International Mission For Prognosis And Analysis Of Clinical Trials Score For Predicting Outcome In Moderate To Severe Traumatic Brain Injury

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Abstract

Introduction: Traumatic Brain Injury (TBI) is a medical and surgical disease of major importance globally. Prognostic models are useful for making decisions in clinical practice. This study aimed to assess the accuracy of the International Mission for Prognosis and Analysis of Clinical Trials in TBI (IMPACT) score in predicting outcome in moderate to severe TBI in 6 months.

Materials and Methods: All patients admitted to Tribhuvan University Teaching Hospital (TUTH) with moderate to severe TBI from April 2019 to February 2020were included in the study. IMPACT scores (core/extended core/ lab) were recorded separately at admission. Outcome was measured with the Glasgow Outcome Scale (GOS) at the time of discharge and in six months. Correlation between observed and predicted outcomes was evaluated by Pearson's correlation coefficient (r). Sensitivity and specificity were plotted in the receiver-operating characteristic (ROC)curve, and the area under the curve (AUC) was calculated to determine the discrimination ability of this prognostic model.

Results: A total of 139 patients were enrolled in the study. Twenty-four (17.3%) patients died within 6 months of TBI, and 40 (28.8%) patients had an unfavorable outcome. The Pearson correlation coefficient showed a good correlation between observed and predicted outcomes. The ROC curve indicated that all 3 models could accurately discriminate between favorable and unfavorable outcomes, as well as between survival and mortality (unfavorable outcome AUC= 0.905, 0.940, 0.955; mortality AUC= 0.875, 0.914, 0.917 respectively) in our patient population.

Conclusions: The IMPACT score is a good prognostic model to predict 6-month outcomes in moderate to severe TBI at admission in the Nepalese patient population.

Keywords: Glasgow outcome score, prognostic model, prognosis, traumatic brain injury

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INTRODUCTION

Traumatic brain injury (TBI) is often referred to as the "silent epidemic", and represents the greatest contributor to death and disability globally among all trauma-related injuries.[1,2]The global incidence rate of TBI is estimated at 939 cases per 100,000 people per year. In comparison to other parts of the Globe, Southeast Asia has the highest overall burden of TBI.[1]

Considering the high mortality due to TBI as well as the high costs of inpatient and long-term treatment, outcome prediction has been a big concern. Accurate prognostication can help with justifiable transfer to neurosurgical specialist services as well as in the early management of the individual patient. Prognostic models may also be useful as tools to compare outcomes across institutions, healthcare systems, and countries, and may be an essential part of the planning of new studies in the field of brain injury.[3]

After the publication of the Glasgow Coma Scale by Teasdale and Jennett in 1974, prognostication for patients with TBI became easier.[4] To overcome this, several prognostic models have been proposed, each with its advantages and disadvantages. A systematic review published in 2006 identified 53 reports, which included a total of 102 models, but their quality was mostly poor.[5,6]

Against this background arises the International Mission for Prognosis and Analysis of Clinical Trials in TBI (IMPACT). Steyerberg et al. in 2008 developed a prognostic model (IMPACT score) based on admission characteristics to predict the risk of 6-month mortality and unfavorable outcomes in patients with moderate to severe TBI, which includes:[7]

IMPACT Core (Age, motor response, and pupillary reactivity)

IMPACT Extended Core (As above, with additional information on secondary insults (hypoxia and hypotension) and CT scan characteristics (Marshall CT classification, traumatic subarachnoid hemorrhage, and epidural hematoma)

IMPACT Lab: As for the extended model with additional lab parameters (glucose and hemoglobin levels)

Materials and Methods

This is a prospective observational study conducted at the Department of Neurosurgery, Tribhuvan University Teaching Hospital, Kathmandu, Nepal. Ethical approval was taken from the Institutional Review Committee (IRC) before the commencement of the study. All patients ≥16 years of age and admitted within 48 hours of injury with the diagnosis of moderate to severe TBI were included in the study. The patients with do not resuscitate (DNR) status, post cardiopulmonary (CPR) status, pregnancy, and polytrauma were excluded from the study. All the patients were followed up regularly for 6 months, and the GOS was recorded and analyzed, and correlated with the IMPACT score.

Collected data was analyzed with SPSS version 21. Pearson's correlation coefficient was used to correlate observed and predicted outcomes. Sensitivity and specificity were calculated for the diagnostic accuracy of the IMPACT score and plotted in the ROC, and the AUC was calculated to determine the discrimination ability of the score. Calibration between observed and predicted outcomes was done with Hosmer-Lemeshow goodness-of-fit. P-value <0.05 was considered statistically significant.

RESULTS

There were a total of 150 cases eligible to participate during the study period. Five were excluded (four with DNR status and one a pregnant lady). Out of 145 patients enrolled, six were lost to follow-up. Hence, 139 patients were finally included for final analysis.One hundred (71.9%) patients had moderate and 39 (28.1%) had severe TBI. The age range was 18-81 years (median 38 years). Most of the patients belonged to the age group 20-29 years (33.1%). There were 112 males and 27 females (M: F = 4.2:1). The most common mode of TBI in our study was a fall from height (46.8%), followed by RTA (42.8%). Seventy-nine (56.6%) patients were managed conservatively, whereas 60 (43.2%) underwent surgery.

Table 1 summarizes patient characteristics on admission based on different IMPACT prognostic models.

Table 1. Patient characteristics on admission by the IMPACT score

IMPACT Core	Age, median (IQR)	38 (26-50)
	Motor score, n (%)	**139 (100)**
	Obeys	48 (34.5)
	Localizes	62 (44.6)
	Normal flexion	15 (10.8)
	Abnormal flexion	8 (5.8)
	None/ extension	6 (4.3)
	Pupils, n (%)	139 (100)
	Both reaction	105 (75.5)
	One reaction	19 (13.7)
	One reaction	19 (13.7)
IMPACT Extended Core	No reaction	15 (10.8)
	Hypoxia, n (%)	31 (22.3)
	Hypotension, n (%)	13 (9.4)
	CT classification, n (%)	139 (100)
	II	25 (17.9)
	III	38 (27.4)
	IV	16 (11.5)
	V	60 (43.2)
	Traumatic SAH on CT, n (%)	61 (43.9)
	Epidural hematoma on CT, n (%)	27 (19.4)
	Glucose, median (IQR), mmol/l	6.8 (5.8-8.0)
IMPACT Lab	Hemoglobin, median (IQR), g/dl	12(11-13)

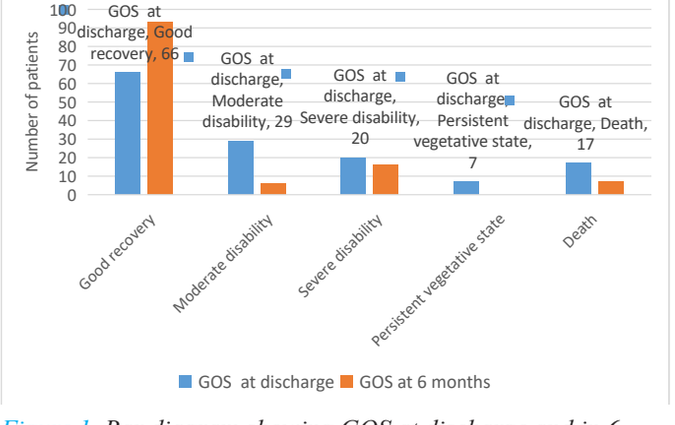

Figure 1. Bar diagram showing GOS at discharge and in 6 months

As shown in Figure 1, the number of patients with good outcomes increased from 66 at discharge to 93 in 6 months. Patients with moderate disability decreased from 29 at discharge to six in 6 months. Similarly, the number of patients with severe disability decreased from 20 at discharge to 16 in 6 months. At discharge, seven patients were in a persistent vegetative state (PVS), whereas in 6 months, none were in PVS. Unfavorable outcome at discharge was 44 (31.7%), and in six months, 40 (28.8%). In-hospital mortality was noted in 17(12.2%) patients, and in 6 months, this number moved to 24 (17.3%).

As shown in Table 2, there is a good linear correlation between the predicted IMPACT score with GOS in 6 months. The observed values and those predicted by all these models of IMPACT score have a strong statistically significant correlation with a p-value of <0.001.

Table 2. Correlation between IMPACT score and GOS

Score	Unfavorable outcome (6months)	Mortality (6months)	P- value
IMPACT core			
Pearson's Correlation (r)	**0.932**	**0.935**	**<0.001**
IMPACT extended			
Pearson's Correlation (r)	0.927	0.939	<0.001
IMPACT lab			
Pearson's Correlation (r)	0.935	0.946	<0.001

The Hosmer Lemeshow test showed good model fit for IMPACT core, IMPACT extended, and IMPACT lab scores in diagnosing mortality and unfavorable outcome in six months, as p-value was >0.05, as shown in Table 3.

Table 3. Hosmer Lemeshow test for various IMPACT scores

Score	Unfavorable outcome	Mortality	
IMPACT core	**p=0.690**	**p=0.614**	
IMPACT extended core	p=0.756	p=0.430	
IMPACT lab	p=0.858	p=0.919	

For unfavorable outcome, the AUC was 0.905 (95% CI, 0.841-0.968) for IMPACT core,0.940 (95% CI, 0.897-0.983) for IMPACT extended core, and 0.955 (95% CI, 0.920-0.990) for IMPACT lab (Figure 2). For mortality, the AUC was 0.875 (95% CI, 0.755-0.954) for IMPACT core,0.914 (95% CI, 0.861-0.968) for IMPACT extended core, and 0.917 (95% CI, 0.866-0.967) for IMPACT lab (Figure 3).

This suggests a good discriminatory ability of the three models in predicting unfavorable outcomes and mortality. However, there are no significant differences in predictive performance between the model iterations.

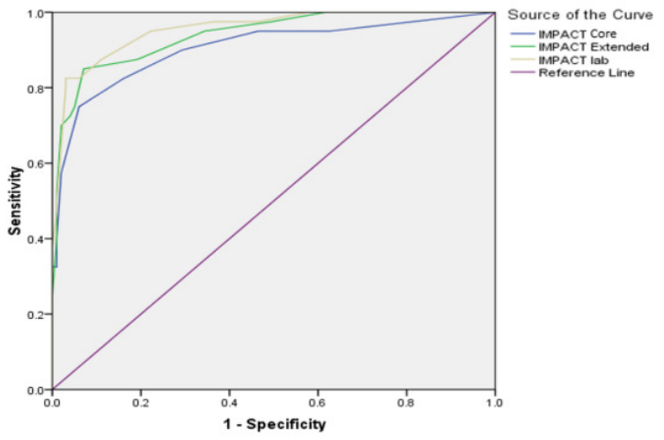

Figure 2. Receiver operating characteristic (ROC) curve for unfavorable outcome in 6 months

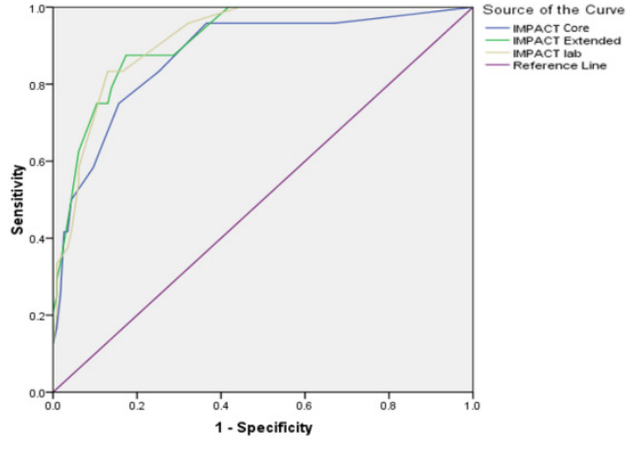

Figure 3. Receiver operating characteristic (ROC) curve for mortality in 6 months

DISCUSSION

Decision-making in taking care of critically ill and often unstable patients is aided by good prognostic models. This helps to decide on the rational use of the resources, as well as informing the family regarding the prognosis at the earliest. Therefore, prognostic models like the IMPACT score are extremely useful in this regard. However, this should be regarded as complementary but not as a replacement for clinical judgment.

The IMPACT model was developed as a tool to estimate the absolute risk of unfavorable neurologic outcome and mortality in 6 months in patients with moderate to severe TBI. In this prospective validation study from our center, all iterations of the IMPACT model demonstrated good prediction of both 6-month unfavorable neurologic outcome and mortality. The overall unfavorable outcome and mortality observed in our study were 28.8% and 17.3% respectively. This is consistent with the study done by Egea-Guerrero et al., which showed unfavorable outcomes and mortality of 25.5% and 16.2% respectively, in patients with moderate to severe TBI.[8] In a study done by Panczykowski et al. in a cohort of severe

TBI patients, 73% had an unfavorable outcome and 41% had mortality in 6months.[9]Another study by Han et al. on a similar patient population showed an unfavorable outcome of 71.0% and mortality of 47.7%.[10] However, in the study by Olivecrona et al., the unfavorable outcome and mortality were much lower (45.8 % and 14.6 % respectively) even in patients with severe TBI.[11] The inconsistency among various studies could be due to a heterogeneous patient population. Our study is directly comparable to the study by Egea-Guerrero et al. in a cohort of the Spanish population.

The ROC curves were used to determine the discrimination ability of the score. The overall predictive performances of IMPACT scores were good in our study which corroborates well the results from Lingsma et al., Raj et al., and Egea-Guerrero et al.[12,13,8] Of all successful three models, it is the IMPACT lab model that has the greatest capacity to discriminate between favorable and unfavorable outcomes as well as survival and mortality in our study though it didn't reach to the point of statistical significance. The superiority of the IMPACT lab model is a consequence of the inclusion of more variables into the model, as explained above.

The Hosmer Lemeshow calibration plot showed good model fit for IMPACT core, IMPACT extended, and IMPACT lab scores in diagnosing mortality and unfavorable outcome in six months ($p > 0.05$), similar to the study by Egea-Guerrero et al. and Lingsma et al.[8,12] However, only IMPACT lab showed good model fit in the study conducted by Raj et al.[13]

To aid in predicting outcomes and guiding clinical management, numerous studies have investigated the role of various biomarkers as prognostic tools in TBI.[14-22]All these studies highlight the clear need for reliable prognostic tools in TBI management. This is a single-center study conducted in an urban-based tertiary care hospital with a follow-up period of only up to six months. Moreover, there is room for doing a larger study with a bigger sample size to further refine the predictive ability of this IMPACT model.

CONCLUSION

The IMPACT score is a good prognostic tool to predict 6-month outcomes in moderate to severe TBI based on characteristics at admission in the Nepalese patient population. Among the three IMPACT models, IMPACT lab has the greatest discriminating ability. Further multicenter studies involving a larger sample size will better clarify the predictive ability of the IMPACT score.

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