypoxia episode, having post-operative complication, and hyperthermia during hospital stay were found to be statistically significant with p-value < 0.05 at 95% CI.

The odds of mortality had 6.12 times higher in males than females (AOR: 6.12, 95% CI: 1.82–20.5). The odds of death in concomitant injured patients had around two times as compared to those without concomitant injury (AOR: 2.08, 95% CI: 1.28–3.38).

The odds of death for patients who lack pre-hospital management were 2.64 times higher as compared to those who had been managed in the pre-hospital setting (AOR: 2.64; 95% CI: 1.6–4.3).

The odds of death had 5.9 times (AOR: 5.9;95% CI: 2.07–17.12) higher in low GCS[3–8] than higher GCS level.[13–15] The odds of mortality for a patient with SBP of 100–149 mm Hg had 91.4% (AOR: 0.086, 95% CI: 0.016–0.46) lower compared with patients having SBP of <100 and >149 mmHg.

Table 5 On Admission Baseline Clinical Characteristics of Traumatic Brain Injury Patients Admitted to UOGCSH from January 2017 to January 2022, Gondar, Northwest Ethiopia

Variables	Category	Frequency	Percent (%)
GCS	3–8 9–12 13–15	115 89 178	30.1 23.3 46.6
HR	<60 60–89 90–99 ≥100	94 171 32 85	24.6 44.8 8.4 22.3
RR	<10 10–20 >20	19 254 109	5 66.5 28.5
SBP	<90 90–99 100–149 ≥150	27 29 300 26	7.1 7.6 78.5 6.8
SpO2	>94 90–94 <90	106 119 96	27.7 31.2 25.1
Pupillary response Number of eye abnormality	Normal Abnormal One Two	117 265 173 92	30.6 69.4 45.3 24.1

Table 6 In Hospital Clinical Management Related Characteristics and Mortality of Traumatic Brain Injury Patients Admitted to UOGCSH from January 2017 to January 2022, Gondar, Northwest Ethiopia

Variables	Category	Frequency	Percentages
Operative management	Yes No	252 130	66 34
IN hospital hypotension episode	Yes No	263 119	68.8 31.2
In hospital hypoxia episode	Yes No	218 162	57.1 42.4
ICU Admission	Yes No	122 260	31.9 68.1
Mechanically ventilated	Yes No	85 297	22.3 77.7
Electrolyte disturbance	Yes No	135 240	35.3 64

Patients with pupillary abnormalities in both eyes had 13.34 (AOR: 13.34,95% CI: 5.1–34.6) times the odds of mortality as compared with those with no documented pupil abnormality. The odds of death among patients with hypoxic episodes intra-operatively were 10.5 times higher as compared to no hypoxia episodes (AOR: 10.5; 95% CI: 2.6–42.1).

Table 7 Bivariate and Multivariate Logistic Regression Showing the Factors Associated with Mortality Among Patients Admitted to UOGCSH from January 2017 to January 2022

Variables	Category	Outcome		OR (95% CI) and p-value			
		Not died	Died	P-value	COR (95% CI)	P-value	AOR(95% CI)
Sex	Male Female	225 47	107 3	0.001	7.4 (2.26–24.5) 1	0.003	6.12 (1.82–20.5)* 1
Pre hospital management	Yes No	158 114	32 78	 0.001	1 3.38 (2.1–5.4)	 0.001	1 2.64 (1.6–4.2)**
Concomitant injury	Yes No	94 176	66 44	0.001	2.8 (1.7–4.4) 1	0.003	2.08 (1.28–3.38)* 1
Admission GCS	3–8 9–12 13–15	41 71 160	74 18 18	0.001 0.025	16 (8.6–29.7) 2.25 (1.1–4.5) 1	0.001 0.54	5.9 (2.07–17.12)** 1.41 (0.46–4.3) 1
Admission SBP	<90 90–99 100–149 >149	6 18 228 11	21 11 63 15	0.122 0.145 0.001	2.5 (0.7–8.4) 0.44 (0.151.32) 0.2 (0.089–0.46) 1	 0.27 0.004	 0.27 (0.03–2.86) 0.086 (0.016–0.46)* 1
Number of pupillary abnormality	One Two	141 28	33 68	 0.001	1 9.7 (5.44–17.5)	 0.001	1 13.34(5.1–34.6)**
Intraoperative hypoxia episode	<90 90–94 >94	67 26 119	35 – 3	0.001 0.998	20.72 (6.13–69.9) 1	0.001 0.98	10.499 (2.6–42.1)** 1
Post-operative complication	Yes No	104 108	40 16	0.003	2.59 (1.37–4.92) 1	0.037	4.89 (1.1–25)* 1
In hospital hyperthermia	Yes No	62 210	45 65	0.001	2.34 (1.46–3.76) 1	0.001	25.2 (5.54–115.16)** 1

Notes: Statistical significance on multivariate analysis: *p < 0.05; **p < 0.001.
Abbreviations: AOR, adjusted odds ratio; COR, crude odds ratio; CI, confidence interval.

The odds of death had 25.2 (AOR: 25.2,95% CI: 5.54–115.16) time higher in patients with hyperthermia than normothermia. The odds of mortality had 4.98 (AOR: 4.89,95% CI: 1.1–25) times higher in patients with postoperative complication than without postoperative complications (Table 7).

Discussion

The aim of the current study was to assess the incidence and predictors of mortality among patients with traumatic brain injury at the University of Gondar Comprehensive Specialized Hospital. Determining the clinical outcomes following TBI and identifying the predictors can help as the evidence to allocate the resource and to build trauma system infrastructure. Mobilizing resources and infrastructures had improved the patient's outcome following TBI.[42,43]

The overall mortality rate following TBI in this study was 28.8%, which is higher than the overall mortality of 9·6% reported in Kampala[44] and studies in Addis Ababa, Hawassa, and Bahir Dar, Ethiopia.[20–22] In contrast, it is lower than a study done in Tanzania and France which reported as 30.7% and 49% mortality, respectively,[16,45] and studies done in Africa as reported that death rates from head injury range from 30% to 35%.[13–16] The possible reason for the difference, those as in Mulago, only included patients who were referred to the neurosurgery department, but the current study included all patients who were admitted to the hospital with TBI. Additionally, this might be explained by a lack of cerebral injury diagnostic tools, limited transportation, minimal ICU access, and a significant distance to the closest neurosurgical center, which may all contribute to the study's apparent variation in mortality. Low mortality rate compared with above studies could be also due to variation in leading causes of TBI. In this study, the most common cause of TBI on admission was assault followed by RTA, FDI and pedestrian, respectively. A study had found that TBI caused by assault was associated with better outcomes than the rest.[46–48]

Our study demonstrated that there was a statistically significant association between death and male sex, lack of pre-hospital management, extra-cranial concomitant injury, lower admission SBP, lower GCS, pupillary abnormality on presentation, intraoperative hypoxia episode, hyperthermia, and postoperative complications in patients with TBI.

Our finding demonstrated that being male sex is highly associated with in hospital mortality. In contrary to this, studies stated that females had poorer prognosis compared to males.[49,50] Other studies have stated that there is no proven relationship between sexual orientation.[25,26,28,30] A possible explanation for this discrepancy in our study is that, the number of participants in male gender was much higher than females.

Studies demonstrated that there is no significant association between the pre-hospital care provided and the risk of mortality.[51] In contrast, another retrospective study demonstrated less mortality had found when pre-hospital care was offered.[52] This study is in line with our finding which stated that patient groups without pre-hospital management resulted in higher mortality.

We identified that having extra-cranial concomitant injury was associated with increased mortality in THI as compared to those without concomitant injury. Consistent with this, having extra-cranial concomitant damage is thought to be a predictive factor for higher mortality in TBI, according to a collaborative investigation of a large number of TBI patients.[24] Extra-cranial concurrent damage was found to not only considerably increase mortality but also serve as a standalone predictor of mortality in TBI patients.[53] However, a study had demonstrated that having an associated extra-cranial concomitant injury was not associated with an increase in mortality of TBI patients.[54] The disparate results would be explained by in our study the extra-cranial injured groups have more severe head injury intensity when compared to those without concurrent injury.

Our study demonstrated that there was a statistically significant association between death and patient clinical conditions like hypotension, hypoxia. Other investigators likewise yielded comparable outcomes as hypotension and hypoxia following TBI was recognized as significant secondary insults associated with adverse outcomes.[27,32,33]

Studies done on the effect of vital signs on mortality of TBI stated that patients with SBP higher than 149 mmHg or lower than 90 mmHg had poor outcomes.[18,34] On admission, arterial oxygen saturation lower than 90% and an intraoperative arterial oxygen hypoxia episode was associated with death.[55] Our clinical prediction in this study demonstrates the same result as studies done before on the basis of those variables, though no contradiction ideas in this regard were found to the extent of the investigators' knowledge. Therefore, patients' chances of survival are considerably increased by prompt diagnosis and intensive resuscitation during the patient's first golden hour of arrival.[18,34]

According to the findings, there is strong evidence for the prognostic value of the GCS on admission and mortality from TBI.[18,25,27–29] Studies showed that lower GCS on admission was associated with more unfavorable outcomes.[25,28–30] As far as we have found in the literature, all authors agree with a reverse association between GCS and mortality from TBI.[56] Our clinical prediction in this study demonstrates the same result as studies done before on the basis of GCS level on admission.

Our study demonstrated that there was a statistically significant association between death and the number of nonappearance or irregular pupillary responses and mortality in TBI. In line with this, there were conditions between nonappearance or irregular pupillary responses and associated with devastating outcomes following TBI.[25,27,29] The possible explanation for this was explained as pupil abnormalities were noted more frequently in patients with severe class injuries such as compressed cisterns, and brain structure shift.[31]

Studies demonstrated that patients who were exposed to hyperthermia in the perioperative period had a higher risk of mortality compared to normothermic.[21,39] In line with this, our study showed that the odds of death among patients who were exposed to hyperthermia were higher as compared with normothermic patients. This finding is in agreement with another study.[57] This could be since hyperthermia increases brain metabolic demand, ICP, and cell damage.[39] Furthermore, hyperthermia may increase the stress level of the patient, resulting in increased cardiac output and blood pressure, which may increase cerebral blood flow, especially under conditions of impaired pressure autoregulation.[58]

In our study, we found that the risk of death among patients with intraoperative hypoxia episode was higher as compared with patients without hypoxia episode. This finding was consistent with the previous studies done in Tikur Anbessa Specialized Hospital and University Teaching Hospital of Kigali.[20,59]

In this study, having postoperative complications along with head injury was associated with mortality. This is in line with studies from other LMICs, which have shown comparable extents of mild and moderate TBI with unfavorable results indeed, with post-operative courses of complications.[43] Furthermore, having postoperative complications was highly associated with mortality, as reported by a study done in Addis Ababa, Ethiopia.[2] This is more explained by more physiological disturbance and brain nutrient requirement, which may result in bad outcome in case of traumatic head injury with postoperative complication.[43]

Strength and Limitations of the Study

This study is the first of its type in the study area, with the largest center in Northwest Ethiopia and with the probability of being generalized.

While being the largest center, it was vulnerable to the problems seen in observational study designs with a retrospective data. Some of the prognostic variables were not accessible for analysis in this investigation since the data was not initially documented for the purposes of this study. We did not have data about patients who died before admission, those referred to other centers, and those discharged with morbidity. Besides, we merely used GCS for diagnosing severity of TBI.

Conclusion

There was a high mortality of TBI patients as compared with studies done in the country. Severe brain injury having low admission GCS score, lack of pre-hospital care, having post-operative complication, male sex, having concomitant extra-cranial trauma, systemic factors like admission systolic blood pressure above/below 100–149mmhg, having two pupillary abnormality, intraoperative hypoxia episode and in hospital hyperthermia remain statistically significant association with higher TBI-related mortality.

Recommendation

Strengthening the pre-hospital services system will greatly impact patient outcomes of traumatic brain injured patients. In-hospital, prompt care should be instituted for already established cases, particularly those at risk of unfavorable outcome (death) in cases with low level of consciousness (GCS < 9), extra-cranial concomitant injuries, post-operative complications, and vital sign instability. Furthermore, prioritizing those measured vital parameter instabilities (such as SBP, SpO2, and body temperature) during immediate and ongoing hospital management may aid in prognosis and improve patient outcome.

For future researchers, prospective study designs to incorporate all possible prognostic variables with possible pre-hospital and referred patient outcome studies are recommended.

Abbreviations

ASDH, Acute Subdural Hematoma; BGL, Blood Glucose Level; CT, Computerized Tomography; EDH, Epidural Hematoma; FDI, Fall down injury; GCS, Glasgow Coma Scale/Score; ICU, Intensive Care Unit; LMIC, Low and Middle Income Country; MV, Mechanical Ventilator; PR, Pulse Rate; RR, Respiratory Rate; RTA, Road Traffic Accident; SBP, Systolic Blood Pressure; SDH, Subdural Hematoma; SpO2, Oxygen Saturation; TBI, Traumatic Brain Injury; THI, Traumatic Head Injury; UOGCSH, University of Gondar Comprehensive Specialized Hospital; WHO, World Health Organization.

Data Sharing Statement

Data for this study are available on request.

Ethical Approval

Ethical approval for this study has been received from the institutional review board of School of medicine, College of medicine and health science, University of Gondar with reference number of 1267/2022. The ethics committee approved this study to not need consent from the study participants because of the retrospective nature of data and a support letter has been obtained from the medical director office of the hospital for retrieving retrospective data from the database and records. All the information was kept confidential, and no individual identifiers were collected. We have confirmed that our study complies with the Declaration of Helsinki.

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Author Contributions

All authors made a significant contribution to the work reported, whether in the conception, study design, execution, acquisition of data, analysis and interpretation, or in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed to be accountable on the journal to which the article has been submitted.

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Disclosure

The authors report no conflicts of interest in this work.

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