Assessment of the Prognostic Value of Helsinki Computer Tomography Score in Severe Traumatic Brain Injury Patients at Kenyatta National Hospital in Kenya

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Abstract

Background: Head injury is usually considered as a silent epidemic conferring high mortality and disability worldwide. In the early assessment of patients with head injury, the computer tomography is of utmost importance and millions of Computed tomography (CT) scans are conducted yearly. These CT scans contain information which can be used to determine the patient's prognosis. The Helsinki computer tomography scoring classification was created in 2014 as a tool for determining outcomes in those patients with traumatic brain injury. The Helsinki computer tomography score being the latest in the armamentarium of outcome predictors and having outperformed previous CT scoring system in the European and Asian subcontinent, it will be necessary to assess its capacity to predict outcome in the African subcontinent on severe traumatic brain injury patients. **Objectives:** To assess the prognostic value of the Helsinki Computer Tomography score among patients with severe traumatic brain injury (TBI).**Study Design:** Prospective observational study. **Setting** – The Emergency Department and Critical care unit, Kenyatta National Hospital. **Subjects** – Forty two patients with severe TBI. **Results** - There was a higher male preponderance at 90% (*n*=38). Mean age for patients with severe TBI was 33 years old with an overall mortality of 64.3%.The Helsinki CT score of 4 had mortality of 33.3% while Helsinki score of 11 had mortality of 100%. Patients with contusions and intracerebral hematomas had mortality of 80% while in acute subdural hematoma and extradural hematoma the mortality were 53.8% and 44.4% respectively. Helsinki CT score was significantly associated with GOS at 6 weeks (p=0.004) and death (p=0.009). The specificity, sensitivity and accuracy for Helsinki CT score for mortality were 88.9%, 53.3% and 71% respectively; and for an unfavorable outcome, these values were 81.8%, 55.6% and 69% respectively. The odds ratio for the Helsinki CT score to predict mortality and unfavorable outcome was 9.1(95% CI 1.9-44) and 5.6(95% CI 1.2-27.4) respectively. **Conclusion** – Severe TBI carries a high mortality and disability in Kenya. The initial Helsinki CT score is significant predictor of outcome.

Introduction

Traumatic brain injury is considered as a global burden hence it is important to determine a classification that correctly diagnoses and accurately predict its outcome. Masson et al (1)in his study on epidemiology of severe brain injury found an incidence of 17.3 per 100,000 population. It is critical for clinicians to assess patients' prognoses in order to develop treatment plans. The Glasgow coma scale (GCS) gives clinical data, but it is limited in its ability to detect structural brain abnormalities. Furthermore, the GCS can be prone to errors in individuals who are inebriated, sedated, or intubated. Biochemical indicators and Intracranial pressure (ICP) monitors (2) are other methods utilized in affluent nations, but these are expensive and not frequently available in public hospitals in developing countries. Because it is easily available and less time-consuming, a computer tomography scan of the brain is a frequent form of study utilized to evaluate structural brain disorders during emergencies. Several CT categorization systems are already available to predict prognosis and classify TBI patients. Currently, no study has been conducted to assess the utility of the Helsinki CT scoring system in the African subcontinent. The goal of this study was to determine the prognostic value of the Helsinki CT scoring system in severe TBI patients presenting at Kenyatta National Hospital, as well as the correlation between clinical parameters such as GCS, pupillary reaction, blood pressure, age, and extracranial injuries on their outcome at 6 weeks after injury. Because resources are scarce in low-income countries like Kenya, and most public hospitals have few intensive care unit beds, it is critical to direct available resources to patients who are likely to survive. Table 1 shows the Helsinki CT scale.

Table 1: Helsinki CT Scale

Variable	Description	Points
Hematoma type	a) Acute Subdural hematoma b) Contusion(s)/Intracerebral c) Epidural hematoma	2 points 2 points -3 points
Hematoma >25 cc	a) Yes b) No	2 points 0 point
IVH present	a) Yes b) No	2 points 0 point
Suprasellar cisterns	a) Normal b) Compressed c) Obliterated	0 point 1 point 5 points

Materials & Methods

This was a prospective observational study of severe TBI patients admitted to the Critical Care Unit/Intensive Care Unit at Kenyatta National Hospital after initial assessment and resuscitation at the Accident and Emergency Department (KNH). The study was conducted between October 2019 and January 2020, and included all patients over the age of 18, with severe traumatic brain injury (GCS of < 8), and who had informed consent obtained from relatives or guardians. Ethical approval

was granted by the KNH-UON Ethics and Research Committee (P747/08/2019).

Using the Fishers' formula, a sample size of 36 patients was calculated. Throughout the procedure, patient anonymity was maintained. The use of serial numbers on the questionnaires prevented duplication. The study population was recruited through consecutive sampling. The investigator interviewed the patient's guardian to get a history of clinical presentation, physically examined the patient, and used the study questionnaire to document both clinical parameters and radiological imaging findings. At the two-week and six-week follow-up visits, the investigator noted the Glasgow outcome scale score. The provided data was processed using Statistical Package for Social sciences (SPSS) version 23.0.

Study variables – The independent variable included demographic, clinical parameters and the Helsinki CT score. Patient characteristics were summarized using the clinical parameters of age, GCS, pupillary reactivity, blood pressure, blood glucose level and extra cranial injuries, and presented as means or proportioned for continuous and categorical variables respectively. The Glasgow outcome score (GOS) was dichotomized as unfavourable (grade I – III) and favourable (IV and V). Association of GOS with extra cranial injuries, blood pressure, blood glucose level, pupillary reactivity, GCS and the initial Helsinki score were done. Logistic regression analysis was used to determine the independent predictors of outcome. Receiver-operator characteristic (ROC) curve was drawn for sensitivity and specificity and Area Under the Curve (AUC) values were calculated. Confidence interval was calculated at 95% for sensitivity and specificity to determine the level of precision. All statistical tests were conducted at a 5% level of significance.

Results

Demographic and clinical parameters

A total of 42 patients were recruited, with a male to female ratio of 9:1. The mean age was 33 years (range 18-100 years). The overall mortality rate was 64.3%. Severe TBI was prevalent in people aged 21 to 50 years. All patients under the age of 20 survived with good outcomes, however all patients beyond the age of 50 years died. Table 2 below summarizes this information.

Road traffic accident (RTA) was the commonest mode of severe TBI at 64%. The mortality among those involved in falls from height was the highest at 100% followed by road traffic accident at 66.7%. This is shown on Table 2.

The most prevalent pupillary finding was slow reacting pupil, which was observed in 27 (64%) of the patients, followed by non reactive pupil in 15 (36%) of the patients. Anisocoria was seen in 19 (45%) of the patients. Among those with anisocoria there were 11(57.9%) patients who died. The non-reactive pupil group had the highest death rate, followed by the delayed reacting pupil group, with 67% and 63%, respectively.

Hypotension (systolic blood pressure less than 90 mmHg) was detected in 5% of patients, however none died. Patients with a random blood sugar of more than 10 mmol/l accounted for 8% of the total, and their fatality rate was 87.5%. Extracranial injuries were found in 18 of the patients, with 66.7% of

them dying. Limb fractures were the most common extracranial injury, while individuals with abdominal injuries had the greatest fatality rate.This is shown in Figure 1 and 2.

Table 1: Distribution by Age and Mortality

AGE (Years)	Number of patients	No of dead	% Mortality
18-20	5 (12%)	0	0
21-30	15 (36%)	10	66.67
31-40	13 (31%)	10	76.92
41-50	6 (14%)	4	66.67
51-60	3 (7%)	3	100.00
60+	0 (0%)	0	0
TOTAL	42 (100%)	27	64.29%

Table 2: Cause of Injury with Mortality

Cause of injury	Number of patients	No of dead	% mortality
Assault	11 (26%)	5	45.45
Others (fall)	4 (10%)	4	100.00
RTA	27 (64%)	18	66.67
Total	**42 (100%)**	**27**	**64.29**

Figure 1: Extra cranial Injury Distribution

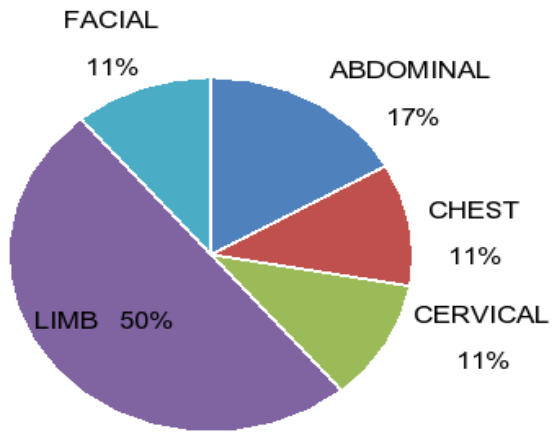
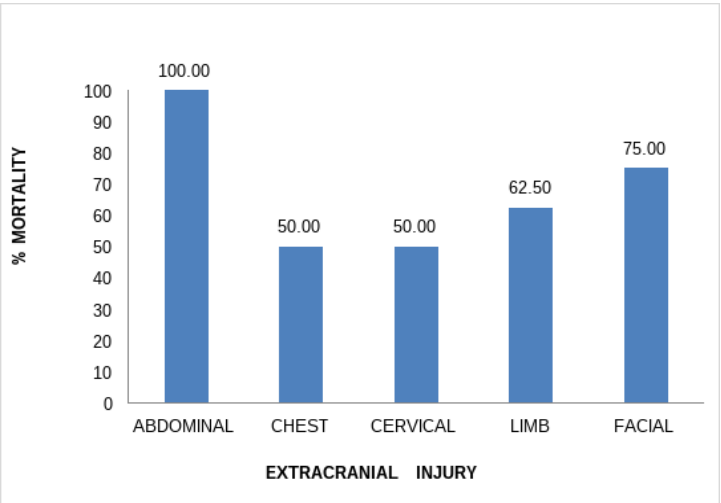


Figure 2: Extra cranial Injury and Mortality



Patients with GCS 7-8 accounted for 23 patients (55%), GCS 5-6 for 16 patients(33%) and GCS 3-4 for 3 patients(7%). As GCS improved, the mortality reduced. This is shown in Figure 3.

The most common intracranial bleed among severe TBI patients was contusions and ICH. The highest mortality was recorded in the group of contusions and ICH at 80%.This is shown in Table 3.

Figure 3: Post-Resuscitation Glasgow Coma Scale and Mortality

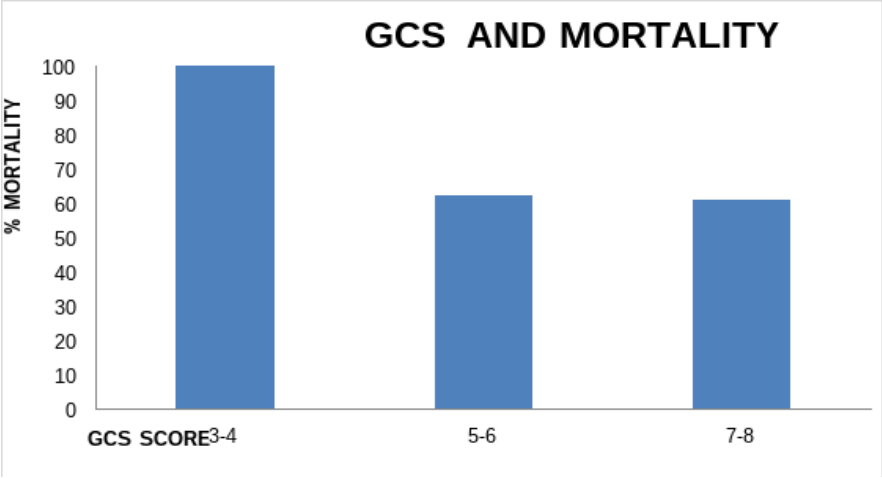


Table 3: Patterns of Intracranial Bleed and Mortality

TYPE OF LESION	NO OF PATIENTS	NO OF DEAD	% MORTALITY
ASDH	13 (31%)	7	53.85
CONTUSION/ICH	20 (48%)	16	80.00
EDH	9 (21%)	4	44.44
TOTAL	42	27	

The largest group of patients constituted with Helsinki score of 9(15 out of 42 patients) with mortality of 66.7%. Patients with a Helsinki score of 4 had mortality of 33.3% while Helsinki score of 11 had mortality of 100%.This is shown in Figure 4.

Only two individuals died beyond six weeks, while the majority of deaths (25 out of 27) happened before two weeks. At 2 weeks, 25 patients had died (GOS 1), 7 had a persistent vegetative state (GOS 2), and 9 had severe disability (GOS 3), with only 1 patient (2.4%) having a favorable prognosis (GOS 4-5). At 6 weeks, 33 patients (78.6%) had bad outcomes (GOS 1-3), while 9 patients (21.4%) had good outcomes (GOS 4-5). This is illustrated in Figure 5.

Figure 4: Helsinki Score and Mortality

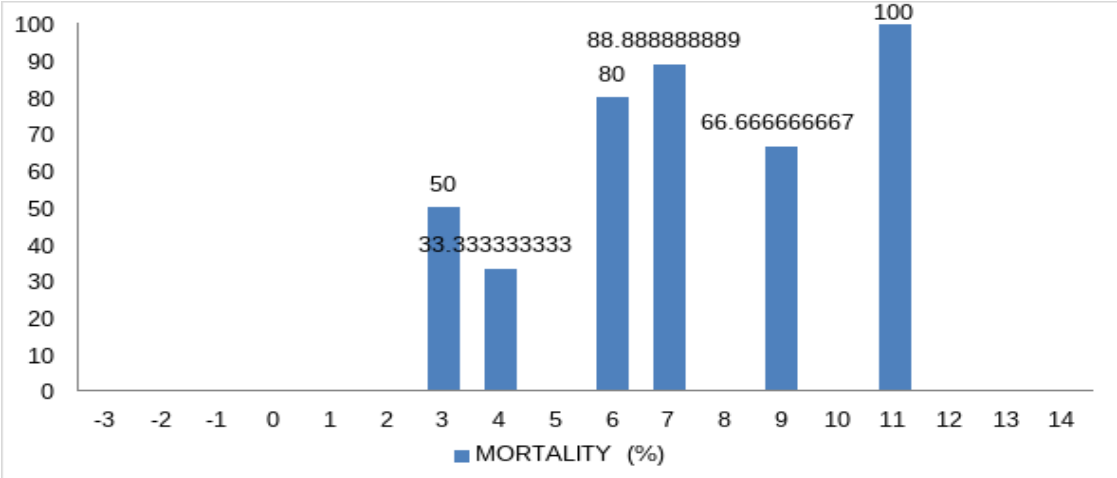
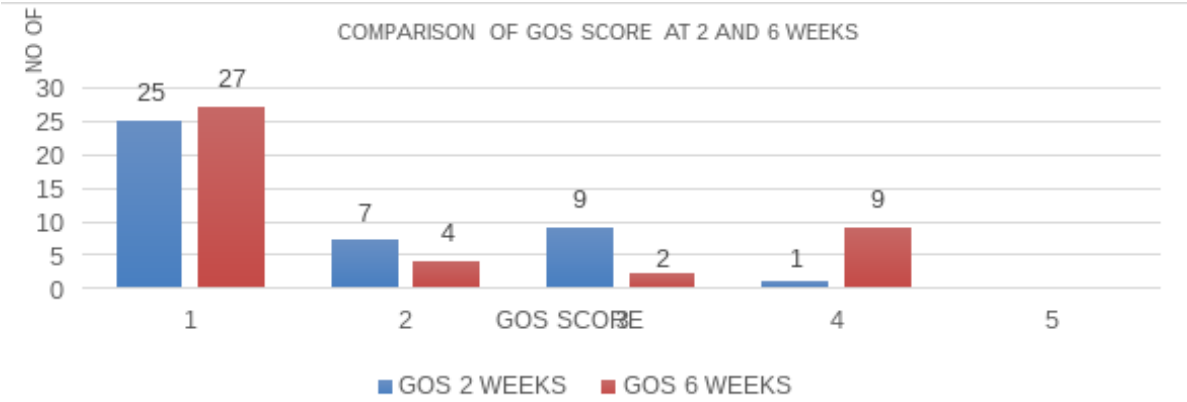


Figure 5: Comparison of Glasgow Outcome Score at 2 Weeks and 6 Weeks



Correlation Analysis of GCS, Helsinki Score on Outcome

The number of patients who had favorable outcomes increased as the GCS score increased. GCS 3-4 had no favorable results, whereas GCS 7-8 had 30.4 % favorable outcomes (Figure 6).

At 6 weeks, patients with a Helsinki score of 2 had 100% favorable results, while those with a Helsinki score of 11 had no favorable outcomes. The proportion of patients with favorable outcomes decreases as the Helsinki score rose. The outcome worsened from 33% to 100% as the Helsinki score increased from 4 to 11 (Figure 7).

Using the Spearman's correlation analysis, we found that the Helsinki score was significantly associated with GOS at 6 weeks (p=0.004), and death (p=0.009). There was no significant association between the Helsinki score and GOS at 2 weeks (p=1.000). The GCS was not significantly associated with GOS at 2 weeks (p=1.000), GOS at 6 weeks (p=0.332) and death(p=0.687). This is illustrated in Table 4.

The other variables that were analyzed are sex, age, systolic blood pressure, random blood sugar, and pupillary reflexes. Their correlation analysis is shown in Table 5.

Figure 6: Comparison of GCS with GOS at 6 Weeks

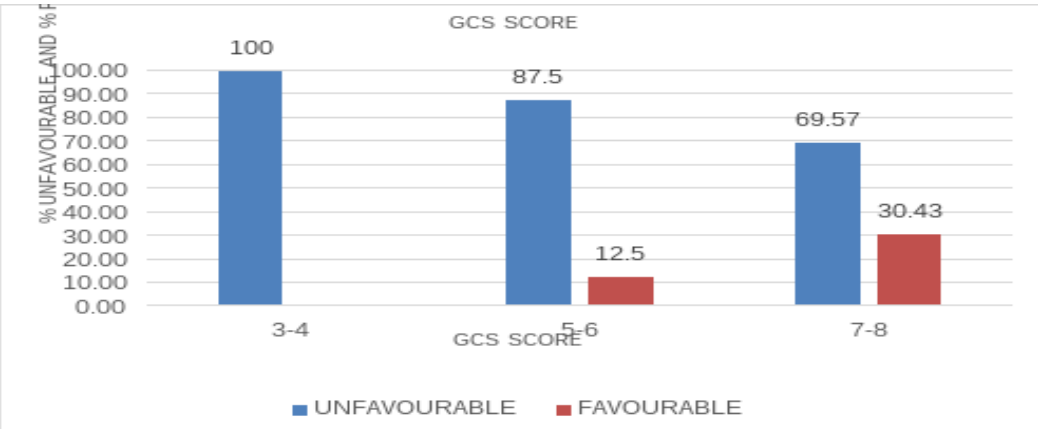


Figure 7: Comparison of Helsinki Score and GOS At 6 Weeks

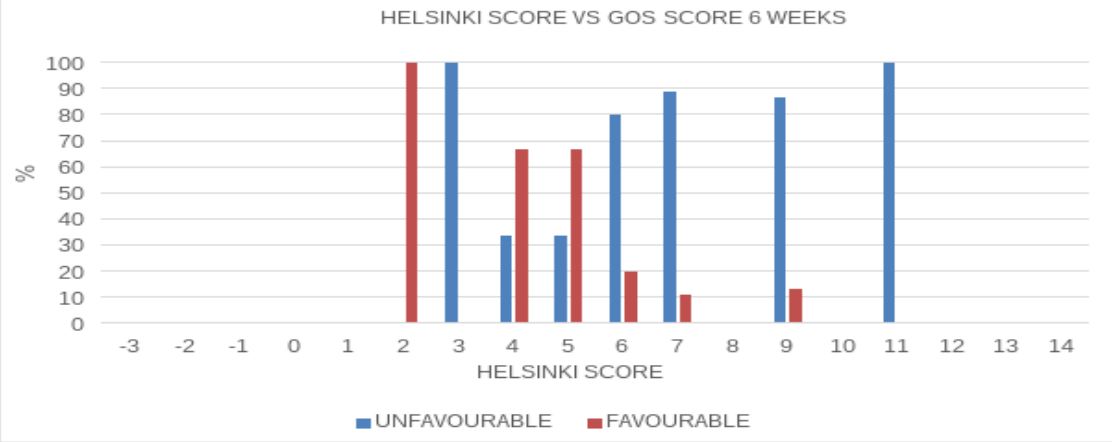


Table 4: Analysis of Helsinki Score, GCS Score and Outcome

	P value		
	GOS (2 WEEKS)	**GOS (6 WEEKS)**	**DEATH**
Helsinki score	1.000	**0.004***	**0.009***
GCS	1.000	0.332	0.687

*. Significant association (p value < 0.05)

Table 5: Summary of P Values For Variables And Outcome

	Sex	Age	Systolic BP	Random Blood Sugar	Anisocoria	GCS	Helsinki Score
GOS (6 Weeks)	1.00	**0.030**	0.210	0.210	0.362	0.332	**0.004**
Mortality	1.00	**0.020**	**0.043**	0.234	0.432	0.687	**0.009**

Receiver-operating characteristics curve analysis was done to evaluate the performance of the Helsinki score by determining the area under the curve value. This yielded AUC value of 0.69 for unfavourable outcome (moderate discrimination power) and AUC value of 0.71 for mortality (moderate discrimination power) at Helsinki score between 6 to 14. The specificity, sensitivity and accuracy for Helsinki score for mortality were 88.9%, 53.3% and 71% respectively; and for an unfavourable outcome, these values were 81.8%, 55.6% and 69% respectively (table 16). After performing logistic regression analysis to determine the predictors of outcome, we found that the odds ratio (OR) for the Helsinki score to predict mortality to be 9.1(95% CI 1.9-44) and unfavourable outcome at 5.6(95% CI 1.2-27.4).This is shown in Table 6.

Table 6: Summary of Analysis of Helsinki Score

	Specificity	Sensitivity	Auc	Odds Ratio	P Value
Mortality	88.9%	53.3%	0.71	9.1	0.009
Unfavourable Outcome	81.8%	55.6%	0.69	5.6	0.038

DISCUSSION

Severe TBI is a debilitating disease that causes a high mortality and disability. Many studies have been carried out to determine variables that could predict outcome[4,5,6,7]. In this study male was mostly affected with severe TBI and sex of patient was not statistically significant in predicting outcome. The most frequent cause of severe TBI was road traffic accident followed by assaults and falls which was similar to the findings by Andriessen et al[8].The overall mortality was higher compared to previous study at 64.2% and the average number of days of mortality from time of injury was 3.7 days.

Severe TBI was found to be more prevalent among the age group between 21 and 40 years (7% of total) and the mean age was 33 years as compared to previous study[8] where the mean age was 46 years. Older patients of age more than 50 years carried a worse outcome with mortality of 100%. Age was found to be statistically significant on mortality and GOS at 6 weeks.

Since its conception in 1974 by Teasdale and Jennet[9], GCS has been found to be a strong outcome predictor in TBI[5,10]. However it may be affected by presence of facial swelling, alcohol intoxication, sedation and paralysis[11,12]. In this study an improving GCS was associated with a reduction in mortality similar to the study by Quigley et al[13]. Favourable outcome were present in GCS 5-6

and 7-8 at 12.5% and 30.4% respectively at 6 weeks period. Though the GCS was not statistically significant for 6 weeks GOS and mortality in this study it remains a strong outcome predictor. This could be attributed to our smaller sample size.

Several studies have shown that hyperglycemia is commonly present in the early phase following TBI and is associated with poor outcome[14,15,16,17]. In this study we found a mortality of 87.5% among patients with hyperglycemia.In contrast to the study by Chestnut et al[18] who found hypotension associated with higher mortality,this study did not record any mortality among hypotensive patients. But there wasa mortality of 67.5% among patients with SBP> 100 mmHg similar to the findings of Barmparas et al[19]. The mean systolic BP shown to predict mortality was 136 mmHg and was statistically significant.

Sarrafzadeh et al[20] showed the impact of extracranial injuries to be more pronounced in minor and moderate TBI and the outcome to be attributed to the primary brain injury rather than the presence of extracranial injuries in severe TBI. In this study patients with significant extracranial injury had a mortality of 66.7% and the most common extracranial injury was limb fracture followed by facial fracture.

Pupillary reaction is considered to be a useful outcome predictor in traumatic brain injury. In this study, 64% of patient had slow reacting pupil with a resultant mortality of 63% and non reactive pupil was 36% with mortality of 67%. Anisocoria was present in 45.2% of patients was not statistically significant in predicting mortality and GOS at 6 weeks. Maas et al[6] highlighted the prognostic impact of patterns of intracranial hemorrhage on outcome following TBI. This study found that mortality was highest in the group of contusions and intracerebral hematomas followed by ASDH and EDH.

Delays between time of injury to undergo surgical intervention for severe TBI are highly correlated with poor outcomes. Previous studies[21,22] have found mortality to be thrice as much in those patients whose surgeries took place 2 to 4 hours after initial trauma. This study found an average time to surgery from time of injury to be 12 hours and those who underwent surgery the mortality was 60%.We also found that 57% of patient were referred from another facility and only 2.3% of them were intubated on arrival and presented more than 8 hours after injury.

The Helsinki CT scoring classification[3] comprises of six attributes ASDH, ICH, EDH, IVH, the volume of the lesion and the status of the suprasellar cisterns. The total score range from -3 to 14.Previous study[3] has found the Helsinki CT score to predict mortality from 3% to 79% and unfavourable outcome from 7% to 94% among TBI patients. In this study we found the Helsinki score to predict mortality and unfavourable outcome at 6 weeks to range from 33% to 100% among severe TBI patients. An increasing Helsinki score conferred a higher mortality and unfavourable outcome. The Helsinki score was significantly associated with mortality and GOS at 6 weeks post injury when compared with GCS. After multivariate logistic regression analysis, the Helsinki score was found to predict mortality with an odds ratio (OR) of 9.1(95% CI 1.9-44) and unfavourable outcome with an odds ratio of 5.6(95% CI 1.2-27.4). The area under the receiver operating characteristic curve analysis yielded an AUC value of 0.71 for mortality and 0.69 for unfavourable outcome. Our study results for AUC were consistent with the studies by Yao et al[23]and by Raj et al[3]. Moreover we also found that the Helsinki CT score has a specificity, sensitivity and

accuracy for mortality at 88.9%, 53.3% and 71% respectively; and for unfavourable outcome at 81.8%, 55.6% and 69% respectively.

Conclusion

Severe traumatic brain injury is a frequent source of mortality and acquired persistent disability among young individuals. It affects more than just the injured person and robs the person of his income per year to sustain a family. The patients often require neuro-intensive care which is expensive in developing countries and burdens the health care resources. A significant proportion of patients (35.7%) were still dependent for care at 6 weeks post-injury.

The age of patient, the systolic blood pressure on admission and the initial Helsinki CT score are significant predictors of outcome ($p < 0.05$). The Helsinki CT score correlates well with the clinical parameters at predicting outcome. Hence, a change to new computer tomography scoring system may be warranted and the Helsinki CT score can be used as a predictor of outcome in the African subcontinent.

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